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C12T/C11T — Kirk's Current Tx XII/XI Bonagura 1995/92
Cat — Cat Dz & Clinical Management:2 Sherding 1994
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Derm — Sm An Medical Diagnosis:2 Lorenz 1993
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D-CT — Current Vet Dermatology Griffin 1993
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D-VC — V C of N A - Dermatology DeBoer 1990
D-Sy — K9 & Fe Dermatology: Syndrome Nesbit 1983
E-hb — Pocket Companion to Ettinger Ettinger 95
E — Textbook of Vet Internal Med:4 Ettinger 1995
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F3IM/F2IM — Feline Internal Med:3/2 August 1997/94
F-N — Feline Practice Norsworthy 1993
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GI-S — Strombeck's Gastroenteritis:3 Guilford 1996
H3B/H2B — Handbook of Exotic:3/2 Morgan 1997/1992
H-F — Canine & Feline Cardiology Fox 1988
H-T/M — Manual of K9 & Fe Cardiology:2 Miller 1995
H-T — Essential of Electrocardiology:3 Tilley 1992
H-Pic — Color Atlas of Vet Cardiology Darke 1996
I-A — Atlas of Ophthalmology Walde 1990
I-D — Magrane's K9 Ophthalmology:4 Helper 1989
I-G — Vet Ophthalmology:2 Gelatt 1991
I-hb — Manual of Ophthalmology Wyman 1986
I-P — Atlas of Vet Ophthalmology Barnett 1990
I-S — Fundamentals of Vet. Ophthal:2 Slatter 1990
IM-WW — Sm An Internal Med:2/1 Nelson 1998/1992
I2M/M — Small Animal Internal Med Shaw 1997
Inf — Manual of Infectious Dzs Baroudy 1988
Inf-G — Infectious Dzs Greene 1990
Lab-S — Laboratory Profiles of Dzs Sodikoff 1995
Lab-C — Vet Clinical Pathology:4 Coles 1986
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NS-L — VetNeurosn & Clin Neuro:2 deLahunta 1983
NS3hb/NS-hb — Handbook of Neuro:2/3 Oliver 1993
NS-K — Neurologic Disorders Kornegay 1986
NS-O — Vet Neurology Oliver 1987
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NS-W — Manual of Neurology:2 Wheeler 1995
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Pa-T/Pa — Thompson's Spec Vet Path:2 Carlton 1995
Pyo-C — Textbook of Vet Pituitary Cunningham 1992
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R-R — Vet Obstetrics & Genital:3 Roberts 1986
R&E-F — K9 & Fe Endo & Repro:2 Feldman 1996
R&E-M — Vet Endo & Repro:4 McDonald 1989
SAM — Small Animal Medicine Allen 1991
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Sx4B/Sx3B — Current Techniq in Sx:4/3 Bojrab 96/90
Sx-G — Atlas of General Sm An Sx Caywood 1989
Sx-OD — Guide to K9 Orthopedic Sx:2 Denny 1985
Sx-OL — Leonard's Orthopedic Sx Alexander 1985
Sx-OP — B. P & Fin's HB of Ortho:3 Piermattei 1997
Sx-S — Textbook of Sm An Sx:2 Slatter 1993
Sx-S-hb — Pocket Compendion to Slatter Slatter 1995
Sx-WW — Small Animal Sx Harari 1996
Sx-A — Canine Sx:2 Slatter 1974
Tox — Clin & Diag Vet Toxicology Oswaller 1996
Tox-WW — Toxicology Oswaller 1996
PP/USA/C — Poison Plants - USA/Canada Kingsbury 1964
PP/M, /O, /A — Poisonous Plants/Mountns, Ok or Al
X-RP — Radiol Technq in Vet Prac:2 Ticer 1984
X-P — Radiographic Interpretation Owens 1982
X3T/X2T — Textbook of Diag. Rad/3/2 Thrall 1998/94
X-Gr — Atlas of Rad Anatomy Schebiz 1986

Condition

References: See page ii

Facts/Cause: important information (cause, pathophysiology, Hx (history), transmission, etc.)

Presentation/CS: clinical signs that can be visualized from a distance, or that an owner might report

Diagnosis: CS, palpation, auscultation, lab tests, radiographs, postmortem, etc.

Treatment

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Antifreeze toxicity M8k 2035; E-hb 162; SAP 803; H2B 1330; 5min 572; IM-WW 330; IM 482, 756; IM-WW 330; Tox 49, 54, 398 ★★	• **Car radiator antifreeze** • Fall & spring when radiators are drained • **Tastes sweet!** • Oxidized by liver alcohol dehydrogenase - Severe renal tubule necrosis . Azotemia in 36-72 hours (dog), 12-24 hrs (cat)	• **Acute (< 12 hrs) stage 1** **- Like alcohol intoxication** - Trembling of convulsions - Vomiting, nausea - Anorexia, PU/PD - Labored breathing - Ataxia, Depression - Coma/Death • Stage 2: 12-24 hours - Nondescript - seems to be recovering • Stage 3: 24-72 hours **- Renal signs** (uremia) . Severe depression . Oliguria/anuria . Anorexia & vomiting . Oral ulcers (common) . Death • Sequela: **Acute renal failure**	• **Hx (antifreeze)**, CS • Urinalysis - Proteinuria - **Ca oxalate** crystals - Hematuria - Isosthenuric (1.010) • Blood values - ↑ BUN, creatinine - Stress leukogram • Ultrasound: hyperechoic kidney - Dystrophic calcification • Necropsy: birefringent crystals on impression smears of kidney - polarized light **DDx:** • Other causes of acute renal failure • Ketoacidotic diabetes mellitus • Pancreatitis • Gastroenteritis • Garbage intoxication • CNS disorders	• **Medical emergency** • If w/in 6 hours - Induce emesis, gastric lavage - Activated charcoal • **20% Ethanol IV** (vodka or the like) • ***4-methylpyrazole** (4-MP) • Supportive care: Prevention: • Use new antifreezes that don't contain ethylene glycol • Proper disposal of ethylene glycol Prognosis: • **Poor if renal failure**

Antifreeze - Deadly
CS: Drunk, Uremia
Dx: Hx, CS, UA (Oxalate crystals)
Tx: Emergency - 20% Ethanol IV, 4-MP

Prevalence (how often you expect to see)

****	Very common (once a week)
***	Common (once a month)
**	Uncommon (once a year)
*	Rare (once a lifetime)
†	Exotic (must travel to foreign country)

Summary Box: Key words

DDx: Differential diagnosis

Prognosis (Px): Success Rate		
Excellent	90-100%	(95%)
Good	65-89%	(75%)
Guarded	35-64%	(50%)
Poor	11-34%	(25%)
Grave	1-10%	(5%)

Page Setup

an example

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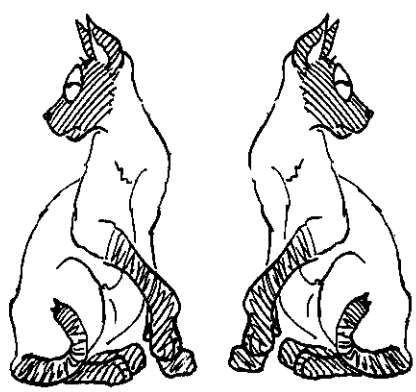
DDx



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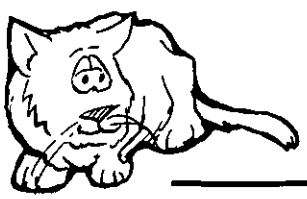
To *Suzy*

the Love of my life, wife and partner in making books



Tschauner's Guide to Small Animal Clinics

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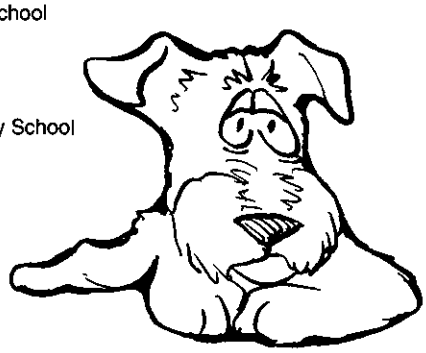

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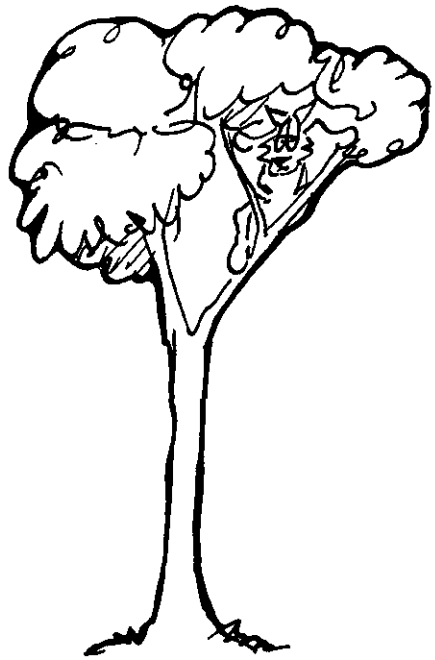

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Sx-S	Textbook of Small Animal Surgery - 2nd edition. D Slatter. WB Saunders Co. 1993
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X3T/X2T	Textbook of Veterinary Diagnostic Radiology - 3rd/2nd edition. DE Thrall. WB Saunders Co. 1998/1994
X-Gr	Atlas of Radiology Anatomy of the Dog & Cat. H Schebitz, H Wilkens. WB Saunders/Paul Parley Pub 1986

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INTRODUCTION

Tschauner's Mini-Guide to Small Animal Clinics is a quick reference guide for veterinarians and veterinary students.

Fashioned after Heidi Tschauner's ***Senior Veterinary Student's Guide to Small Animal Clinics*** and a direct continuation of the ***Guide to Bovine Clinics, Guide to Equine Clinics*** *and* ***Guide to Equine Lameness***, it helps quick assessment of cases until a more thorough reference can be located. This is not meant to replace other texts, but encourage veterinarians & students to read something for every case and to use other references by keying each condition to commonly used veterinary texts. Except for very generalized conditions of the eye and/or skin, the chapter on the integument (i.e. the eye and dermatology) has been omitted. These two categories have become so specialized that they are books within themselves, hopefully to be completed as such at a later date.

This guide is set up in table form to mimic class notes. The first column gives the "condition" and any synonyms for it. Under the condition's name are the abbreviations and pages where that condition may be found in commonly used veterinary textbooks. The second column, "Facts/Causes", gives pertinent information, incidence, breed predisposition and pathophysiology of the condition. The "Presentation/CS" column outlines how the animal presents with the condition and possible future sequelae. The "Diagnosis" column outlines how to use the history, presenting signs and further procedures to make a diagnosis. The last column, "Treatment", outlines treatment, prevention & prognosis. Differential diagnoses, the key to diagnosis, are highlighted in rounded boxes for most conditions. The box in the lower left briefly summarizes key words from each of the columns to provide a quick handle for each condition.

Stars under the references are rough indications of the prevalence of each condition. Four stars indicates that in a normal clinic you can expect to see the condition at least once a week, whereas one star indicates you may see it only once a lifetime.

Prognosis is divided into Excellent, Good, Guarded, Poor or Grave. These correspond to the percentage of cases that have a favorable outcome. Guarded indicates that roughly half of all cases of a certain condition either has a favorable or unfavorable outcome (i.e, 50/50 chance), thus you must be guarded when giving a prognosis.

Boldface type allows skimming Facts/Causes, Presentation/Clinical signs, Diagnosis and Treatment. More in-depth information is given in lighter print and smaller print. Other texts keyed under the condition allow for quick references; while the cartoons hopefully add life and help page recognition.

The inside of the front cover contains a quick index and Quick References and their abbreviations.

The inside of the back cover has normal laboratory values.

Chris Pasquini

**** *** ** *

Prognosis: success rate

Excellent	90-100%	(95%)
Good	65-89%	(75%)
Guarded	35-64%	(50%)
Poor	11-34%	(25%)
Grave	1-10%	(5%)

Disclaimer: the authors do not assume any responsibility for any results obtained from the procedures, treatment, drugs, and/or dosages used; nor shall the authors be held liable for any misinformation or errors that may have been obtained inadvertently by any persons or organization using this book.

Acknowledgment: Special thanks to the authors of the books to which this guide is keyed. Hopefully the guide will encourage the student to use these more often.

Students - Memory = Notebooks

Students - Welcome to the clinics. This should by far be your most exciting year in veterinary school. If it isn't think about becoming a virology teacher. You have been given and remember all the facts needed to function in this new world of "hands on" medicine(?). It can be terribly confusing. As you move from Equine Medicine rotation to Theriogenology to Radiology to Small Animal Medicine you may lose track of your cases and may wonder whatever happened to "Fido", the schnauzer with anti-freeze poisoning.

Notebooks: My major advice is get two pocket notebooks, a 2.5x4" and a 5.5x8" notebook and write things down. Carry the pocket notebook everywhere and write down instructions the clinician gives you. Give up on trying to impress people with your phenomenal memory, clinicians won't care if you remember 99% of the things they told you, but will be upset if you forget to give an animal its life saving medicine. Write down things that you want to look up. Use the larger notebook for rounds, when, as a group, you talk about the animals everyone is treating. Below is a scheme that I am trying to iron out. Perfect it for your needs or idiosyncrasies or come up with your own scheme.

Number all the pages in the big notebook in the lower outside corner.

Table of contents: While you are waiting for something to happen in the clinic, make a table of contents. On the first page, write page numbers along the left hand side, skipping a line between numbers. Continue this onto the next pages until all the pages in the notebook have two corresponding lines in your table of contents. As you fill out the pages in the notebook, name them after their contents and record them in your table of contents. This will be invaluable as you try to find vital information you wrote in the notebook last week.

Cases: Label the four pages following the table of contents "CASES". As cases are passed out, draw an opened box at the start of a line. Follow this with the case number, animal's name. Later when the diagnosis is made, write it on the same line in bold **BLOCK LETTERS**. This will obviously give you a list of all the cases seen. If you move to another rotation before the animal is discharged, the open box will help you follow the case through (an important thing to do!). Ask the clinician in charge what happened or go look up the chart with the case number. Check the box off when the animal is discharged or necropsied. An open box indicates an unfinished learning experience.

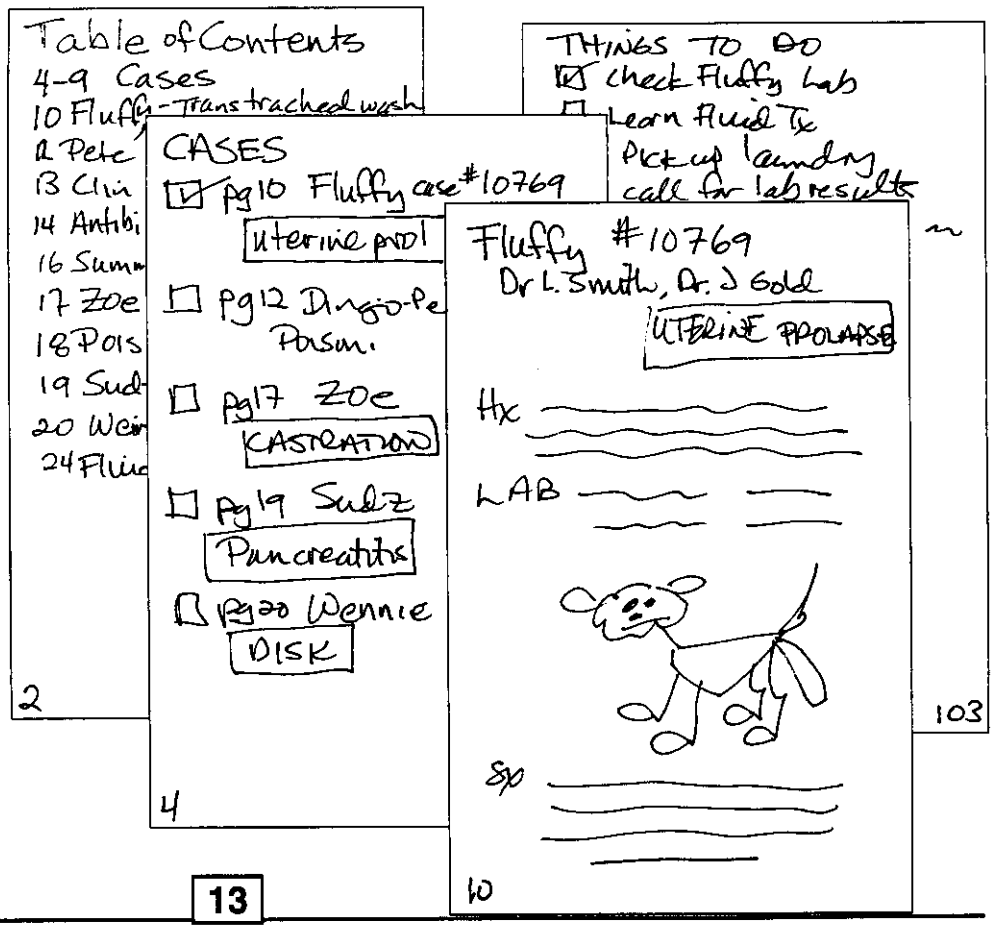
Information, confusion, drugs, cases, etc.: The pages following the CASES pages are for the mass of information that will be coming towards you. For your own case give yourself enough pages to cover it (3 or 4 pages per case). For all cases write the case number, animal's name, owner's name, clinician's name and assigned student. Later write the diagnosis in bold **BLOCK LETTERS** enclosed in a box.

For all cases write down the history, signalment, etc. Be sure to write down all the instructions preceded by open boxes for you to check off as things get done. As you read up on the condition, jot down notes and organize your thinking. Write down things to ask the clinician. As lab data, radiology and other information comes in, write it down. If you run into another case's pages, write: continued on an open page and continue on that page.

Miscellaneous: Fluid therapy, drugs, clin-path, etc. may need to be reviewed. Write down pertinent information for you to use in other cases and put page number in the table of contents.

Things to do! On the last page list the things to remember to do as they come up. Put a box on the left hand side and write down what task to do. When each task gets done, check it off.

Optional: Draw case animals, trying to characterize their clinical signs. These can be stick figures or cartoons. They will help you observe the animal and remember it in the future.



Vaccination Schedules

Cat - Vaccination Schedule

6 weeks
- General physical exam (PE)
- Vaccination: FVRCP-C* SQ†
- Deworm "hooks/rounds" (pyrantel pamoate)
- Health record
- Discuss prophylactic dental care & flea control
- Discuss FeLV

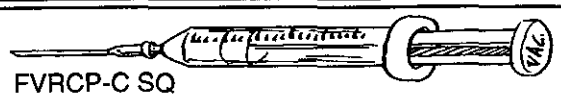
9 weeks
- Vaccination: FVRCP-C SQ
  - Optional: Test FeVL & 1st FeLV vaccination
- Fecal/deworm (pyrantel pamoate)

12 weeks
- Vaccination: FVRCP-C SQ
  - Optional FeLV booster
  - Optional FIP vaccination
- Fecal/deworm (pyrantel pamoate)

*FVRCP-C refers to feline rhinotracheitis virus, calicivirus, parvovirus (panleukopenia) vaccines & may or may not come with Chlamydia psittaci vaccine; FIP: feline infectious peritonitis vaccine; FeLV: feline leukemia virus vaccine: SQ to subcutaneous injection

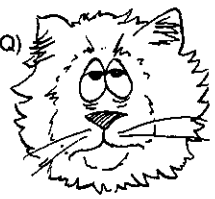
†FVRCP-C SQ: associated with fibrosarcomas (injection sarcomas)

16 weeks



Vaccination: FVRCP-C SQ
- Rabies IM (semimembranosus/semitendinosus) or SQ if appropriate vaccine

Yearly - Cat Health Maintenance



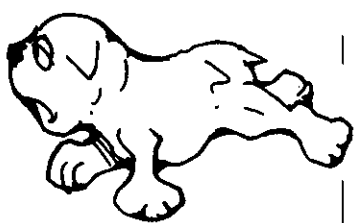
- Vaccination: FVRCP-C SQ*
  Rabies (IM epaxial or hamstrings or SQ)
  Optional: FeLV SQ, FIP SQ
- Fecal/deworm if + and flea control
- General physical exam

1st visit over 16 weeks (never been vaccinated)
- Vaccination: FVRCP-C SQ, Revaccinate in 2 weeks, revaccinate yearly
  Rabies at same time, revaccinate yearly
  Optional: FeLV (2 doses) & FIP
- Deworm/fecal (pyrantel pamoate)

Summary
1st visit between 6-16 weeks
- Vaccination: FVRCP-C SQ every 3-4 weeks until 16 weeks old
  Rabies with the 16 week vaccinations
  Optional: FeLV at 9 weeks & 12 weeks and FIP
- Fecal/deworm (pyrantel pamoate)

Dr. Barbara Buxton,
Oklahoma State Univ. vaccination schedule

Dog - Vaccination Schedule



Under 4 wks
- General physical exam
- DA2MP† (without lepto) SQ

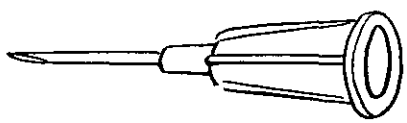
6 weeks
- General physical exam
- Vaccination: DA2PLP* SQ
- Deworm "hooks/rounds" (pyrantel pamoate) ± fecal
- Health record
- Discuss prophylactic dental care & flea control
- Start heartworm prevention

9 weeks
- Vaccination: DA2PLP SQ
- Fecal/deworm (pyrantel pamoate)
- Start heartworm prevention or check dose if started at 6 weeks

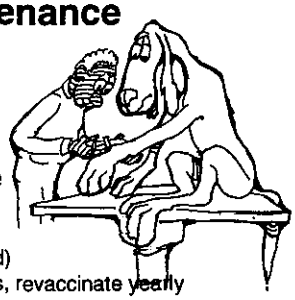
12 weeks
- Vaccination: DA2PLP SQ
- Fecal (check deworming)
- Check heartworm preventative dose

16 weeks
- Vaccination: DA2PLP SQ
  Rabies IM (hamstring muscles) or SQ
- Fecal (check deworming)
- Check heartworm preventative dose

20 weeks
- Rottweilers/Dobermans
  - Vaccination: DA2PLP SQ



Yearly - Dog Health Maintenance



- Vaccination: DA2PLP SQ
  Rabies IM or SQ
- Fecal, deworm if + and flea control
- Heartworm test (Knott's or Occult)
- Check heartworm preventative dose
- General physical exam

1st visit over 16 weeks (never been vaccinated)
- Vaccination.: DA2PLP SQ , repeat in 2 weeks, revaccinate yearly
  Rabies at same time, revaccinate yearly
- Heartworm test/prevention
- Fecal/deworm

Summary
1st visit between 6-16 weeks
- Vaccination.: DA2PLP SQ every 3-4 weeks until 16 weeks old,
  Rabies with the 16 week vaccinations
- Fecal/deworm (pyrantel pamoate)
- Initiate heartworm prevention on or after 9 weeks
  - Check heartworm preventative dose on next vaccination

Contraindication for vaccinations
- Fever - see why sick, vaccine is an extra stress & may not be effective

†DA2MP: refers to distemper, adenovirus type 2 (infectious canine hepatitis), measles, Parainfluenza(?) Parvo

*DA2PL-P: refers to canine distemper, adenovirus type 2 (hepatitis/CAV-2), parainfluenza, leptospirosis, parvovirus

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Lips - Mouth

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Harelip *	• **See Resp pg 120** - Occasionally seen, often associated w/ cleft palate. Tx: Surgically join			
Lip injuries E- hb 433; IM-WW 244; Sx-WW 116, 117 ***	• Commonly from bites or biting an electrical cord • Reattach portions of lips ripped from their normal position to prevent contraction & distortion			
Chronic lip fold dermatitis **Cheilitis** M8k 278; E-hb 433; Mk 125; SAP 348; H2B 334; IM-WW 245; Sx-WW 117 **	• **Chronic moist dermatitis** • Cheilitis: inflammation of lips • Breeds w/ pendulous lips that collect saliva & food - **Spaniels, English Bulldogs, St. Bernards**	• **Noxious odor** • **Drooling from lower lip** • **Pawing at mouth**	• Hx (breed), CS • Physical exam: **inspect lip fold** **DDx:** • Periodontal disease • Uremic halitosis	• **Frequent gentle washing w/ antibacterial soap & water** • **Steroid cream** (antiinflammatory) • Clip hair around fold • **Surgical resection** curative in recurrent cases • Treat coexisting periodontal diz Prognosis: **Good**
Feline eosinophilic granuloma, Labial ulcer, Labial granuloma, Indolent ulcer, **Rodent ulcer** M8k 713; Mk 126, E-hb 434; H3B 305; H2B 951; IM-WW 245; 5min 542; F-N 445; Sx-WW 116, 117; Pa-T 9 **	• **Chronic granulomatous lesion of lip of cats** • **Part of eosinophilic granuloma complex in cats** • Midline or just to side of upper lip • Licking m/ cause to spread: hind-limbs, base of tongue, palate & fauses of oral cavity • Females > males	• **Red, well circumscribed, ulcerated lesions** w/ raised edges • ↑ In size gradually	• Hx, CS • Physical exam • **Biopsy** (chronic ulcerative dermatitis w/ PMNs, plasma cells, mononuclear cells & some eosinophils)	• **Empirical ABs** tried especially in refractory cases (amoxicillin-clavulanate, cefadroxil or enrofloxacin • **Steroids** frequently effective, prednisolone until heals or ethyl prednisolone acetate (SQ q3wk for X3) **Steroids** • **Recurrent lesions:** - Alternate-day oral prednisolone (evenings) or - Repeated methylprednisolone acetate not more frequent than q2mo • **Surgical excision** m/be effective; **but** distorts lip, dehiscence common • **Megestrol acetate** (Ovaban®) has been **effective but not** recommended because of side effects: see Toxicology pg 732 • Other Tx tried: radiotherapy, cryosurgery, laser surgery, mixed bacterial vaccine, immunomodulating drugs • Skin testing & hyposensitization recommended for cats refractory to medical management

Skin, Breeds w/ pendulous lips
CS: Odor, Drooling
Dx: Hx, CS, PE
Tx: Washing, Steroid cream, Surgical resection

Cats, Chronic granuloma
CS: Lip ulcer
Dx: Hx, CS, PE, biopsy
Tx: Steroids

Stomatitis, Glossitis, Gingivitis M8K 279, 136; Mk 127; 5min 72, 160; GI-S 190; H3B 299; H2B 333, E-hb 434; IM 320; IM320; IM-WW245; SAP 622; C12T 568(f); Cat 1123; 1129; Neo 133 **	• **Inflammation of oral mucosa, tongue or gums** • Usually 2° to systemic diz - Localized or generalized • Causes: see box - **Dental plaque #1** - Idiopathic - Infectious dizs (1° or 2°) - Metabolic dizs - Physical/chemical trauma - Drugs & toxins - Immunemediated dizs - Nutritional deficiency • Pathophysiology: unclear, see individual causes	• Variable • **Anorexia** or inappetence • **Excessive salivation** • Exaggerated chewing • **Halitosis** • Dysphagia (difficult swallowing) • Pawing at mouth • Vomiting or retching	• **Hx, CS & PE: tentative** • **Oral exam** - Hyperemia, gingivitis - Oral ulceration & pain • ± Enlarged regional lymph nodes • Hematology: - Leukocytosis - inflam. diz - Anemia - chronic bleeding - Eosinophilia - eosinophilic granuloma • Biochemical: - Renal dlz: ↑ BUN, creatine, phosphorus - Diabetes mellitus: hyperglycemia • Thyroid function • Viral tests (FeLV, FIV & resp. viruses) • Immunological tests • Cytology - fungus • Culture, Gram's stain: seldom diagnostic • Biopsy: differentiate nonspecific inflammation from neoplasia	• **Remove underlying cause** • **Gentle cleansing** if cooperative • **Antiseptic** (chlorhexidine sol.) or **AB-fungicide** (tetracycline-amphotericin B) locally TID - QID • **ABs**: symptomatically to suppress overgrowth • Soft diet & rinse mouth w/ salt solution after eating • ± Metronidazole (Flagyl®) every other week may be helpful • ± Steroid (prednisolone) granulation tissue lesions may respond • Electrocautery or chemical cautery (silver nitrate or phenol) in nonresponsive cases • Parenteral or SQ fluids if not drinking • Pharyngostomy or gastrotomy tube if severely debilitated Prognosis: **guarded to good** for control

DDx:
• Oral neoplasia
• Idiopathic oral diz

Inflammation, Dental plaque #1
CS: Anorexia, Salivation, Halatosis
Dx: CS, PE
Tx: Tx cause, ABs, Diet, Rinse mouth
Px: Guarded to good

Stomatitis - Causes

- **Dental plaque #1**
- Idiopathic
- Infectious dizs (1° or 2°)
  - Bacterial
    - *Fusobacterium fusiformis* - dog
    - *Borrelia vincenti* - dog
    - *Leptospira canicola*
    - *Leptospira icterohemorrhagiae*
    - Bacteroides - cat - Rare?
  - Viral infections
    - Feline calicivirus
    - Viral rhinotracheitis
    - Feline panleukopenia
    - Feline leukemia (FeLV)
    - Feline immunodeficiency (FIV)
    - Canine distemper
  - Mycotic/fungal infections
    - *Candida albicans*
    - *Blastomyces dermatitidis*
    - *Histoplasma capsulatum*
- Metabolic diseases
  - Uremia - #1 systemic diz
  - Diabetes mellitus
  - Hypoparathyroidism
- Physical/chemical trauma
  - Phycogranulomatosis (embedded foreign material)
  - Electric cord bites
  - Caustic substance ingestion
- Drugs & toxins
  - Heavy metals (thallium most common, but rare)
  - Dilantin® (sodium diphenylhydantoin)
- Immunemediated dizs
  - Allergic contact dermatitis
  - Bullous pemphigoid
  - Discoid lupus erythematosus
  - Drug eruptions (sulfas, tetracyclines, penicillins)
  - Pemphigus vulgaris
  - Sjogren's-like syndrome
- Nutrient deficiency
  - Dietary calcium imbalance
  - Protein-calorie malnutrition
- Recurrent ulceration in silver-gray Collies w/ cyclic hematopoiesis

Stomatitis

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Mycotic stomatitis; Oral candidiasis M8k 281; Mk 128; SAP 623; E-hb 434; H3B 299; H2B 333 **	• Dogs & cats • Overgrowth of ***Candida albicans*** • Cause: - Associated w/ other oral dizs - Long term antibiotic therapy - Immunosuppression	• **Creamy white plaques ("thrush")** on tongue or mucous membranes - Peripheral reddening - May coalesce in time - May spread to pharynx • Underlying tissue red or ulcerated	• Hx, CS, PE • **Culture organism** • Biopsy: - Identify yeast hyphae - Periodic acid-Schiff stain **DDx:** • Ulcerative stomatitis • Bullous autoimmune skin dizs	• **Tx any underlying systemic diz** • **Ketoconazole (Nizoral®)** (BID) until resolves Prognosis: **Good; guarded** if predisposing diz not controlled
Plant awn stomatitis ***	• Commonly to tongue and gingivae of incisors & canines • Dx: **Salivation**, physical exam (PE) • Tx: **Heals rapidly once removed**			
Cat stomatitis complex, **Plasma cell stomatitis/ pharyngitis, Feline plasma cell gingivitis** **Lymphocytic-plasmacytic pharyngitis** M8k 280, 139; Mk 129; SAP 624; 5min 943; H3B 303, 299; H2B 338; I2M 411; IM 20; F-N 442; F3IM 56, 59 **?	• **Persistent gingivitis-pharyngitis** - May spread to palatopharyngeal arch & rostrally • Neck lesions of teeth may contribute	• **Raised, glistening, erythematous, proliferative lesions** of glossopalatine arches - **Cobblestone** appearance • Halatosis (bad breath) • **Excessive salivation** (ptyalism) • Dysphagia (difficult swallowing) • Weight loss in time • Slowly progressive • Rarely other areas of skin or feet may be involved	• Hx, CS, PE • Submandibular lymphadenopathy sometimes present • Sedation m/b needed to examine oral cavity • Biopsy: hyperplastic & ulcerative mucosa w/ submucosal inflammatory cell infiltrate (predominantly **plasma cells)** **DDx:** • Spirochetal stomatitis • Lymphosarcoma • Mast cell tumor • Eosinophilic granuloma complex	• **Oral hygiene**: dental cleaning & extractions, mouthwash • Treat any periodontal diz • Tx tried with variable results: - Hypoallergenic diet - ABs - Levamisole - Steroids (prednisolone) - Methylprednisolone acetate - Triamcinolone (Vetalog®) - Surthioglucose (Solganal®) - Mouthwash - Megestrol acetate (not recommended) Prognosis: **Poor** until cause &/or a more successful treatment is found

Cat, Mouth & pharynx
CS: Mouth & pharynx
Dx: Hx, CS, PE, Biopsy
Tx: Frustrating • Px: Poor

Overgrowth of *Candida*, Immunosuppression
CS: Creamy white plaques ("thrush")
Dx: Hx, CS, PE, Culture
Tx: Ketoconazole. Px: Good

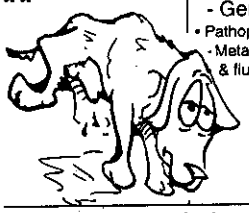
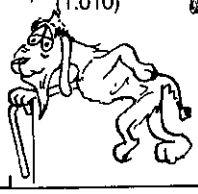
Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Ulcerative stomatitis, gingivitis, **Acute necrotizing ulcerative gingivitis/stomatitis, Vincent's stomatitis, Idiopathic** stomatitis, Trenchmouth M8k 281; Mk 129; GI-S 192; 190; SAP 623; I2M 411; F-N 444; Pa-T 7, 10 *	• **Cause: many** - Immunemediated, bacterial, viral - Idiopathic: Fusiform bacilli & spirochetes: normal inhabitants out of control suggested, *Bacteroides melaninogenicus* suggested • **Maltese terriers** may be predisposed to ulcerative stomatitis	• **Swollen & red gingiva** - Painful & bleeds easily • **Ulcerative necrotic mucous membranes** & exposed bones • **Severe halitosis** • **Ptyalism** (↑ salivation), blood tinged • Progress to severe gingivitis & gingival recession • ± Anorexia, cachexia, febrile, depressed • Sequela: pneumonia	• Hx, CS, PE • **R/O (rule out) other causes** • Culture: impression smears may show ↑ number of spirochetes **DDx:** • Severe periodontal diz • Autoimmune skin diz • Uremia • Neoplasia • Systemic diz w/ oral lesion	• **Teeth cleaning** • Mechanical & chemical (2-5% silver nitrate) debridement • **ABs** for 3-6 weeks (amoxicillin, ampicillin, clindamycin, cephalosporins) • **Mouth rinses** (0.2% chlorhexidine or 3% hydrogen peroxide diluted 1:1 w/ water) • **Steroid** (prednisolone) for weeks for granulation tissue lesions - may respond • Soft diet, ± pharyngostomy tube Prognosis: **Guarded to good** for control
Mouth burns M8k 279; Mk 127; SAP 622; E-hb 433; IM-WW 245 **	• Electrical burns • **Chewing an electric cord in puppies & kittens**	• Excessive salivation • **Hesitant to eat or drink** • Mouth shy • Mild: temporary discomfort • Severe: serious	• Hx, CS • **Examine oral cavity** - Tissue destruction - Ulcerative or gangrenous stomatitis - Necrosis	• Initially: **copious lavage w/ water** • Mild reddening - Soft or liquid diet until heals • Extensive tissue damage - Frequent flushing w/ isotonic sol. - ± Debridement & cleaning under anesthetic • **Systemic ABs** for several days Prognosis: **Good**
Chemical mouth burns SAP 622; H2B 335; IM-WW 245 *	• **Alkaline** (most common) • **Acid** compounds	• **Excessive salivation** • **Hesitant to eat or drink** • **Mouth shy**	• Hx, CS • **Examine oral cavity**	• **Alkaline** - vinegar or lemon juice to neutralize • **Acid** - Na bicarbonate to neutralize • Mild reddening - Soft or liquid diet until heals • Extensive tissue damage - Frequent flushing w/ isotonic solution - Debridement & cleaning under anesthetics m/b needed • Systemic ABs for several days Prognosis: **Guarded**

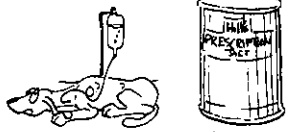
Many causes
CS: Ulcers
Dx: R/O
Tx: Hygiene, ABs, Soft diet

Electrical cord
CS: Salivation, Mouth shy
Dx: Hx, CS, PE
Tx: Water, Soft diet until heals • Px: Good

Mouth

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Uremia IM 481; H2B 572, 119, 86; C12T 951, 966, 971; C11T 846; GI-S 192; Sx-S 1401; Pa-T 211; H-T/M 321 **	• **See Urinary guide** • **Retention of protein by-products in blood resulting in toxic condition** - Associated w/ **renal failure** - Geriatric pets • Pathophysiology - constellation of CS - Metabolic acidosis & uremic toxicity, anemia & fluid overload, GI complications	• **PU/PD** (polyuria/polydipsia) • Depression, lethargy • Anorexia, weight loss • GI: vomiting, bleeding - **Stomatitis/oral ulcers** • Respiratory distress • CNS/encephalopathy • Osteodystrophy	• **Hx, CS, PE** • ECG abnormalities • ↑ **BUN, creatinine**, phosphorus . Nonregenerative **anemia** • Urinalysis: isosthenuria (1.010)	• **Manage uremia & underlying cause** - Parenteral fluids - Diet restriction of protein & phosphorus - Phosphate binders - ± Calcitriol & erythropoietin • **Manage concurrent heart failure** **Prognosis**: resolution of uremia may improve ECG abnormalities or may not

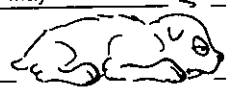





Toxic - Renal failure
CS: PU/PD, Dyspnea, Vomiting, stomatitis
Dx: ↑ BUN, Creatinine
Tx: Renal & concurrent cardiac problems

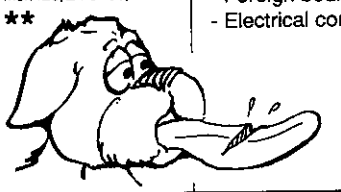
Tongue congenital anomalies *
M8k 126; E-hb 434; E 1091

- **Rare!!! "Bird tongue"** (ankyloglossia): abnormal developmental narrowing of tongue, 2° to lingual frenulum abnormality
- CS: **Inability to nurse**, die w/in days of birth; Survivors: difficulty eating & drinking
- Tx: **Incise frenulum**. Px: Normal w/ Sx



Tongue trauma
M8k 126; E-hb 435, E 1091
**

- Cause:
  - Licking sharp objects
  - Ingestion of caustic material
  - Foreign bodies
  - Electrical cord bites
- **Lingual swelling**
- Drooling of blood-tinged saliva
- **Pawing at mouth**
- Physical exam of mouth
- **Suture clean lacerations**
- **Debride & suture jagged lacerations**
- **Electric cord burn**
  - Check for shock & pulmonary edema
  - Clean & irrigate w/ isotonic saline & broad spectrum ABs
  - Necrotic part sloughs & heals by granulation



Tongue paralysis: see Neuro, rare w/o other deficits
CS: Sloppy eating, drooling
Dx: Hx, CS, Neuro exam
Tx: Treat underlying cause, support

Prognosis: **Good**: dogs do OK with less than 1/3rd of tongue missing

Canine oral eosinophilic granuloma *
Mk 126; SAP 624; SX-WW 116

- **Rare;** All breeds, especially **Siberian huskies**; Cause: ? - hypersensitivity suspected, hereditary; Males < 3 yr old most commonly
- CS: **Vegetative lesions w/ superficial ulceration of tongue**, drooling, halitosis, oral bleeding, dysphagia, anorexia (pain), weight loss
- Dx: Hx, CS, PE; R/O underlying systemic disorders; **Biopsy/histo**: collagen degeneration, eosinophilic & histiocytic cellular infiltration, palisading granuloma
- DDx: Neoplasia (mast cell tumor), Mycotic infection, Foreign body reaction
- Tx: 1st w/ **steroids** (glucocorticoid [prednisolone]), frequently cause regression in 10-20 days, lesions rn/ regress spontaneously, Laser surgery
- Px: **Guarded**

Steroids

Malignant oral neoplasms
M8k 282; Mk 130; E-hb 431; H3B 308; H2B 341; I2M 409; IM 319; IM-WW 247; E 1084; C12T 691; Cat 1144; F-N 444; Sx-WW 117
**

- **Dogs: likely to be malignant**
  - **Malignant melanoma**
  - Squamous cell carcinoma (SCC)
  - Fibrosarcoma
  - Gingivae & tonsils most frequently affected
  - > 10 yr old
  - Cocker & G. Shepherds

Cats:
- **Squamous cell carcinoma** (SCC) most common malignant tumor
  . Gingivae & tongue
  . Highly invasive & readily metastasize
- Fibrosarcoma: locally invasive

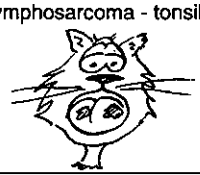
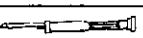
- Vary: location & extent
- **Halitosis**
- **Reluctance to eat**
- **Salivation**
- **Swelling of face** w/ surrounding tissue invasion
- Swelling of regional lymph nodes
- Malignant melanoma: variable in appearance, pigmented or nonpigmented
- SCC: commonly in gingivae or tonsils
- Lymphosarcoma - tonsil

- Hx, CS
- **Mouth exam for growths**
- Impression smears
- Fine needle aspiration
- **Biopsy** usually required for definitive Dx
- **Metastasis**: evaluate regional lymph nodes & lungs
  - Biopsy
  - Chest rads

DDx:
- Chronic nonhealing ulcers
- Sublingual foreign bodies
- Eosinophilic granuloma
- Other tumors
- Abscess

- **Dogs:**
  - **Malignant melanoma**: surgical resection can extend survival time
  - Nontonsillar SCC: aggressive surgical resection &/or radiation Tx
  - Tonsillar SCC: poor Px because aggressive
  - Fibrosarcoma: poor Px, moderately radiosensitive, recurrence common following resection
- **Cat: SCC**: Px poor, local tumor removal by hemimandulectomy possible

- **Other tumors**
  - Mast cell tumors
  - Adenocarcinoma of minor salivary glands
  - Adamantinoma
  - Hemanglosarcoma
  - Lymphosarcoma
  - Granular cell tumor
  - Oncocytoma

Dogs: Malignant melanoma, SCC, Fibrosarcoma
Cats: SCC
Dx: Aspiration, Biopsy, Metastasis
Tx: ± Sx & radiation. Px: Guarded to poor

Prognosis: Guarded to poor

Feline immunodeficiency virus, FIV

- **See Systemic**; Retrovirus -**Lentivirus, male** > female (fights), **Destroys T-lymphocytes**
- CS: **Recurrent infections, multiple systems: oral** (> 50%) stomatitis, gingivitis, periodontitis
- Dx: Hx, CS, PE, **ELISA: in-office screening**
- Tx: **Incurable,** supportive •Px: can live for years before CS, die w/in 1 year of diagnosis

Canine oral papillomatosis, COP
M8k 282; Mk 129; E-hb 431; H3B 307; H2B 340; E 1084; IM-WW 247; Pa-T 9
**

- **Benign tumors**
- **Papovavirus**
- Regresses spontaneously
- Immunity for life on recovery
- Most common in young animals
  - Skin papillomas of aged dogs not caused by virus

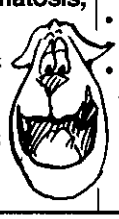
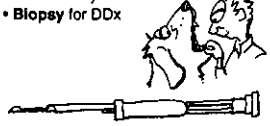
- **Masses** of oral mucosa & commissures of lips usually
  - Palate, oropharynx, lips, occasionally
  - Not in skin or genital mucosa
- Signs occur if interfere w/ eating
- Bleeding if dog chews on them

- Hx & CS (**young dog w/ oral masses**)
- **Biopsy** for DDx

DDx:
- Transmissible venereal tumor
- Squamous cell carcinoma
- Fibromatous epulis

- **Spontaneous regression** in 1-3 month so Tx unnecessary
- Electrosurgical debulking if interference
- Surgical removal of one or more may initiate regression
- Commercial autogenous wart vaccines are disappointing

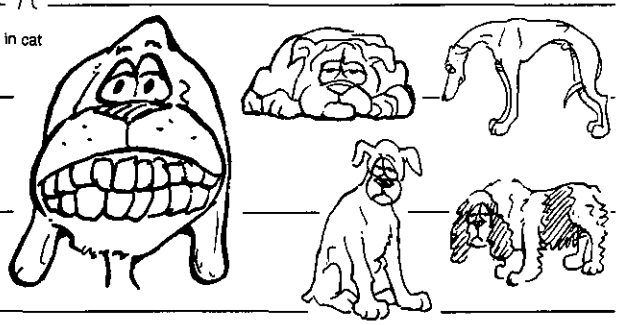
Prognosis: **Good**

Benign, Virus, Masses, Spontaneous regression • Px: Good

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Epulides, Periodontal epulis, Fibromatous epulis, Fibromatosis gingivae M8k 282, 157; Mk 130; E-hb 442; 5min 598; H3B 396; H2B 341; IM-WW 247; E 1084; Sx-S-hb 771; Sx-S 2321; Neo 139; C12T 691; Pa-T 16 **	• **Tumor of periodontal ligament** • Most common benign oral (gums) tumor in dogs - Occasionally seen in cats • Types: - Fibromatous (noninvasive) - Ossifying (noninvasive) - Acanthomatous (invasive - tissue & bone) • Cause: unknown • > 6 yr old (any age can be affected) • Boxers & English Bulldogs m/b predisposed	• **Tumors** - single or multiple - Commonly adjacent to canine or carnassial teeth • Masses may be ulcerative & bleeding • Solitary or multiple • Signs if interfere w/ eating	• Hx, CS • Deep biopsy: contains epithelium, bone & cementum **DDx:** • Gingival hypertrophy • Oral papillomas • Odontogenic tumor or cyst • Squamous cell carcinoma • Fibrosarcoma & osteosarcoma	• **Wide surgical excision** of fibromatous & ossifying epulides if causing discomfort • Surgical excision of acanthomatous epulis - Remove all involved tissue &/or bone to avoid recurrence Prognosis: **Good**
Tumor of periodontal ligament **CS: Tumor near canine** **Dx: PE, Biopsy (epithelium, bone & cementum)** **Tx: Wide excision • Px: Good**				
Anodontia Sx-S-hb 770; C12T 685 *	• **Rare,** congenital absence of teeth; Oligodontia or hypodontia: partial anodontia (1 or more teeth missing - P1 & M3 most commonly) • Cats commonly missing incisors • Only treatment needed is to present food so it can be prehended & swallowed			
Supernumerary teeth M8k 126; SAP 607; E 1209; Sx-S-hb 770; C12T 685 *	• **Polydontia:** too many teeth, congenital defect, less common than loss of teeth • **Breed predilection** (Spaniels, Hounds, Greyhounds, Bulldog, Boxer); Occasionally seen in cat • **Odontomas:** rarely cause large number of formed or partly formed teeth • Tx: **If crowd other teeth - remove;** Cosmetics, Braces are also used			
Abnormal shapes SAP 608; E 1210; Sx-S-hb 769; Sx-S 2316. C12T 686 *	• Fusion of roots or **missheped** crown occur uncommonly due to trauma or fever occurring during tooth development - CS: Usually of no clinical significance - Tx: None usually required, remove if problems • Dens in dente: rare anomaly, forming a tooth w/in a tooth during development			
Impaction SAP 608; Sx-S-hb 770; Neo 127 *	• **Rare, Failure to erupt out of alveolar bone,** rarely recognized in dogs or cats • CS: Nasal discharge, orthodontic problems, pain • Dx: Radiology • Tx: **Extraction** if causing problems • Prognosis: **Good**			

Dog: Dental formula M8k 131
Deciduous 2(3/3I 1/1C 3/3PM) = 28
Permanent 2(3/3I 1/1C 4/4Pm 2/3M) = 42
Cat: Dental formula
Deciduous 2(3/3I 1/1C 3/2PM) = 26
Permanent 2(3/3I 1/1C 3/2Pm 1/1M) = 30



Periodontal diz

M8k 136; Mk 117; SAP 615, 607; E-hb 439, IM-WW 249; E 1102; H3B 310; H2B 344; Sx-S-hb 776; Sx-S 2332; C12T 686; Cat 1125; F3IM 55, 58; F-N 438; Sx3B 166; Neo 131, 140 ***

- **Bacterial** infection of tissue surrounding teeth (gingiva, periodontal ligament, alveolar bone & cemental surface of teeth)
  - #1 reason for tooth loss in dogs
- Cause: **Plaque** (build up of mucous, cells, bacteria, food particles)
  - Plaque builds up to calculi (calcified plaque)
- 2 forms:
  1. **Gingivitis**: affects gums - **reversible**
  2. **Periodontitis:** destruction of gingiva, periodontal lig., alveolar bone & root cementum, **irreversible**

- **Redness around gums**
- **Plaque on teeth**
- **Gingivitis**
  - Red or purple gums
  - Swelling of gums (blunting of free gingival margin [FGM])
  - Gums bleed on contact
  - Fetid breath
  - Leads to periodontitis if untreated
- **Periodontitis**
  - Hyperplasia of gum margin
  - Recession of gum attachment w/ loss of bone
  - **Mobility of teeth**

- Hx, CS
- PE: Plaque
  - **Periodontal probe** into periodontal pocket (space between tooth & gum)
    - . Normally: 3 mm in depth
    - . Mild diz: 4-6 mm
    - . Moderate: 7-9 mm
    - . Severe: > 10 mm w/ mobility of tooth
- Radiographs: loss of **lamina dura** (edge of alveoli) & bony support of affected teeth

#1 cause of oral infection & tooth loss in dog

- Sequelae:
  - **Periodontal abscesses**
  - Apical abscesses
  - **Tooth loss**
  - Recurrent transient bacteremia

DDx
- Gingival inflammation from immunodeficient state (FeLV, FIV)
- Primary gingivitis
- Primary stomatitis
- Plasmacytic/lymphocytic stomatitis
- Uremic stomatitis

Arrest plaque stage with prophylactic care:
1. **Crown scaling** to remove plaque & calculi
   - Ultrasound dental scaler, high speed rotating burr or hand scaler
2. **Root planing** (removal of plaque & calculus from root below gum margin in periodontal pocket)
   - Periodontal curette
   - Do not use ultrasound or damage of soft tissue (sublingual)
3. **Subgingival curettage** to remove inflammatory soft tissue of inner lining of periodontal pocket (periodontal, curette)
4. **Polish all tooth surfaces**: rubber prophy cup, fine grade prophy paste (pumice), retards accumulation of plaque & calculus

- **Gingivectomy**: resection of unsupported gingival tissue
  - Eliminate periodontal pockets > 5 mm deep
- **Open flap curettage**: to treat periodontal pockets extending beneath level of alveolar crest
- **Antibiotics,** depending on severity
  - Mild: not required
  - Moderate: perioperative ABs
  - Severe w/ extractions: perioperative & postop ABs
  - Penicillin, tetracycline & clindamycin
- Topical agents: chlorhexidine or stannous fluoride - short term benefits

Prevention:
- Home dental care
  - Plaque removal: soft wet tooth brush or gauze sponge
  - Rawhide chew toys
  - Dry pet food or dog bones minimally effective
- Annual oral check ups

Prognosis: Good early, **poor** in advanced diz

Plaque + bacteria = diz
CS: Red gums, Plaque, Swelling, Mobility - Tooth loss
Dx: PE, Probe, Rad: no lamina dura
Tx: Arrest plaque: scaling, planing, curettage, polish; ± ABs
Px: Good early to poor late

Teeth

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Enamel hypoplasia/ Canine distemper ** M8k 139, 127; Sx-S-hb 770; Neo 130	• **Failure of full formation of enamel** • Cause: disruption of enamel formation in utero or shortly after birth - **Canine distemper** usual cause - Any fever during teeth formation	• **White opaque areas** or brown-stained irregularities or depression in the enamel	• Hx, CS • Physical exam (PE)	• **None if no problems** • If rare caries develops - Resin restoration Prognosis: **Good**, no problem usually
Tetracycline staining M8k 127; E-hb 442; S-Sx-hb 770 *	• **Tetracycline administration during tooth development** - Bonds to calcium in dentin & enamel	• **Permanent discoloration**	• Hx, CS, PE Tetracyclines	• **No treatment** • Bleaching successful in humans **No tetracyclines** to dogs & cats under **5 month old** or to pregnant females
Canine cavities/ Caries M8k 138; Mk 119; E-hb 441; SAP 608; IM-WW 249; Sx-S-hb 771; Sx-S 2320; H2B 345; Pa-T 16 *	• **Erosion of tooth structure** • **Rare** in dogs & cats due to different oral flora, diet & slightly acidic saliva • Middle-aged to older dogs • Pathophysiology: bacteria liberate acidic by-products which degrade enamel, may continue through the dentin to pulp cavity, resulting in pulpitis & apical abscesses • Common sites: pits of occlusal surfaces of premolars & molars	• **Oral pain** - Ptyalism - Anorexia - Head shyness • Periapical abscess CS	• Dental explorer - explore any discoloration or defect of enamel - Caries are soft **DDx:** • Teeth fractures • Xerostomia (2° caries)	• **Extract severely affected teeth** • Restoration w/ silver amalgam or composites Prognosis: **Good** w/ appropriate Tx
Cat caries, Neck lesions, **Neck (cervical) line resorption or osteoclastic lesions; Subgingival erosions, Odontoclastic resorptive lesions, External root resorptions** M8k 138; Mk 119; H3B 312; H2B 346; SAP 608; E-hb 442; E 1109; C12T 688; Cat 1126; F-N 293; F3IM 55; **	• Not true cavities • **Subgingival resorption lesions** • Junction of crown & root, just under gum • Premolars & molars most frequently • Buccal surface usually • Cats ≥ 6 yr old • Causes: unknown - idiopathic - Advanced periodontal diz - Nutritional 2° Hyperparathyroidism - Repeated or excessive vomiting - Inherited	• **Oral pain** • "Chattering" motion of mouth • Reluctance to eat • Temperature sensitivity to food • **Granulation tissue** usually covers erosion	• Physical exam of gum margins - Defects & granulation issue **Tooth resorption below gum** **CS: Oral pain, "Chattering", Anorexia** **Dx: PE: defects & granulation tissue** **Tx: Tooth extraction •Px: Guarded**	• Many cases advanced by diagnosis • Tooth extraction if extend into pulp cavity • Restoration for mild lesions - silver amalgam or type II glass ionomer cements Prognosis: **Guarded**, progressive
Endodontic diz, Pulpitis, Pulpal hyperemia M8k 137; Mk 119; SAP 607; H2B 346; E-hb 442; C12T 689; Sx3B 172 **	• **Diz of pulp** (pulpal hyperemia - inflammation of pulp) • Pulpitis: irreversible inflammation of pulp w/ pressure necrosis & abscessation • Cause: - **#1: Tooth fx w/ pulp exposure** - Invasion of pulp by caries - Trauma affecting blood supply - Periodontal lesions extending into periapical region • Pathophysiology: - Trauma &/or bacteria w/in pulp cavity resulting in pulpitis (inflammation) - Swelling results in ischemic necrosis of surrounding pulp tissue & dentin - Infection spreads out apical foramen to periap-cal tissue in time	• **Fractured crown** **- Painful, salivation** • ± Oral pain • ↑ sensitivity of tooth to touch • Discoloration of tooth (dark gray-purple) • Sequela: - Periapical abscess - Osteomyelitis - Sepsis **Diz of pulp - tooth fx** **CS: Fractured tooth, pain** **Dx: PE, probe, Rads** **Tx: Teeth extraction, endodontic Tx. Px: Good**	• Hx, CS • Palpate over root ends for abscess • **Dental probe** for defects in enamel • **Radiographs** for periapical abscess	• **Teeth extraction** • Endodontic therapy: pulp cap, pulpotomy, apexogenesis, root canal Prognosis: **Good** w/ appropriate Tx
Periapical abscess, Carnassial abscess, **Malar abscess, Facial sinus** M8k 139; SAP 608; H3B 313; H2B 347; Mk 119; IM-WW 249; Sx-S-hb 420; Sx-S 1248; Sx-WW 117; E-hb 437; E 1097 **	• **Infection of periapical alveolar bone** • Carnassial abscess: maxillary (PM4) > mandibular (M1) • Common in middle-aged & old dogs, also seen in cats • Causes: - Fracture of tooth - Extension of periodontal diz or endodontic or systemic or hematogenous infections (endocarditis) **Tooth abscess, Upper PM4** **CS: Draining fistula on skin** **Dx: Hx, CS, PE, C&S, Rads** **Tx: Tooth extraction & establish drainage, ABs** **Px: Good, resolve in 1-2 weeks**	• Varies depending of tooth root affected • **Local cellulitis & swelling** • **Draining fistula** on skin near root - Under eye for carnassial tooth • Gum boil (draining fistula) of adjacent gum • Nasal discharge if maxillary teeth affected	• Hx, CS • PE: check crown for damage • Culture & sensitivity (C&S) of any draining tract • Radiography: radiolucent area around root (disappearance of **lamina dura**) **DDx:** • Facial swelling - Neoplasia - Puncture wounds - Salivary adenitis - Trauma • Nasal discharge - Neoplasm - Inflammation of nasal cavity - Nasal cavity foreign body • Mandibular swelling - Trauma - Neoplasia	• **Tooth extraction & establish drainage** - **Carnassial tooth:** section multiroot tooth into 2 or 3 sections . Then simple extraction of each section • Systemic ABs - 2 weeks • Root canal w/ apicoectomy Prognosis: **Good**: should resolve in 1-2 weeks

Teeth, Pharynx

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Dental attrition & abrasion, Rock chewers, Worn teeth E-hb 443; H2B 347; E 1211; Sx-S-hb 770; C12T 688 ***	• Causes: - **Normal wear of aging** - **Rock chewing** • Pathophysiology: - If the crown is worn down slowly, odontoblast cells in the pulp cavity produce secondary dentin (brown spot) to protect the pulp cavity from the encroaching occlusal surface	• **Asymptomatic** usually **Aging, Rock chewing, Asymptomatic**	• Hx, PE • Dental probe: central occlusal surface, if hard 2° dentin is protecting pulp cavity - If probe falls into cavity, endodontic diz exists	• **None required** if pulp cavity remains sealed • If pulp cavity exposed: root canal therapy or extraction • ± Modify behavior Prognosis: **Good** for life, Poor to control
Retained deciduous teeth E-hb 442; SAP 607; H2B 348; C12T 685; Sx-S-hb 783, 770; Neo 126 ***	• **Deciduous teeth present along with permanent counterpart** • Hereditary in some: Tibetan terrier & other small breeds **Milk + adult teeth** **CS: Usually asymptomatic** **Dx: Mouth exam** **Tx: Extraction • Px: Excellent**	• **Usually asymptomatic** • **Sequela:** may result in permanent malocclusion	• Mouth exam	• **Extraction** when detected to prevent malocclusions Prognosis: **Excellent** if removed early; guarded if present > 1 yr-old
Orthodontic diz, Malocclusion M8k 139, 126; Mk 120; E-hb 441; SAP 621; H2B 334; F-N 301; Sx-S-hb 783; Sx-S 2349; Neo 127 ***	• **Malocclusion** • Orthodontics: movement & repositioning of teeth to a more normal position. Only to alleviate traumatic malocclusions resulting in pain or inability to eat or function. Not to correct cosmetic or genetic dental defects • Cause (etiology): - Genetics - Retained deciduous teeth • Types: - **Prognathia** (mandibular teeth rostral to maxillary) - Parrot mouth/brachiognathia (maxillary teeth rostral to mandibular teeth) - Lingually displaced mandibular canines	• **Clinically insignificant** usually • Cosmetic • Lower canine displaced lingually - Palatine defects **Malocclusion: prognathia, brachiognathia** **CS: Clinically insignificant usually** **Tx: None unless problems**	• **Oral exam**	• **No treatment unless hampers function** • Orthodontics: tipping most common correction • Remove retained deciduous teeth • Intraorally fabricated acrylic inclined plane for lingually displaced mandibular canines **Prognosis: Good to guarded** w/ appropriate Tx
Tonsillitis/ pharyngitis SAP 626; E-hb 264; H3B 303; H2B 337; GI-S 198; IM-WW 149; C12T 568(f); E 568; Sx-WW 120; Neo 139 ***	• **Inflammation of tonsils** • Common in dog, less frequent in cat • Young small dogs • Usually bilateral • Types - 2° tonsillitis . Chronic vomiting or regurgitation (megaesophagus, pylorospasm, gastric neoplasia) . Chronic productive cough (bronchitis, bronchiectasis) . Chronic contamination of nasopharynx (cleft palate, dizs causing nasopharyngeal discharge, dysphagia due to pharyngeal dysfunction) - 1° tonsillitis • Coprophagy	• **Retch** • Cough • **Inappetence** • Malaise • Fever **Inflammation of tonsils** **CS: Cough, Inappetence, Fever** **Dx: Mouth exam** **Tx: ABs • Px: Good**	• Hx, CS • Mouth exam: visualize tonsils in their crypts	• **ABs** usually enough for clinical improvement • Tonsillectomy rarely necessary, but provides permanent relief - Occasionally indicated in mature animals when causes mechanical interference w/ swallowing ABs Prognosis: **Good**
Pharyngeal trauma, Foreign bodies, Retropharyngeal abscess E-hb 246; IM-WW 249; Sx-S-hb 753 **	• Evidence of external trauma not usually found • Fish hooks, grass awns **Fish hook, Grass awn** **CS: Pyrexia, Anorexia** **Dx: Mouth exam** **Tx: Remove FB, Drainage of abscess**	• Pyrexia • Anorexia • Pain & swelling of pharyngeal region	• Hx, CS • Mouth exam: try to visualize any foreign body - Palpate mouth & pharynx • Therapeutic trial of ABs if nothing found • Persistent CS - Radiographs - Surgical exploration	• **ABs** • **Remove foreign bodies** • **Surgical drainage of abscess** ABs Prognosis: **Guarded**
Pharyngeal neoplasms * E-hb 265; Sx-S-hb 678; Sx-S 2088; SAP 626; H2B 341; IM 319; IM-WW 250	• Most pharyngeal tumors are **malignant** in dog & cat • Most common: - Dog: squamous cell carcinoma - Cat: lymphomas			**Tonsillar neoplasia**: Squamous cell carcinoma (SCC): Tonsillar crypt in dogs, locally invasive, metastasizes to lymph nodes & lungs, Lymphosarcoma • CS: Dysphagia, anorexia, emaciation, coughing, retching; dyspnea; ± cranial cervical mass • Dx: PE: visualization, biopsy; Rads for metastasis • Tx: **Euthanasia**; SCC: R/O metastasis - chemotherapy + radiation; Extensive excision (hemimandibulectomy or total mandibulectomy greatest success) + radiotherapy • Prognosis: **Grave**: < 9 mo. survival w/ Sx or radiotherapy

Condition	Facts/causes	Presentation/CS	Diagnosis	Treatment
Dysphagia E-hb 58; SAP 632, 646; E 110, 568; 5min 54; H3B 305; H2B 338; I2M 346, 472; IM 321; IM-WW 5,250; C11T 572; NS-W 24; NS-C 261; NS-hb 232, 237; NS-O 43; NS-L 106; DDx 253; Neo 143 **	• **Difficulty in swallowing** • **Clinical sign, not a diz**	• **Drooling** • Nasal discharge • Cough from aspiration • Sequela: - **Aspiration pneumonia**	• Hx, CS, PE, rads • **R/O causes** - **R/O rabies first in all dysphagia**	• **Supportive therapy:** - Nasogastric or pharyngostomy tube - Syringe inserted in buccal vestibule (liquid diet) • ± Corticosteroid
Pharyngeal paralysis H2B 339 *	• **Rare**; Myopathy or neuropathy of glossopharyngeal, vagus or trigeminal nerves; Cause: Trauma & idiopathic (unknown) • CS: **Dysphagia** (difficult swallowing), Quidding, coughing, sneezing; Aspiration pneumonia • Dx: Hx, CS • DDx: **Rabies**; Cricopharyngeal achalasia, Other causes of dysphagia • Tx: Supportive, Pharyngostomy tube feeding • Prognosis: Good if temporary condition, Grave if permanent			

Dysphagia - Causes SAP 633

- **Neurological**
  - CNS or cranial nn. 9, 10
    - **Rabies,** other viral, bacterial, protozoal or fungal infections
  - Trigeminal neuralgia
  - Hypoglossal nerve problem
  - Brainstem disorders: trauma, tumors, hemorrhage, edema
  - Myopathies or myositis
    - Masticatory myositis
    - Immune polymyositis
    - Hypothyroidism
  - Neuromuscular diz
    - Myasthenia gravis
    - Botulism
    - Acute polyradiculoneuritis
- **Nonneurological**
  - **Oral dysphagia**
    - Cleft palate
    - Dental diz
    - Oral foreign body
    - Oral neoplasia
    - Persistent frenulum
    - Severe stomatitis/glossitis
    - Skeletal disorders
      - TMJ diz (temporomandibular joint)
      - Craniomandibular osteopathy
      - Fractured hyoid apparatus
  - **Pharyngeal dysphagia**
    - Cricopharyngeal achalasia, dysphagia
    - Neoplasia: pharynx, tonsils, retropharyngeal lymph nodes
    - Tonsillitis/Pharyngitis
    - Retropharyngeal abscess
    - Iatrogenic short soft palate
    - Esophageal hypermotility

Difficulty in swallowing
CS: Drooling, Cough
Dx: Hx, CS, PE, R/O
Tx: Supportive therapy, Food

Prognosis: **Guarded** depending on cause, lack of adequate treatment & frequent aspiration pneumonia

Cricopharyngeal achalasia/ dysphagia H3B 339; M8k 276, 128; Cat 1174; Sx-WW 12; Pa-T 18 *	• **Rare condition** • Inability to relax cricopharyngeal muscle which forms a sphincter for the proximal esophagus • Cocker spaniel, Springer spaniel, Irish setters; not recognized in cats • Young	• **Coughing, gaging & sneezing** • **Dysphagia** (difficult swallowing) • Dyspnea w/ aspiration pneumonia • Underweight	• Hx, CS • Endoscopy • Barium swallow or fluoroscopy • EMG **DDx:** • Rabies • Other causes of dysphagia	• Medical: supportive care (pharyngotomy tube) for aspiration pneumonia • **Cricopharyngeal myotomy:** resection of dorsal cricopharyngeus muscle
Hypersialism, "Drooling", Hypersialosis, Ptyalism M8k 2843; 5min 136; H3B 317; H2B 351; I2M 347; E-hb 435; E 1092 ***	• **Overproduction & oversecretion of saliva (ptyalism)** • Rarely reported as a primary diz (parotid duct)	• **Excessive salivation** • Other CS depends on cause - 1° diz - enlargement of parotid gland	• **Hx, CS** • Palpate parotid gland for enlargement	• **Depends on cause** • 1° disease of parotid - Anticholinergic drugs to alleviate drooling short term . Atropine sulfate 0.04 mg/kg SQ PRN . Glycopyrrolate 0.01 mg/kg SQ PRN - Ligation of parotid duct - permanent • Giant breed drooling - Cheiloplasty to correct lip conformation - Excise mandibular & sublingual glands bilaterally - Ligate mandibular & sublingual ducts • Organophosphate - Atropine & 2-PAM • Obstruction - remove
Xerostomia, Aptyalism, Dry mouth M8k 284; Mk 252; E-hb 435; IM-WW 250 **	• ↓ Secretion of saliva, uncommon	• Dry mouth	• Diagnose cause (Hx)	• Treat cause • Mouthwashes • ± Fluids for dehydration

DDx - Drooling

- **Malformation of lips in giant breeds**
- Cats:
  - Anxiety
  - Apprehension
  - Contentment
  - Anticipation of feeding or injections
- **Inflammation of oral mucosa**
  - Gingivitis
- Glossitis
- Oral foreign body
- Pharyngeal or esophageal obstruction
- Viral diz (distemper)
- Oral neoplasia
- Organophosphates
- Portosystemic shunt (especially in cat)
- Esophagitis

Excessive salivation
DDx; Tx cause

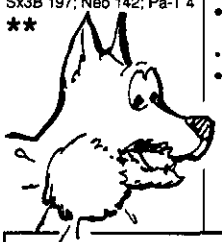
Prognosis: **Guarded,** depends on cause

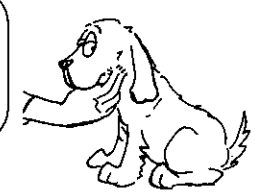
Causes - Dry mouth

- Drugs (atropine)
- Dehydration or pyrexia
- Anesthesia
- Immune mediated (accompanying keratoconjunctivitis sicca)
- Diz of salivary glands

Salivary Glands

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Sialocele, Mucocele, Ranula M8k 283; Mk 251; SAP 626; 5min 1048; H3B 319; H2B 353; E-hb 436; E 1092; I2M 408; IM 318; IM-WW 250; Cat 1150; F-N 446; Sx-WW 120; Sx-S-hb 190; Sx4B 183; Sx3B 197; Neo 142; Pa-T 4 **	• Accumulation of saliva w/in tissue outside salivary system • **#1 salivary diz of dogs & cats** • Causes: - Foreign body into salivary gland or duct - Blunt trauma - Obstruction of duct - Tumor invasion - Hereditary factors - Spontaneous • **Sublingual gland or duct** primarily, also in mandibular or zygomatic glands or duct • Rarely in parotid gland or duct • Locations: - Cranioventral cervical (submandibular) - Ranula: sublingual space of oral cavity - Pharyngeal area (rarely) - Retrobulbar area (zygomatic gland)	• Depends on site • **Fluctuant, nonpainful, noninflammed swelling** • Ranula: sublingual - ± Mechanical interference w/ mastication - Pain if traumatized • Pharyngeal: - ± Swallowing difficulty - ± Dyspnea • Retrobulbar: ± Exophthalmos	• Hx of slow developing swelling • **Aspiration of honey colored to blood-tinged fluid** - 18-20 gauge needle - Thick, tenacious & stringy - Smear stained w/ acid-Schiff (PAS) for mucus • Radiology-Sialography: difficult to perform so rarely done • Ultrasound to differentiate from soft tissue masses • Histopathology: nonepithelial, nonsecretory wall to cavity	• **Cervical mucocele or ranula** - **Removal of both mandibular & sublingual glands** on affected side (TOC); can't remove sublingual by itself - Determining side may be difficult, when in doubt remove both sides • Periodic drainage every 6-12 weeks - May be enough, especially in poor surgical candidate - Occasionally will not recur after aspiration • Retrobulbar mucocele: - Remove zygomatic salivary gland Prognosis: • **Good** w/ surgery, recurrence rates < 5%

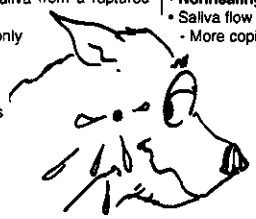


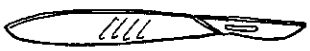


DDx:
- Abscess
- Hematoma
- Branchial cyst
- Thyroglossal duct cyst

Saliva w/in tissue
CS: Fluctuant, nonpainful swelling
Dx: PE, Aspirate
Tx: Removal of mandibular & sublingual glands. Px: Good

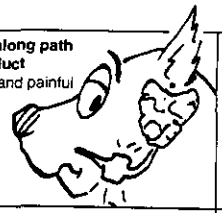
Salivary gland fistula M8k 283; Mk 250; E-hb 436; H2B 356; IM-WW 250; Sx-WW 121; Sx-S-hb 190; Sx-S 515; Neo 142 *	• **Cutaneous leakage** of saliva from a ruptured salivary duct • **Parotid duct** most commonly • Cause: - Blunt trauma - Penetrating wound - Carnassial tooth abscess - Iatrogenic (surgery) • Saliva flow inhibits healing	• **Nonhealing wound on side of face** • Saliva flow out of wound - More copious during eating	• Hx, CS, Physical exam (PE) • Sialography: inject dye retrograde • Atropine orally increases flow • Surgical exploration	• **Ligation of parotid duct** - Identify duct by 2-0 colored nylon suture per os into duct Prognosis: • **Good:** transient swelling then atrophy & loss of function - Fistula heals in a few days

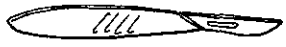




DDx:
- Drain fistula or foreign body
- Chronic infection & cellulitis

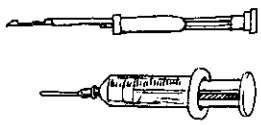
Sialolithiasis H3B 321; H2B 257; Sx-WW 121; Pa-T 5 *	• **Rare** • **Stone or concretion in salivary duct:** magnesium carbonate, calcium carbonate &/or calcium phosphate • Parotid duct, rare: usually under oral mucosa at end of duct • Cause: unknown	• **Swelling along path of parotid duct** • Salivary gland painful • Loss of function	• CS • **Palpate stone maybe** • Plain radiology may reveal stone • Retrograde sialography to locate obstruction	• **Surgically remove stone** - Allow to heal by secondary intention Prognosis: **Good**





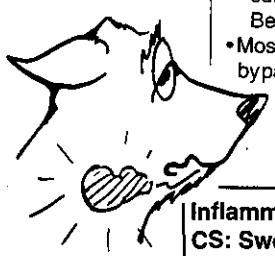
Stone in salivary duct

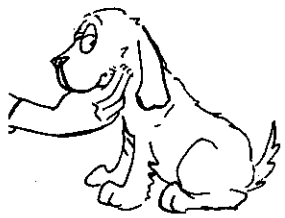
Neoplasia of salivary glands M8k 283; Mk 251; H3B 321; H2B 358; SAP 627; E-hb 436; E 1092; Cat 1150; F-N 446; Sx-WW 121 *	• **Rare** • **Usually malignant** • Types: - Adenocarcinomas most commonly - Mixed tumors, mucoepidermoid carcinoma & acinic cell tumor • Parotid or mandibular glands usually • Benign tumors only documented in cat • Metastasis common to regional lymph nodes, but slow to develop • Older animals usually	• **Firm painful swelling in region of gland** • Exophthalmos if zygomatic gland affected • Sequela: ± mucocele	• **CS, PE** • **Fine needle aspiration** • Incision or excisional biopsy • Tumors should be staged(?)	• **Excision of gland** - Parotid removal difficult because of anatomy - Radiation therapy - adjunctive Tx • Chemotherapy trials not reported Prognosis: **Poor** - long term • Recurrence common, monitor every 3 months • Early surgical resection occasionally curative if before local invasion or metastasis

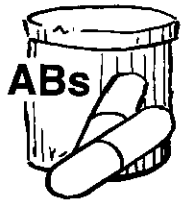


DDx:
- Salivary abscess
- Salivary adenitis
- Neoplasia in local lymph nodes
- Myxosarcoma of face or orbit

Adenitis, Sialoadenitis M8k 284; Mk 251; SAP 627; H3B 318; H2B 352; IM-WW 250; E-hb 435; E 1092 **	• **Inflammation of salivary gland** (1° or 2°) • Uncommon in dogs & cats • Causes: - Abscesses (foreign bodies) - Mucocele, carnassial tooth abscess, paramyxovirus, systemic viral diz, sublingual inflammation in young Beagles • Most common in mandibular followed by parotid	• **Local swelling & heat** • **Pain on palpation** • Mandibular gland: pain; inflammation inside tight capsule results in extreme **pain on opening mouth** • Zygomatic: - Exophthalmos, tearing, divergent strabismus ± Pain on opening mouth - Inability to retropulse globe • Parotid: - Warm, painful, firm gland - Mucopurulent discharge from duct	• Hx, CS • **Palpation for pain**	• **Conservative Tx recommended** - Systemic ABs - Drainage of abscess . Zygomatic gland abscess, drain into oral cavity - Warm compresses • Surgical treatment not recommended Prognosis: **Guarded to good**



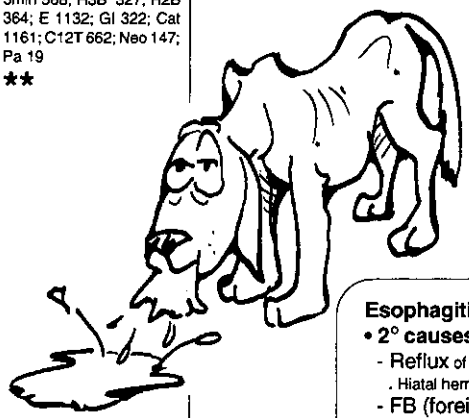


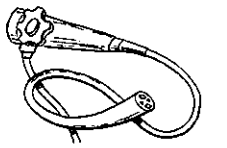


DDx:
- Salivary abscess
- Salivary neoplasia
- Salivary mucocele
- Other cause of retrobulbar diz

Inflammation of salivary gland (1° or 2°)
CS: Swelling, heat & pain on palpation
Dx: CS, PE
Tx: ABs, Drainage, not Sx • Px: Guarded

Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Esophagitis M8k 277; Mk 220; SAP 637; I2M 415; IM 323; IM-WW 250, 256; E-hb 449; 5min 568; H3B 327; H2B 364; E 1132; GI 322; Cat 1161; C12T 662; Neo 147; Pa 19 **	• **Dogs & cats** • **2° causes, 1° causes rare** • Acute or chronic • Cats acute w/ calicivirus	• **Regurgitation** • Refuse food or immediate regurgitation • **Drooling - pain** • Weight loss • Caustic agent - Violent retching & vomition - Burned mouth & anorexia • Sequelae (rare) - Stricture - Esophageal perforation	• Hx & CS • **Endoscopy w/ biopsy:** definitive Dx • Radiology: - Survey films - normal - **Contrast: normal m/b** . Adherence of barium to mucosal erosions . Thickening of wall . Disruption of longitudinal folds . Hiatal hernia . Mild esophageal dilation	• **Tx cause** • **Gastric reflux or vomiting** - **Cimetidine** (Tagamet®): Histamine-2 antagonists to reduce gastric acids, do not use w/ antacids - **Sucralfate** (Carafate®): binds to & protect mucosa - **Antacids** (Mylanta®) - **Metoclopramide** (Reglan®): to empty stomach, antiemetic - **Chlorpromazine** (Thorazine®) antiemetic - **Cisapride** (Propulsid®) increases gastric emptying & gastroesophageal sphincter tone - **Feed late at night & early AM** - **ABs** against oral anaerobes . Amoxicillin, metronidazole - ± Steroids: prednisolone if severe, to prevent stricture (cicatrix/scar) • **Caustic agents:** - **NO emesis if caustic agents** - Acids: neutralize w/ milk of magnesia - Caustic alkalis: vinegar or lemon juice - Sucralfate (intestinal protectant) - Rest esophagus: nothing PO 24 hrs - ABs (as above) - Steroids (as above) • **FB** (foreign body) remove: if severe trauma: ABs, steroids & sucralfate® • Hiatal hernias: Sx repair • **All of above:** - **Soft bland diet**, frequent, small, hi protein, low-fat meals - Meperidine (control pain) rarely used • **± Gastrostomy tube feeding** to rest esophagus





Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Vascular ring anomalies, Persistent right aortic arch, PRAA M8k 128; SAP 641, 646; IM 323; IM-WW 255; E-hb 452; 5min 936; H3B 69; H2B 68; GI 319; C12T 696t; Cat 1165; Sx-WW 123; Sx-S-hb 196, 202; Sx-S 538; Neo 145 *	• **Rare, Dog>> cats** • **Congenital defect:** persistence of 1 of the aortic arches, entraps the esophagus - **Persistent right aortic arch most common** (normally left persists) - Less common vascular anomalies: double aortic arch, aberrant subclavian aa. m/ cause same problem . All have same signs & treatments • Genetic: Ger. shepherd, Irish setters, Boston terrier • **Causes extraluminal esophageal obstruction**	• **Regurgitation of solid food** - 1st noted when puppy weaned onto solid food - Ravenous appetite - Often thin, stunted • Aspiration pneumonia - coughing **DDx:** • Stricture • Diverticulum • FB obstruction • Megaesophagus Esophagus surrounded by aortic arch to right, base of heart ventrally, pulmonary a. on left & ligamentum arteriosum dorsally	• Hx, CS • Radiographs: - **Dilation** of thoracic esophagus cranial to base of heart (contrast study) - Ventral displacement of trachea - Aspiration pneumonia in cranial & middle lung lobes	• **Sx: ligate & cut restricting ligamentum arteriosum** - Double ligate because 10% patent (opened) • Frequent gruel feeding 6 wks, head elevated Prognosis: **Poor, Sx helps all** - 10% cured - 50% intermittent regurgitation - 40% continue severe signs
Esophageal hiatus disorders; Hiatal hernia SAP 643 652; IM 323, I2M 415; 5min 674; H3B 324; IM-WW 257; E-hb 450; GI 331; Cat 1170; Sx-WW 197; Sx3B 240; Emrg 325 **	• **Abdominal esophagus & stomach through esophageal hiatus of diaphragm (hiatal hernia)** - Gastroesophageal intussusception (stomach into esophagus) • Young dogs > old • Large breeds • ± Associated w/ megaesophagus	• **Occasional or persistent regurgitation or vomition** • **Reflux esophagitis** **DDx:** • FB obstruction • Stricture • Chronic esophagitis • Persistent rt. aortic arch • Neoplasia • Megaesophagus • PRAA	• **Hx, CS** • **Radiology** - Dilation cranial diaphragm - ↑ radiopacity at intussusception, m/b normal (intermittent) - Contrast rads • **Endoscope**	• Medically manage gastric reflux (limited success, if no improvement in 1 mo - Sx) - Metoclopramide (empty stomach) - H-2 antagonists (↓ acid) - Sucralfate protects - ABs in some cases • **Surgical correction** of hiatal defect: esophagopexy, gastropexy, diaphragmatic crural opposition Prognosis: Guarded, many improve after surgery
E. tumors * SAP 644; IM 325, I2M 418; H3B 330; H2B 368; E-hb 453; C12T 696t; GI 321; Sx-WW 124; Pa-T 20	• **Rare** in dog & cat, Squamous cell carcinoma, fibrosarcoma, osteosarcoma, Undiff. carcinoma, leiomyoma, metastatic; **Spirocerca lupi** induced fibrosarcoma & granuloma • CS: Many **asymptomatic**; If large or disrupt esophagus: **regurgitation, anorexia, fetid breath, drooling, pain** • Dx: **Rad** - survey- m/b normal, mass in thorax, if obstruction - dilation cranially, **Contrast**: filling defect, stricture if ring neoplasia, thickened esophageal wall • DDx: FB obstruction, Stricture, Chronic esophagitis, Hiatal hernia • Tx: **None**, Sx rarely curative • Prognosis: **Grave**			
Esophagobronchial fistula * SAP 640, 650; H3B 329; H2B 364, E-hb 451; GI 321	• **Rare** in dog & cats, congenital or acquired (FB) • CS: **Respiratory dysfunction**: coughing associated w/ drinking: regurgitation; Aspiration pneumonia • Dx: **Rads** - survey: pulmonary consolidation, pleural fluids; contrast definitive; Esophascopy & bronchoscopy • Tx: **Surgical correction**; Broad spectrum ABs • Px: **Guarded** w/ successful surgery, **Grave w/out** (chronic bronchopneumonia)			

Mega-esophagus, Dilatation M8k 278, 128; Mk 110, 173; SAP 634, 1177; I2M 413; IM 322, 711; IM-WW 252; E-hb 322, 445; 361; 5min 810; H3B 323, 325; H2B 361; NS-C 258; NS-hb 238; NS-O 358; NS-L 111; NS-W 199 GI 324; C11T 580; Cat 1174; Neo 149; Sx-WW 122; Emrg 324; Pa-T 18 **	• Congenital: hereditary • Acquired: **Usually idiopathic**: unknown 1° neuromuscular dysfunction • 1° dogs • Breeds: G. shepherds, Great Danes, Irish setters **Causes: megaesophagus** • Congenital • Neuromuscular - **Idiopathic - #1** - **Myasthenia gravis** - SLE - Polymyositis - Polyneuropathy - Polyradiculoneuropathy (Coonhound paralysis) - Dermatomyositis - CNS diz (Caud. brain stem) - Tick paralysis - Giant axonal neuropathy - Labrador myopathy • Toxins - Botulism - Chronic organophosphate - Lead - Tetanus - Thallium • Miscellaneous - **Esophagitis**/fistula - Hypothyroid - Addison's - Thymoma - PRAA (persistent rt. aortic arch) - Mediastinitis - Dysautonomia [cat]	• **Regurgitation** (not vomiting) - Puppies suckle normally, but regurgitate solids - M/b immediately after eating or delayed • Progressive loss of condition • Sequela: **aspiration pneumonia**	• **History** • Pressure to abdomen m/ cause ballooning at thoracic inlet, difficult to see • Radiology: survey films - **Dilation** of thoracic esophagus - **Esophageal cone** in front of diaphragm - Ventral displacement of trachea - Aspiration pneumonia (cranial & middle lung lobes) - Contrast: esophageal dilation, little barium into stomach • Endoscopy • Fluoroscopy - motility • Neuromuscular: - Myasthenia gravis: measure antibodies to acetylcholine receptors, Tensilon® test if systemically weak - Electromyography • Immune-mediated diz markers, ANA (antinuclear antibody, serology) • Thyroid stimulation (TSH) test	• **Treat underlying cause (usually not determined)** • **Symptomatic (can't be cured)** - **Elevate dish** so eat while standing (gravity), maintain standing for 5-10 min after eating - **Semiliquid diet** at frequent intervals small portions, high calorie liquid or gruel diet, occasionally canned food better - Cisapride (prokinetic drug more potent than metoclopramide, available in Canada) • Myasthenia gravis - Pyridostigmine, neostigmine - ± Steroid: Prednisolone • Various drugs tried, usually ineffective (cisapride, metoclopramide) • Permanent gastrotomy tube • Tx aspiration pneumonia + H2O Prognosis: • **Grave to poor - rarely cure** - Especially if aspiration pneumonia - Most continue to regurgitate, but may improve w/ upright feeding - Aspiration always possible • Congenital: good, normal when mature
Dilated esophagus **CS: Regurgitation, Aspiration** **Dx: Hx, Rads** **Tx: Elevated dish, Semiliquid diet**	**DDx:** • Chronic esophagitis • Gastroesophageal intussusception • Obstructive dizs (FB, Ring anomalies, stricture, diverticula, neoplasia) • Hiatal disorders			
Periesophageal obstruction SAP 644; GI 322; C10T 904; Sx-S-hb 198; Sx-S 544; M8k 127; Cat 1166 *	• **Mechanical obstruction** of esophagus from surrounding tissue, may lead to stricture: mediastinal masses, thymomas, hilar lymphadenopathy, foreign body abscesses, tumors, mediastinal masses, fungal granulomas, heart base tumors, cysts • CS: Regurgitation, CS associated with mass & location • Dx: Contrast radiographs, esophagoscopy • Tx: **Treat cause of mass**			

Branchial (or lateral cervical) cyst M8k 127
Thyroglossal cyst M8k 127

Regurgitation - Vomiting

Condition	Facts/Causes	Presentation/CS	Diagnosis

Regurgitation or Vomiting

M8k 346; SAP 630; IM 259; I2M 348; 5min 140, 176; IM-WW 5, 9; E-hb 54, E 103; GI 150, 159; Cat 1184; F-N 223; F3IM61; C12T679; C11T583; DDx 261; Emrg 325

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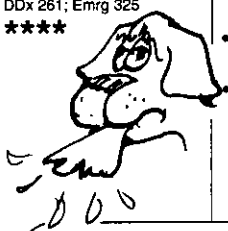
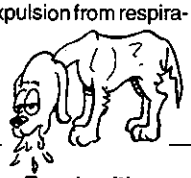
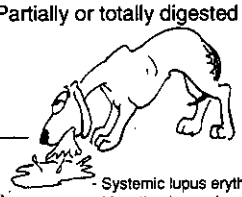


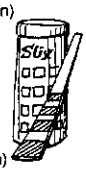
- **Clinical sign, not a disease**
- Need to R/O (rule out) causes
- **Regurgitation: passive**, retrograde movement of food, water from mouth &/or esophagus - **hallmark sign** of esophageal disorders
  - Megaesophagus very common cause of regurgitation
- **Vomiting: forceful** ejection of gastric (± intestinal) contents through mouth
- Expectoration: expulsion from respiratory tract



- **Regurgitation**: possible associated signs
  - Coughing & dyspnea (2° regurgitation)
  - Weakness (systemic disorder: myasthenia gravis, hypoadrenocorticism or polymyositis)
  - Weight loss & ravenous appetite (decreased nutrition)
  - Post ingestion distress (acquired esophageal obstruction/stricture)
- **Vomition**: possible associated signs
  - Marked abdominal effort
  - Nausea present
  - Partially or totally digested food

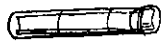


- **Differentiate regurgitation, vomiting & expectoration**
- Physical exam:
  - Expectoration associated w/ simultaneous coughing
  - Regurgitation & vomition, m/ cough; but not simultaneously
  - Mouth exam < check base of tongue
- Urine dip stick: for blood (false due to meat/vegetable protein)
  - pH > 7, no bilirubin = regurgitation
  - pH < 5, ± bilirubin = vomition



- **Regurgitation: pharynx or esophagus?**
  - Esophageal dysfunction: no dysphagia
  - Pharynx or cricopharyngeal region: dysphagia (difficult swallowing) & coughing after drinking water (aspiration)
  - Fluoroscopy: pharyngeal from cricopharyngeal dysfunction
  - Plain radiographs: for radiopaque foreign body
  - Contrast rads (barium): radiolucent foreign body, obstruction, muscular weakness
    - . Radiolucent foreign body: filling defect or stop barium
    - . Obstruction: barium stopped or constricted (vascular ring anomaly, stricture [cicatrix], achalasia of lower sphincter, neoplasia, extraesophageal)
- **Vomiting**: chronic or acute? hematemesis?
  - Coagulated blood = "coffee grounds" or fresh blood
  - Fecal exam for parasites
  - **Dietary trials before extensive diagnostic tests**
  - **Diagnostic workup** if symptomatic Tx ineffective
    - . Radiographs (plain): intestinal obstruction, FB, masses, pancreatitis or peritonitis (ground glass, free gas)
    - . Contrast radiographs: gastric outflow obstruction
    - . Hemogram, serum biochem. (electrolytes, Ca, glucose, hepatic enzymes [ALT & ALP], BUN, creatinine, albumin, amylase, lipase)
    - . Urinalysis
    - . FeLV (feline leukemia virus) & FIV (feline immunodeficiency virus)
    - . Serum thyroid concentration
    - . Heartworm test

(Dx continued below)



Regurgitation: causes

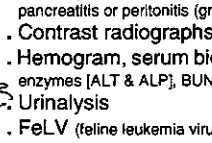
IM 262; E-hb 57

Esophageal obstruction
- Congenital vascular ring anomaly
- Foreign body
- Stricture
- Neoplasia (carcinoma, sarcoma from *Spirocerca lupi*)
- Extraesophageal compression
  - Thyroid carcinoma
  - Pulmonary alveolar cell carcinoma
  - Anterior mediastinal mass (cats)
- Gastroesophageal intussusception (rare)
- Functional obstruction of esophagus
- Cricopharyngeal achalasia (rare)
- Esophageal diverticulum (rare)
- Esophageal atresia (rare)

Esophagitis
- Gastroesophageal reflux
- Persistent vomiting
- Hiatal hernia
- Caustic agents

Megaesophagus (neuromuscular)
- Congenital megaesophagus
  - Idiopathic
  - Myasthenia gravis
- Acquired megaesophagus
- Neuropathy
  - Giant cell axonal
  - Ganglioradiculitis
  - Polyradiculoneuropathy
- Immune-mediated
  - Polyneuritis
  - Polymyositis
  - Systemic lupus erythematosis
  - Myasthenia gravis
  - Dermatomyositis (Collies)
- Myopathy
- Metabolic
  - Hypothyroidism
  - Hypoadrenocorticism
  - Other
- Lead
- Canine distemper
- Dysautonomia (cats)
- Chaga's diz

Pharyngeal disorders
- Rabies
- Foreign body
- Other obstructions



Vomiting - Causes

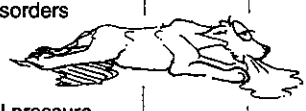
E-hb 55; IM 263, SAP 656

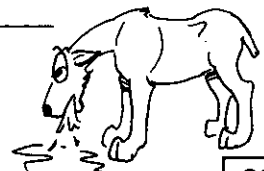
- **Motion sickness**
- **Overeating**
- **Drugs** (almost any)
  - Tetracyclines
  - Erythromycin
  - Adriamycin
  - Digoxin
  - Cisplatin
  - Cyclophosphamide

- **Toxins**
  - Blood-borne toxins
  - Heavy metals
  - Pesticides
  - Solvents, etc.
- **Systemic diseases**
  - Pancreatitis
  - Pyometra
  - Hypoadrenocorticism
  - Diabetic ketoacidosis
  - Renal failure/uremia
  - Liver disease
  - Cholecystitis
  - Hypercalcemia
  - Splenic disease
- **Infectious diseases**
  - Viral:
    - . Feline panleukopenia
    - . Canine distemper
    - . Canine Corona, Parvo & ICH
  - Bacterial & Rickettsia
    - . Leptospirosis
    - . Salmonellosis
    - . Neorickettsia
  - Parasitic
    - . Ascarids
    - . Giardiasis
- **Abdominal Inflammation**
  - Inflammatory bowel diz
  - Enteritis
  - Gastritis
  - Colitis
  - Pancreatitis
  - Peritonitis (septic, ruptured bowel, bile duct or urinary tract)

- **GI obstruction**
  - Stomach outflow
    - . Foreign body
    - . Gastric dilation/volvulus
    - . Pyloric stenosis
    - . Mucosal hypertrophy
    - . Infiltrative diz (phycomycosis)
    - . Neoplasia (rare)
  - Intestinal obstruction
    - . Foreign body
    - . Torsion/volvulus
    - . Intussusception
    - . Stricture
    - . Neoplasia

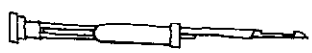
- **Nervous**
  - Vestibular diz: peripheral & central
  - Behavioral disorders
  - Epilepsy
  - Psychogenic
  - CNS diz
  - ↑ Intracranial pressure
    - . Trauma
    - . Tumor
    - . Hydrocephalus
  - Encephalitis
  - Hypoxia of vomiting center: extreme anemia or blood loss
- **Miscellaneous:**
  - Postsurgical nausea
  - Idiopathic hypomotility
  - Feline heartworm diz
  - Feline hyperthyroidism
  - **Idiopathic**





CS, not diz
Other CS clues to cause
Dx: Differentiate
Tx: Symptomatic 1st

(Dx continued)



- **GI tract biopsy if above inconclusive**, endoscopy or laparotomy/biopsy of stomach, duodenum, mesenteric lymph nodes, liver & anything abnormal
- **Review DDx list if above inconclusive**
  - . Hepatic function tests: may have normal ALT & SAP
  - . ACTH stimulation test (glucocorticoid insufficiency)
  - . 2° hypoadrenocorticism may have normal electrolytes
  - . Pancreatitis may have normal amylase & lipase
  - . Serum thyroid concentration (feline hyperthyroidism may have normal thyroxine early)
- **Consider less common cause**
  - . Occult CNS dizs
  - . Idiopathic gastric hypomotility
  - . Limbic epilepsy
  - . Feline heartworm diz (seen in 50% of cases)

- **Treatment of regurgitation**
  - Remove initiating cause
  - Minimize chances for aspiration
  - Maximize nutrition into GI tract
  - Check & correct dehydration, electrolyte imbalances or sepsis

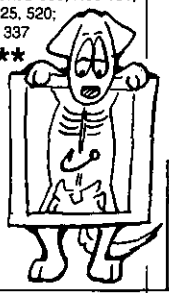
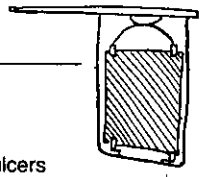
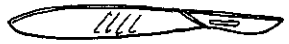
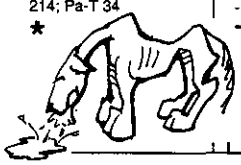
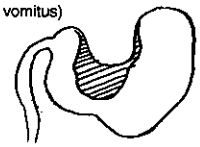
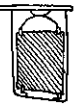
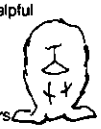
Px: Obstruction: Guarded depending of severity & duration
- Megaesophagus: Poor
- Esophagitis: Guarded to good

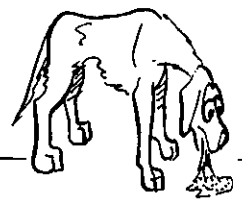
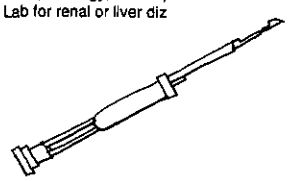
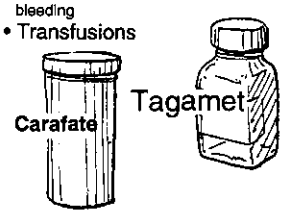
- **Tx: vomiting**
  - **Treat symptomatically** if no cause determined
    - . Fluids & electrolytes if necessary
    - . Dietary trials before extensive diagnostic tests
  - **Diagnostic work up** if symptomatic Tx ineffective

Gastritis

Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Acute gastritis M8k 294; Mk 236; SAP 658; E-hb 455; E 1151; 5min; H3B 335; H2B 375; I2M 420; IM 326; IM-WW 258, 260; Cat 1190; Emrg 157; Neo 157; Pa-T 27 ****	• **Dog** (indiscriminate eaters) > cat • Low-grade inflammation w/ shallow erosions of mucosa • Pathophysiology: damage to mucosa - HCl into wall; stimulates vomiting center (brain stem) **Causes: acute gastritis** • Idiopathic #1 • Dietary indiscretion (overeating, "garbage can" intoxication) • FB (bones, hair, shoes) • Irritant drugs (aspirin) or chem. • Sequela to gastric torsion • Assoc w/ metabolic diz • GI parasites • Early chronic GI diz	• **Vomiting** • **Depression** • **Abdominal pain** (restlessness, crouching) • Anorexia or depraved appetite (chew dirt, eat grass) • Excessive thirst • Dehydration • Severe: ± enteritis also • ± Concurrent diarrhea • Borborygmus • Halitosis **DDx:** • Pyloric obstruction • Gastric diz (ulcers, pyloric dysfunction, tumors) • Metabolic diz: vomiting (pancreatitis, hepatic diz, renal diz, hypoadrenocorticism, DKA [diabetic ketoacidosis]) • Toxins/poisons • CNS: cerebellar/vestibular disorders • Small or large bowel diz	• **Hx, CS** • **Mild CS:** - **No diagnosis necessary** - **Response to Tx is diagnostic** - Fecal • **Serious:** - CBC, protein - Fecal - Abdominal radiographs • Dx often by elimination - R/O pyloric obstruction, FB & parasites	• **Mild gastritis - self-limiting** - **NPO for 12-24 hours** to rest stomach - If no vomiting then ice cubes or sm. amounts of water - Bland diet at 24 hrs if no vomiting (I/d, cottage cheese + rice, tofu + rice) - SQ fluids - Cat: treat for hairballs • Serious: - SQ or IV fluids - ± Antiemetics: . **Chlorpromazine** (Thorazine®) (vomit center) . Metoclopramide (local GI & CTZ [chemo. receptive trigger zone, brain]) - Follow w/ diagnostics as needed - ± H_2 blockers **NPO** Prognosis: **Excellent**
Cats: Chronic gastritis Mk 236; SAP 663; H3B 336, 373; I2M 421; IM 327; Cat 1195 **	• Causes: - **Lymphocytic/plasmacytic gastritis (LPE), most common** . Thought to be immune-mediated - Internal parasites: *Ollulanus tricuspis, Gnathostoma* - Eosinophilic gastritis - Hairballs (trichobezoars) - Pica (eat grass, chew dirt) **Immunemediated? Intermittent vomiting - Biopsy** **Tx: i/d diet, Steroids • Px: Guarded**	• **CS ill-defined** & m/b obscure • **Usually in good condition w/ little weight loss or diarrhea** • **Intermittent vomiting** (not in all) - ± Periodic exacerbation • ± Weight loss, anorexia • ± Abdominal pain • Chronic belching • Pica (eat grass, chew dirt)	• Hx, CS • Lab: usually normal - ± Eosinophilia in eosinophilic gastritis . Often assoc. systemic diz (bad Px) • Radiographs usually normal • Endoscopy: variable • **Biopsy - definitive** - Lymphocytes & plasma cell infiltrate: suspect immune mechanism - Eosinophilic infiltrate in eosinophilic gastritis	• **Dietary control** for 3-4 weeks to rule in or out food allergies or intolerance . Bland, hypoallergenic diet (hi CHOs) .. **i/d** or **d/d**, boiled lamb & rice, Small freq. meals. May respond • Steroids + Diet (prednisolone) • NO Imuran® (azathioprine) in cats • Parasite Tx: Panacur (FBZ), Ivermectin • Treat for hair balls **Prognosis: Guarded: LPE** • Poor: eosinophilic gastritis • Good: parasites

Dogs: Chronic gastritis M8k 294; Mk 236; SAP 663; E-hb 457; E 1154; 5min 618, 620, 622, 624; H3B 336; H2B 376; I2M 421; IM 327; IM-WW 263; Pa-T 28 **	• **Uncommon** • Chronic inflam. of gastric wall • Most never diagnosed: idiopathic • **Histological types - biopsy** - Chronic superficial gastritis (most common) - Atrophic gastritis - Chronic hypertrophic gastritis - Eosinophilic gastritis - Granulomatous gastritis - Lymphocytic/plasmacytic gastritis (cats) - Phycomycosis: fungus **Causes: Chronic gastritis** • Idiopathic #1 • Chronic irritation • Allergies • Parasites • Immunemediated (esp. in cats) • Hyperacidity • 2° motility disorder • Metabolic diz (renal failure, hepatic diz) • Pica (eat grass, chew dirt) **Histo types** **CS: Intermittent vomiting, Ulcers** **Dx: Difficult to Dx & Tx, Biopsy** **Tx: Symptomatic, Steroids**	• **CS ill-defined** & m/b obscure • Some asymptomatic or symptomatic for several months • **Usually in good condition w/ little weight loss or diarrhea** • **Intermittent vomiting** (not in all) - M/b periodic exacerbation, many times/d to once/wk • ± Weight loss, anorexia • ± Abdominal pain • Chronic belching • Pica (eat grass, chew dirt) • Sequela: **Gastric ulcers** from any cause of chronic gastritis **Elimination/hypoallergenic diet** • Bland diet (easily digestible & nonirritating) - Hill's i/d or d/d - Cottage cheese & rice - Tofu & rice - Boiled chicken & rice **DDx:** • Acute gastritis • Gastric diz (ulcers, FB, pyloric dysfunction, neoplasia, phycomycosis) • Small or large bowel diz • Metabolic diz (renal, hepatic, hypoadrenocorticism, pancreatitis) • CNS - cerebellar/vestibular disorders	• **DIFFICULT TO Dx** • **Lab: not diagnostic** - Anemia if ulcers - Eosinophilia m/b assoc. w/ eosinophilic types - Other chemistries usually normal • Multiple fecals - parasites • Radiographs - not diagnostic - Plain film: m/b normal - Contrast films - ↓ to enlarged rugae, granulomatous nodule, blotch contrast contact - ↑ Mucous or inflam. & ulceration, delayed emptying - Contrast: pyloric obstruction, hypomotility • Endoscope: thinning or thickening, edema, ulceration, hemorrhage, hyperemia or normal • **Biopsy: definitive Dx - histopath. necessary** - **Superficial**: inflammatory cell infiltrate (lymphocytes, plasma cells & PMNs) & fibrosis, no thickening - **Atrophic**: m/b advanced chronic superficial gastritis, thinning of mucosa, inflammation infiltrate, ↓ glandular cells - **Hypertrophy**/hyperplasia of gastric epithelium (↑ size or number of cells) - **Eosinophilic**: eosinophilic infiltrate - **Granulomatous**: granulomas - **Lymphocytic/plasmacytic**: lympho/plasma cell infiltrate . Suspect immune mechanism - Pythiosis: nonseptate or sparsely septate hyphae: Romanowsky stains: "**ghosts**" (don't stain)	• **Remove cause if determined** • **Usually no Dx** • **Symptomatic Tx if no biopsy** - **1. Dietary control** for 3-4 wks to rule in or out food allergies or intolerance . Bland, hypoallergenic diet (hi CHOs) .. I/D or D/D, Cottage cheese or tofu & rice .. Small frequent meals - **2. Histamine H2-receptor blockers** Cimetidine (Tagamet®), Ranitidine (Zantac®) . Inhibit acid secretion; may help many . Contraindicated in atrophic gastritis - **3. Deworm even if negative fecal** - **4. Sx if pyloric obstruction** • **If no response: biopsy & treat according to biopsy** - **1-4 above** **Steroids +** - **5: Steroids + diet** . If immune mech. is suspected (see lympho/plasma cells in biopsy or eosinophils) . Steroid (prednisolone) . Contraindicated if lymphoma • If continued vomiting - **2° gastric motility disorder** . Metoclopramide (Reglan®) 30 min before meal, or q6h-q8h. Central antiemetic & promotes gastric emptying, but no effect on 1° chronic gastritis • Pythiosis: complete surgical excision only cure, resistant to antifungal drugs **Tagamet** **Prognosis:** Variable • Superficial: good • Hypertrophic: guarded • Immune-mediated: good • Eosinophilic: good dog, poor cat? • Pythiosis: grave

Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Gastric foreign body Mk 229; I2M 424; IM 328; GI 341; E-hb 462; E 1160; Cat 1193; Sx-WW 128; Sx-S-hb 206; Sx-S 568; Sx4B 205; Sx3B 568; Neo 161; X-T 525, 520; Emrg 337 ****	• **Common** in dogs >> cats • **Radiopaque** (metallic, needles, stones, fish hooks) • **Radiolucent** (trichobezoars [hairballs], cloth [panty hose], plastic) • Depraved appetites associated w/ rabies, pancreatic diz, avitaminosis, mineral deficiency  **Dogs > Cats, Hairballs: Cats** **CS: Variable - Vomiting** **Dx: Rads** **Tx: Remove**	• **Extremely variable CS** • **Some asymptomatic** • **Gastritis:** - **Vomiting** not regurgitation - Depression - Abdominal pain - Refuse to eat • **Hairballs in cats** - Retching, vomiting, inappetence, loss of condition - Behavior change: eat 2 bites ravenously then loses interest 	• History & PE (tentative) • ± Palpate object • **Radiology** (definitive) - Radiopaque easily seen - Contrast: radiolucent . Filling defect or retain barium when stomach empty (fabric) • Endoscope: difficult if food in stomach  **DDx:** • Rabies • Gastritis • Gastric ulcers • Pyloric canal obstruction • Gastric tumors • Pancreatic diz • Vit. & mineral deficiency	• Some m/b allowed to pass if unlikely to cause trauma - **Petrolatum**: hair balls in cats . 1 or more doses, usually pass • Most should be removed - Small smooth objects . Induce vomiting .. Dog: Apomorphine 0.02-0.4 mg/kg IV/SQ ... Cat: Rhompun® (xylazine) 1-2 mg/kg IV/SQ - Gastroscopy: removal of some small objects or cloth - **Gastrotomy** necessary for many FB  Prognosis: **Good** if removed & no septic peritonitis from perforation of GI tract
Gastric tumors M8k 295; I2M 431; IM 332; SAP 672, 678; E-hb 458, 465; IM-WW 265; E 1164; H3B 341; H2B 385; Cat 1204; C11T 595; Sx4B 214; Pa-T 34 *	• **Rare**: low incidence in dogs > cats (1% of all anaplasias) • Alter gastric motility or obstruct outflow • Malignant tumors - **#1: adenocarcinoma - dog** - **#1: lymphosarcoma - cat** - Metastasis uncommon • Benign tumors - Leiomyomas: #2 gastric tumor in dog - Polyps  Adeno - Dog, Lympho - Cat CS: Persistent vomiting/wt. loss Dx: Rads Tx: None • Px: Grave	• **Hematemesis** (blood in vomitus) • **Persistent vomiting** • **Weight loss/anorexia** - **Cancer cachexia** • Diarrhea, **melena** • Sequela: **Metastasis** (ascites, jaundice, respiratory distress)  **DDx:** • Chronic gastritis • Gastric ulcers • Gastric FB • Pyloric canal obstruction • Phycomycosis	• **Suspect in older dogs w/ chronic vomiting** • Radiographs - Plain film: undiagnostic; m/ be normal or thickening of wall, intraluminal mass - Thorax for metastasis - **Contrast** or double contrast . Filling defect . Thickened or irregular wall . Fixed rigid walls, undistended . Pyloric canal obstruction . Delayed emptying . Ulceration frequent  • ± **Endoscopy: biopsy mucosa** • **Laparotomy: full thickness biopsy,** control hemorrhage, check for metastasis/invasion	• **None**: usually advanced lesions before CS - Complete surgical removal usually impossible for malignant tumors (invasive), may increase survival time by several months . Partial gastrectomy . Pylorotomy if obstructed - Chemotherapy rarely helpful . Lymphosarcoma chemotherapy m/b helpful  Prognosis: **Grave**, < 6 mo survival time for 1° tumors

Gastric ulcers/ Erosions, GI bleeding M8k 299; Mk 118, SAP 660; I2M 429; IM 330; ; IM-WW 261; E-hb 458; GI 348; E 1155; 5min 610; H3B 338, 366; H2B 382, 412; Cat 1199; C12T 706; C11T 132; Sx-S-hb 207; Sx-S 576; Sx-WW 129; Pa-T 25; X-T 533 **	• **Dogs >> cats** • Pathophysiology: - Damage to gastric mucosa - HCl diffuses backwards further damage **Causes - gastric ulcers:** • Iatrogenic: NSAIDs (naproxen, indomethacin, Banamine®, phenylbutazone, **aspirin**, ibuprofen, piroxicam, naproxen - Steroids especially dexamethasone or combo w/ NSAIDs) • "Stress": hypovolemic or septic shock, trauma, surgery & endotoxemia • Acute or chronic gastritis (erosion of mucosa) • Foreign body abrasion • Hyperacidity: Mast cell tumor, Gastrinoma (rare) • Neurological diz • Metabolic disorders: renal failure, liver diz, Addison's diz, systemic mastocytosis • Bacterial • Severe uremia • Idiopathic • Inflammatory bowel diz	• **Chronic vomiting** - **"Coffee grounds"** digested blood • **Melena (blood in feces)** • Weight loss • Abdominal pain variable • ± **Asymptomatic** • Sequelae: Gastric rupture & peritonitis  **Stress** **CS: Vomiting, "Coffee grounds"** **Dx: Endoscope** **Tx: Antacid/Cimetidine/Sucralfate**	• **Blood in vomitus, assume ulcer** • Aspirate any cutaneous mass for mast cell tumor • Lab to rule out (R/O) metabolic diz & coagulopathies • Radiology: - Plain films : normal or local thickening - Contrast films: . Craters, niches, ulcers (doesn't show superficial lesions so negative doesn't rule out [R/O]) . Lesser curvature & pyloric region . Mucosal fold m/ radiate from ulcer & be irregular & thickened • **Endoscope best, ± biopsy** • Exploratory laparotomy (biopsy for histopathology, tumors) • Lab for renal or liver diz 	• Correct cause: remove stress • **Nonlife threatening ulcers** - **Symptomatic** - Reduce H^+ & peptic activity . Antacids not recommended . Na bicarbonate (be careful of alkalosis) . **Cimetidine (Tagamet®) or Ranitidine (Zantac®)**, H_2-receptor antagonist effective in controlling, ↓ **HCl**; famotidine (Pepcid®) more potent . **Sucralfate** (Carafate®) protect . Misoprostol (Cytotec®) especially for NSAIDs ulcers - Parenteral fluids • Sx excision: if life-threatening bleeding • Transfusions  Prognosis: **Good** if cause removed or controlled & no perforation

Hematemesis

I2M 354; IM 266; 5min 76

- **Blood in vomitus**
- Most common cause is gastric ulcers/erosions

Causes Hematemesis
- **GI ulceration (see above)**

- Gastritis
- Hemorrhagic gastroenteritis
- Bleeding oral lesions
- Esophageal diz (uncommon)
- Gallbladder diz (rare)

- Coagulopathy (uncommon):
  - DIC
  - Clotting factor deficiency
  - Thrombocytopenia

- Extra-GI tract lesions (rare)
  - Respiratory tract
    - Caudal nares bleeding
    - Lung lobe torsion
    - Pulmonary tumor
    - Thromboembolism

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Pyloric canal obstruction, Gastric outlet obstruction M8k 129; IM 327; I2M 423; IM-WW 264; SAP 668, 681; E-hb 461; E 1160; 5min 996; H3B 334; H2B 373; GI 353; Cat 1201; Sx-S-hb 203; Sx-S 561; Sx-WW 127; Sx4B 207; Sx3B 232; X-T 528; Pa-T 25 ** **Obstruction** **CS: Vomiting** **Tx: Pyloroplasty**	• **Causes:** - **Pyloric stenosis** (benign hypertrophy of muscles of pylorus) congenital & acquired, brachiocephalic dogs (Boxer, Boston terrier), Siamese cats - Pyloric neoplasia - Hepatic & pancreatic abscesses, neoplasia or inflammation - Gastric histoplasmosis & phycomycosis - **FB**, gastric ulcers, antral polyps - Pyloric spasms - Antral polyps	• **Gastric distention** • **Vomiting** following meals (undigested food) • **Projectile vomiting** (stenosis) • Vomiting food > 8 hr after meal • Chronic - weight loss & dehydration • Excellent appetite **DDx:** • Gastritis • Gastric ulcers • Gastric FB • Gastric tumors • Motility disorders	• **Hx (breeds), CS** • Lab: metabolic alkalosis (loss of gastric acid) • **Radiology**: definitive - Enlarged stomach - Contains fluid & food - Foreign bodies - Narrow canal in hypertrophy & neoplasia . **"Beak-sign"**: contrast entering pyloric canal in stenosis - **Delayed emptying time** 3 to 6 hrs (< 30 minutes normal) If normal m/ mix barium w/ food	• Correct any electrolyte imbalance • **Pyloroplasty** better than pyloromyotomy: widens pyloric canal - Biopsy to rule out neoplasia • Metoclopramide (Reglan®) if gastric stasis persists after Sx to improve gastric emptying Prognosis: **Good if no neoplasia**
Idiopathic gastric hypomotility, Motility disorder IM 330; SAP 670; 5min 612; H3B 340; H2B 381; E-hb 464; E 1163; GI 355; Cat 1203 Neo 161 ** **Syndrome** **CS: Vomiting hours after eating** **Dx: R/O DDx, Fluoroscope, Rads** **Tx: i/d diet, Raglan • Px: Good**	• **Syndrome**: poor gastric emptying & motility w/ no anatomic or mucosal inflammation • Dogs > cats **DDx: Motility disorders** • Gastric outlet obstruction • Infiltrative bowel diz • Inflammatory bowel diz (parvovirus, gastritis, ulcers) • Organ failure: Renal, Adrenal, Hepatic • Neurological disorders (stress, trauma, pain, surgery, psychogenic) • Metabolic disorders (hypokalemia, uremia, hepatic encephalopathy, hypothyroidism) • Drugs: anticholinergics, narcotic analgesics	• **Normal healthy dog** • **Vomit several hours after eating** • ± Weight loss	• **R/O** (rule out) other causes of delayed emptying (See DDx) • Fluoroscope to seemmotility • Radiology: **delayed contrast emptying** (5-10 hrs)	• **Dietary management** - Feed small amounts of semiliquid, low protein, low fat diet (i/d or d/d) frequently • **Metoclopramide (Raglan®)** ↑ Gastric peristalsis - Contraindicated in gastric outflow obstruction • Cisapride & domperidone (new drug that m/ help those not responding to metoclopramide) Reglan i/d Prognosis: • **Good** if respond to metoclopramide • Poor if doesn't, but still m/b an acceptable pet

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Gastric dilatation/ volvulus - torsion, GDV, Bloat M8k 291; Mk 234; SAP 674, 677; I2M 426; IM 329; IM-WW 260; E-hb 463; E 1161; 5min 608; H3B 345; H2B 389; GI 361, 396; Sx-S-hb 209; Sx-S 580; Sx-WW 129; Sx4B 223; Sx3B 224; Neo 162; Pa-T 22; X-T 527 ** **Narrow & Deep-chested** **CS: Pain, Shock** **Dx: Percuss, Decompress** **Emergency: Decompress & Tx shock**	• **Medical & surgical emergency** • **High mortality** • Dilatation: all small animals due to swallowed air, overeating • Volvulus (twisting) common, rotates clockwise occluding esophagus & pylorus - **Narrow & deep-chested medium to large breed dogs** (Great Dane, Doby, St. Bernard) • Cause: unknown - Hereditary - Large meals/quantities of water - Splenic engorgement & rotation - Pyloric sphincter dysfunction - Postprandial exercise - Aerophagia (swallowing air) - Motility disorders • Pathophysiology: - Distention precedes volvulus - Volvulus m/ obstruct stomach . Progressive distention . Obstructs portal & cranial vena caval blood flow .. Hypovolemic shock .. Endotoxic shock & death - Torsion of spleen **DDx:** • Simple dilation • Splenic torsion • Peritonitis • Pleural effusion • Small intestine volvulus • Diaphragmatic hernia • Acute abdomen syndrome	• Inconsistent depending on degree of rotation, 2° shock & toxemia • **Retching, but can't vomit** • **Pain**, restlessness, excessive salivation • **Distended** cr. abdomen - Tympanic • Cyanosis • Depression w/ time • Dyspnea w/ hyperpnea • Partial volvulus: intermittent episodes of partial bloat & vomiting • Sequelae: - **Hypovolemic shock** - DIC - Gastric necrosis (greater curvature) rupture w/ peritonitis - Cardiac arrhythmias - **Death** in a few hours if volvulus/ torsion	• **Simple dilatation indistinguishable on CS from dilatation/ volvulus** • Percuss tympanic abdomen • Treat for shock & decompress before radiography - **Shock** w/ time (tachycardia, weak peripheral pulse, pale mucous membranes, cold extremities, depressed capillary refill weakness) • **Rads plain: right lateral recumbency** - Distend gas or fluid filled stomach - **Soft tissue line** ("shelf") across twisted stomach, not in simple distention - Pylorus displaced - **Spleen not in normal location**/orientation in lat & VD/DV views - ± Paralytic gas ileus - Enlarged spleen, m/b displaced to the right - Small heart & caud. vena cava (hypovolemia) • Contrast rads helps see - Distention - pylorus in cranial right abdomen - Gastric volvulus, pylorus in dors. lt. cr. quadrant • Lab: - Acidosis usually - Hypokalemia common • Postmortem (PM): - Atonic, large stomach - Hyperemia, venous engorgement, splenomegaly, gas filled intestines, gastric mucosa lesions	• **EMERGENCY** usually • **1st gastric decompression & treat shock simultaneously** - **Decompress** . Trocharize 16-18-g needle, then . Stomach tube - **Lavage stomach** - Fluids, isotonic saline IV 90ml/kg/hr - Steroids - Banamine® (flunixin meglumine) 1 dose for toxemia - ECG monitor constantly • **Surgically correct volvulus** - Circumcostal gastropexy to prevent recurrence - **Post surgical Tx critical** . ECG for 48-72 hrs - arrhythmias .. Lidocaine, procainamide &/or quinidine . Hypokalemia common - fluid Tx **Prevention:** • Difficult because unknown cause • Small meals w/ low fat to promote gastric emptying • Minimize exercise after eating • Minimize water after exercise • Train clients to recognize signs & come in immediately **Prognosis: Grave to guarded** depending on how quickly diagnosed & treated

Diarrhea

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Diarrhea M8k112; Mk225; SAP 687; E-hb 468, 474; E 1178; 5min 46; 12M 434; IM 335; IM-WW 15; GI 163, 399; Cat 1211; DDx 273; NB 10.17 ★★★★	• **Major presenting CS, not diz** • Most consistent CS of small intestinal diz • **Acute diarrhea less than 3 wks duration** - Most resolve spontaneously - Some life-threatening • **Chronic if over 3 wks duration** - Extensive diagnostic procedures	• **Acute diarrhea of short duration** • **Severe acute diarrhea** - Severe diarrhea, bloody, or associated w/ systemic signs	• **Mild acute** **- Extensive Dx not needed** - Hx, PE & fecal m/b enough • **Severe acute: further work up needed** • **Chronic: extensive diagnostic procedures**	• **Mild acute diarrhea** **- Symptomatic Tx (fluids, NPO, i/d diet)** • **Severe acute diarrhea (cause unknown)** **- Intense symptomatic Tx** • **Chronic diarrhea** **- Symptomatic Tx** **- Intensive diagnostic procedures to find cause**
Mild, acute diarrhea, Idiopathic diarrhea, Acute enteritis Mk 225; 5min 46; I2M 434; IM 335; IM-WW 270; E-hb 468; E 1178; GI 163, 400, 405; Cat 1213; DDx 273; C12T 701; NB 10.17 ★★★★	• **Common** • Dogs & cats, especially kittens & puppies • Acute or chronic inflam. of mucous membrane of small intestine • **Less than 3 wks duration** • Often of unknown cause • **Most spontaneously improve** - Mortality possible in young because of little nutritional reserves - Dehydration, acidosis, electrolyte imbalance or sepsis • Associated w/ gastritis or colitis usually (all 3 m/be single entity)	• **Diarrhea** • **± Vomition** • Initially borborygmi (sounds in gut) • Complications - Dehydration - Electrolyte depletion - Acidosis	• **Often not diagnosed** • Dx by elimination - History & clinical signs - Fecal for parasites • **If mild: Tx symptomatically & Dx not pursued further unless doesn't resolve** • If severe or unresolved - further Dx (see below)	• Generally self limiting **NPO** • Tx similar to gastritis • **Symptomatic** because unknown cause or virus w/ no specific treatment - Fluids: rehydrate Ringer's sol, Mild dehydration: fluids (oral &/or SQ), IV fluids if severe, home oral rehydration • **Withhold food ("rest" GI)** for 24 hrs (if vomiting persists give ice cubes to lick only) - After 24 hrs, slowly start to bring onto food: easily digested food (cottage cheese + rice, boiled chicken + rice, rice added to canine i/d & feline c/d Hill's diet • Pepto-Bismol® (bismuth subsalicylate): good because of antienterotoxin, antisecretory & antiinflammatory. Use carefully in cats (toxic) • Antiemetics if vomiting: chlorpromazine (Thorazine®), metoclopramide (Raglan®) or prochlorperazine/ (Compazine®), isopropamide (Darbazine®) - inhibit vomiting • Meperidine (Demerol®) for pain

Mild acute diarrhea: Causes similar to enteritis
- **Idiopathic** (frequently cause unknown)
- Overeating, spoiled foods
- FB (bones, hair, etc.)
- Associated w/ infectious diz (distemper, viral hepatitis, leptospirosis, acute pancreatitis, pyelonephritis, chronic renal failure, gastrointestinal parasites)
- 2° to viral (parvo & coronavirus)
- Bact. infec (*Salmonella, E. coli, Shigella, Campylobacter sp.*)
- Heavy metal poisoning
- Parasites
- Abrupt change in diet

< 3 wks duration
CS: Diarrhea
Dx: Tx, Diagnostic workup if unresolved
Tx: Fluids, Rest GI, Pepto-B • Px: Good

Prognosis: Good

Severe acute diarrhea, Idiopathic diarrhea, Severe acute enteritis Mk 225; 5min 46; I2M 434; IM 335; E-hb 468; E 1178; GI 163, 400, 405; DDx 273; C12T 701; NB 10.17 ★★★	• **Common** • Severe, bloody or systemic signs (fever, depression & dehydration) - Requires more thorough Dx than mild diarrhea	• **Same as mild, but more severe** • **± Bloody diarrhea** (dark & foul smelling, m/b black if bleeding hi up, or frank blood if down low) • **Vomition** (if proximal duodenum & stomach involved) • **Systemic signs** **- Fever** **- Depression** **- Dehydration** • Complications - Dehydration - Electrolyte depletion - Acidosis - Septic shock - Hypoglycemia (kittens & puppies esp.)	• **Comprehensive Dx** • Lab: - Neutropenia - Hemoconcentration (dehydration) - Virologic testing . ELISA for canine parvovirus . Serology for FeLV & FIV viruses - Fecal cultures (Salmonella, Campylobacter) - Blood glucose (hypoglycemia) - Serum electrolytes (fluid therapy) - Blood gases • Radiology: - Mechanical disorders - Obstructive disorders	• **Symptomatic** (unknown cause) • Rehydrate: Ringer's sol - > 8-10% dehydration IV fluids (sunken eyes, fast, weak pulse, marked depression) . Add K (potassium) . Home oral rehydration **Pepto-Bismol** • **Antidiarrheal**: make home care more acceptable in severe diarrhea **- Pepto-Bismol®** (bismuth subsalicylate) controls diarrhea in mild to moderate cases (antienterotoxin, antisecretory & antiinflammatory) . Use w/ caution in cats: subsalicylate intoxication, fortunately cats seldom need - Opiates: diphenoxylate (Lomotil®) - If needed for more than 3-5 d, reassess patient carefully - Avoid anticholinergics • **Antiemetics: chlorpromazine (Thorazine®)**, metoclopramide (Raglan®) or prochlorperazine/isopropamide (Compazine®/Darbazine®) - inhibits vomiting - Only in well hydrated patient, may causes hypotension • **Withhold food & water or feed?** - Feeding m/ quicken recovery w/ less wt. loss in humans (IM) . Feed if doesn't markedly worsen vomiting or fluid loss . Easily digested food (cottage cheese + rice, boiled chicken + rice, rice added to Hill's i/d diet) • **NPO withhold food ("rest" GI)** for 24 hrs (if vomiting persists give ice cubes to lick only) - After 24 hrs, slowly start to bring onto food • Febrile, neutropenia, septic shock or bloody stool **- Broad-spectrum ABs** • Hypoglycemia & septic shock in puppies & kittens **- Dextrose** added to IV fluids or 20% bolus or 20% dextrose IV • Septic shock: **steroids** • **Disinfect area w/ Chlorox** (dilute 1:32 in water)

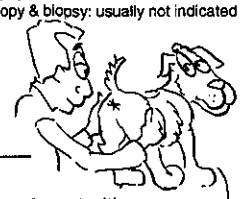
Severe, bloody or systemic signs
CS: Severe diarrhea, ± Bloody diarrhea, ± Systemic signs
Dx: Comprehensive Dx
Tx: Fluids, Pepto-Bismol, Antiemetics, "Rest" GI

Prognosis
- Good
- Guarded for emaciated, young & heavily parasitized

Colitis

Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Acute colitis, Proctitis M8k 280; 5min 466; H3B 377; I2M 460; IM-WW 281; H2B 419; E-hb 491; E 1233; C12T696t	• **Acute, nonspecific inflammation of colon** • Common in **dog**, less frequent in cats • Young or debilitated animals (especially infectious dizs, garbage scavengers) • Pathophysiology: **inflammation** - Mucosal damage: bleeding, diarrhea - Mucous secretion: mucoid stools - ↓ Water & sodium absorption = watery diarrhea - Colonic stimulates + ↑ frequency of defecation, straining, pain	• **Acute large bowel diarrhea** - **Semiformed to liquid feces** - **Fresh blood** (hematochezia) - **Mucus** - ↑ **Frequency** of defecation - **Straining** to defecate (tenesmus) - **Painful** defecation (dyschezia) • ± Vomiting • Dehydration, depression • Fever	• **Hx** (young, debilitated, garbage), CS • **R/O Trichuris 1st**, #1 cause • **PE**: dehydration, nonlocalized abdominal pain • **Rectal exar...** fresh blood, mucous, FB • CBC: ↑ PCV, ↑ TPP, stress leukogram, leukopenia, ± eosinophilia • Fecal exam: - Flotation, repeat 2-3 x if negative - Cytology: saline smears: motile, S-shaped rods (Campylobacter) - Stained Wright's or new methylene blue - Fecal cultures • Radiography to R/O other disorders • Colonoscopy & biopsy: usually not indicated	• Specific Tx for underlying cause • **Symptomatically** if idiopathic - **Withhold food for 24 hours**, free choice water if not vomiting - **Bland diet**: 2nd day small frequent bland diet if signs resolve (baby food, boiled hamburger or poultry w/ rice & cottage cheese, Hill's i/d) - **Fluid**: Lactated Ringer's sol. + potassium - **ABs**: broad spectrum: . Ampicillin IV, IM, SQ, QID, esp. Clostridium . Chloramphenicol PO, Yersinia, *E. coli* . Tetracycline PO, Yersinia, *E. coli* . Metronidazole, Clostridium . Norfloxacin PO, Salmonella - ± **Motility-modifying** . ± **Narcotic analgesics**: only for 36-48 hrs, ↓ frequency of bowel movements, ↓ pain & tenesmus, ↓ fluid secretion; contraindicated for infectious enteritis (salmonellosis), **not for cats**; side effects: constipation, bloating, sedation .. Diphenoxylate HCl (Lomotil®) PO TID .. Loperamide (Imodium®) PO TID .. Paregoric PO TID . ± **Anticholinergics-antispasmodics**: maximum of 24-48 hrs or ileus; blocks acetylcholine on smooth mm.; for tenesmus & pain. Contraindicated in obstructions, infectious enteritis, glaucoma, obstructive uropathy .. Propantheline (Pro-Banthine®) PO TID .. Dicyclomine (Bentyl®) PO TID . ± **Antisecretory drugs** containing bismuth subsalicylate; may cause dark-colored feces, effect on cats?? .. Pepto-Bismol PO, QID .. Corrective mixture of paregoric PO QID Prognosis: most resolve in 72 hours; monitor for chronic colitis

Causes/DDx: Acute colitis
- Garbage gut
- Bacterial
  - *Clostridium perfringens*
  - *Escherichia coli*
  - Salmonella spp
  - *Campylobacter jejuni*
  - *Yersinia enterocolitica*
- Parasites
  - *Tricuris vulpis*
  - Coccidia spp
  - *Ancylostoma caninum*
- Feline panleukopenia virus
- Food-induced allergic colitis poorly documented

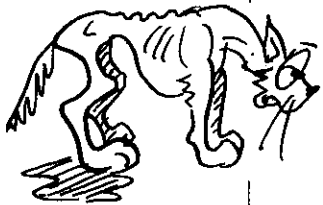


DDx:
- Acute gastroenteritis
  - Hemorrhagic gastroenteritis
  - Viral gastroenteritis
- Early chronic colitis

Pepto-Bismol

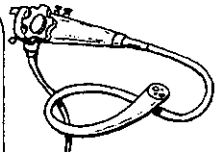
Inflammation of colon; Dog > Cat, Young or Debilitated
CS: Acute large bowel diarrhea; ± Vomiting
Dx: Hx, CS, PE, Rectal exam
Tx: NO food, Bland diet, Fluids, ABs, ± Motility-modifying

Chronic colitis, Idiopathic chronic colitis H2B 421; IM-WW 283	• **Chronic nonspecific inflammatory diz** • Poor response to Tx • Most common nonparasitic colitis in dogs - ↑ Incidence in purebreds (G. Shepherds), 1/2-4 yrs - Less frequently in cats • Causes: uncertain? multiple etiologies? dietary? immunologic? stress? motility? • Pathophysiology: immunological likely	• **Chronic large bowel diarrhea** - Semiformed to liquid feces - Fresh blood (hematochezia) - Mucus - ↑ Frequency of defecation, small amount - Straining to defecate (tenesmus) - Severely painful defecation (dyschezia) • ± Vomiting, ± anorexia • Dehydration • **Weight loss**, severe progressive	• **Hx , CS** • **R/O Trichuris 1st** • **PE**: dehydration, caudal abdominal pain • Rectal exam: ± pain, ± stimulates tenesmus, ± roughened mucosa, blood, mucus • CBC: usually normal • Hypoalbuminemia • Fecal exam: - Stained fecal/rectal smear: RBCs &/or inflammatory cell • Radiograph barium enema: late signs: mucosal serrations, thickened folds, ulcers, strictures • **Colonoscopy & biopsy**: definitive: variable finding - Infiltration of colonic wall w/ lymphocytes, plasma cells, eosinophils, & PMNs	• **Specific Tx difficult** - cause unknown, Tx according to individual & biopsy findings • Symptomatically/stabilize: bland diet, fluid: Lactated Ringer's sol. + potassium • **Sulfasalazine** (Azulfidine®) broad spectrum: often beneficial, PO TID-QID response may be slow - weeks to months • **Diet**: mutton-based diet or rice, cottage cheese & chicken, Hill's i/d + fiber (psyllium) 3-4 weeks, may be enough alone if mild • Metronidazole (Flagyl®) PO if refractory to other Tx • Tylosin (Tylan®) PO, unpredictable • Steroids: improve some & worsen others, use if severe diz & poor response to sulfasalazine • Azathioprine (Imuran®) immunosuppression only if unresponsive to sulfasalazine or steroid, PO • Monitor: weight gain resolution of CS, perforation, biopsy before stopping Tx



Chronic colitis: Causes/DDx
- Idiopathic inflammatory bowel diz
- Lymphocytic-plasmacytic colitis
- Ulcerative colitis

DDx:
- Small bowel diz
- Eosinophilic colitis
- Infectious colitis
- Neoplasia
- Cecal inversion
- Irritable bowel syndrome



Azulfidine

Prognosis:
- Most resolve in 4-6 wks
- Some long term - guarded
- Relapses common

Chronic nonspecific inflammatory diz
CS: Chronic large bowel diarrhea, Weight loss
Dx: Hx , CS, P, Rectal exam, Colonoscopy & Biopsy
Tx: Sulfasalazine, Diet

Colitis

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Pseudomembranous colitis, Antibiotic associated colitis H3B 427 *	• **Antibiotic associated colitis** (lincomycin, ampicillin, cephalosporins) suppress normal flora, allowing overgrowth - Exudative plaque on reddened to necrotic mucosa • *Clostridium difficile* likely causative bacteria of overgrowth = cytotoxins & enterotoxins • May develop w/in days of ABs or be chronic	• Colitis w/in days of ABs - Mucoid diarrhea • Chronic large bowel diarrhea	• **Hx (ABs + CS)** • **Colonoscopy**: erythematous, friable, mucosa w/ adherent , plaque like pseudomembranes • Biopsy: pseudomembrane of inflammatory cells, mucin, fibrin & epithelial debris; mucosal necrosis • Definitive: *C. difficile* toxin w/ ELISA or tissue cultures (3 cases?)	• **Stop offending antibiotic** • **Fluids** • **ABs** effective against *C. difficile*: vancomycin, metronidazole, bacitracin recommended for people - Sulfasalazine maybe for dogs Prognosis: • Usually prompt response to Tx, relapses occur = prolonged Tx
Cecal inversion, Cecocolic intussusception H2B 435; SAP 720; 5min 430; I2M 461; IM-WW 284 *	• **Infrequent in dog** • Inversion of cecum into colon • Potentially partial or complete lower bowel obstruction • Causes unknown • Predisposing factors - **Trichuris infections** - SE USA (Trichuris country) - 2° to inflammatory bowel diz - Weak iliocecocolic lig. • Pathophysiology: ? altered motility due to inflammatory diz, inversion = edema, congestion, ischemia, necrosis, obstruction, sepsis; endotoxemia & perforation	• **#1 intermittent hematochezia** (fresh blood in stool) w/ normal to soft stool - 1 month or more • ± Signs of small or large bowel diarrhea • Unresponsive to Tx (anthelmintics, motility modifiers, ABs) • **Weight loss** • Variable tenesmus & dyschezia as distal colon not affected • Sequela: - **Obstruction or perforation = endotoxic shock**	• Hx (**chronic hematochezia, Trichuris Dx**) • CS • PE: ± Normal appearance; thin, dehydrated; normal rectal exam • Palpation: ± firm midabdominal mass, painful • Fecal: usually normal due to previous Tx • ± Radiography: - Plain film: soft tissue density in cecal region, absence of gas-filled cecum - **Barium enema** or double contrast: diagnostic - pleated radiolucent filling defect in proximal colon • Colonoscopy: friable, necrotic mucosa (should proceed barium enema)	• **Fluids:** Lactated Ringer's ± potassium supplementation • **Typhlectomy: removal of cecum** only effective Tx: remove at ileocecal junction or anastomoses of ileum to viable colon • Monitor: postop fluids for 24-48 hrs, next 24 hrs give water, broth & easily digested food (?), monitor for peritonitis for 72 hrs • Discharge when bowel movement normal

ABs associated colitis
CS: Colitis
Dx: ABs + CS, Colonoscopy
Tx: Stop ABs, Fluids, ABs

DDx:
- Other causes of acute colitis
- Other causes of chronic colitis

Infrequent, Trichuris
CS: Intermittent hematochezia, Weight loss
Dx: Hx, CS, Barium enema
Tx: Fluids, Surgical removal

DDx:
- Trichuriasis
- Polyps
- Chronic colitis
- Neoplasia
- Ileocolic intussusception

Intestinal neoplasia

M8k 295; E-hb 489, 494; SAP 713; I2M 460, 461; IM 353; IM-WW 281, 285; H3B 368, 380; H2B 415; GI 453; Cat 1255; F3IM 99; C11T 595; Sx-WW 136; Pa-T 64

**

- Benign tumors:
  - Adenomatous polyps
  - Adenomas
  - Leiomyomas
- Malignant neoplasms:
  - **Adenocarcinoma**
  - **Lymphosarcoma**
  - Less common: carcinoid tumors, leiomyosarcoma, fibrosarcoma, mastocytomas, hemangiosarcoma & anaplastic sarcoma

Adenocarcinoma
- Locally invasive & slow-growing
- Older animals
- Dogs: most common in duodenum, ileum & terminal colon
- Cat: most common in ileum & distal jejunum
- Forms:
  - Infiltrative: thickened stenotic region of bowel - obstructs lumen
  - Ulcerative: deep w/ raised edges
  - Proliferative: lobulated, expanding mass
- Ulceration frequent, melena & blood loss anemia
- Locally invasive (mesentery, omentum, regional lymph nodes, more widespread metastasis may also occur

Lymphoma
- Arise from B lymphocytes of gut-associated lymphoid tissue (GALT)
  - Most common extranodal lymphoma in dogs & cats
- Cats: over 8 years old, FeLV (+)(feline leukemia virus) although not all viremic
- Types:
  - Diffuse lymphoma: diffuse infiltration of lamina propria & submucosa - Malabsorption & deep ulceration
  - Nodular lymphoma: expanding intestinal mass often in iliocecocolic region - Progressive luminal obstruction
- Metastasis to regional lymph nodes & other organs

- **Small intestinal tumor**
  - Insidious, vague, progressive CS
  - **Diarrhea**
  - **Intermittent vomiting**
  - **Weight loss**
  - **Melena, hematemesis**
  - Anemia, fever, icterus, abdominal effusion, anorexia, lethargy
- Colonic polyps & tumors (same CS as inflammatory colitis)
  - **Hematochezia**
  - **Dyschezia**
  - **Tenesmus**
  - ± Mucoid diarrhea
- **Sequelae:**
  - Malabsorption
  - Protein-losing enteropathy
  - Blood loss anemia
  - Intestinal obstruction
  - Intussusceptions
  - Intestinal perforation & peritonitis
  - Metastasis to liver & kidney

- Hx, CS
- **Abdominal palpation**: abdominal mass, thickened intestinal loops, or mesenteric lymphadenopathy
- Rectal palpation: stenosis or polypoid rectal masses
  - Adenomatous rectal polyps: expose by everting rectal mucosa
- Lab:
  - Blood loss anemia, neutrophilic leukocytosis w/ left shift, hypoproteinemia, elevated liver enzymes
- **Radiology/ barium contrast**
  - Mucosal irregularity
  - **"Napkin ring" sign** (luminal narrowing)
  - Intramural (wall) infiltration, thickening or nodularity
  - Thoracic radiography for metastasis
- Abdominal ultrasound: delineate mass lesion
- **Surgical excision or biopsy**
  - Definitive diagnosis
  - Endoscopic biopsy: stomach, duodenum or colon are accessible
  - Percutaneous fine-needle aspiration possible if mass or loop can be well delineated & stabilized by palpation

- **Surgical resection** (TOC) for polyps & some adenocarcinoma & other nonlymphomatous tumors
- Lymphoma: anticancer chemotherapy

Prognosis:
- **Grave to poor** for malignant
- **Guarded to good** for benign neoplasia

CS: Depend on site
Dx: Sx excision or Biopsy
Tx: Sx resection, Chemotherapy
Px: Benign: Guarded to good; Malignant: Grave to poor

Chronic Diarrhea

Chronic intractable diarrhea

5min 50, 48(f); H3B 363; H2B 422 I2M 451; Cat 1213; GI 402; IM-WW 265, 23, 51

- **Diarrhea for longer than 3 weeks**
  - **Symptomatic Tx**
  - **Intensive diagnostic procedures to find cause**

#1. Symptomatic treatment (NPO, fluids, i/d diet)
- **R/O (rule out) diet if doesn't resolve diarrhea**
- **If resolves need to go no further**

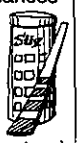
#2: R/O simple causes: diet, parasites, infectious diz, intoxications

- **Hx (history)**
  - Helps localize to small or large bowel
  - May indicate extraintestinal diz (i.e., hyperthyroidism, renal failure, Cushing's diz)
  - Predisposing factors (breed, diet, infectious diz, drug, toxin or parasite exposure, environmental stress)

- **PE (physical exam)**
  - Look for underlying systemic diz
    - . Fever, wt. loss, malnutrition, dehydration
    - . Weakness or depression (acid-base or electrolyte imbalances)
    - . Pallor (anemia, blood loss)
    - . Edema or effusion (hypoalbuminemia)
  - Palpate thyroid (hyperthyroidism)

- Palpate abdomen (liver, intestine)
- Rectal palpation (foreign bodies, masses, strictures, wall texture)
  - . Check feces (bone particles, blood, mucus)

- **Lab** (see box): CBC, Biochem., TPP, T4 assay
  - To rule out (R/O) infections, parasites, diet & other diz
  - Characterize dehydration & electrolyte imbalances
  - Protein-losing enteropathy (TPP)
  - Blood glucose (hypoglycemia)



- **Fecal exam**: Parasites: gross & microscopic

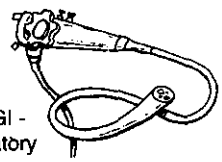
#3. Localize to small or large bowel (see chart)

#3a: R/O malabsorption/maldigestion, bacterial overgrowth if small bowel problem
- Further evaluation of infection **(bacteria, viral or fungal)**

- **Digestive & absorption tests**
  - Pancreatic insufficiency (maldigestion)
  - Characterize intestinal function (malabsorption)
  - Evaluate bacterial overgrowth
  - Protein-losing enteropathy (check lab)

- **Microscopic fecal exam:** different stains to differentiate maldigestion & malabsorption (see box below)
- Bacterial culture of feces: infectious agents (Salmonella, Campylobacter, Vibrio)

- Virologic testing: ELISA for canine parvovirus, Serology for FeLV & FIV
- Fecal biochemistry
  - Occult blood valuable
  - Other tests impractical



- Endoscopy/biopsy: upper GI - mucosal lesions - inflammatory bowel diz

#3b: Large bowel
- Endoscopic exam
- Biopsy

- **Combined large & small bowel diz** (lymphosarcoma, chronic inflammatory bowel diz, histoplasmosis)

Summary Dx chronic diarrhea

- #1 Symptomatic Tx: R/O diet
- #2. R/O simple causes: Hx, PE, Lab, Fecals
  - Parasites, infectious diz, intoxications

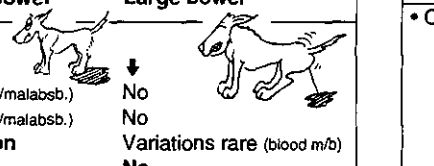
#3: Localize to small bowel or large bowel - CS

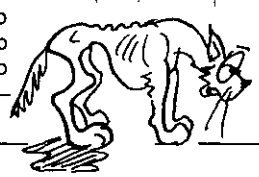
#3a. Small bowel
- R/O exocrine pancreatic insufficiency
- Characterize malabsorption
- Bacterial overgrowth
- Endoscope

#3b. Large bowel
- Endoscope
- Biopsy

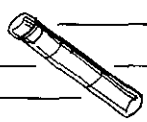
DDx Small from Large Intestine Diz

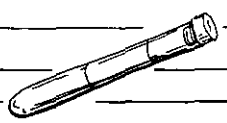
Finding	Small bowel	Large bowel
Feces		
Volume/defecation	↑	↓
Steatorrhea	± (maldig./malabsb.)	No
Undigested food	± (maldig./malabsb.)	No
Color	**Variation**	Variations rare (blood m/b)
Melena	±	**No**
Hematochezia (bloody stool)	Usually no	**Frequent**
Mucus	Rare	**Frequent**
Urgency	No - usually	**Usually**
Frequency	2-3 x normal	**> 3x normal**
Dyschezia (painful evacuation)	No	± - dist. colonic or rectal
Tenesmus	No	**Frequent**
Others		
Weight loss	± (maldig./malabsb.)	Rare
Vomiting	± (inflammatory diz)	Uncommon (colitis)
Flatulence	± (maldig./malabsb.)	No
Borborygmus	± ((maldig./malabsb.)	No
Halatosis	± (maldig./malabsb.)	No



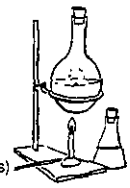


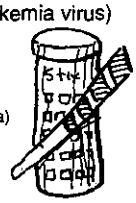
Lab





Findings	Suggested condition
• CBC	
Eosinophilia	Parasites, eosinophilic enteritis, Mast cell tumor, Cushing's diz
Regenerative neutrophilia	Necrosis or Widespread inflam. process
Degenerative/toxic neutropenia	Parvo, septicemia, endotoxemia, Bowel necrosis (peritonitis)
Lymphopenia	Intestintinal Lymphangiectasia
↑ PCV	Dehydration
↓ PCV	Anemia
RBC morphology	Characterize anemia
Microcytic hypochromia	Iron deficiency (chronic enteric blood loss)
Macrocytic RBCs	Malnutrition, anemia
Macrocytosis (cats)	Hyperthyroidism, FeLV (feline leukemia virus)
• Biochemicals	
↑ BUN + ↓ Sp. gravity	Renal failure
↑ K+ & ↓ Na	Addison's diz
↓ Calcium	Protein-losing enteropathy (binds Ca)
↑ Liver enzymes	Liver diz
• ↓ TPP	Protein-losing enteropathy
• T4 assays	Suspected thyrotoxicosis (esp. cats)





Digestive & absorption tests

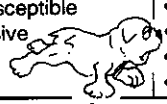
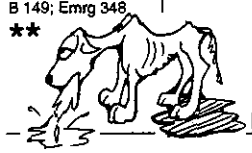
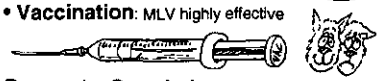
• TLI (trypsin-like immunoreactivity)	↓ Exocrine pancreatic insufficiency (EPI)
• BT-PABA digestion test	Flat curve exocrine pancreatic insufficiency
• Xylose absorption test	Evaluates small intestinal function
• Serum folate*	↓ Folate - malabsorption (jejunum) ↑ Folate - bacterial overgrowth
• Vit B12* (cobalamin) test	↓ B12 - malabsorption or bacterial overgrowth

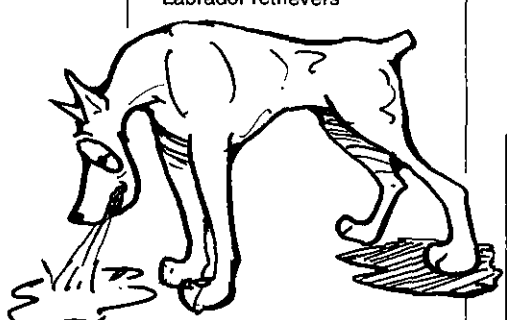
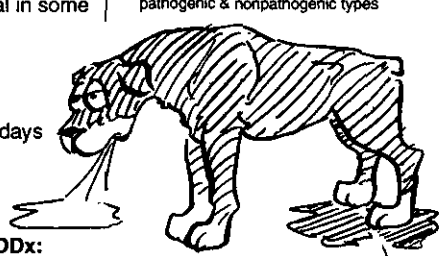
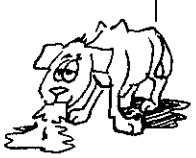
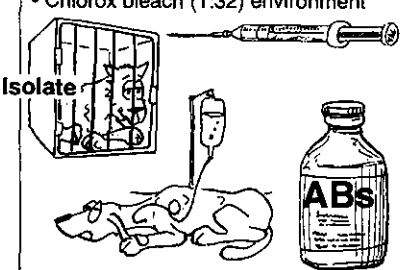
*Dietary levels must be considered

Microscopic fecal exam

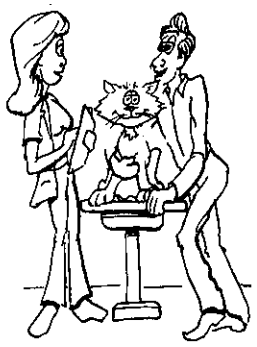
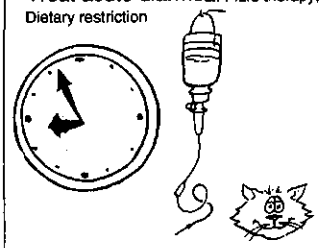
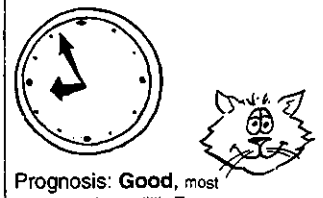
• Direct Sudan stain	Undigested fat (steatorrhea)	- Pancreatic insufficiency
• Indirect Sudan stain	Stains digested fat (steatorrhea)	- Malabsorption
• Lugol's iodine stain	Undigested starch	- Pancreatic insufc. or Giardia
• New methylene blue	Leukocytes	- Exudative inflam. bowel diz
• Saline smears	Protozoa	

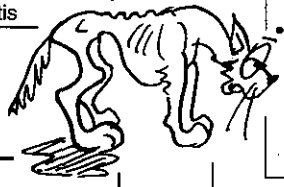
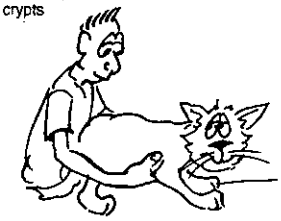
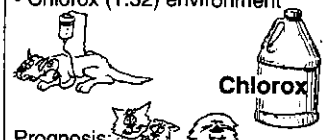
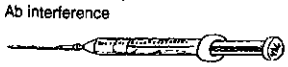
Virus - Enteritis

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Canine coronavirus enteritis, CCV Mk 229; E-hb 478; SAP 114; H2B 400; H3B 354; I2M 438; IM 337; IM-WW 273; GI 420; C12T 700; Inf-B 101; Emrg 348 ***	• **Acute contagious diz of dogs** • Epitheliotropic virus - invades enterocytes of the villus tips, but spares cells of crypts - Sloughing of villus tips = villous atrophy - **Malabsorption** due to reduced surface area **Acute contagious diz of dogs** **CS: Most subclinical, Diarrhea** **Dx: Not needed - Tx** **Tx: Fluids • Px: Excellent**	• **Minor cause of enteritis** • **Most subclinical** • Some: anorexia & depression • Mild to moderate diarrhea 7-10 days • Afebrile (usually) 	• **Definitive lab confirmation not needed** because mild & nonfatal diz, treated by support • **Should be distinguished from serious parvovirus** - CCV has no fever, leukopenia, hematochezia & fatalities not typical • Definitive Dx: - Electron microscope of fresh feces early - Serology only retrospective Dx	• **Tx like any acute diarrhea** - Supportive therapy (fluids & electrolytes) Prevention: • Vaccination optional part of vaccination program - Consider vaccination for high risk dogs (show, field & kenneled dogs) - Killed (inactivated) vaccine available, efficacy & justification for use controversial - Attenuated (MLV) briefly marketed, but withdrawn because of adverse reactions Prognosis: • **Excellent**: most recover rapidly w/ Tx • Some: diarrhea persists for 3-4 weeks • Fatalities reported, but rare
Rotavirus E-hb 478; SAP 114; H3B 354; H2B 400; IM-WW 273; GI 422; C12T 700; Inf-B 101; Emrg 348 ***	• Dogs & cats • Not sure cause clinical diz • Found in normal & diarrheic feces • Cause malabsorption in other mammals **Clinical significance?**	• **Not of major clinical importance in dogs** • Usually subclinical • M/b self-limiting diarrhea in pups 	• **Definitive lab confirmation not needed** • Definitive Dx: Electron microscope, virus isolation, ELISA 	• **Tx like any acute diarrhea** - Supportive therapy (fluids & electrolytes) • No vaccine Prognosis: • **Excellent**: most recover rapidly w/ Tx
Canine distemper M8k 548; E-hb 478; SAP 107; H3B 354; H2B 400; IM-WW 557; GI 421; C12T 707; Inf-B 149; Emrg 348 **	• **See Systemic dizs pg 689** • **Severe, highly contagious, multisystem viral diz** • Unvaccinated 6-12 wk-old puppies more susceptible • Immunosuppressive   **Severe, Contagious** **CS: Multisytemic: GI, CNS, Resp., etc.** **Tx: ABs, Symptomatic Tx • Px: Guarded • Prevention: Vaccination**	• Subclinical in 50% • Multisytemic & extremely variable • Malaise, Fever of 103-105° F • Respiratory CS • **GI: Vomiting & diarrhea** • Eye - chorioretinitis • Nervous system • Hard pad diz 	• **Hx of young, unvaccinated dog (2-6 months), CS, & possible exposure** • FA (conjunctival scraping or blood smear) • CSF antibody titer in dogs w/ CNS signs 	• **Broad-spec. ABs** for 2° bacteria • **Symptomatic Tx** (resp., CNS, etc.) • GI (vomiting & diarrhea) - Antiemetics - Antidiarrheals • **Vaccination**: MLV highly effective  Prognosis: **Guarded**, mortality from 1-100%

Parvovirus M8k 285; 249; E-hb 477; SAP 110; H2B 1191; H3B 354; I2M 435; IM 336; IM-WW 272; GI 417; E 401; C12T 699; Inf-B 102, Emrg 348; Pa-T 52 ***	• **Viral gastroenteritis** • Canine 2-6 mo old • Pathogenic & nonpathogenic forms • **Contagious:** - Oral fecal route of infection - Persists in environment - Dilute Chlorox (1:32) kills virus • Pathophysiology: - Destroys rapidly dividing cells - . Intestinal crypt epithelium . Bone marrow cells - Excrete virus in feces - Cardiomyopathy in puppies < 2-4 weeks, rare • Predisposition: - **Rottweilers** - **Dobermans** - Pit bulls - Labrador retrievers  **Contagious, GI** **CS: Severe diarrhea/Vomiting/Dehydration** **Tx: Fluids & ABs** **Vac: No guarantee**	• **Intractable fluid diarrhea** - ± Hemorrhagic • **Depression** • **Severe vomiting** • **Progressive dehydration** • Fever • Septic shock • ± Mild or subclinical in some • Sequela: - Endotoxic shock - DIC - Death m/b in 1-2 days if untreated  **DDx:** • Hemorrhagic gastroenteritis (↑ PCV) • Salmonellosis • Campylobacteriosis • Canine distemper • Canine coronavirus  Prevention: • **Vaccinations - highly recommended** - No Vac program guarantees protection (maternal immunity) more effective against vaccine virus than street virus - 5-8 wks-old MLV (modified live) (not during pregnancy) - Revaccinate 2-3 week intervals - Lasts between 14-18 wks (maternal immunity m/ block up to 18 wks) • No MLV vac. before 5 wks old or if has distemper • Inactivated vac. booster to dogs living w/ infected dog (in case incubating parvo) or pregnant animals • CEV strain 154 vaccine may overcome maternal antibody interference problems • Recent vaccination (w/in 10 days) may produce false positive ELISA	• **Tentative: Hx & PE, distinctive smell** • Previous vaccination doesn't R/O • Lab: - ↓ **WBCs** (500-2000/µl) suggestive - PCV normal or slightly ↓ - ELISA must be done early - Electron microscope can't distinguish betw. pathogenic & nonpathogenic types	• **Emergency** - start treatment before lab results • Symptomatic & supportive (as for severe acute enteritis) • **#1 Aggressive fluids** - Add K+ (potassium) - Overzealous fluids m/b problem in severe hypoproteinemia, sepsis or intussusception • **#2 Broad spectrum ABs** to control 2° bact. sepsis (aminoglycosides to well hydrated, pen/aminoglycosides IV if septicemia) • Other treatments: - Antiemetic for persistent vomiting - Pepto-Bismol (bismuth subsalicylate) - Blood or plasma transfusion if hypoproteinemia or anemia - Antiendotoxin hyperimmune serum • Bland diet once vomiting stopped for 18-24 hrs • Isolate for 2-4 weeks, dispose feces • Vaccinate other dogs in household • Chlorox bleach (1:32) environment  **Isolate** **ABs** **Prognosis:** • **Good**: most dogs survive if supported long enough - Worse for Dobermans & Rottweilers • Guarded for septic shock or hemorrhagic diarrhea • Survival gives prolonged immunity (m/ not be lifelong)

Viruses

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Feline enteric coronavirus, FECV M8k 290; E-hb 479; SAP 115; H2B 400; I2M 438; IM 338; IM-WW 273; GI 422; Cat 1228; F3IM 44; F-H 193; C12T 697 ** 	• **Ubiquitous virus endemic in catteries** • Villous atrophy & malabsorption • Oral route of infection	• Young kittens - **Mild enteritis** - **Diarrhea** - Vomiting, low-grade fever, anorexia & lethargy • Adults - inapparent infection 	• Hx, CS • Cross react w/ FIP antibodies giving false-positive FIP results 	• **Usually self-limiting** w/in 2-4 days • Treat acute diarrhea: Fluid therapy, Dietary restriction  **Prognosis: good**: most recover uneventfully, often remain infectious, shedding virus in feces Prevention: Intranasal strain of PIP coronavirus probably cross protects for enteric coronavirus
Feline astrovirus SAP 116; H2B 401; IM 338; Cat 1228; C12T 700 ** 	• Little known about this virus 	• **Mild, nonspecific diarrhea** • Transient low-grade fever • Depression & inappetence • Implicated in outbreaks of diarrhea in a cattery • Kittens most likely to be affected 	• Hx, CS, PE • EM (electron microscope) 	• Treat like any other acute diarrhea: supportive (fluids & dietary restriction)  Prognosis: **Good**, most recover w/ no or little Tx Prevention • No preventative measures available
Heliobacter infection: M8k 301				

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
***Feline panleukopenia,* FPV, Feline parvovirus enteritis, Feline distemper** M8k 559; I2M 438; IM 336; IM-WW 273; SAP 114, 700; E-hb 479, 467; H2B 1194, 400; Cat 1228; F-H 182; Inf-B 1; GI 421; Pa-T 50 ** 	• **See Systemic pg 690** • **Severe, highly contagious infection** • Multisystems: **viral gastroenteritis** • 3-4 month olds highest incidence, at risk throughout life • Parvovirus: relatively rare now (vaccinations); occasionally seen in unvaccinated kittens • Destroys rapidly dividing cells - Intestinal epithelium: enteritis - Bone marrow: panleukopenia - Fetus: abortion, teratologic - Cerebellar hypoplasia **DDx:** • FeLV (persistent leukopenia) • Other viral enteritides • Acute bacterial enteritis - Salmonella - Campylobacteriosis • Toxoplasmosis • Cryptosporidiosis • Toxicosis • Linear foreign bodies/peritonitis • Pancreatitis	• **Adults: subclinical** • **Perinatal infection: neonate** - **Cerebellar damage**/ataxia - Fading kitten syndrome • **Severe: older kittens** - **Like parvo in dogs** - **104-106°F** (pyrexia) - **Persistent vomiting** (bile stained) - **Severe, fetid diarrhea** (watery, mucoid or bloody) • Ulcerative or necrotic stomatitis • Mild icterus • Infertility, abortion & stillbirth • Sequelae: - **Severe dehydration** - Endotoxic shock (gram neg.) - DIC - Death m/b in 1-2 d if untreated 	• Hx (unvaccinated), CS (gastroenteritis/systemic/panleukopenia) • Previous vac. doesn't R/O • Laboratory: - **Transient leukopenia** (↓ WBCs) in most cats < 500/µl, lasts 2-4 days - **Rebound leukocytosis** w/ marked lt. shift upon recovery (500-2000/µl) • Serum chem. nonspecific & inconsistent - Prerenal azotemia - dehydration - Thrombocytopenia if DIC - Serological testing & viral isolation rarely done • Necropsy: severe necrosis of intestinal crypts 	• **Emergency** - start treatment before lab results • Symptomatic & supportive • **#1 Aggressive fluids** (IV catheter) - Add K+ (potassium) • **#2 Broad spec. ABs** 2° bact. sepsis - Gentamicin to hydrated patient 5 days, prevent gram-neg. sepsis & endotoxemia • **#3. NPO** (nothing per os) if vomiting • #4 Antiemetics - Anticholinergic antiemetics/antidiarrheal Rx (antimotility) contraindicated, ↑ risk of endotoxin absorption • Moribund, severe anemia or hypoproteinemia - Plasma/whole blood transfusions from healthy donor cats - Check for DIC 1st (platelet count & activated coagulation time) • Other treatments: - Vit B complex parenterally - Pepto-Bismol® (bismuth subsalicylate) antidiuretic, use w/ care/toxic • Bland diet once vomiting stopped for 18-24 hours • Isolate for 2-4 wks, dispose feces • Vaccinate other cats in household • Chlorox (1:32) environment  Chlorox Prognosis: • **Guarded to grave**: young kittens (mortality 50-90%) - Guarded until impending recovery indicated by cessation of vomiting & diarrhea, return of appetite • Guarded for septic shock or hemorrhagic diarrhea
Multisystemic diz **CS: Severe diarrhea/Vomiting/Dehydration** **Tx: Fluids & ABs** **Vaccinate**		**Vaccinations very effective** as apposed to parvo vaccination in dogs, but may still have maternal Ab interference • **Vaccination schedule**  - 8-9 wks-old - 1st dose - Revaccinate 2-4 wks until 14-16 weeks old - At least 2 doses for MLV & 3 doses for killed vaccine - Booster annually, even though immunity probably lifelong - Do not administer MLV during pregnancy		

Diarrhea

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Rickettsial diarrhea, Salmon poisoning M8k 321; Mk 242; E-hb 481; SAP 126, 690; 12M 439; IM 338; IM-WW 275; GI 428; Inf-B 245; Pa-T 61 * to *** (Regional)	• ***Neorickettsia helminthoeca*** (rickettsia) or Elokomin fluke fever agent • ***Nanophyetus salmincola*** (fluke) • Very common in dogs of **Pacific Northwest** • Transmission: ingesting **raw salmon** containing metacercaria of the fluke *N. salmincola* - Fluke matures in 5 to 7 days (life cycle 3 hosts: snail, fish & dog or bird) - Rickettsial agent it carries causes clinical signs - Incubation period 5-21 days	• **Vomiting** • **Diarrhea** (usually hemorrhagic) • **Profound weight loss** • **Fever** • **Nasal discharge** (serous to mucopurulent) • Hypothermia • Generalized lymphadenopathy • Most die if not treated	• Hx (**NW**), CS • **Operculated eggs** in feces (direct smear or washing-sedimentation technique) • Rickettsia in macrophages of aspirated lymph nodes	• **Isolate** • **Tetracycline or doxycycline** IV to kill rickettsial agent (most important part of therapy) • Fluke: - Praziquantel (Droncit®) - Mebendazole (Telmintic®) - Fenbendazole (Panacur®) • **Supportive fluids,** electrolytes Prognosis: • **Good** w/ appropriate Tx • W/o Tx 50-95% die **Prevention:** • Keep dogs from eating **infected fish** • Freeze or thoroughly cook fish • Isolate infected dogs
Hemorrhagic gastroenteritis, HGE, **Hemorrhagic enteritis** M8k 302; Mk 248; E-hb 482, 457; SAP 704, 695; H2B 406; H3B 360; 5min 626; I2M 421; IM 327; IM-WW 276; GI 428; E 1154 **	• **Peracute necrotizing enteritis** • Unknown cause? - Suspected: Clostridium or its toxins • 2 - 4 years old • Toy to miniature breed dogs	• **Peracute onset of bloody vomiting & diarrhea** • Rapid dehydration • Signs resemble toxic shock • Lack of fever • Sequela: Death may occur due to circulatory failure & shock if not treated	• Hx (peracute), CS • Shock: prolonged capillary refill time • Fresh blood in feces & vomitus • **PCV of 50 to 80%** w/o comparable level of clinical dehydration **DDx:** • Parvovirus (has fever) • Toxicity • Bacterial gastroenteritis • Foreign body • Intussusception	• **Shock doses of fluids** (IV, 90 ml/kg/hr until capillary refill time & PCV normal, then continue on maintenance rate) - ± Steroids initially if shock appears refractory to fluids • **Broad-spectrum ABs** (ampicillin or amoxicillin) empirically • Withhold food & water until vomiting & diarrhea stops, then small bland meals Prognosis: ??

Peracute necrotizing enteritis, Clostridium?
CS: Peracute bloody vomiting & diarrhea, Death
Dx: Hx, CS, PCV of 50 to 80 %
Tx: Shock doses of fluids, ABs

Clostridial enteritis E-hb 481; SAP 702; H2B 402; H3B 356; 5min 456; I2M 441; IM 339; IM-WW 274; GI 423; C11T 602; Cat 1223; Inf-B 193; Emrg 346; Pa-T 57 **	• ***Clostridium perfringens*** (part of normal flora). • Large anaerobic gram + bacillus • Associated w/ **canine hemorrhagic gastroenteritis** • Differentiate pathogenic from nonpathogenic	• **Acute bloody, explosive diarrhea** • Patient otherwise feels good • Occasionally chronic diarrhea	• Hx, CS • **Presumptive: fecal leukocytes & predominance of large gram+ rods w/ endospores** - Diff-Quick or Wright's stain . > 2-3 spores ("safety-pin") per high power oil abnormal • Assay for specific cytotoxin	• **ABs for 5-7 days** (amoxicillin, ampicillin, metronidazole, tylosin, tetracycline or chloramphenicol) • **Chronic diarrhea: long-term ABs** • **If shock: fluids** • Responds well to symptomatic therapy & diarrhea spontaneously resolves in 2 to 4 days **Prognosis: ??**
Associated w/ canine hemorrhagic gastroenteritis				
E. coli E-hb 481; H2B 402; I2M 441; Cat 1232; GI 426; Emrg 345 *	• ***Escherichia coli,*** **Normal bowel flora** of ileum & large bowel, Systemic illness (septicemia) in neonates • CS: **Endotoxic shock** (depression, CNS deficits, anorexia, diarrhea, weakness, cyanosis, hypothermia & death); **severe fatal hemorrhagic gastroenteritis** • Tx: **Aggressive supportive therapy**, ABs (gentamicin & ampicillin), Banamine® or corticosteroids m/b indicated • Px: **Tx often unsuccessful in endotoxic shock**			
Salmonella M8k 120; E-hb 479; SAP 701; H2B 402; H3B 356; I2M 440; IM 339; IM-WW 273; GI 423; Cat 1230; F-H 289; Inf-B 161; Pa-T 72 **	• **Gram negative bacilli** - Often isolated from feces of normal dogs • Uncommon • Predisposing factors: exposure, young age, immune deficiency (steroid Tx, chemotherapy), debilitating illness, overcrowding or unsanitary conditions, major surgery, oral ABs	• **Subclinical carrier state** • Enterocolitis - Diarrhea - watery & mucoid or hemorrhagic - Vomiting - Tenesmus - Fever, anorexia, lethargy, abdominal pain, dehydration • Enterocolitis w/ bacteremia (rare) - Potentially fatal bacteremia or endotoxemia & DIC (disseminated intravascular coagulation) - Shock, dehydration, high fever, hypothermia, extreme depression	• Hx, CS • **Culture feces** or blood in bacteremic animals • Bacteremia or endotoxemia - Azotemia, electrolyte imbalances, neutropenia, hypoglycemia, hypoproteinemia or coagulopathy	• **ABs controversial** in Tx of Salmonellosis - Enterocolitis usually self-limiting & ABs won't affect - ABs may prolong infection (disrupt flora) - Indicated if evidence of bacteremia or endotoxemia . Culture & sensitivity (C&S) . ABs 7-10 days, reculture feces 1 & 4 wks after Tx . Baytril® (enrofloxacin) maybe helpful in eliminating carrier state . Trimethoprim-sulfa • **Support - fluids & electrolytes** • Hygiene: prevent spread to animals & humans Prognosis: • **Good** for most animals • Mortality can be high in susceptible populations

Public health: Man infected

Diarrhea

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Campylobacteriosis M8k 117; E-hb 480; SAP 702; H2B 402; H3B 356; I2M 439; IM 138; IM-WW 274; GI 424; Inf-B 177; Emrg 344 **	• *Campylobacter jejuni*: gram negative bacteria, "seagull shape" • Pathogen of animals & humans • Many clinically normal dogs & cats shed bacteria - Therefore **poor sanitation** & crowding predispose • May require other enteropathogens (viruses, bacteria, Giardia or helminths) • Erosive enterocolitis or enterotoxin **- Mediated secretory diarrhea**	• **Mild, watery, mucoid diarrhea to hemorrhagic dysentery** • Fever usually mild or absent • Some chronic or intermittent diarrhea **Public health:** Infects humans - hygiene	• CS • Isolation from fresh feces (difficult, obtain fecal directly from rectum)	• **Erythromycin (DOC)** • Other ABs: neomycin, Baytril® (enrofloxacin), chloramphenicol, furazolidone, doxycycline • Repeat fecal cultures 1 & 4 weeks after Tx **Erythromycin** Prognosis: Good, but rare fatalities reported
Yersiniosis IM-WW 275; SAP 129t, 690t; H2B 402; H3B 356; I2M 441; Cat 1233 *	• *Yersinia enterocolotica*, *Y. pseudotuberculosis*, Gram negative rod, May be found in asymptomatic dogs & cats • Causes invasive gastroenteritis in man & dogs: *transmission* from animals & food sources • CS: Usually causes self-limiting diarrhea in dog • Dx: Culture • Tx: Chloramphenicol, tetracyclines • Some forms may be fatal in cats (invades GI tract & liver)			**Chloramphenicol**
Bacillus piliformis, Tyzzer's diz M8k 336, 123; IM-WW 275; H2B 402, 446, 1213t; H3B 356; SAP 129t, 690t; E-hb 481; Cat 1234; F-H 295; Inf-B 187; Pa-T 58 *	• Rare • Dogs & cats relatively resistant - Young most often infected • Intracellular, filamentous, spore-forming gram-negative bacteria • Source: rodent feces	• Acute hepatic necrosis - Cholangitis (inflam. of biliary ducts) • Hemorrhagic enterocolitis - Dry, pasty feces, diarrhea - Depression, weakness, abdominal pain, hypothermia, anorexia in young • Can be fatal in the very young	• Biopsy (gut, liver) for filamentous bacteria • Mouse inoculation • Cell culture isolation • Necropsy lesions	• None, 100% fatal Prognosis: **Grave**
Mycobacteria enteritis SAP 129; H2B 202; Cat 1234; Inf-B 213; Pa-T 63 *	• **Cats** (dogs usually have pulmonary involvement) **- Alimentary tuberculosis** - Ingesting *Mycobacterium bovis* in milk - Granulomatous enteritis & mesenteric lymphadenopathy	• **Usually subclinical** • Vomiting • Diarrhea (loose, malodorous) • Anorexia • Polysystemic signs (coughing, PU/PD, dehydration, icterus, depression) **Public health:** Infects humans - hygiene	• **Dx usually made at necropsy** • Cytology (acid fast bacteria) • Culture difficult • May see laboratory or radiographic findings consistent w/ intestinal malabsorption or obstruction **DDx:** • Alimentary lymphosarcoma	• **Euthanasia is** recommended due to zoonotic concern • **Notify Health officials** Prognosis: **Grave**

Histoplasma capsulatum E-hb 488; SAP 133, 690; H2B 405; H3B 358; I2M 442; IM 340; IM-WW 551; GI 445; Cat 1234; F-H 342; Inf-B 327; Pa-T 64 *(Regional)	• **Systemic fungal disease** • **River valleys of Central USA** • 1° pulmonary, but can invade any organ system • **Intestinal form**: most common extrapulmonary form in dog - Diffuse granulomatous gastroenteritis of the bowel & mesenteric lymph - Disseminated or 1° infection . Stomach, colon, small intestines . Granulomatous thickening of bowel wall, mucosal ulcerations . Mesenteric & visceral lymphadenopathy	• **Pulmonary diz 1°** (see Resp) • **Intestinal form** **- Intractable diarrhea** - Progressive weight loss - Granulomatous colitis: bloody, mucoid, large bowel diarrhea, tenesmus - Granulomatous enteritis: voluminous, watery, small bowel diarrhea, malabsorption, cachexia, protein losing enteropathy • Other signs: fever, pallor, inappetence, vomiting, lethargy, abdominal effusion • Other extrapulmonary forms (w/ or w/o lung signs) - Liver, Spleen, Lymph nodes, Bone marrow, Bone, Oral cavity, Peritoneum, Eyes, CNS	• Hx (**area**), CS • Organisms in monocytes or PMNs on blood smears **- Delayed xylose absorption, ↑ fecal fat** • **Palpable thickened intestines** • Radiology: intestinal form: irregularities of mucosa & thickening of bowel wall • Serology: complement fixation titer of 1:16 strongly suggestive, false negatives & false positives • Biopsy/cytology: fine-needle aspiration & exfoliative cytology - Intestine: smears or fecal mucosal scrapings, impression smears or endoscopic biopsies, fine needle aspirates of lymph nodes, bone marrow • Histopathology - special fungal stains (periodic acid-Schiff [PAS], Grocott-Bomori methenamine silver nitrate, or Gridley) • Culture: Sabouraud's media: difficult to isolate & requires 10-14 days for growth	• **Itraconazole (DOC)** • Ketoconazole • Amphotericin B, or a combination **Itraconazole**
Pythiosis, Zygomycosis, Phycomycosis E-hb 488, 463; SAP 703; H2B 405; I2M 431; IM 332; IM-WW 263; H2B 379, 948, 953; E 1226; Cat 1235; F-H 347 *(Regional)	• **Poorly septate molds & fungi** • **Pythium** spp. (pythiosis) most common agent - Young, larger-breed dogs in **southern Gulf States (LA, TX)** - Zygomycetes (zygomycosis) • Deeply invades GI tract, causing granulomatous gastroenteritis & mesenteric lymphadenopathy • Transmission: inhalation, ingestion, wound contamination	• **Intractable vomiting & diarrhea (bloody m/b)** • Anorexia, depression, progressive weight loss • May produce bowel obstruction • Anorexia • Colon (less common than cranial GI): tenesmus, hematochezia, ± constipation • Usually chronic • SQ lesions (less common) • Feline (ulcerative GI) • **Sequela: Obstruction** **DDx:** • Histoplasmosis (see above) • Lymphosarcoma • Granulomatous enteritis	• Hx, CS • PE: ± palpable enteromesenteric masses • Radiology: **- Abdominal mass** - Barium contrast: thickened, stenosed segment of bowel • **Biopsy**: to confirm (nonseptate or sparsely septate hyphae) - Stomach, intestine, abdominal lymph nodes - Gridley's or methenamine silver stains, Romanowsky stains: **"ghosts"** (don't stain)	• **Complete surgical excision only cure** • **Resistant to antifungal drugs** - M/ try amphotericin B, itraconazole, fluconazole Prognosis: **Grave**: spreads to structures that can't be removed
Aspergillus spp. & *Candida albicans* E-hb 489; SAP 703; GI 449; Cat 1236; F-H 330, 327 *	• **Rare, Opportunists, fungus** • CS: **Chronic diarrhea** with mucosal ulceration & necrosis • Dx: Histopathology • Tx: **Itraconazole** may have some benefit • Prognosis: **Poor**			**Itraconazole**
Prototheca (algae), Intestinal protothecosis E-hb 498; SAP 703; H2B 426; H3B 1184; I2M 443; IM 341 *	• **Ubiquitous unicellular algae** • Dog • Rarely colonize GI - Severe necrotizing or ulcerative enterocolitis - Disseminates widely to other visceral organs, eyes, CNS	• **Chronic large bowel diarrhea** • CS of other organ systems	• **Colonoscopy** (thickened, corrugated mucosal folds m/b friable or ulcerative) • Cytology (Wright's or Gram stain) /biopsy (Gomori's or periodic acid-Schiff stain) - Clusters of endosporulated ovoid structures • Culture: Sabouraud's cycloheximide-free dextrose media	• **Successful Tx not reported** • Itraconazole may be of some benefit **None reported** Prognosis: **Grave**

Algae, Large bowel

IBD

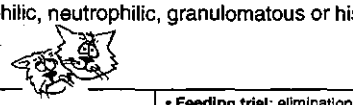
Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment

Chronic inflammatory bowel diz, IBD

Idiopathic bowel diz,

SAP 704; C12T 723; H2B 425; H3B 363; 5min 732; I2M 451; IM-WW 278; GI 421; Cat 1239; F-N 413; Inf-G 138; Pa-T 75

- **Diverse group of chronic enteropathies**
- Characterized by **idiopathic** infiltration of GI mucosa & sometimes submucosa w/ **inflammatory cells** of the **stomach, small intestines & colon**, or a combination of these
- Classified by predominate cell type: lymphocytic-plasmacytic, eosinophilic, neutrophilic, granulomatous or histiocytic
- Dx: Hx, CS, Feeding trial, **Endoscopic biopsy**
- Tx: **Feeding trial**, Antiinflammatory Tx (**steroids**), **ABs**



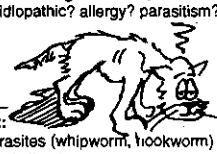
Eosinophilic gastroenteritis

- colitis, EGE;

Feline hypereosinophilic syndrome *

E-hb 487; GI 429, 431(f); GI-S 477; SAP 707, 708; IM-WW 278, 284; H2B 424; H3B 363; 5min 552; I2M 451; IM 347; Cat 1239; F-N 413; Pa-T 38

- **Uncommon form of IBD = rare**
- Diffuse or segmental infiltration of eosinophils often accompanied by peripheral eosinophilia
- Stomach, small intestine, or colon
- **Aggressive & high mortality in cats**
- Cause: idiopathic? allergy? parasitism?

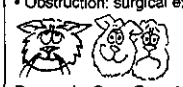


DDx:
- Parasites (whipworm, hookworm)
- Food allergies

- **Chronic vomiting** (eosinophilic gastritis)
- **Chronic small bowel-type diarrhea** (eosinophilic enteritis)
- **Chronic large bowel-type diarrhea** (eosinophilic colitis)
  - ↑ Volume
  - ↑ Frequency
  - Tenesmus/dyschezia
  - ↑ Mucus, hematochezia
  - Weight loss & vomiting uncommon
- **Combinations of above**
- Partial intestinal obstruction

- Hx, CS
- PE: palpation of tumorlike intestinal mass, hepatomegaly, mesenteric lymphadenopathy
- Lab:
  - **Peripheral eosinophilia** (not in all)
  - Hypoproteinemia
  - Impaired absorptive function tests
- Fecal for parasites
- Therapeutic anthelmintic trial for parasitism
- Radiographs: barium
  - Normal or thickening & mucosal filling defects or partial obstruction
- **Endoscopic biopsy** - definitive
  - Eosinophilic inflammation

- **Feeding trial**: elimination or hypoallergenic diet
  - Seldom effective alone
- **Steroid: high dose (prednisolone)**, usually most effective Tx to induce remission
  - Typically improve rapidly, when remission for 2 weeks, taper dosage to lowest effective maintenance dose, some may stop steroid, others alternate day maintenance required
- **Azathioprine (Imuran®) + prednisolone** to refractory cases or alkylating cancer
- Obstruction: surgical excision + corticosteroid Tx



Steroids

Prognosis: **Dog: Guarded; Cat: Poor**

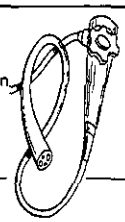
Histiocytic ulcerative colitis, Boxers

SAP 709; H2B 425; %min 468; GI-S 480; GI 465; IM-WW 284; Pa-T 75 *

- Chronic idiopathic IBD
- **Young Boxers**, < 2 years old
- Infiltration of lamina propria & submucosa of colon w/ histiocytes

- Severe, unresponsive, bloody, mucoid, large bowel diarrhea
  - ↑ Volume
  - ↑ Frequency
  - Tenesmus/dyschezia
  - ↑ Mucus, hematochezia
- Severe weight loss & debilitation

- Hx (**young Boxer**), CS
- Colonoscopy biopsy
  - PAS-positive histiocytes
  - Severe mucosal ulceration



- **Feeding trial**
- **Steroids (prednisolone)**, sulfasalazine, Olsalazine, metronidazole; single-agent or combination as for lymphocytic-plasmacytic colitis
  - **Lifetime** therapy needed
- Highly digestible diet rather than high-fiber

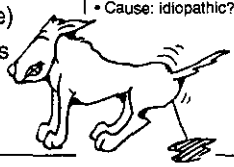
Steroids

Prognosis: **Guarded** for effective control

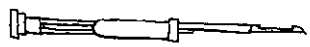
Neutrophilic (suppurative) enterocolitis

SAP 709; IM-WW 284 *

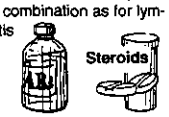
- **Bacterial enterocolitis**
- Cause: idiopathic?



- **Large bowel diarrhea** - acute or chronic
  - ↑ Volume
  - ↑ Frequency
  - Tenesmus/dyschezia
  - ↑ Mucus, Hematochezia
  - Wt. loss & vomiting uncommon
- Hx, CS
- **Colonoscopic biopsy**
  - Infiltration of PMNs (predominantly)
  - Variable mucosal ulceration, necrosis or crypt abscesses
- Tests to exclude bacterial enteropathogens



- **Feeding trial**
- **ABs** (trimethoprim-sulfa, enrofloxacin [Baytril®])
- Sulfasalazine, olsalazine, metronidazole, or **prednisolone** single-agent or combination as for lymphocytic-plasmacytic colitis



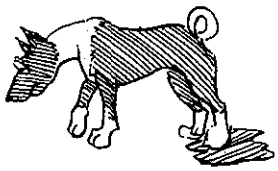
Steroids

Lymphocytic-plasmacytic inflammatory bowel diz, IBD

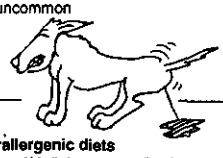
E-hb 485; SAP 704; I2M 449; IM 345; IM-WW 283; 5min 554; H3B 364; H2B 421; GI-S 468; GI 432; Cat 1239; Pa-T 39

**

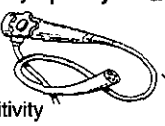
- **Most common form of chronic inflammatory bowel diz (IBD)**
- Both dogs & cats
- Cause: idiopathic ?
  - Suggested: genetic, dietary, bacterial, immunologic & permeability
  - Hypersensitivity to bacteria, food or self antigens
  - Genetic: **Basenji**, Soft-coated Wheaton terrier, Shar Pei



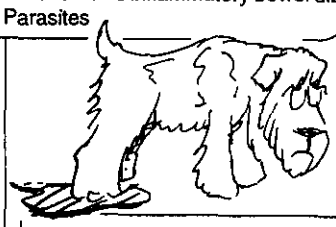
- **Gastroduodenitis:**
  - Intermittent vomiting
  - Most commonly in cats w/ IBD
- **Diffuse enteritis:**
  - Chronic unresponsive small bowel diarrhea
  - Progressive weight loss
  - Intermittent or persistent
  - If severe: protein-losing enteropathy (ascites, hydrothorax, edema)
- **Colitis:**
  - Chronic large bowel diarrhea
  - ↑ Volume
  - ↑ Frequency
  - Tenesmus/dyschezia
  - ↑ Mucus, Hematochezia
  - Weight loss & vomiting uncommon



- **R/O other differential diagnosis**
- Exclude parasitic & infectious cause of IBD
- Feeding trial (hypoallergenic diet) to R/O food hypersensitivity
- Lab & radiographs: unremarkable
- **Endoscope - intestinal biopsy** - definitive
  - Histo: diffuse infiltration of mucosa w/ mature **lymphocytes & plasma cells**



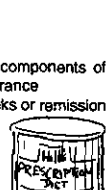
DDx:
- Dietary hypersensitivity
- Bacterial overgrowth syndrome
- Interstitial lymphosarcoma
- Intestinal lymphangiectasia
- Other chronic inflammatory bowel diz
- Parasites



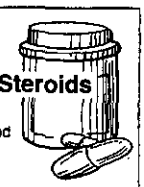
- **Feeding trial**, homemade or commercial (d/d) hyperallergenic diets for 4-6 weeks
- **Medical Tx** if no response to dietary
  - **Anti-inflammatory Tx** (see box)
    - **Steroid: prednisolone** PO
    - **5-aminosalicylic acid**
    - Sulfasalazine (Azulfidine®)
    - Olsalazine (Dipentum®)
  - **ABs** (metronidazole [Flagyl®] combined w/ tylosin [Tylan-Plus] for colitis m/b helpful)
  - Azathioprine (Imuran®) + prednisolone to refractory IBD
  - Motility-modifying antidiarrheal drugs
    - Opioid drugs (loperamide [Imodium®] & diphenoxylate [Lomotil®]) m/ control diarrhea
    - Anticholinergic Antispasmodics (dicyclomine [Bentyl®]) for tenesmus & urgency

Prognosis: **Guarded**
- Persistence or recurrence likely despite Tx
- Poor in Basenjis, Wheaton Terriers & Shar Peis; often progressive despite Tx

Hyperallergenic diet:
- **Homemade or commercial hyperallergenic diets**
  - Canine prescription **d/d** diet, Feline **d/d** diet, Nature's Recipe Rabbit & Rice, Nature's Recipe Venison & Rice
  - Homemade diet: 1 part low-fat cottage cheese, tofu or lamb (cooked or baby food) combined w/ 3 parts rice
- Feed for at least 4-6 weeks
- Eliminate all other food (table scraps etc.)
- If improvement, may re-challenge w/ original diet or components of original diet, recurrence of signs confirms dietary intolerance
- Some can be returned to original diet after several weeks or remission or m/ need to stay on hypoallergenic diet indefinitely



Anti-inflammatory Tx:
- **5-aminosalicylic acid** (5-ASA, Mesalamine drugs)
  - 1st choice for dogs w/ IBD of colon
- **Prednisolone** PO: taper off to lowest alternate day dose
  - Methylprednisolone acetate injection periodically for cats that can't be pilled
- Sulfasalazine (Azulfidine®) combines 5-ASA w/ an -azo bond to sulfapyridine to get drug to colon
  - Irreversible keratoconjunctivitis sicca is a side effect (do baseline Schirmer tear test 1st)
- Olsalazine (Dipentum®) two molecules of 5-ASA w/ -azo bonds, but no sulfa
  - Only in 250 mg capsules



Steroids

#1 chronic inflammatory bowel diz (IBD)
CS: Gastroenterocolitis
Dx: R/O DDx, Feeding trial, Biopsy
Tx: Feeding trial, Anti-inflammatory Tx, ABs

Parasites

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Parasites of intestines M8k 317; Mk 237; E-hb 475; SAP 695; H2B 403; I2M 423; IM-WW 270, 282; C12T 711, 714; GI 407 ****	• **Common cause of diarrhea** • Young, aged or debilitated animals at greater risk • Incidence depends on geographic location (e.g., uncommon in Colorado to very, very common in Florida)	• **Usually asymptomatic** • If CS - **Diarrhea** - **Weight loss** • Combo w/ other diz (viral or bacterial enteritis) - Push animal over "diarrhea threshold"	• Hx (age), CS • Identification of eggs, cysts, larvae, trophozoites or proglottids in feces • Hard to detect parasites - Giardia in small bowel diarrhea - Whipworm in dogs w/ large bowel diarrhea - **Therapeutic trial** is an indirect approach to diagnosis	• **Treat for parasite** • **Sanitation** Prevention: • Milbemycin • Heartguard® Prognosis: **Good to excellent** w/ proper Tx & sanitation
Ascariasis, Roundworms M8k 317; Mk 237; E-hb 475; SAP 695; 5min 1047; H3B 357; H2B 403; I2M 444; IM 342; IM-WW 270; C12T 711; C11T 626(f); Emrg 346; Pa-T 47 ***	• **Ascarids #1 parasite of dogs & cats** worldwide • Dog: *Toxocara canis* >>> *T. leonina* • Cats: *T. cati & T. leonina* • Infection by 4 routes - Prenatal: transplacental migration in only *T. canis* - Milk born: transmammary migration (*T. canis* & *T. cati*) - Ingestion of host • **Most puppies born** infected • Milk-borne major cause in kittens • Migration patterns - Liver-lung migration (*T. canis, T. cati*) - In wall or GI tract (all) - Somatic tissue migration (*T. canis, T. cati*)	• **Mild diarrhea** • **Vomiting** • **Potbelly** • Abdominal discomfort (whimpering & groaning) • Stunted growth • **Dull coat**, unthriftiness • Worms passed in feces & vomitus • Adults & lightly affected pups - Asymptomatic or loss of body condition Sequelae: • Pneumonia (lung migration) • Obstruction, Intussusceptions or perforation (rare)	• Hx (pups) CS • **Fecal flotation** - ascarid eggs - Shed about 3 weeks or age & continue for 4-6 month until treated **Public health:** Toxocara visceral larva migrans (VLM) of *T. canis* in humans (especially children)	• Initiate Tx as early as 2 weeks-old - Repeat every 2 weeks (maturing life stages until 8 weeks old) - **Strongid-T®** (pyrantel pamoate) good for pups & kittens . Also controls hookworms • Treat nursing bitch • Clean environment (eggs resistant in soil) **Strongid-T** Prognosis: **Excellent** w/ treatment

#1 Parasite, Puppies born infected
CS: Diarrhea, Potbelly, Stunted growth, Dull coat
Dx: Fecal flotation
Tx: Strongid-T at 2 weeks old • Px: Excellent

Hookworm, Ancylostoma, Ancylostomiasis M8k 318; Mk 240; E-hb 475; SAP 697; H2B 403; H3B 357; 5min 682; I2M 445; IM 343; IM-WW 270, 282; C12T 713; C11T 627(f); GI 410, 457; Emrg 347; Pa-T 47 ***	• *Ancylostoma caninum* most common in dog • ***A. tubaeforme*** in cats • *A. braziliense* (South USA) & *Uncinaria stenocephala* (Canada) less common & less pathogenic • Transmission: prenatal, milk, direct skin penetration, ingestion of larva or host • Eggs passed in 2-3 weeks • Blood suckers ("graze" gut) • Liver/lung migration of larvae	• **Blood loss anemia** - Iron deficient anemia • Intestinal ulcers • Tarry (melena) or bloody diarrhea • Pallor, weakness • Emaciation & dehydration • Acute death in neonates possible • Pruritic dermatitis occasionally due to penetration of skin • **Adults: usually asymptomatic**	• Hx, CS • Fecal flotation (Strongyloid ova) • Eosinophilia	• **Strongid-T® (pyrantel pamoate)** as for ascarids, start as early as 2 weeks, every 3 weeks until 8 weeks • Other drugs: fenbendazole, febantel, butamisole HCl, mebendazole & dichlorvos • Severely anemic - Whole blood transmission - Iron supplementation - Supportive therapy **Strongid-T** Prevention: • Good sanitation • Oxibendazole & milbemycin: preventative agents against both heartworm & hookworms Prognosis: **Good**

Ancylostoma, Blood suckers
CS: Anemia, Emaciation & Dehydration
Dx: Fecal flotation
Tx: Strongyl-T • Px: Good

Strongyloidiasis, Strongyloides M8k 316; Mk 238; E-hb 476; SAP 698; H2B 403; H3B 357; 5min 1088; I2M 446; IM 343; IM-WW 272; GI 412; Pa-T 47 *	• **Tiny** (2 mm/ <1/4") rhabdoid nematodes • Humid, warm tropical regions (**Gulf States**) • Dogs: *Strongyloides stercoralis* (proximal small bowel) • Cats: *S. tumefaciens* (large intestine) • Life cycle: infectious 3rd-stage larvae: oral or cutaneous route - Migrate in circulation & lungs, then to adult in intestine - Eggs hatch in gut, 1st-stage larvae passed in feces - develop into infectious stage or free living adults	• **Pups: hemorrhagic enteritis** - Often fatal • **Cats: asymptomatic** usually - Some: peculiar tumorlike white nodular (2-3 mm) proliferations in colonic mucosa & submucosa . Chronic diarrhea & debilitation	• **Fecal flotation** - first-stage **larvae** • Free larvae by direct smears or Baermann technique • Cats: colonoscopy also of nodules	• **Fenbendazole** (Panacur®) PO, 5 days • Diethylcarbamazine PO, once • Nemex®/Strongid T® (pyrantel pamoate) **Panacur** Prognosis: **Good**

Tiny worms, Gulf States
CS: Pups: Hemorrhagic enteritis; Cats: Asymptomatic
Dx: Larvae
Tx: Panacur • Px: Good

Parasites

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment

Whipworms, Tricuris, Trichuris colitis

M8k 319; Mk 241; E-hb 476; SAP 698; H2B 404, 427; 5min 1160; I2M 444; IM 341; IM-WW 282; C12T 713; C11T 628(f); Emgr 347; Pa-T 68

****?**

- ***Trichuris vulpis* : canine**
  - Cat: *T. campanula* & *T. serrata*, rare & not associated w/ clinical signs
- **#1 colonic diz in dogs**
- Transmission: Ingestion
- Direct life cycle - 3 months
  - Adults in cecum & colon
- Dogs of all ages infected

- **Large bowel diarrhea**
  - Acute, chronic or intermittent
  - Mucoid
  - Urgency & hematochezia (fresh blood)
- Colitis & typhlitis (cecal inflammation)
- Pseudohypoadrenocorticism (hyperkalemia & hyponatremia) in several severely affected dogs

- **Fecal flotation** (Strongyloid ova)
  - Brown, bipolar, **operculated,** football-shaped ova
  - Repeat m/b necessary due to long prepatent period (2-3 mo.) & intermittent shedding of eggs
- Colonoscopy visualization in bowel lumen
- **Therapeutic treatment test**, before extensive workup

- **Anthelmintics:** **Panacur**
  - **Panacur®** (fenbendazole) or
  - Vercom® (febantel) for 3-5 days
  - Repeat at 3 weeks & 3 months because difficult to eradicate
  - Other whipicides: Telmintic® (mebendazole), Styquin® (butamisole), Task® (dichlorvos)
  - Less efficacious & more toxic
- Typhlectomy (removal of cecum) in rare cases of transmural granulomatous typhlitis

Prevention:
- Virtually impossible to eradicate from infected ground, frequent reinfection common
  - Disposal of feces
  - Chronically exposed dogs
    - Retreat every 2-3 months
  - Concrete runs - Na HCl bleach

Prognosis: **Good**

All ages, Large intestine
CS: Large bowel diarrhea, Typhlitis
Dx: Fecal flotation (operculated egg)
Tx: Panacur • Px: Good

DDx:
- *Ancylostoma caninum*
- Acute or chronic colitis
- Eosinophilic colitis
- Cecal eversion
- Colonic polyps or neoplasia
- Colonic motility disorders

Tapeworm, Cestode

M8k 320; Mk 242; E-hb 476; SAP 698; H2B 404; 5min 1092; I2M 446; IM 342; IM-WW 272; C12T 714; C11T 628(f)

****

- ***Dipylidium caninum*: dogs & cats**
  - **Flea intermediate host**
- Taenia spp: *T. pisiformis*: dogs; *T. taeniaeformis*: cats
  - Ingestion of cysticercus-infected tissue (rabbits, rodents, sheep, ungulates)
- Rare cestodes: Echinococcus, Multiceps, Mesocestoides & Spirometra

- **Relatively harmless**
  - Most subtle decline in body condition
- Anal pruritus: proglottids, crawling on perineum

- **Ova in feces**
- *D. caninum* proglottides- barrel shape & double genital pore

- Most effective all-around drugs
  - **Droncit® (praziquantel)**
  - **Cestex® (epsiprantel)**
- Taenia spp drugs
  - Telmintic® (mebendazole) & Panacur® (fenbendazole)
- **Flea & lice control** (*D. caninum*)

Droncit

Prognosis: **Excellent**

Prevention: predation & scavenging control

Dipylidium (flea); Taenia
CS: Harmless
Dx: Flotation: Eggs
Tx: Droncit, Flea & lice control • Px: Excellent

Coccidiosis

M8k 142; E-hb 476; SAP 699; IM-WW 271; C12T 715, 728 (f); C11T 629(f) H3B 1171; H2B 404; 5min 462; I2M 447; IM 342; Cat 1236; F-H 361; Pa-T 46

*

- **Coccidia: Protozoan parasite**
- Rare, less common than in ruminants, pigs, poultry or rabbit
- Transmission: ingestion of infected oocytes or parasitic host
- Most nonpathogenic, commensal infections
- Cryptosporidia, Cytoisospora, Isospora, Besnoitia, Hammondia, Sarcocystis, Neospora, Toxoplasma. **No Eimeria** in dogs or cats
- Life cycle: ingestion feces or infected tissue

- **Many asymptomatic, incidental finding**
- Clinical in very young, debilitated, crowded, unsanitary animals (diarrhea)
- Diarrhea, fever, anorexia, weight loss, emaciation, ± death

- **Oocysts in fresh feces**
  - **Clinical significance questionable,** even if diarrhea, look for other causes

- **Tx only if CS & Dx**
- Sulfonamethoxine (Albon®)
- Trimethoprim-sulfa (Tribrissen®)
- Amprolium (Corcid®) (unapproved for dogs, but often recommended for kennels)

Albon

Protozoan, Asymptomatic, Oocysts • Tx: None

Giardia, Giardiasis

M8k 146; E-hb 477; SAP 698; H3B 1169; H2B 404; 5min 629; I2M 447; IM 342; IM-WW 271; C12T 714; C11T 628(f); Cat 1236; F-H 394; Pa-T 44

******

- **Pear-shaped, binucleated, flagellated protozoa**
- Transmission: ingestion of contaminated food or water (direct life cycle)
- Trophozoites attach to small intestine & interfere w/ absorption
- PH: zoonotic concern
- Worldwide distribution

- **Most subclinical**, esp. in adults
- Young dogs & cats
  - Intestinal malabsorption
  - **"Cow patty"** diarrhea
  - Steatorrhea
  - Weight loss
  - Coexistent viral, bacteria, or helminth infections increases severity

- **Hx, CS**
- **Cysts in feces** (oval, zinc sulfate centrifugation-flotation of feces
  - Negative exam doesn't rule out (R/O) intermittent shedders so can miss
- **R/O by therapeutic trial**
- ELISA & IFA are becoming more available

- **Flagyl® (metronidazole): 1/3rd resistant,** don't use in pregnant animals
- **Valbazen® (albendazole)**
- **Atabrine®** (quinicrine): 100%
- **Furoxone® (furazolidone)** PO BID suspension good in cats

Flagyl

Public Health: Infects humans - hygiene

Pear-shaped, Binucleated, Protozoa, PH
CS: Subclinical, Malabsorption
Dx: Cysts in feces, (-) doesn't R/O, Tx trial
Tx: Flagyl • Px: Excellent

Prognosis: **Excellent**, some may require longer or repeated treatments

Trichomonads

E-hb 497; SAP 700; F-H 397 *

- *Pentatrichomonas hominas*, motile, pear-shaped, flagellated protozoa, colon of dogs & cats
- CS: **Pathogenicity unproven**
- Dx: **Saline fecal smears**: trophozoites w/ characteristic wavelike motion of an undulating membrane & a constant turning & rolling motion
- Tx: **Flagyl®** (metronidazole)

Amebiasis *

M8k 140; SAP 700; H2B 428; IM-WW 282; F-H 398; Pa-T 67

- **Rare** in USA, ***Entamoeba histolytica***, primarily **human** pathogen, tropical & subtropical countries w/ poor sanitation & high population density
- CS: **Rarely** cause **amoebic colitis** (bloody mucoid diarrhea) in dogs & cats; asymptomatic
- Dx: **Direct fecal smear: amoeboid trophozoites** w/ pseudopodial movements, Amoebic cysts in zinc sulfate flotation, Colon biopsy (diagnostic- reliable mucosa/ulcer
- Tx: **Flagyl®** (metronidazole), Furazolidone (Furoxone®), dehydroemetine. **Public health**

Flagyl

Balantidiasis

E-hb 497; SAP 700; H2B 429; IM-WW 282 *

- ***Balantidium coli***, ciliated protozoan, 1° infects swine & humans, infrequently in dogs, not reported in cats; Associated w/ Trichuris infection
- CS: **Rare** cause of chronic ulcerative colitis in dogs (persistent hemorrhagic diarrhea, depression, anorexia, dehydration)
- Dx: **Fecal smear**: large, oval, brown, rapidly swimming, ciliated trophozoites w/ prominent macronuclei, Protozoal cysts in **zinc sulfate or sedimentation preparation** of feces
- Tx: **Flagyl®** (metronidazole); eliminate contact w/ swine, check & treat Tricuris

Cryptosporidiosis: M8k 145, I2M 447, H3B 1173; Cat 1236; F-H 366; Pa-T 45; Rare in dog, cat & horses

Other parasites *

M8k 315, I2M 423; IM-WW 272

- **Rare or found in other countries**; e.g., physaloptera spp. (stomach worm), trichinosis, schistosomiasis, macracanthorhynchiasis (*Macracanthorhynchus ingens*), Ollulanus sp. (O. tricuspis), Acanthocephalans (Thorny-headed worms), *Oncicola canis*

Acute Abdomen

Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Acute abdomen, Abdominal pain	• **Symptom, not a condition** • Any abdominal process producing severe diz - Hypovolemic &/or septic shock - Sepsis - Severe pain • Diagnosis pursued aggressively, to determine if Sx necessary before irreversible deterioration • Causes (see box) - Inflam. of abd. viscera or wall - Obstruction of viscus - Penetrating or blunt trauma - Ischemia of abdominal organs	• **Pain:** classic finding defining syndrome • Anorexia • Vomiting/retching • Diarrhea • Dyschezia • Dehydration • Lethargy/collapse • Fever (pyrexia) • Dysuria/stranguria • Abdominal distension	• **Aggressive Dx & symptomatic Tx** • Initially treat for shock & stabilize • Determine if Sx or medical treatment needed • Initial PE to R/O obvious causes needing surgery after stabilized - Gastric dilatation/torsion (decompress immediately & Tx shock & stabilize) - Abdominal masses & bunched, painful bowel • Collect samples before or early in therapy - Blood, urine, feces - Abdominal fluid - Arterial blood gases • Plain radiographs for less obvious - Surgical cases . Abdominal mass . FB . GI obstruction . Pneumoperitoneum • Peritoneal fluid: do fluid analysis - Septic peritonitis: surgery • Lab analysis • If above doesn't apply delay surgery (many not acute abdomen, just abdominal pain) - Parvoenteritis - Peritonitis - Continually monitor & treat symptomatically • Surgery if deterioration, persistent pain, unresponsive to Tx or Dx indicates	• **Symptomatic/supportive Tx while aggressive diagnosis** • **Tx shock & stabilize first** - Decompress gastric dilatation/volvulus - **IV catheters, fluids, ± steroids, Banamine®** - ± ABs, ± Potassium, ± bicarbonate (if Total CO2 <14) • Surgery or medical treatment required? • If medical: - Symptomatic & supportive until Dx - Monitor continually - Continue diagnosis • Sx if doesn't respond, deteriorates, persistent pain or surgical Dx (mass, abdominal fluid findings [urine, bacteria, organic debris, bilirubin hemorrhage], peritonitis, free abdominal air or fluid of undetermined origin) • **Medical therapy** - Monitored closely for response to Tx - Poor response indicates further diagnostic workup, change in therapy, or consideration of surgery

I2M 364; IM 276; IM-WW 33; H3B 425; H2B 483; GI 368, 389; DDx 291; Emrg 342

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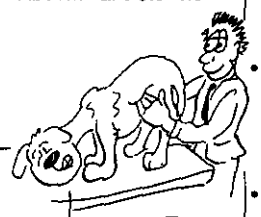
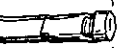
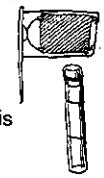
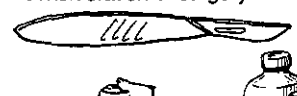
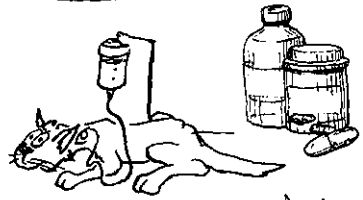










Prognosis: **Guarded** (varies w/ cause & duration)

Acute abdomen - DDx

Medical conditions

- Gastroenteritis: bacterial, viral, toxic
- Cholecystitis
- Pancreatitis
- Pyelonephritis
- Acute prostatitis

Extra-abd. mimicking abd. pain

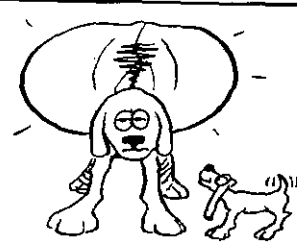
- Intervertebral disc herniation
- Diskospondylitis
- Fractured ribs
- Sublumbar or retroperitoneal abscess

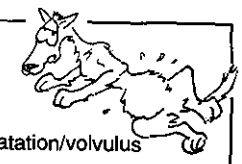
(continued below)

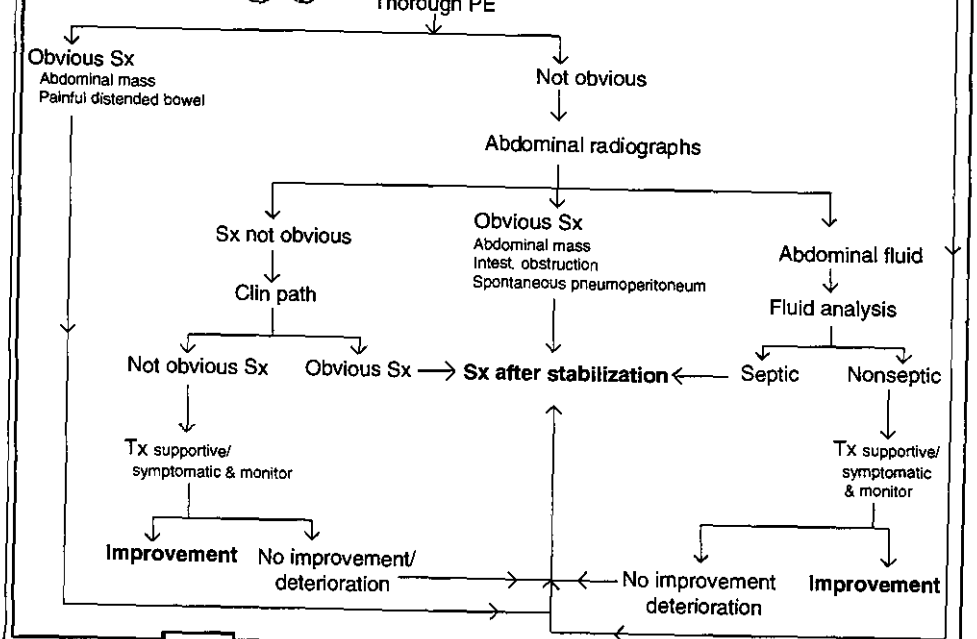
(Continued from above)

Requiring surgical treatment

- Gastrointestinal
  - Obstruction
    - . Foreign body
    - . Tumor
    - . Volvulus
    - . Torsion
    - . Intussusception
    - . Herniation
  - Rupture
    - . Obstruction
    - . Ulceration
    - . Blunt or penetrating trauma
  - Vascular compromise:
    - . Infarction
    - . Mesenteric avulsion
    - . Incarceration in hernia, volvulus or torsion
- Urogenital:
  - Pyometra, fetal death, uterine rupture
  - Uterine or testicular torsion
  - Prostatic abscess
  - Ruptured bladder, ureter, or urethra
  - Renal abscess
  - Ureteral calculi
  - Fractured kidney
- Liver & biliary tract:
  - Hepatic abscess
  - Obstruction of common bile duct
  - Rupture of gallbladder or bile ducts
- Pancreatic abscess
- Splenic torsion
- Hernia/strangulated gut: umbilical, inguinal, scrotal, abdominal, or perineal
- Penetrating abdominal wounds
- Ruptured abdominal neoplasia
- Peritonitis

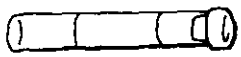






Interpretation of abdominal fluid

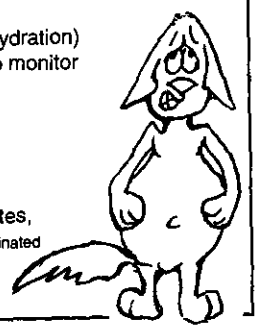
I2M 364



Finding	Indication
• Hemorrhage	
- Clotted blood	Spleen, liver, or vessels
- Not clotted	Free abdominal effusion does not clot
- + Platelets	Ongoing hemorrhage
- Unreadable through newsprint	Significant blood
• Cytology (centrifuge & slides)	
- Organic debris	GI perforation
- ± Bacteria (free or w/in WBCs)	Septic peritonitis (Indication for laparotomy)
- WBCs > 500-1,000 cells/µl	Significant peritonitis
. Toxic or degenerative PMNs	Peritonitis
• Biochemical tests: compare concentrations of albumin/protein, amylase, bilirubin, creatinine, or BUN in lavage to peripheral blood serum	
- ↑ Relative to blood	Inflammation or traumatic injuries
• Clinical pathology (test m/not Dx, but invaluable for severity)	
- CBC	
. Anemia	Acute blood loss, fluid overload
. Leukocytosis	Reflects stress, inflammation or infection
. Left shift w/o leukocytosis	Severe inflammation or infection
. Leukopenia	Viral diz
- Biochemical tests	
. ↑ Plasma proteins	Dehydration (hyperalbuminemia), hypergammaglobulinemia
. ↓ Plasma proteins	Blood loss, fluid overload
- ↑ BUN, **creatinine**	Urinary tract obstruction/**leakage**
- Electrolytes: deranged	Vomiting, diarrhea, obstruction & perforation of GI & urinary tracts

Acute abdomen - Patient monitoring

- CS & laboratory info: chronologically recorded to determine if improving, stabilizing or deteriorating
- Cardiovascular system:
  - Heart rate: should return to normal range
  - Blood pressure (Doppler or oscillametric)
  - Mucous membrane color, capillary refill time, temperature of extremities
  - These parameters vary w/ packed cell volume (PCV), vascular resistance, & blood pressure
- Central venous pressure (CVP): relative changes during therapy are more significant than an absolute value
  - Rising CVP indicates fluid overload of right heart
- Respiratory rate & tidal volume: should return to normal
- Urine output (normal 1-2 ml/kg/h)
- Laboratory testing:
  - PCV & total solids (hemorrhage & hydration)
  - Electrolytes: measured frequently to monitor therapy
- Rectal temperature
- Persistence of CS
  - Vomiting, diarrhea
  - Abdominal distension and pain
  - Hemorrhaging from venipuncture sites, petechiae: m/ indicate onset of DIC (disseminated intravascular coagulopathy)



Abdominal distention

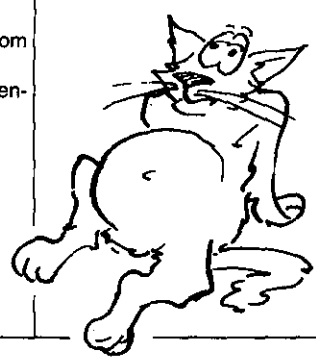
I2M 366; IM 278; IM-WW 39

**

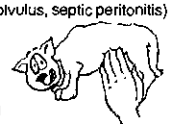
- **CS, not a diz**
  - May be associated w/ acute abdomen
  - Usually separate problem from acute abdomen
- Take client's word about distention until proven otherwise

Causes: (see box)
- Tissue
- Fluid
- Gas
- Fat
- Weak abdominal muscles

- **Reported or viewed distended abdomen**



- R/O acute abdomen (gastric dilatation/volvulus, septic peritonitis)
- **Physical exam: palpation**
  - R/O pregnancy & obesity



- Plane radiographs:
  - Spontaneous pneumoperitoneum
  - Sx indicated (GI tract rupture or septic peritonitis)
  - Gas in hollow organ: obstruction (Sx) or ileus
- Fluid analysis or free abdominal fluid
- Biopsy of abdominal masses m/b

- Ultrasound
- ACTH stimulation or low-dose dexamethasone suppression test
  - Weak muscles, Cushing's diz
- Lab to localize system involved

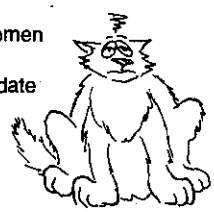
- **Treat cause**

Prognosis: **Guarded**; varies w/ cause

Abdominal distention (IM 278)

Tissue (organomegaly)
- Pregnancy
- Renomegaly
  - Infiltrative diz
  - Hydronephrosis
  - Neoplasia
  - Compensatory hypertrophy
- Hepatomegaly
  - Neoplasia
  - Lipidosis
  - Infiltrative/inflammatory diz
- Splenomegaly
  - Neoplasia
  - Infiltrative/inflammatory diz
- Granuloma
  - Phycomycosis
- Other neoplasia

Fluid
- Fluid inside organs
  - Intestines/gastric (obstruction, ileus)
  - Congestion: torsion, rt. heart failure
    . Liver
    . Spleen
  - Hydronephrosis
  - Cysts
- Fluid free in abdomen
  - Transudate
  - Modified transudate
  - Exudate
  - Chyle
  - Blood



Gas
- Inside organs
  - Intestines - obstruction
  - Stomach - dilatation/volvulus
- Free inside abdomen
  - Rupture - GI tract/reproductive tract
  - Spontaneous pneumoperitoneum
  - Peritonitis - bacterial metabolism
  - Iatrogenic - post Sx

Fat
- Obesity
- Lipoma

Weak abdominal muscles
- Cushing's diz

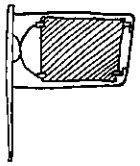
Intestine

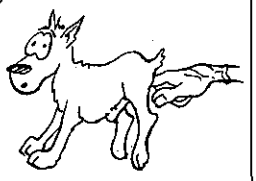
Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Small intestinal bacterial overgrowth E-hb 484; SAP 712; I2M 453; IM 749; IM-WW 279; 5min 1062; GI 443; Cat 1253 **	• **Over proliferation of microflora in proximal intestine** • Results in malabsorption & diarrhea • Fasting bacterial count of > 10^5 bacteria/ml **Causes: bacterial overgrowth** • Intestinal surgery (iatrogenic) • Stasis-producing mechanical obstruction (FB, stenosing neoplasia, inflammatory lesions) • Destructive lesion of iliocecocolic junction allowing colon enteric reflux • Motility disorders (idiopathic pseudo-obstruction) • Immune deficiency states • Hyposecretion of gastric acid • Exocrine pancreatic insufficiency	• **Small bowel diarrhea** - Chronic, foul-smelling **watery diarrhea** (no blood or mucus) • **Weight loss** • **Steatorrhea**	• **Difficult to document** • Quantitative aerobic & anaerobic cultures - > 10^5 organism/ml duodenal juices - Endoscopic, laparotomy or intestinal intubation for duodenal specimen - Not routinely done • Expiratory H2 gas concentration, not routinely done • **Therapeutic ABs trial** response - indirect evidence - Response to ABs - Failure to respond to Tx of condition known to be conducive to bacterial overgrowth • Delayed intestinal transit of barium (obstruction or poor motility) • Idiopathic pseudo-obstruction • Hypermotile segment of gut • ↑ Serum folate & ↓ serum cobalamin (bacteria synthesize folate & bind cobalamin) • Intestinal biopsy: minimal morphologic abnormalities	• **Tx underlying disorder** • **ABs**: oral broad-spectrum w/ activity against anaerobes (tetracycline, oxytetracycline, doxycycline, metronidazole, ampicillin, chloramphenicol, tylosin, erythromycin) - 10-14 days & repeat as necessary, some require continuous treatment • Lactobacillus or live yogurt culture usually not effective Prognosis: **Good** for most w/ Tx; some require continuous treatment
Stasis - Over proliferation of bacteria in proximal intestine **CS: Small bowel diarrhea** **Dx: Difficult; Response to ABs** **Tx underlying disorder; ABs • Px: Good**				
Short-bowel syndrome E-hb 489; SAP 481; I2M 459; IM 353; IM-WW 280; GI 452; I 1227; Cat 1252; Sx-S-hb 222 Sx-WW 137 *	• **Malabsorption w/ diarrhea & malnutrition following resection of a large portion of the small intestine** **Sx removal of small intestines**	• Progressive **weight loss** • Ravenous appetite • **Chronic persistent watery diarrhea (small bowel)** - Foul smelling w/o obvious blood or mucus	• **Hx (bowel resection surgery)** • **CS (small bowel diarrhea)** • Lab: malabsorption - Abnormal xylose absorption - Marked steatorrhea - Abnormal bentiromide test - Positive urine nitrosonaphthol test • ± Moderate nonregenerative normochromic-normocytic anemia • Radiology: - Dilated intestinal loop - Barium: marked accelerated stomach-to-colon transit time	• **Fluid therapy initially** • **Return to oral food** intake early to stimulate adaptive hyperplasia: 1. Frequent small meals 4-8/day, 2. Low-fat diet (**r/d** diet), 3. Daily vit. & minerals • **Control complications** - Bacterial overgrowth: **ABs** (tylosin, tetracycline) - 2° gastric acid: **H2 blocker** (cimetidine) - Rapid intestinal transit time: motility-modifying antidiarrheals (diphenoxylate, loperamide) - Bile acid-mediated diarrhea: oral bile acid-binding agents (cholestyramine) Prognosis: **Poor**
***Irritable bowel syndrome,* Spastic colon, Stress colitis** E-hb 495; SAP 710; I2M 454; IM 350; H3B 379; H2B 431; 5min 746; C11T 604; GI 468; GI-S 532 **	• ***Functional disorder lacking in any identifiable lesions*** - Noninflammatory mucoid large bowel diarrhea w/ episodic disturbances of colonic myoelectrical function • Human diz: circumstantial evidence in animals • **Large breed working dogs** (Ger. Shepherd, seeing eye dogs) & temperamental/excitable dogs predisposed **Functional disorder w/o lesions, Working (stressed?) dogs** **CS: Large bowel diarrhea, then constipation** **Dx: No identifiable lesions, R/O** **Tx: w/d diet, Motility modification, Antispasmodics, Sedation**	• Alternate patterns of: - **Diarrhea** (large bowel): soft, mucoid feces - **Constipation** - Abdominal cramping	• **No identifiable lesions** • R/O (rule out) known causes of colonic diz (dietary, parasitic, infectious & idiopathic colitis [IBD])	• **Dietary modification** - Add dietary fiber (unprocessed wheat bran) (1-5 tbsp/meal) - **w/d diet** • **Motility modification** - Anticholinergics/antispasmodics: **propantheline** [Pro-Banthine®], clidinium [Quarzan®] or dicyclomine [Bentyl®] or opioid drugs (diphenoxylate [Lomotil®] or loperamide [Imodium®] • **Mood modification:** - Light sedation during stress (acetylpromazine, chlorpromazine or phenobarbital in nervous dogs) - Anticholinergic CNS depressant, drug combo (clidinium-chlordiazepoxide [Librax®]) Prognosis: **Guarded**, many can be reduced or controlled
Intestinal lymphangiectasia E-hb 487; SAP 710; I2M 453; IM 349; IM-WW 280; 5min 788; GI 439; Neo 169; Pa-T 40 *	• **Chronic protein-losing enteropathy** - Marked dilation & dysfunction of intestinal lymphatics - Blockage of lymph drainage of intestines - Over-distended lacteals release intestinal lymph into gut lumen (loss of plasma proteins, lymphocytes & lipids (chylomicrons) . Reduced colloidal osmotic pressure **DDx:** • Non-enteric hypoproteinemia: Liver failure, Renal diz • Cardiac diz - lymphangiectasia • Exocrine pancreatic deficiency • Other enteric diz - lymphosarcoma, histoplasmosis, LPE	• **Due to protein-losing: edema** - Dependent pitting edema of SQ & limbs - Ascites (fluid distention of abdomen) - Hydrothorax (respiratory distress) • ± Chronic intermittent or persistent diarrhea, watery or semisolid • **Progressive weight loss**	• Lab: - **Hypoalbuminemia**, hypoglobulinemia, lymphocytopenia, hypocholesterolemia & hypocalcemia - DDx from liver: liver function tests - Urine protein determination - DDx renal diz • Abdominocentesis: transudate, chylous ascites & chylothorax occasionally • Radiology: **Ascites** & pleural effusion • Laparotomy/endoscopy w/ biopsy definitive	• **Lower loss - enteric plasma proteins** - **Dietary therapy: r/d diet** . Restrict intake of LCTs (long-chain triglycerides) reduce lymph flow, lymphatic distention & protein loss in lymphangiectasia .. **r/d diet** or homemade (1 part low fat cottage cheese or yogurt to 2 parts rice or potatoes + fat-soluble vitamins .. Promote regain of lost weight: **medium-chain triglycerides** (MCT Oil®) added to diet - **Steroid**: prednisolone PO helps protein loss & diarrhea. On remission reduce to lowest effective maintenance level Prognosis: **Poor to guarded**, remission in some for months to years; others fail to respond & eventually relapse into incapacitating effusion & intractable diarrhea
Mesenteric thrombosis E 1187; Sx-S-B 243 *	• **Acute occlusion of several mesenteric arteries** • Infrequent sequela to blunt abdominal trauma • Initially intestinal hyperactivity • Ileus follows, Intestinal infarction?	• Sudden anorexia • **Vomition** • Bowel evacuation (w/ contain blood) • **Abdominal pain**	• **Hx, CS** • **Radiology** - Local gas ileus - Local or general loss of peritoneal detail due to effusion • **Exploratory laparotomy**	• **Intestinal resection & anastomosis** Prognosis: **Guarded**

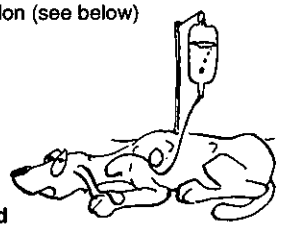
Megacolon

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Megacolon H3B 371; H2B 430; SAP 777, 719; I2M 466, 371; IM 357; E-hb 498; 5min 808; E 1257; Cat 1266; F3IM 104; F-N 416; Sx-WW 135; Sx-S-hb 223; Sx4B 272; Pa-T 65; X-T 564 **	• Severe colonic distention & hypomotility • Uncommon • **Cats > dogs** • Pathophysiology: - Fecal impaction, colonic dilatation, chronic obstruction - ↑ Colonic bacteria & enterotoxins - ↑ Intraluminal pressure = mucosal wall problems	• **Chronic & recurrent constipation** - No feces, but straining (tenesmus) & frequent attempts - Intermittent fetid, liquid feces ± blood & mucus • ±**Obstipation** (intractable constipation) - Intermittent vomiting - Depression, anorexia, weakness - Weight loss	• Hx (history) • CS (clinical signs) • PE: dehydration • **Abdominal palpation**: distended, firm colon • Digital rectal • **Plain films** - megacolon, ± pelvic fxs, ± vertebral lesions	• **Mild**: Oral laxatives: DSS (Colace®), bisacodyl (Dulcolax®) • **Severe - initially** - Fluids: polyionic solutions + potassium chloride (40 mEq/L) - Remove fecal material: . Multiple warm enemas (mild soap or DSS [dioctyl sodium sulfosuccinate] to hydrated pet) . Lubricate rectum & distal colon: water soluble lubricant in large, catheter tipped syringe & a feeding tube . ± Small sponge forceps to break up & remove fecal concretions (sedation or anesthesia) - Tx cause: Sx for strictures, obstruction, idiopathic megacolon • **Medical management:** - Oral laxatives: DSS (Colace®), bisacodyl (Dulcolax®) - Diet: moist food + psyllium (Metamucil®) or bran fiber to soften feces - Periodic enemas in mild constipation - ↑ Exercise, weight loss in obese, clean litter pan • **Subtotal colectomy**: for nonresponsive cats/ idiopathic megacolon (see below)

Causes: Megacolon
- **Idiopathic megacolon in cats (#1 cause)**
- Acquired megacolon: 2° to any cause of obstruction & chronic constipation
  . Foreign bodies: bones, string, hair
  . Neoplasia (lymphosarcoma in cats)
  . Strictures, pelvic fractures
  . Terminal spinal cord lesion (Manx cats)
- Cats: dysautonia or Key-Gaskell syndrome
- ? Congenital myenteric ganglion cells problem in humans; not well documented in small animals







Prognosis: **Guarded**

Cat > Dog
CS: Recurrent constipation
Dx: Rads
Tx: Conservative, Sx

Idiopathic megacolon

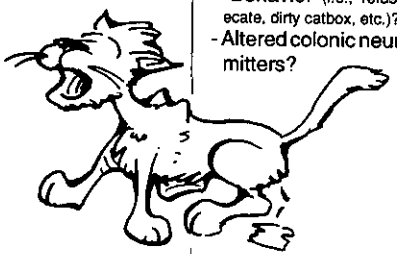
H3B 371; H2B 430; SAP 777, 719; I2M 466, 371; IM 357; E-hb 498; 5min 808; E 1257; Cat 1266; F3IM 104; F-N 416; Sx-WW 135; Sx-S-hb 223; Sx4B 272; Pa-T 65; X-T 564

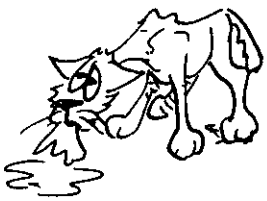
- ***Adult cats***
- *Important* cause of chronic constipation
  - Acquired diz w/ no organic lesions
  - 1° cat diz, but occasional dog
- Severely colonic distention & hypomotility w/o obstruction
- Cause: ? Idiopathic
  - Behavior (i.e., refusal to defecate, dirty catbox, etc.)?
  - Altered colonic neurotransmitters?

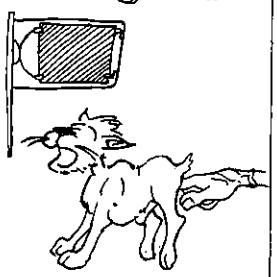
- **Chronic & recurrent constipation**
- Depression
- Anorexia
- Weight loss
- Vomiting

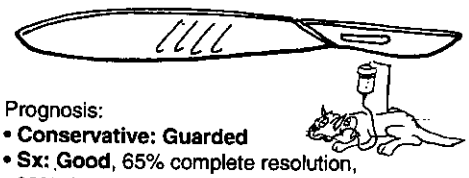
- Hx (adult cat)
- CS
- Abdominal palpation: distended firm colon
- Plain films - megacolon
- Digital rectal exam
  - R/O (rule out) other causes
  - Dietary, behavioral, metabolic & anatomical causes (see above)

- **Severe - initially hydrate & remove feces:**
  - Fluids: polyionic solutions + potassium chloride (40 mEq/L)
  - Remove fecal material:
    . Multiple warm enemas (mild soap or DSS [dioctyl sodium sulfosuccinate] - to hydrated cat)
- **Conservative Tx to prevent impaction:**
  - Diet change: moist food + psyllium (Metamucil®) or bran fiber to soften feces
  - Clean litter box at all times
  - Osmotic laxatives: lactulose (Duphalac syrup®), ice cream, milk
  - Bisacodyl (Dulcolax®): stimulant laxative, not for long term use
- **Subtotal colectomy** with ileorectal or colorectal anastomosis (remove most of colon)
  - For nonresponsive cats
  - After Sx cats defecate more frequently, but less diarrhea & weight loss, in time firms up in some









Prognosis:
- **Conservative: Guarded**
- **Sx: Good**, 65% complete resolution, 20% decrease frequency of signs

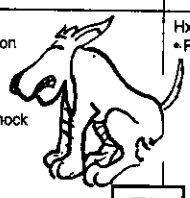
Adult cat
CS: Chronic & recurrent constipation
Dx: Hx, Plain films
Tx: Conservative, Subtotal colectomy
Px: Sx -Good

Cecal-colic volvulus

Sx-WW 136; Pa-T 66

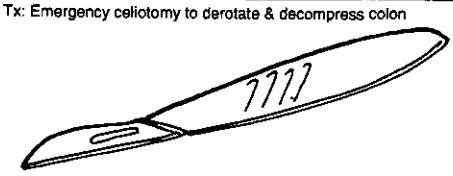
- Rare
- Cecum, ascending colon & transverse colon rotated around cranial mesenteric root

- Depression
- Abdominal distention
- Tenesmus
- Diarrhea
- Vomiting
- ± Dehydration & shock



Hx, CS
- Radiology: gas distended loops

Tx: Emergency celiotomy to derotate & decompress colon



Px: Depends on severity of GI compromise

Rare
CS: Tenesmus, Diarrhea, Vomiting
Dx: Hx, CS, Rads
Tx: Surgical correction

Malabsorption

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Malabsorption syndrome M8k 305, 129; Mk 141; SAP 711; H3B 360; H2B 407; E-hb 558; GI 437; I2M 449; IM 345; IM-WW 15; H2B 407; Pa-T 39 ***	• **Loss of 1 or more nutrients in feces** • **Maldigestion:** - Exocrine pancreatic insufficiency (EPI) • **Malabsorption** - Enteropathogenic & invasive bacterial colonizing gut - Persistent diarrhea (loss of water & electrolytes) - Viral (villous atrophy) • **Protein losing enteropathy** - Neoplastic, infiltrative or proliferative lesions of small intest. • Dogs >>> cats	• Insidious onset • **Chronic small bowel-type diarrhea,** persistent or intermittent - ↑ **Volume** - Normal - ↑ frequency - Melena - **Steatorrhea** - **Weight loss** (chronic), (while still eating) - ± Vomiting • Abdominal distention w/ or w/o ascites • Peripheral edema, muscle wasting	• **Hx (breed predilection)** • **Biopsy/histopathology** required • **Fecal flotation** (parasites) • **Wheat withdrawal from diet test** • **Eliminate parasite & caloric problems** • **Serology:** - **Trypsin-like immunoreactivity (TLI) for EPI** (exocrine pancreatic insufficiency) - **Cobalamine & folate for small bowel malabsorption w/ 2° bacterial overgrowth** • Further lab tests expensive - Fecal fat test m/ differentiate maldigestion from malabsorption - Fecal trypsin (exocrine pancreatic insufficiency [EPI] if absent) - Carbohydrate absorption tests (starch, D-Xylose, oral glucose tolerance tests) - Lactase deficiency - tests inconclusive - Dx by adding & excluding milk from diet & evaluating feces • Plain rads, maybe normal: diffuse thickening of small intestines • Contrast radiographs - Ulcerative or nonulcerative thickening of wall - Constriction or dilation of bowel lumen w/ normal mucosal pattern - Distal ileum maybe more distended than rest of small intestine	• **Tx parasites** • **Calories** • Wheat withdrawal from diet test • **Pancreatic insufficiency** - Oral pancreatic enzymes - Diet low fat high protein - Only 1/2 patients improve • **Lactase deficiency** - Remove milk & milk products from diet • Undifferentiated malabsorption protein-losing enteropathies - No response to specific Tx Prognosis: • **Good for EPI** • **Poor** for lymphangiectasia or chronic granulomatous enteritis • Grave for neoplastic infiltrate

Cause-malabsorption
- Lymphangiectasia
- Eosinophilic enteritis
- Exocrine pancreatic insufficiency (EPI)
- Plasma cell enteritis
- Lymphosarcoma
- Chronic parasitism
- Histoplasmosis
- Steatorrhea
- Mastocytosis
- Villous atrophy
- Wheat sensitivity
- Lactase deficiency

Loss of 1 or more nutrients in feces
CS: Small bowel diarrhea
Dx: Hx, Biopsy, Fecal, Serology
Tx cause. Px: variable

Villous atrophy

SAP 711; GI 449; Cat 1254; Pa-T 39
**

- ***Short, blunted mucosal villi***
- ***Associated w/ malabsorption & chronic diarrhea***

- Insidious onset
- **Chronic small bowel-type diarrhea** (persistent or intermittent)
  - ↑ **Volume**
  - N- ↑ Frequency
  - Melena
  - **Steatorrhea**
  - **Weight loss** (chronic), while eating
  - ± Vomiting
- Abdominal distention w/ or w/o ascites
- Peripheral edema, muscle wasting

- **Hx (breeds predilection)**
- Wheat withdrawal from diet test
- Test for enteric infections (Giardia) or bacterial overgrowth
- **Endoscopy**
- **Duodenal/jejunal biopsy** required
  - Characterize morphological & biochemical abnormalities
- Sometimes infiltration of lymphocytes & plasma cells & fibrosis make it difficult to differentiate from chronic inflammatory diz (lymphocytic-plasmacytic enteritis w/ 2° villous atrophy)

- **Tx 2° causes** (parasites, bacteria & viruses)
- **Wheat-sensitivity:** eliminate wheat & other gluten-containing diets
- **Idiopathic villous atrophy**
  - **Dietary:** (d/d diet, Hill's) gluten-restricted hypoallergenic diet sometimes beneficial)
  - **Vitamin Tx:** folate (5 mg daily PO) & cobalamin (500µg monthly, IM for 6 months) if serum levels low
  - ABs sometimes useful (tetracycline, tylosin or metronidazole) for bacterial overgrowth
  - **Inflammatory bowel diz:** steroid (prednisolone)

Causes: villous atrophy
- Idiopathic
- Primary form
  - Wheat-sensitive enteropathy
  - Idiopathic canine villous atrophy (G. shepherds)
- Secondary forms:
  - Sequelae of diffuse infiltrative dizs
    - Chronic inflammatory bowel diz
    - Lymphoma
  - Sequelae of enteric infections
    - Viruses (coronavirus, rotavirus)
    - Bacteria (overgrowth syndrome)
    - Parasites (Giardia)

Short, blunted mucosal villi, Malabsorption & chronic diarrhea
CS: Chronic small bowel CS, Weight loss
Dx: Hx, CS, Endoscopy, Biopsy
Tx: Tx 2° causes, Idiopathic: d/d diet, Vitamins, ± ABs , ± Steroids • Px: Guarded

Prognosis: **guarded**, often diarrhea & weight loss continues despite Tx

Wheat-sensitive enteropathy

Mk 121; SAP 711; Neo 173; GI 451; H3B 353
*

- **Rare**
- **Primary form of villous atrophy**
  - Partial villous atrophy
  - Deficiency or delayed development of microvillus enzymes
  - Dietary sensitivity to wheat
  - Associated w/ malabsorption & chronic diarrhea
- **Irish Setters in Great Britain**

- Insidious onset
- **Chronic small bowel-type diarrhea**
  - ↑ **Volume**
  - N- ↑ Frequency
  - Melena
  - **Steatorrhea**
  - **Weight loss** (chronic)
  - ± Vomiting
- Weight loss (while eating)
- Persistent or intermittent diarrhea
- Abdominal distention ± ascites
- Peripheral edema, muscle wasting

- **Hx (breeds predilection)**
- **Biopsy** - jejunum: Villous atrophy
- Wheat withdrawal from diet test

- **Eliminate wheat & other gluten containing diets**
  - **Hill's d/d** & i/d diets & Science Canine Growth Diet, Iams (Chunks, Plus & Eukanuba)
  - Wheat restriction for life
- Breeding discouraged

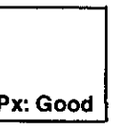
Prognosis: **poor**

Irish Setters in Gr Br, Malabsorption

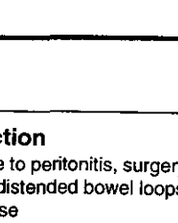
Intestinal Obstruction

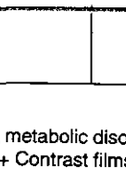
Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Intestinal obstruction M8k 296; Mk 252; E-hb 482; SAP 713; H3B 367; H2B 413; I2M 455; IM 350; IM-WW 276; GI 173, 370; E 1212; Sx4B 245; SX-WW 133; Emrg 341; Neo 174; Cat 1262; 5 min 742; X4T 540, 560; Pa-T 34 **	• **Uncommon** • **Causes (see box):** - Foreign body (FB) - Intramural thickening or stenosis from any cause - Extramural compression • **Complications** - Intestinal rupture - Peritonitis - Endotoxic shock	• Acute or chronic • **Complete duodenal obstruction** - Nausea - **Vomition** of bile - Abdominal pain - Anorexia, depression - Weakness - Dehydration (rapid electrolyte & water loss) • **Distal small bowel obstruction** - Tolerated longer than proximal obstruction - **Vomition** feces-like - Onset of dehydration & weakness delayed - Abdomen distends slowly - Gas & fluid-filled loops of bowel palpated - Tender abdominal mass - Intussusception sausage-shaped palpated • **Partial obstruction** - **Vomition** - Prolonged or intermittent signs - Reduced food & water intake - Chronic weight loss - Remain alert - Feces fluid, bloody & putrid - Transient response to previous AB Tx • **Strangulating obstruction** (vascular compromise) - Rapid progressive toxemia - Shock - Death • In general: **the more proximal (orad) the obstruction, the sooner vomition occurs after ingestion**	• Hx, CS, common in young dogs • History (FB): vomiting & dehydration • **Palpation** of dilated gut or FB suggestive - Sausage in abdomen (intussusception) - Gas-filled loops prox. to obstruction • Borborygmi in distended loops • **Radiology - plain** - **Gas or fluid ileus** common w/ complete obstruction, prox. to obstruction - Degree of ileus depends on duration of obstruction & location - Partial obstruction m/b no ileus • **Contrast** radiographs - Complete obstruction . Delayed transit time prox. to obstruction - Barium in ileus, proximal - Partial obstruction . Intestinal transit time & appearance distal to obstruction usually normal . **Filling defects** • Lab: fluid, electrolyte, & acid-base derangement - ↑ WBC & septic abdominal effusion, ischemia or perforation w/ peritonitis	• **Surgical emergency: to relieve obstruction** - **Meperidine (Demerol®)** (relieve pain) - **IV fluids** & electrolytes prior to & during surgery - Balanced electrolyte sol (if blood gas & pH data not available) - **Broad spectrum ABs**, IV - ±Whole blood or plasma transfusions if circulatory shock - Postoperative ABs & fluids continued • 1-3 days oral intake of fluid & bland, low residue diet • 5-6 days begin to return to regular diet Demerol Prognosis: **good** in general if relieved early & not neoplastic

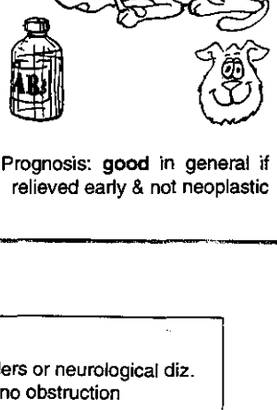
Causes: intestinal obstruction
- Foreign bodies
- Mass of parasites
- Postoperative adhesions or strictures
- Granulomas
- Tumor
- Intramural abscesses, granuloma or hematoma
- Intussusception
- Volvulus, torsion
- Hernial incarceration
- Congenital malformation (stenosis or atresia)



Blockage
CS: Vomition, Depression
Dx: Hx, CS, PE, Rads, Lab
Tx: Sx, Emrg, fluids, ABs • Px: Good







Intestinal volvulus, Mesenteric volvulus

- Dogs >>> cats, No known predilection
- Rapidly progressive diz fatal unless surgery early

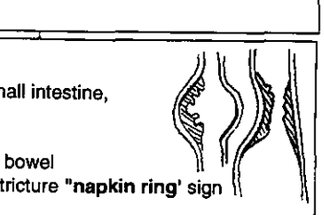
Physiologic obstruction

- From segmental ileus due to peritonitis, surgery, metabolic disorders or neurological diz.
- Dx: Survey radiographs: distended bowel loops + Contrast films: no obstruction
- Tx & Px: depends on cause

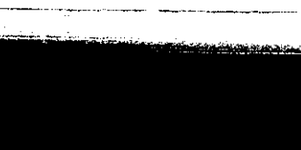
Intestinal FB (foreign body)

- Common in dog & cats
- Spherical, irregular or linear (thread, string) FB
- Linear FB: more common in cats
  - Maybe anchored proximally around base of tongue or stomach - do not pull if string from mouth or anus
  - If untreated peristalsis saws through intestine = peritonitis
- Partial or complete obstruction

Diagnosis:
- Radiographic plain films
  - Radiopaque objects easily to ID
  - Radiolucent m/b surrounded by gas or contain gas
  - Linear FB bunched or gathered bowel
- **Contrast rads: accordion pleating** of small intestine, classical for linear FB
  - Partial obstruction, filling defect

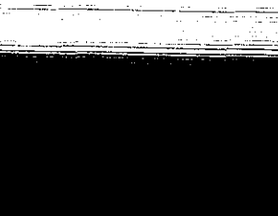


Intussusception



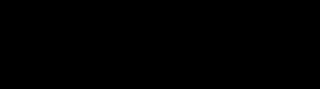
- Young >>> old dogs & cats
- 2° to hypermotility due to:
  - **Ascarid infection** or other causes
- Older 2° to intestinal stricture caused by neoplasia
- Proximal part intussuscepts into distal part
- Ileocolic junction (most common) but may involve any part

Diagnosis:
- Plain films: **Localized ileus**
  - **Sausage-shaped bowel** in mid to caudal abdomen
- Contrast rads: Obstructive ileus proximally
  - **Thin line of barium** into intussuscepted segment **"coiled spring"** appearance
- Barium enema:
  - Dx only if ileocolic or colon or cecum
  - Filling defect within colon (ileum into cecum)

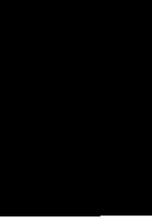


Intestinal tumors

- Older dogs & cats
- Most are primary
  - Adenocarcinoma, lymphosarcoma, mast cell tumors, leiomyoma, leiomyosarcoma
- Most common in duodenum & distal ileum



Diagnosis: intestinal tumor rads
- Plain films m/b normal, mass lesion involving small intestine, m/ contain dystrophic calcification
- Contrast radiographs:
  - Irregular filling defect originating from 1 side of bowel
  - Annular adenocarcinomas m/ circumferential stricture **"napkin ring'** sign



Constipation

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment

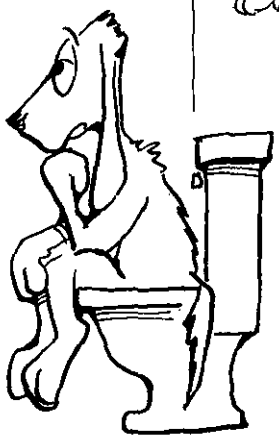
Constipation

M8k 288; Mk 228; E-hb 498; SAP 777; t2M 361, 405, 465; IM 272, 356; IM-WW 286, 29; F3IM 104; GI-S 511; C11T 613, 619(f); Cat 995, 1264; 5 min 28; Sx-S-hb 223; Sx-S 613; DDx 285

***?

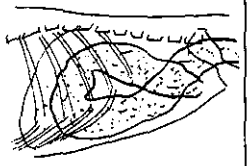
- A clinical sign, not a diagnosis
- **Absent, infrequent or difficult defecation**
  - Retention of feces in colon & rectum
- As feces is retained it becomes harder & drier then impacted

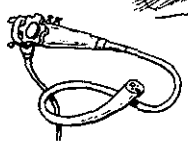
- **Failure to defecate for days**
- Tenesmus
- ± Paradoxical diarrhea (fluid around fecal mass)
- Anorexia, lethargy, vomiting, dehydration
- Abdominal discomfort (hunched up stance)



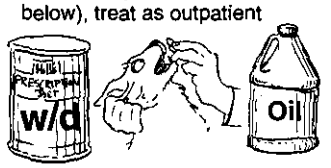
- **Hx, CS (no defecation)**
- **Palpation of colonic distention w/ hard feces**
- **Goal to identify predisposing factors**
  - History (Hx)
  - Physical exam:
    - . **Digital anorectal exam**
    - . Neuro exam
    - . Exam pelvis, hip & hind limb for pain
  - Lab
    - . Identify underlying systemic diz (renal)
    - . Results of fecal retention
    - ..Fluid & electrolytes, endotoxemia, azotemia
- Thyroid function test
  - Dogs w/ recurrent constipation
- Radiology:
  - Confirm extent of impaction
  - Foreign bodies
  - Prostatic enlargement
  - Pelvic, hip or spinal lesions
  - Barium enema after evacuation (intraluminal obstruction)
  - Myelographic (lumbosacral spinal cord)

- Colonoscopy





- **Mild constipation**: resolves spontaneously
  - **Oral or suppository laxatives** (see below), treat as outpatient



- **Severe constipation**
  - Evacuate impacted feces (enemas & manual extraction) m/b over 2-3 days
  - Fluids & electrolytes for dehydration
- Eliminate or control underlying causes
- Surgery: obstructive neoplasia, strictures, etc.

Prevention of recurrence:

- Prevent ingestion of constipating material (bones)
- Prevent hair ingestion - regular grooming
- Clean litter box
- Fresh water at all times
- Correct any predisposing problems

Terms associated w/ constipation

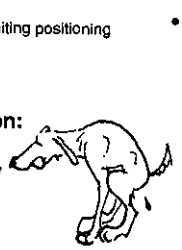
- **Obstipation**: intractable constipation due to impaction of colon & rectum so defecation cannot occur
- **Dyschezia**: difficult or painful evacuation of feces, associated with lesions in or near anus
- **Tenesmus**: straining to defecate, usually ineffectual & painful, usually accompanies dyschezia
- **Megacolon**: a disorder, not a sign; irreversible dilated & hypomotile colon

Causes of constipation

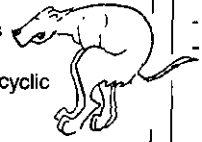
SAP 778

- Dietary:
  - **Ingested foreign material** (hair, bones, cloth, cat litter, rocks, plants)
  - Inadequate water intake
- Environmental/psychological:
  - **Change in habitat or daily routine**
  - **Unsanitary litter box**
  - Hospitalization
  - Prolonged activity

- **Idiopathic megacolon**
- **Painful defecation:**
  - **Anorectal obstruction:**
    - . **Anal sac impaction/abscess**
    - . Anorectal foreign body, stricture, tumor
    - . Fly maggot infestation (myiasis)
    - . Bite wounds, cellulitis, or abscess
    - . **Pseudocoprostasis** (feces matted in perineal hair)
  - Orthopedic disorders: limiting positioning for defecation
    - . Spinal diz/injury
    - . **Dizs of pelvis, hips**
- **Rectocolonic obstruction:**
  - Extramural compression
    - . **Prostatic hypertrophy**
      - .. Prostatitis
      - .. Tumor
    - . Paraprostatic cyst
    - . **Pelvic fractures**
    - . Pelvic collapse - nutritional bone disease
    - . Perianal tumor
    - . **Pseudocoprostasis**



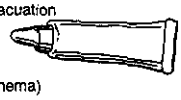
  - Intraluminal obstruction
    - . **Rectocolonic stricture, tumor, inflammation, foreign body**
    - . Rectal diverticulum
    - . **Perineal hernia**
- **Neuromuscular dysfunction:**
  - **Lumbosacral spinal diz**
    - . **Deformity (Manx cats)**
    - . **Intervertebral diz**
    - . Degeneration, injury, neoplasia
  - Bilateral pelvic nerve injury
  - **Dysautonomia (ANS - cats)**
  - **Hypothyroidism**
  - **Idiopathic megacolon**
- **Fluid & electrolyte abnormalities:**
  - **Dehydration**
  - **Hypokalemia**
  - **Hypercalcemia** (Hyperparathyroidism)
  - Chronic renal failure
- **Drug-induced:**
  - Adrenergic blockers & calcium channel blockers
  - **Antihistamines**
  - **Anticholinergics**
  - **Aluminum hydroxide**
  - **Barium sulfate**
  - **Diuretics**
  - Iron
  - Overuse of laxatives
  - **Opiates & opioids**
  - Phenothiazines & tricyclic antidepressants
  - Sucralfate



Laxatives - enemas

- **Oral laxatives/cathartics:**
  - **High fiber bulk-forming laxatives**: added to food
    - . Promotes soft feces (hydrophilic) & normal colonic motility
    - . All-Bran® (Kellogg cereal), Canned pumpkin, Metamusil® (psyllium), 1-5 tbsp/day
    - . **w/d Hill's diet**

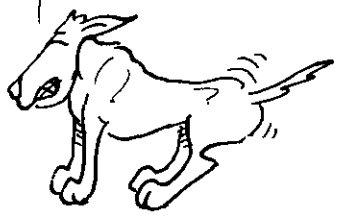
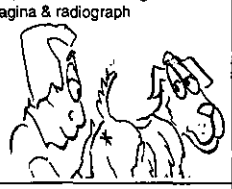
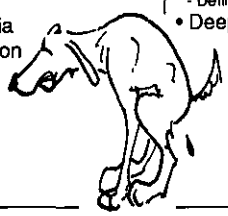
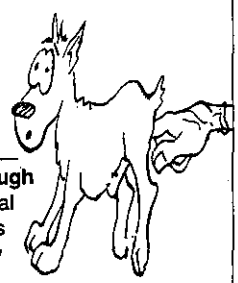
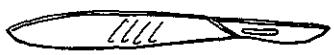
  - **Lubricants-laxatives**: soften & lubricate to facilitate evacuation
    - . Laxatone® (white petrolatum)
    - . Mineral oil



  - **Emollient laxatives**: promote water into feces (oral & enema)
    - . Colace® (dioctyl sulfosuccinate sodium), Surfak® (dioctyl sulfosuccinate calcium), Dialose® (dioctyl sulfosuccinate potassium)
  - **Saline laxatives:**
    - . Milk of Magnesia® (magnesium hydroxide)

  - **Osmotic laxatives**: soften by pulling water into lumen
    - . **Duphalac syrup®** (lactulose)
      - .. **Excellent safe, all-purpose laxative for dogs & cats**
    - . Colyte®, GoLYTELY® (polyethylene glycol)
    - . Milk (lactose)
  - **Stimulant laxatives**: ↑ propulsive motility of bowel
    - . **Contraindicated** in obstructive lesion & not for long term use
    - . Dulcolax® (bisacodyl)
    - . Castor oil: good for clinic use to prepare for radiographs & endoscopic procedures
- **Enema & suppositories**: soften hard, impacted feces & promote evacuation
  - Warm isotonic tap water or saline (5-10 m/kg) ± mild soap
  - Colace® (dioctyl sulfosuccinate sodium) emollient
  - Mineral oil: lubricant, do not mix w/ Colace®
  - **Fleet (children's) enema®** (sodium phosphate): softening, bulk-producing & irritating effect) only safe in medium to large dogs w/ normal renal function
    - . **Never in small dogs or cats!** (may cause dangerous hypernatremia, hyperosmotility, hyperphosphatemia & hypocalcemia)

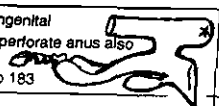
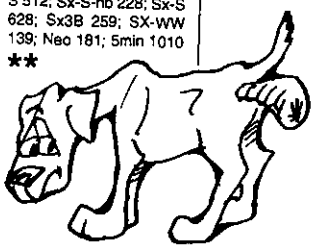
Rectum - Anus

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Imperforate anus, Anal atresia, Atresia ani, Atresia recti M8k 130; Mk 100; SAP 789; H3B 417; H2B 473; IM-WW 287; GI 495; GI-S 505; Cat 1275 * 	• **Rare**, congenital • Rectum ends blindly • Atresia ani: absence of an anal opening • Atresia recti: rectal pouch cranial to membrane overlying anus	• **Tenesmus** • Abdominal pain & distention, retention of feces • **Absence of anal opening** • **Sequela: Anesthetic risk** 	• **No anal opening** • Radiology: - Differentiating atresia recti from ani (hold animal up by hindlimbs & shoot a horizontal beam; gas will rise into rectum) - Dilated, fecal-filled bowel w/o anus - Rectovaginal fistula, m/b no fecal material - Barium enema if anus perforated - If imperforate, see feces out vagina or barium in vagina & radiograph 	• **Sx create anus** (remove membrane) - Cruciate pattern incision in membrane over anus & into rectal pouch - Suture opened pouch to skin • **Atresia recti** need to cut opening & bring rectum caudally (use a combined abdominoperineal approach) • Monitor for suture line breakdown • **Aggressive fluid Tx** during & after surgery because of young age • Postoperative complications: - Fecal incontinence often a problem, it m/ spontaneously resolve or continue indefinitely - Stricture possible - ± Constipation & megacolon ongoing problem Prognosis: **Poor**, grave for normal function
Rectal & anal/ anorectal stricture M8k 149; Mk 132; E-hb 540; SAP 783, 788; H2B 475; I2M 465; IM 357; GI 491; GI-S 513; Sx-S-hb 227; Sx-S 627; 5min 104; Cat 1275 ** 	• **Constriction of rectum** • Cause: - 2° to chronic inflammation (perianal fistula, chronic anal sac) - Anorectal trauma - Adenocarcinoma of rectum - Anorectal surgery	• **Thin ribbon feces** • Tenesmus • Dyschezia • Hematochezia • 2° Constipation 	• **Digital palpation** • Contrast radiography - Defines extent if can't palpate • Deep biopsy 	• **May respond to dilation** - Bougienage or balloon dilation - Give prednisolone for 10-14 days (1 mg/kg BID) • **Resection/anastomoses w/ rectal pull-through** • **Anal ring stricture - Sx** • **Surgical complication** - Fecal incontinence - Additional scar formation - Wound dehiscence  **Prognosis:** • Poor: if due to adenocarcinoma • Guarded: if due to inflammatory process

Stricture
CS: Ribbon stool, Straining
Dx: PE: digital
Tx: Dilate or Sx

• **Resection/anastomoses w/ rectal pull-through**
- Remove diseased rectal tissue circumferential
- Pull healthy rectal tissue to & oppose to anus
- Stool softeners for 2 weeks following surgery

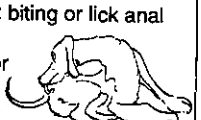
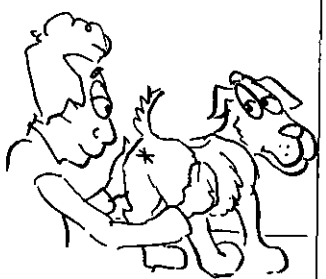
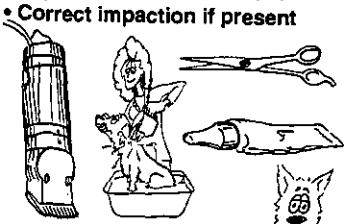
• **Anal ring stricture**
- Cut stricture at 3,6,9 & 12 o'clock perpendicular to ring
- Suture incisions in opposite direction

Rectovaginal fistula * M8k 130; SAP 783; GI 495; SX-WW 140; Neo 183	• **Very rare**, congenital • Usually has imperforate anus also 	• **Fecal incontinence through vaginal opening** • Contamination of perineum, dermatitis	• Hx (young), CS; Physical exam (PE)	• **Sx restore rectum & vagina** Prognosis: **guarded**
Rectal prolapse, Anorectal prolapse M8k 150; Mk 130; E-hb 540; SAP 787; I2M 461; IM 354; IM-WW 287; H3B 422; H2B 478; GI 499; GI-S 512; Sx-S-hb 228; Sx-S 628; Sx3B 259; SX-WW 139; Neo 181; 5min 1010 ** 	• **Protrusion of rectum through anus** (only mucous membrane or entire rectum) • Limited to puppies & young cats almost exclusively • Cause: #1: parasites & straining • Boston terriers & many cats - weak perineum	• **Elongated cylindrical mass projecting out through anus** • **Tenesmus** 	• **Prolapsed rectum!** • Insert thermometer or finger between prolapsed tissue & anal sphincter - If no resistance met: intussusception of ileum or colon • Contrast radiographs for extent of prolapse	• **1° cause** • **Replace viable prolapse** (w/ finger) - Sugar solution (50% dextrose or 70% mannitol) relieves edema to help replacement • **Stop straining** - Stool softened & moist diet - Antispasmodics (dicyclomine [Bentyl®]) - Hydrocortisone retention enema (Cortenema®) - Mesalamine retention enema (RowASA®) - Mild sedation • **Anal purse string** for 5-7 days maybe required if continuous straining - Low-fiber diet while suture in place • **Resection & anastomose** if necrotic • **Colopexy**: for recurrent prolapse - Abdominal approach, pull on colon to reduce, scarify colon & abdominal wall, appose scarified areas (2-0 or 3-0 monofilament nonabsorbable suture Prognosis: **Guarded**

Cause: Rectal prolapse
- Parasites & straining #1
- Enteritis
- Rectal foreign body
- Lacerations
- Diverticula
- Neoplasia
- Urolithiasis
- Urethral obstruction
- Cystitis
- Dystocia & prostatic diz
- Perineal hernia

DDx:
Prolapsed ileocolic intussusception (probe around, in rectal prolapse cant go far)

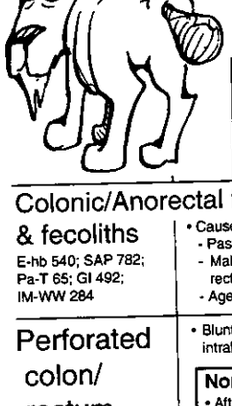
Rectum through anus, Neonate, Parasites & Straining
Tx: 1° Cause, Replace, stop straining, Sx • Px: Guarded

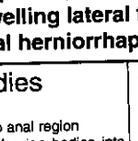
Hair matted anus, Pseudo-coprostasis SAP 781; Cat 1273 *** 	• **Matting of hair surrounding anus** • Causes obstruction • Long haired dogs & cats, especially if diarrhea	• **Anal obstruction** - Constipation - Inability to pass feces - Irritation: biting or lick anal region - Foul odor  • Sequelae: - Underlying dermatitis - Myiasis (fly maggot infestation) - Impaction	• **Examine anal region** 	• **Clip hair** • **Cleanse underlying irritated skin** • **Topical antibiotic ointment** • **Correct impaction if present**  Prognosis: **Good** for most

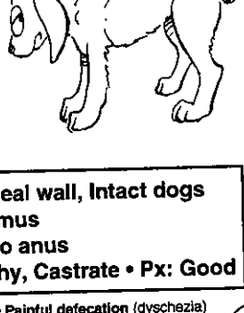
Anus matted closed
CS: Obstruction
Tx: Correct

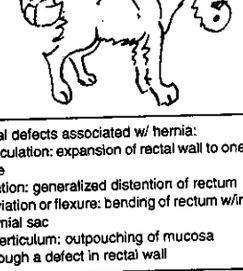
Anal Region

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Perineal hernia M8k 149; Mk 132; E-hb 539; SAP 782; H3B 418; H2B 476; IM 355; I2M 463; IM-WW 287; GI 493; GI-S 512; SX-WW 141; 5min 928; Cat 1274 **	• Protrusion through perineal wall • **Aged, intact male dogs** almost exclusively; reported in a few cats • Cause: - Weakness of pelvic diaphragm (levator ani & coccygeus muscles) - Tenesmus (constipation, prostatomegaly, urethral calculi) • Pathogenesis : poorly understood - Male hormones? rare in castrated dogs • Bilateral or unilateral (predominantly right sided) • Contains rectum usually, retroperitoneal fat, prostate, rarely abdominal organs (urinary bladder, intestine)	• Constipation • Obstipation • Dyschezia • **Tenesmus** • Stranguria if urinary bladder herniated	• **Palpation: swelling lateral to anus** • Rectal palpation of weakened pelvic diaphragm & rectal defects	• Initially: evacuate rectum • Laxative therapy m/b enough • Castration if mild hernia may prevent progression • **Perineal herniorrhaphy**: best long term - Castrate at same time to prevent straining from prostatomegaly - Open hernial sac & replace contents into pelvis - Reconstruct pelvic diaphragm: connect the coccygeus, external anal sphincter & internal obturator muscles (obturator flap technique) . Avoid the pudendal nerve & internal pudendal vessels - Complications: . Suture into urethra . Rectal prolapse . Fecal incontinence . Urinary incontinency (infrequent) . Wound infection . Recurrence of hernia



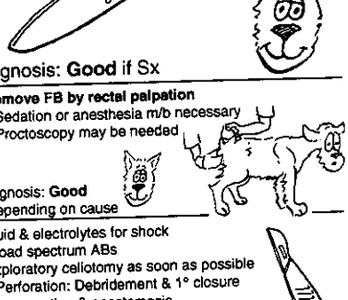






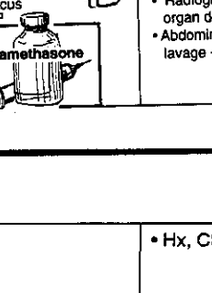
Protrusion through perineal wall, Intact dogs
CS: Constipation, Tenesmus
Dx: PE: Swelling lateral to anus
Tx: Perineal herniorrhaphy, Castrate • Px: Good

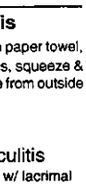
Rectal defects associated w/ hernia:
- Sacculation: expansion of rectal wall to one side
- Dilation: generalized distention of rectum
- Deviation or flexure: bending of rectum w/in hernial sac
- Diverticulum: outpouching of mucosa through a defect in rectal wall



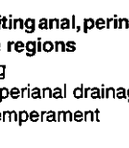
Prognosis: **Good** if Sx

Colonic/Anorectal foreign bodies & fecoliths E-hb 540; SAP 782; Pa-T 65; GI 492; IM-WW 284	• Causes: - Passing foreign body to anal region - Malicious insertion of foreign bodies into rectum - Aged cats: fecolith (firm lump of feces)	• **Painful defecation** (dyschezia) • Tenesmus • 2° impaction • Sequelae: - Rectal laceration - Anorectal stricture	• Rectal palpation	• **Remove FB by rectal palpation** - Sedation or anesthesia m/b necessary - Proctoscopy may be needed Prognosis: **Good** depending on cause
Perforated colon/ rectum Sx-S-hb 224	• Blunt or sharp trauma to abdominal wall or intraluminal trauma (sadistic)	• Rapid peritonitis & septic shock • ± Bloody feces or mucus	• Hx, CS • Radiographs: ± loss of abdominal organ detail, pneumoperitoneum • Abdominal paracentesis or peritoneal lavage - microscope	• Fluid & electrolytes for shock • Broad spectrum ABs • Exploratory celiotomy as soon as possible - Perforation: Debridement & 1° closure or resection & anastomosis - Lavage abdomen w/ warm saline

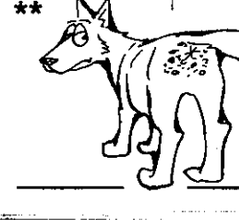


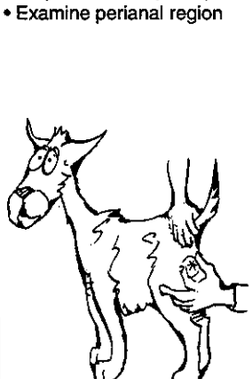


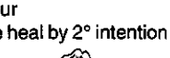
Nontraumatic perforation of colon Sx-S-hb 225
- After parenteral dexamethasone Tx following neurosurgical procedures, all 10 dogs died 10 days after surgery
- Stop dexamethasone if bloody mucoid diarrhea develops



Anal sac diz, **Anal sacculitis** M8k 147; Mk 131; E-hb 541; SAP 784; H3B 421; H2B 479; I2M 464; IM 355; IM-WW 288; GI 497; GI-S 513; SxB 283; Sx-S-hb 231; Sx-S 640; Sx3B 270; SX-WW 140; Cat 1275 ***	• ***#1 diz of anal region*** of dogs; cats get anal sac impaction also • Classification/continuum of diz process - **Impaction**: distended sac, mildly painful on palpation - Anal sacculitis: moderate to severe pain on palpation, purulent fluid - Anal sac abscess: marked distention (pus, cellulitis, erythema, fever) - Rupture draining fistulous tract • Cause: poorly understood	• Anal discomfort - **Scooting** - Tenesmus - **Licking & biting anal, perineal, & tail base regions** - Tail chasing • Malodorous perianal drainage • Change in temperament • Sequela: self-inflicted dermatitis	• Hx, CS, PE	• **Anal sac impaction & sacculitis** - **Manually evacuate sac** (hand in paper towel, shove into perineum on either side of anus, squeeze & pull caudally, or 1 finger in anus & pressure from outside to evacuate each sac individually) - Follow up & express in 1-2 weeks - High fiber diet to prevent recurrence • Recurrence of impaction or sacculitis - Irrigation w/ Betadine® (povidone-iodine) w/ lacrimal needle - ABs instillation (otic or ophthalmic antibiotic ointment) - Express sac every 3-4 days • Surgical removal if persists • Abscesses - Drain, irrigate w/ Betadine® - Systemic ABs - Surgical excision of sac if recurrent abscesses **Prognosis: good; guarded** if chronic w/ Sx

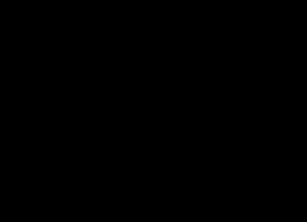


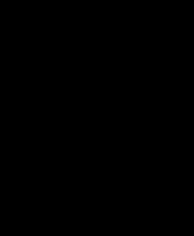


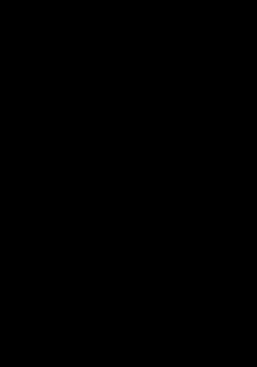


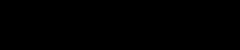
#1 anal diz region, esp. in dogs
CS: Scooting, Licking & Biting anus
Dx: PE
Tx: Manually evacuate sac, ± Sx • Px: Good

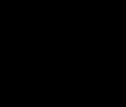
Perineal fistulae, **Anal furunculosis** M8k 148; Mk 131; E-hb 541; SAP 784, 789; I2M 463; IM 355; IM-WW 288; H3B 419; GI 495; GI-S 513; SxB 276 Sx-S-hb 228; Sx-S 629; SX-WW 140; 5min 922 **	• **Chronic progressive diz** • **German Shepherds** primarily (sporadically in Irish Setters, Labrador Retrievers & others) • Pathogenesis: unknown? - Low slung tail, moist environment, infection & abscesses	• **Deep, ulcerating fistulous tracts** - Suppuration in perineum - Small draining puncture holes - Large coalescence of small tracts • **Anal discomfort** - **Licking anal region** - Scooting, Dyschezia, Tenesmus • Hematochezia • Constipation • Fecal incontinence • Foul-smelling purulent perianal discharge	• Hx (German Shepherd), CS • Examine perianal region	• Preoperative & medical Tx - Perianal cleansing w/ antiseptic solution & hot packs - ABs for 2-3 weeks - Most cases will require some surgery • **Surgery TOC**: excise affected tissue, try to spare external anal sphincter (continence) • Postop: hydrotherapy BID to keep clean - Stool softeners 1-2 weeks • Complication - **Fecal incontinence** - **Recurrence** can occur - Incisional dehiscence heal by 2° intention Prognosis: **Poor to guarded** • Earlier diagnosis & treatment the better











German Shepherds primarily
CS: Deep, ulcerating fistulous tracts
Dx: Hx, CS, PE
Tx: Surgery TOC • Px: Poor to guarded

Rectum - Anus

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Perianal dermatitis SAP 785; Cat 1276 **	• Anal irritation causing self trauma	• **Irritation of perianal region** • **Licking & biting**	• **Examine perianal region**	• **Treat cause** • **Topical Tx** • **Grooming**: long haired breeds Prognosis: **good** for most cases
Proctitis E-hb 540; SAP 781; H2B 477; IM C11T 616; GI 512 *	• **Inflammation of rectum** • Usually a component of colitis	• **Tenesmus** • **Dyschezia** (difficult defecation) • Diarrhea • Hematochezia	• Differentiate from other anorectal dizs	• Dietary manipulation 1st: High fiber (>10%)/low fat diet (10-15%), small frequent meals 3-6/day, 3-6 weeks • If no response: Highly digestible, moderate to high at (20-30%), low-residue, hypoallergenic diet, m/ also benefit lymphocytic-plasmacytic enteritis • Treat for chronic colitis Prognosis: **good** if acute, guarded if chronic
Anorectal polyps M8k 150; E-hb 539; I2M 462; IM 355; GI-S 512; Sx-S-hb 230; Cat 1274; 5min 1012; Pa-T 77	• **#1 benign tumor of rectum** • Benign adenomatous polyps • Sessile, raised or pedunculated, single or multiple	• **± Blood & mucus in feces** • **Tenesmus**, ± rectal prolapse • Prolapse of polyp from anus	• **Digital rectal palpation** • Biopsy & histo, may be difficult to differentiate from rectal carcinoma	• **Surgical excision** (electrocoagulation, excision) for small sessile polyps • Large sessile polyps may require intestinal resection Prognosis: good
Malignant anorectal tumors M8k 150; E-hb 539; Sx-S-hb 230; SX-WW 141	• **Rectal** or **anal adenocarcinoma #1** • Lymphosarcoma	• Diarrhea • Dyschezia (**painful defecation**) • Passage of blood & mucus w/ feces • **Tenesmus**	• **PE: digital rectal exam** • **Endoscopy or proctoscopy** • **Biopsy**	• **Surgical removal** best for all except lymphosarcoma; technique depends on location (abdominal colorectal resection & anastomoses, dorsal perineal approach, rectal pull-through) • **Lymphosarcoma**: initially w/ chemotherapy

Cause - perianal dermatitis
- **Any pruritic skin condition**
  (#1 fleas, anal rectal diz, anorectal disorders)
  - **Self-inflicted** (anal licking & biting)
- Systemic mucocutaneous dermatological disorders (bullous-pemphigoid, pemphigus vulgaris, systemic lupus erythematosus)
- Candidiasis
- Cutaneous drug eruptions
- Eosinophilic granuloma complex in cats

Anal irritation
CS: Licking & biting
Dx: PE
Tx: Cause, Topical • Px: Good

Anal & perianal tumors E-hb 539; SAP 785; H3B 422; H2B 480; IM-WW 288; GI 501; Sx3B 274; SX-WW 141 **	• #1 benign perianal (circumanal) gland adenoma of dogs - Other benign tumors are rare (lipoma & leiomyoma) • Malignancies: - Perianal (circumanal) gland adenocarcinoma **see pg 86 above** - Apocrine gland (anal sac, anal gland) adenocarcinoma - Other malignant tumors (squamous cell carcinoma, melanoma, lymphoma, mast cell neoplasia)			
Perianal (circumanal) gland tumors E-hb 542; SAP 785; H2B 480; I2M 465; IM 356; IM-WW 288; GI 501; SX-WW 141 **	• Arise from modified sebaceous glands found principally around anus & base of tail (also back & prepuce) • **Adenoma**: benign, androgen-dependent tumors • **Adenocarcinoma**: **rare**, resemble an ulcerative perianal gland adenoma, except they are locally invasive, metastasize to regional lymph nodes (sublumbar) & beyond eventually • **Older, intact male dogs (Cocker, Beagle, G. Shepherd)**	• **Small, firm well-described nodules surrounding anus** • Asymptomatic: incidental finding • Anal irritation (scooting, licking of region) • Sometimes ulcerate & periodically bleed	• CS, PE • **Excision biopsy** • **If malignant** do thoracic & abdominal radiology for metastasis	• **Excision** (TOC) • **Castrate** at same time • Estrogen not for prolonged use because of myelotoxic effect • Radiation therapy for multicentric & some malignant tumors Prognosis: • **Adenoma: excellent** w/ Sx • Adenocarcinoma: poor if extensive local invasion or regional lymph node metastasis; early excision can be effective
Anal sac tumor * HB 482; I2M 464; IM 356; IM-WW 289; SX-WW 141	• **Apocrine gland adenocarcinoma** • **Arise in anal sac** • Older, spayed **female** dogs • Uniquely can be a source of parathyroid hormone like activity • Metastasis to lungs &/or regional lymph nodes (sublumbar) may occur	• Produce hypercalcemia of malignancy syndrome see Hypercalcemia pg 676 • PU/PD	• **Hypercalcemia** • Rectal (anal sac) palpation • **Excision biopsy**	• **Surgical excision** (TOC) • Adjunctive chemotherapy may be needed for incomplete excision or metastasis Prognosis: **guarded**

DDx:
- Perianal adenocarcinoma
- Perianal fistula
- Ruptured anal sac
- Anal sac adenocarcinoma

Sebaceous glands, Benign & malignant, Intact male dogs
CS: Nodules, ± CS
Dx: Biopsy: Malignant or benign, Rads
Tx: Excision & Castration • Px: Excellent to poor

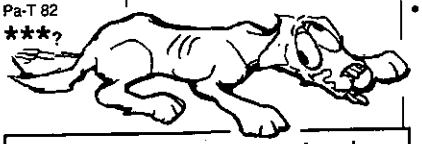
Liver Disease

Condition	Facts/Causes	Presentation/CS	Treatment

Liver diz

M8k 326, 130; Mk 138, 1170; 1207; SAP 722; E-hb 599; I2M 487; IM369,379; IM-WW 297; H3B 383; GI-S 553,633; GI504; C12T 736; E 1261; F3IM 68; Sx3B 291; Sx-WW 143; X-T 426; Neo 189; Pa-T 82

***?



Facts/Causes

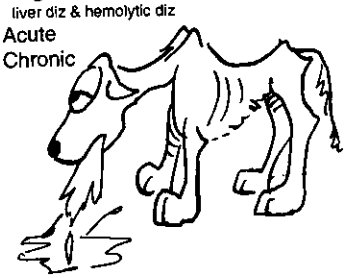
- **Liver functions**
  - Hepatic blood flow
  - Protein, carbohydrate & fat metabolism
  - Detoxification of drugs & toxins
  - Formation & elimination of bile
  - Thus clinical & lab abnormalities are diverse
- Acute or chronic

Clinical approach: acute vs chronic

- Hx, PE, Lab, Radiology & US may suggest acute or chronic
- Biopsy often required for definitive Dx
- Acute:
  - Cause: toxic, infectious are common
  - Tx: intensive supportive care to allow time to regenerate
  - Prognosis: good if survive initial stages
- Chronic:
  - Irreversible changes (cirrhosis more likely)
  - Prognosis: poor for long term

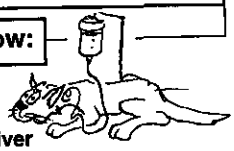
Presentation/CS

- **Jaundice**
- **Hepatic encephalopathy**
  - Depression
  - Hypersalivation
  - Behavioral changes
  - Altered consciousness
  - Motor disturbances
  - Seizures & coma
  - CS wax & wane w/ interspersed normal periods
- Ascites from hypoproteinemia, portal hypertension & renal sodium & water retention
- **Excessive bleeding** (occasionally) vit K
- Achoic (gray-colored) feces (cholestasis)
- **Nonspecific signs**
  - **Vomiting** (common signs)
    - . Hematemesis suggest ulcers
  - **Anorexia**
  - **Lethargy**
  - **Weight loss** (chronic)
  - Diarrhea occasionally (small bowel)
  - PU/PD
  - Pigmented urine (bilirubinuria) cholestatic liver diz & hemolytic diz
- Acute
- Chronic



Treatment

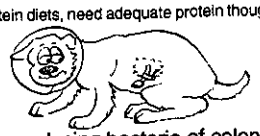
Diagnosis - see below:



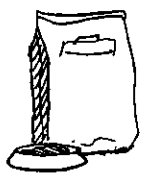
Treatment:

- **Treat inciting cause** (see following conditions)
- **Prevent or manage complication of liver failure**
- **Drugs: consider if metabolized or excreted by liver**
  - Hepatotoxic drug: thiacetarsamide
  - Worsen hepatic dizs: methionine-containing products, tranquilizers, sedatives, diuretics, aspirin & corticosteroids

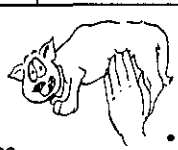
- **Supportive therapy:**
  - Maintain normal fluids
  - Avoid alkalinizing agents (lactate in lactated Ringer's solution, sodium bicarbonate - augments ammonium into CNS)
- **Nutritional support**
  - Bulk of calories as carbohydrates, avoid high-protein diets, need adequate protein though
  - Gastrotomy or pharyngostomy tube



- **Control complications:**
  - **Hepatic encephalopathy**
    - . Restrict protein intake
    - . ABs (neomycin, metronidazole) to ↓ urease-producing bacteria of colon
    - . Lactulose (synthetic disaccharide) cathartic & colonic acidifier
  - **Control any GI hemorrhage:** fresh, not stored blood for transfusion (less ammonia)
  - **Ascites & edema**
    - . Restrict sodium in diet
    - . Diuretic
    - . Plasma transfusions or volume expanders (hetastarch or dextran)
  - **Coagulopathy & anemia**
    - . Vit K_1 parenterally
    - . Prevent DIC
  - Gastrointestinal ulceration
    - . H_2 blocked (Ranitidine or cimetidine)
    - . Sucralfate (mucosal protection)
  - **Infection & endotoxemia**
    - . ABs (penicillins, cephalosporins or aminoglycosides [eliminated by kidney])
  - **Renal failure:** fluid to avoid **prerenal azotemia**
  - **Cholestasis:** may use choleretic agent (ursodial)

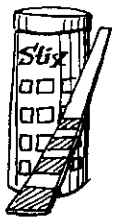


Diagnosis:



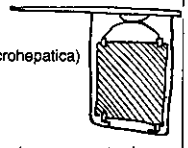
- ***History:***
  - Age (young - portocaval shunts)
  - Acute vs chronic
    - . Chronic: weight loss & ascites
  - Exposure to damaging substances
  - Intolerance to substances (anesthesia intolerance)
  - Vaccination status (ICH, leptospirosis & FIP)
- Physical exam:
  - **Jaundice**
  - **Abdominal palpation**
    - . Liver hard to palpate in normal animal, edges sharp & not rounded normally
    - . Hepatodynia (pain on palpation of liver)
    - . Abdominal effusion
  - Neurologic exam if CNS signs
  - Fecal: melena & achoic feces
  - Skin & mucous membrane for bleeding

- CBC (complete blood count)
  - Anemia (blood loss, chronic diz)
    - RBC microcytosis - shunts
    - Target cells & ancanthocytes
- UA (urinalysis):
  - Isosthenuric or hyposthenuric specific gravity if PU/PD
  - Bilirubinuria (sensitive & preceeds jaundice)
  - Urobilinogen (absence & jaundiced - bile duct obstruction)
  - Ammonium biurate crystal - portosystemic shunts & normal animals
- **Liver enzymes - not specific - screening tests** (donot evaluate liver function, normal enzymes & liver diz or abnormal enzymes & no liver diz possible)
  - **ALT:** liver specific - magnitude correlates w/ injured hepatocytes (100x normal w/ hepatocellular necrosis & inflammation, 20-40x in cholestasis) ALT/SALT = serum alanine aminotransferase formerly called SGPT = serum glutamic pyruvic transaminase
  - AST (aspartate aminotransferase, formerly called SGOT/serum glutamic oxaloacetic transaminase): **nonspecific for liver**
    - . Liver injury ↑ AST & ALT w/ normal CK
    - . Muscle injury: ↑ AST & CK
  - ALP/alkaline phosphatase: nonspecific - bone, glucocorticosteroids, or liver
  - GGT/ gamma glutamyltransferase: nonspecific



- **Biochemical tests**
  - Hypoalbuminemia: nonspecific - liver, urinary, GI
  - Hypoglycemia: insensitive, poor prognostic factors
  - Hypocholesterolemia - rare in liver diz
  - Hypercholesterolemia nonspecific
- **Liver function tests**
  - **sBA/serum bile acid** concentrations: ↑ when loss of hepatic function. Fasting serum bile acid concentration (FsBA): 12 hr fast, sensitive, specific measure of liver function
    - . Normal values < 10 µmol/liter
    - . > 30 µmol/l warrant liver biopsy
    - . Postprandial serum bile acid (PPSBA) concentration
      - .. High fat diet, take blood sample 2 hrs after feeding
      - .. Normal values < 25 µmol/l, > 30 µmol/l warrant liver biopsy

  - BA/ blood ammonia concentration for hepatic encephalopathy, but still can be normal w/ encephalopathy
  - ATT/ammonia tolerance test: not as good as bile acids
- **Homeostasis parameters** (coagulation factors synthesized in liver)
  - PT/prothrombin time: extrinsic coagulation system
  - APTT/ activated partial thromboplastin time: for intrinsic coagulation system
  - ACT/activated coagulation time: rapid screening test for intrinsic system
  - Thrombocytopenia: splenic sequestration of platelets assoc. w/ portal hypertension, DIC, liver diz
  - DIC suggested by combination of prolonged PT & APTT, low plasma fibrinogen, increased fibrin degradation products, fragmented RBCs & thrombocytopenia
- Blood gas analysis: abnormalities may occur 2° to liver diz (resp. alkalosis, metabolic alkalosis, metabolic acidosis & mixed acid-base disturbances)
- Abdominal fluid analysis
  - Transudate: 2° to liver diz & hypoalbuminemia
  - Modified transudate (protein > 2.5 gm/dl) hepatic venous congestion (vena caval obstruction) or cardiac causes
  - Bile peritonitis: biliary tract rupture (bilirubin, yellow to green, mixed inflammatory infiltrate

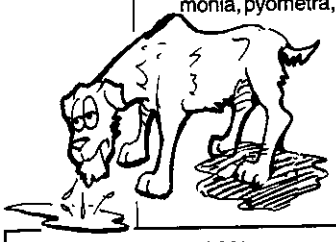


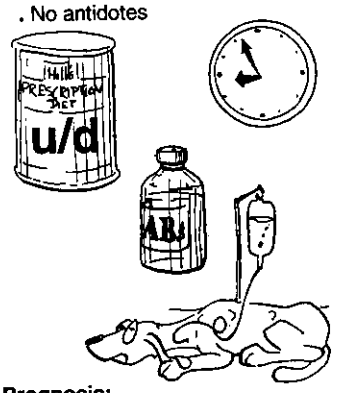
- **Radiology:**
  - Change in size (hepatomegaly, microhepatica)
  - Mineralization (choleliths)
  - Radiolucencies (abscesses)
  - Abdominal effusions
  - Thoracic films if hepatic neoplasia suspected
- **US/ultrasound**
  - Detect focal parenchymal abnormalities
  - Biliary tract (obstruction, calculi)
  - Vascular lesions
  - Percutaneous liver biopsy
- **Liver biopsy** (hemostasis screen prior to biopsy)
  - Fine needle biopsy (diffuse lesions)
  - Blind percutaneous needle biopsy (diffuse)
  - Ultrasound-guided biopsy
  - Keyhole needle biopsy (general anesthesia)
  - Laparoscopy (direct visualization)
  - Laparotomy (if surgically correctable diz suspected)
  - Biopsy analysis: samples in 10% buffered formalin 24 hrs
  - Monitor for bleeding after biopsy

ALT: liver specific
Bile acids: ↑ w/ liver damage (N = <10)
PTH: extrinsic coagulation
APTT & ACT: intrinsic coagulation

Acute Hepatic Failure

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Acute hepatic failure M8k 326; E-hb 509; SAP 732; H3B 383; H2B 449; I2M 525, 542; IM 408; IM-WW 297; GI 512; GI-S 654; Pa-T 91; Emrg 351 ***	• Sudden severe insult that compromises **70-80%** of liver • **Causes** (complete table below) - Hepatotoxins (industrial chemicals, organic solvents, pesticides, heavy metals, & biologic toxins) - Drugs: . Thiacetarsamide (arsenic adult heart worm Tx) . Idiosyncratic: anticonvulsants, steroids - Infectious & parasitic agents . Leptospirosis, toxoplasmosis, histoplasmosis, FIP virus, ICH - Miscellaneous disorders . Hemolytic anemia . Anesthesia, surgical hypotension, hypoxia, shock . Acute pancreatitis . Extrahepatic bacterial infections (pneumonia, pyometra, peritonitis, abscesses)	• **Often nonspecific** • **Acute** - **Anorexia** - **Lethargy** - **Vomiting** - **Diarrhea** • Other CS - PU/PD - Jaundice - Excessive bleeding - Hepatic encephalopathy	• **Hx** (toxin exposure) • CS (clinical signs) • Lab: - ↑ **ALT**, ± ↑ ALP maybe - **Hyperbilirubinemia*** - ↓ **Serum bile acid*** - **Hypoglycemia*** - **Hyperammonemia*** - **Coagulopathy*** - Concurrent damage of kidneys possible w/ some agents - If acute pancreatitis: serum amylase & lipase • Radiology: - Size - usually normal to increased - Small liver indicates chronic • Liver biopsy: - Do if cause not found from preliminary lab findings - Diffuse hepatic necrosis * Indicative of functional loss	• **Supportive therapy - allow time to regenerate** - **Fluid**, electrolyte & acid-base . Correct hypokalemia - **ABs**, nonabsorbed antibiotics, such as neomycin to sterilize the gut flora - Lactulose (cathartic & colonic acidifier) - **u/d, k/d diet** or home made equivalent • Prevent or control complications (hypoglycemia, encephalopathy, coagulopathy, endotoxemia) • **Specific treatment - cause** - Penicillin for leptospirosis - Discontinue use of suspected drug . No antidotes





Compromise 70-80%
CS: Anorexia, Vomiting, Diarrhea
Dx: Hx, Lab (bile acids, hyperbilirubinemia), Coagulopathy
Tx: Supportive, Tx cause

ALT: liver specific
Bile acids: ↑ w/ liver damage (N= < 10)
PTH: extrinsic coagulation
APTT & ACT: intrinsic coagulation

Prognosis:
• Supportive Tx m/ allow for hepatic regeneration

Causes of Acute Hepatic Failure

SAP 732, E 1493

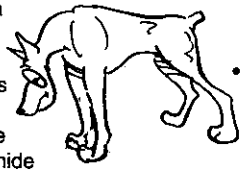
Hepatotoxins

• **Chemical toxins:**
- Arsenic
- Carbon tetrachloride
- Chlordane
- Chlorinated biphenyls
- Chloroform
- Copper
- Dieldrin
- Dimethylnitrosamine
- Heavy metals (copper, iron, lead, mercury)
- Hydrocarbons
- Naphthalenes
- Phosphorus
- Selenium
- Tannic acid

• **Drugs - toxic:**
- Steroids:
. Glucocorticoids
. Androgenic anabolic steroids
.. Methyltestosterone
.. Mibolerone
- Analgesics:
. **Acetaminophen**
. **Salicylates**
. Phenylbutazone
- **Anticonvulsants:**
. **Phenobarbital**
. **Phenytoin**
. **Primidone**
. Valproic acid
- Antineoplastics (methotrexate)
- Antimicrobials:
. Trimethoprim/Sulfa
. Griseofulvin
. Ketoconazole
. Chlortetracyclines
. Erythromycin
. Isoniazid
. Itraconazole
. Sulfonamides
- Anthelmintics:
. Mebendazole
. Thiacetarsamide
. Diethylcarbamazine
. Oxibendazole + diethylcarbamazine
- Aprindine
- Glipizide (cats)
- Megestrol acetate (cats)
- Methimazole (cats w/ hyperthyroidism)

• **Anesthetics:**
- Halothane
- Methoxyflurane

• **Biologic Toxins:**
- Aflatoxins
- Blue-green algae
- Amanita mushroom
- Cycads (cycasin)
- Pyrrolizidine alkaloids
- Pennyroyal oil



Infectious & parasitic dizs:

• **Viruses:**
- Canine herpes virus
- Feline infectious peritonitis (FIP)
- **Infectious canine hepatitis** (ICH)

• **Bacteria:**
- Cholangiohepatitis
- Hepatic abscess
- Leptospira spp.
- Bacillus piliformis (Tyzzer's diz)

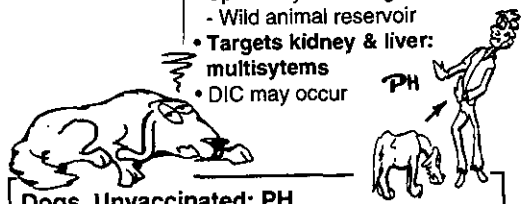
• **Fungi:**
- Histoplasma
- Coccidioides
- Blastomyces
- Others

• **Protozoa:**
- Toxoplasma
- Babesia
- Dirofilaria

Systemic conditions:

• Acute pancreatitis
• Hemolytic anemia
• Heat stroke
• Inflammatory bowel diz/colitis
• Sepsis & extrahepatic infections
• Shock, congestive heart failure
• Surgical hypotension/hypoxia
• Trauma
• Feline hyperthyroidism

Liver

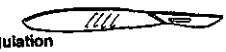
Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Leptospirosis M8k 336; SAP 128; E-hb 186; H2B 1207; GI 517; GI-S 681; E 373; Inf-B 143; Pa-Y 98 **	• **See Urinary pg 351 & Systemic pg 695** • *Leptospirosis icterohaemorrhagiae, L. canicola, L. grippotyphosa* • Filamentous, motile spirochete • **Diz in dogs; not cats** • **Public health** • Spread by shedding in urine - Wild animal reservoir • **Targets kidney & liver: multisytems** • DIC may occur  **Dogs, Unvaccinated; PH** **CS: Renal failure & Hepatic diz + Jaundice** **Dx: Serology & CS** **Tx: Support, Pen, Doxycycline** **Vaccinate**	• **Subclinical in vaccinated dogs & all cats** • **Systemic signs** (fever, depression, reluctance to move, dehydration, congested mucosa, vascular collapse, peracute death in some) • Acute renal failure (oliguria or anuria) • **Acute hepatic failure** - Icterus - DIC (petechial & ecchymotic hemorrhages, melena, hematemesis, epistaxis) • Occasional manifestations - Abortion or stillbirths - Uveitis - Meningitis 	• Serology in conjunction w/ CS • Lab: - ↑ PMNs w/ left shift - Thrombocytopenia - UA (urinalysis) proteinuria, pyuria, cylindruria, bilirubinuria, isosthenuria - Azotemia: ↑ BUN & creatine (kidney) - ↑ ALT (specific for liver), also AST, ALP nonspecific - ↑ Bilirubin - Electrolyte imbalances (renal & GI) • Serology: - Microscopic agglutination (MA) - **4 fold ↑ in paired sera*** . Single titers never diagnostic but ≥ 1:300 suggestive, ≥ 1:1000 highly indicative . **IgM-IgG (ELISA)** . Culture: difficult to grow & identify - **Dark field microscopy*** * Useful to confirm diagnosis 	• **General therapy** for: - Dehydration - Acute renal failure - Acute hepatic failure - DIC • **ABs** (antibiotics) - **Penicillin G** for leptospiremia - **Doxycycline** for leptospiruria, dihydrostreptomycin • Zoonotic - hygiene especially regarding urine, Betadine® (povidone-iodine) Prevention: • **Vaccination**: - Part of most polyvalent canine vaccines - Vaccinate at 9, 12, 15 wks (3 doses required) - Revaccinate annually (endemic areas every 4-6 months) Prognosis: ?

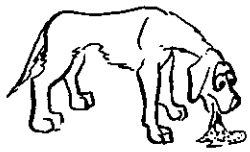
Hepatic abscesses

E-hb 516; SAP 737; H3B 387; I2M 544; GI 518; GI-S 677, 751; Inf-G 147; Sx-S-hb 233; Sx-WW 147; Sx4B 289; Sx-G 190; Neo 208; Pa-T 97

*

- **Rare** in dog & cat; **Common in ox**; Cause: hematogenous spread, penetrating wounds, umbilical infections, immunosuppression
- CS: **Sepsis**, inflammation & hepatic dysfunction: anorexia, fever & vomiting, Rupture of abscess (**peritonitis**, septic shock & death)
- Dx: Hx, CS; ↑ PMNs w/ left shift, ↑ **ALT**, hyperbilirubinemia, hypoglycemia, septic abdominal effusion; Radiology (radiolucent areas); **Ultrasound**, **Biopsy** (culture); exploratory laparotomy
- Tx: **Surgical excision of affected liver lobe**; Broad spectrum **ABs** 6-8 weeks
- DDx: **Should be ruled out (R/O) in diabetic patients experiencing difficulty in regulation**





Liver cysts

SAP 756; E 1340; Neo 194

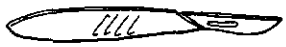
*

- **Rare**
- Single or multiple
- Congenital or acquired
- Usually incidental finding at necropsy

- **Solitary cyst asymptomatic** usually
  - Cause problems if compress or displace adjacent structures
- Congenital polycystic dlz w/ dilation of extrahepatic biliary tract more likely to show signs

- **Usually incidental finding at necropsy**
- **Cavitated hepatic mass** on radiology, ultrasonography or palpation or exploration

- **Nothing**: incidental finding
- **Surgical excision** of large solitary cysts (may recur)



Infectious canine hepatitis, ICH

M8k 335; Mk 138, 418; H2B 1189; H3B 1129, 1130; I2M 532; IM-WW 304; E-hb 199; E 402; GI 515; GI-S 675; Inf-B 11; Inf-G 242; Pa-T 96; Neo 209

**

- ***Canine adenovirus-1*** (CAV-1) related to CAV-2 (causes tracheobronchitis)
- Highly contagious, multisystem - primarily of liver
- Puppy immunity ↓ by 9-12 weeks
- **Diz of unvaccinated dogs < 1 yr**
- Pathophysiology:
  - Exposure to virus (urine, feces, saliva) to tonsils - viremia
  - Affects liver, kidney & eye
  - **Fox**, wolf, coyote, skunk & bear are infected w/out developing diz

Diz of unvaccinated
CS: Subclinical
Dx: Hx, CBC, ↑ ALT
Tx: Time

- **Most inapparent**, but occasionally acute fatal diz resembling distemper or parvovirus
- **Fever 106° F**, transient or biphasic
- **Depression & lethargy**
- **Mild: recovery in a few days**
- Moderate diz:
  - Reluctance to move, abdominal tenderness
  - Pale mucous membranes, Anorexia
  - Tonsillitis, pharyngitis, cervical lymphadenopathy
  - Recovery in 3-5 days
- Severe diz:
  - Diathesis: petechial & ecchymotic hemorrhages
  - Coughing to pneumonia, Bloody diarrhea
  - Neurologic signs
  - Serosanguinous ascites, Hepatomegaly
- **"Blue eye"** from immune mediated corneal edema may occur during convalescence
- Chronic diz: cirrhosis; ascites, hepatic encephalopathy, weight loss

- **Complications:**
  - Glaucoma
  - Pyelonephritis
  - DIC (disseminated intravascular coagulation)
  - Peracute death

- **Hx (unvaccinated)**, CS
- Lab:
  - ↓ PMNs & lymphocytes early
  - Thrombocytopenia usually
  - ± Prolonged bleeding time & coagulation abnormalities (severe diz)
  - **↑ ALT** & SGPT, also AST, SGOT & ± AP
- Bilirubinuria & albuminuria
- **Rising titer in paired serums*: confirms**
- Virus isolation*: swabs from oropharynx can be used early in diz
- Nuclear inclusion bodies* - liver parenchymal cells

* Useful in confirming diagnosis

DDx:
- Canine parvovirus (also has low WBC w/ bloody diarrhea)
- Leptospirosis
- Histoplasmosis
- Distemper

- **Symptomatic**
- **Most recover w/o supportive**

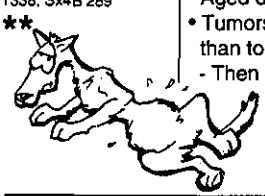
- **Vaccines** (MLV [modified live]-CAV-2 preferred)
  - < 1% have eye lesions (blue eye) w/ MLV-CAV-1 vaccine
  - Give at least 2 vaccines 3-4 weeks apart
    . At 8-10 & 12-14 weeks of age
- Inactivated must be given frequently

Prognosis:
- **Good**: most recover
- Guarded if multisystem involvement

Liver neoplasia

M8k 343; Mk 120; E-hb 521; SAP 755; H2B 456; H3B 397; I2M 545; IM 404, 424; IM-WW 311; GI-S 847; Pa-T 105; E 1338; Sx4B 289

**



- 1° tumors uncommon < 2% of all tumors
  - Hepatocellular & cholangiocellular carcinoma
- **2° - metastatic tumors** (2.5 x 1°)
  - Lymphosarcoma (hematopoietic)
  - Pancreatic carcinoma
  - Adenocarcinomas (epithelial)
  - Hemangiosarcoma (mesenchymal)
- Aged dogs & cats
- Tumors metastasize to liver more than to the lungs (3:2.5)
  - Then metastasize to lungs

Metastatic
CS: Vague, Hx, Lab, Biopsy
Tx: Sx • Px: Poor

- **Vague, nonspecific signs of hepatic dysfunction**
- Nonspecific (depression, weakness, anorexia, lethargy, vomiting, weight loss [cachexia])
- **Abdominal distention** ±
- Other signs (PU/PD, jaundice, diarrhea, excessive bleeding)
- CNS dysfunction due to encephalopathy, hypoglycemia or CNS metastasis
- Fever

- Hx (older), CS + Hepatomegaly
- Lab profiles of liver dysfunction
  - Hypoglycemia
- Abdominal effusion: modified transudate, may be hemorrhage or neoplastic
- Rads: enlargement local or general
  - **X-ray chest** before Sx (metastasizes)
- Ultrasound: focal, multifocal or diffuse changes
- **Exploratory Sx**
- **Biopsy: definitive**
  - Large mass: laparotomy (excision can be performed at same time)
  - Focal or diffuse: ultrasound-guided biopsy
  - Blind percutaneous needle biopsy for diffuse

- **Hepatectomy**: surgical excision of affected liver lobe of solitary tumor
  - Chest X-rays for metastasis before Sx
  - Evaluate abdominal cavity for metastasis & biopsy hepatic lymph nodes
- Chemotherapy: questionable efficacy in dogs & cats

Prognosis:
- **Poor** because of metastasis
- Poorer if all lobes involved

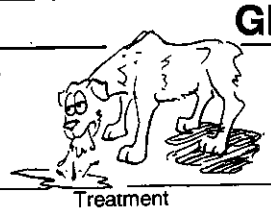
Liver

Drug-induced hepatitis

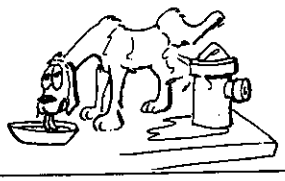
E-hb 512; E 1320

**

- Anticonvulsants, Analgesics, Gas anesthetics, Antimicrobials; Antihelmintics, Steroids (see Acute hepatitis for full list pg 91)
- CS: Usually acute hepatitis except in anticonvulsants & steroid
- Dx: Presumptive diagnosis usually, cannot be proven
- Tx: Withdraw the drug, supportive care, no antidotes



Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Anticonvulsants-associated hepatic diz E-hb 513; SAP 741; GI 539 *	• Long-term anticonvulsants therapy - **Primidone, phenobarbital & phenytoin** • **Cirrhosis & liver failure**	• **Chronic hepatic diz** - Anorexia, lethargy, weight loss, weakness, PU/PD, jaundice, ascites, encephalopathy • Impaired inactivation of phenobarbital - Ataxia, weakness & depression ↑ frequency of seizures	• Hx - long term anticonvulsant therapy • Lab evidence of hepatic diz - >4 x normal levels of **ALT** - ↑ **serum bile acids** (indicated loss of liver function) • **Liver biopsy:** hepatocellular hypertrophy w/ ground glass appearance of cytoplasm	• **Discontinue or modify anticonvulsant** • Phenobarbital DOC, max. serum concentration of 35 µg/l - Gradually discontinue primidone or phenytoin over 2-3 weeks **Prevention: routinely** monitor liver enzymes (ALT, ALP), bilirubin, cholesterol albumin & phenobarbital levels every 6-12 weeks in long term anticonvulsant therapy Prognosis: ???
Chronic liver failure				
Corticosteroid-induced hepatopathy, Steroid hepatopathy E-hb 515; SAP 742; H2B 742; GI 540; GI-S 687 **?	• **Common sequela to glucocorticoid administration to dogs** - Cats resistant - Cause hepatic glycogen accumulation & hepatomegaly • **Benign**, reversible lesion, do not mistake it for serious hepatic disorder • Spontaneous hyperadrenocorticism	• **PU/PD** - Polyphagia • Healthy dog • Thinning of hair coat	• **Hx (hepatomegaly & increased serum ALP & Hx of glucocorticoid Tx)** - CS of hyperadrenocorticism • ACTH stimulation or dexamethasone suppression test • Dramatic ↑ in ALP, but normal or slightly ↑ liver specific ALT	• **Withdraw exogenous steroids or** • **Tx hyperadrenocorticism** Steroids Prognosis: **Good**, reversible w/ treatment in weeks to months
	↑ ALP & hepatomegaly w/ steroid Tx, benign, Stop Tx, Px: good		**Steroids - ↑ ALP >> ALT**	

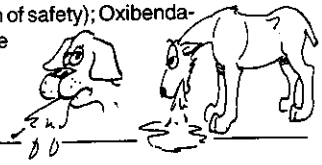


Anthelmintics: Mebendazole (Telmintic®), Thiacetarsamide (Caparsolate®), Oxibendazole (Filaribits®), Diethylcarbamazine (DEC)

E-hb 515, H2B 449

*?

- Mebendazole (Telmintic®): dewormer; Thiacetarsamide (Caparsolate®) heartworm adulticide (small margin of safety); Oxibendazole (Filaribits®): hookworm-heartworm preventative, Diethylcarbamazine (DEC): heartworm preventative
- CS: Jaundice, Vomiting, Coagulopathy
- Dx: ↑ ALP, ALT, hyperbilirubinemia, Liver biopsy (centrilobular necrosis)
- Tx: Supportive care for acute hepatic failure (fluids)



Feline idiopathic hepatic lipidosis, Feline fatty liver syndrome

M8k 337; E-hb 525; SAP 749; H2B 443; H3B 392; I2M 510; IM 398; IM-WW 309; GI-S 792, 766; GI 553; Neo 208; Pa-T 90

**?

- *Not associated w/ CS in* **dog**
- **Common liver diz in Cat**
  - Associated w/ severe intrahepatic cholestasis & hepatic failure
  - **#1 cause of liver failure: cat**
  - High mortality if not treated
  - Females > males
  - Most obese before onset
- Pathophysiology: fat accumulates in liver of insulin deficient animals:
  - Starvation of obese cats in 60% of cases
  - Diabetes mellitus
  - Obesity
  - Drug-induced (tetracycline)
  - Nonhepatic conditions
  - Possible arginine or taurine deficiency

- Most obese before onset
- **Anorexia of > 2 wks duration**
- Significant weight loss: thin cat
- Lethargy, vomiting
- Constipation or diarrhea
- Jaundiced
- Muscle wasting
- Paunched belly - intra-abdominal fat maintained
- Hepatic encephalopathy CS uncommon
- Overt bleeding uncommon

Cause - Lipidosis
- **Idiopathic** in most cats
- 2° to:
  - Malnutrition
  - Hypoxic liver injury
  - Diabetes mellitus
  - Drugs/tetracycline

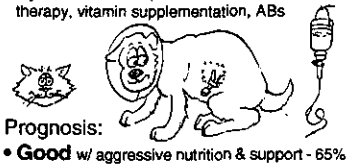
DDx:
- Cholangiohepatitis
- FIP
- Neoplasia

- Hx (**fat cat, anorexia**), CS
- Lab:
  - ↑ Liver enzymes (ALT, sBA [serum bile acids])
  - UA (urinary analysis): bilirubinuria
- Radiology: normal to ↑ size of liver
- Ultrasound:
  - Hepatomegaly
  - ↑ Echogenicity
- **Liver biopsy: definitive**
  - Fine needle aspirate, do clotting profile 1st
  - **Floats in formalin**
  - Oil red O stain for excess fat
  - Cytology - foamy & vacuolated hepatocytes

Never see bilirubinuria of any degree in cats unless they are sick

Prevention:
- Initiate nutritional support to any fat cat becoming anorexic from other dizs
- Monitor liver enzymes for any cat put on a reducing diet

- **Treat cause + supportive & symptomatic care**
- **Aggressive nutritional support**
  - Feed according to illness energy requirement (60 kcal/kg/day)
  - **Force feed or nasogastric or gastrotomy tube**, 3-6 weeks usually
  - Balanced canned commercial cat food (Feline prescription Diet p/d, a/d or c/d (Hill's Pet)
    . Mix w/ water to make a gruel
    . Small feedings 4-6 x/day
    . Restricted protein diet only if hyperammonemia or overt CNS signs
  - Double multiple vitamin (thiamine)
- **IV fluids**, balanced electrolyte + potassium chloride initially, avoid dextrose unless hypoglycemia (stim. fat synthesis)
- **Control complications**
  - Coagulopathies - vit K1, transfusions
  - Hepatic encephalopathies: low protein diet, lactulose, neomycin or metronidazole
- ABs (amoxicillin) to prevent infection, avoid tetracycline (predisposes to lipid accumulation)
- If due to diabetes mellitus, insulin reverses hepatic lipidosis
- If due to hypothyroidism, treat with synthetic thyroxine, ensure a positive caloric balance, fluid therapy, vitamin supplementation, ABs



Prognosis:
- **Good** w/ aggressive nutrition & support - 65% respond w/in 3-6 weeks. Recurrence is rare
- **Good once start eating on own**

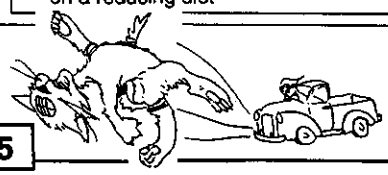
Cat (obese female), No CS in dog
CS: Obese, Anorexia, Vomiting
Dx: Hx, CS; ↑ ALT & sBA, Bilirubinuria, Biopsy (floats)
Tx cause, Force feed, IV fluids, ABs • Px: Good

Liver rupture/ trauma

Sx-S-hb 233; Sx-S 645; Sx-WW 147

*

- **Blunt trauma**
- CS: Asymptomatic, hemoperitoneum (If laceration, hemorrhage)
- Dx: Hx, Centesis; Radiology: local loss of peritoneal detail (margin of liver near trauma), Effusion (laceration)
- **Tx: Laceration: surgical emergency,** may require lobectomy



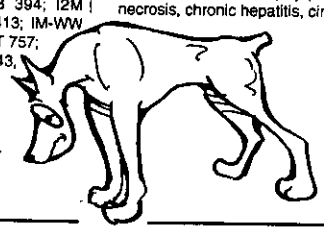
Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Chronic hepatitis M8k 339; E-hb 511, 518; SAP 743; H2B 448; I2M 529; IM-WW 305; C12T 740, 749; GI 521; GI-S 705; Pa-T 91 **	• **Diverse group of dizs, not a diagnosis** - Necrotizing inflammatory dizs • Cause & pathogenesis not well understood	• **Vague & nonspecific** - Weight loss - Anorexia - Depression • Liver failure CS in time - Jaundice - Ascites - Coagulopathy - Hepatic encephalopathy	• Lab & histopath often fail to definitively diagnose **Types of Chronic hepatitis** • Idiopathic chronic hepatitis • Chronic hepatitis of Doberman pinschers • Copper-associated hepatitis (Bedlington, West Highland White & Skye terriers) • Anticonvulsant chronic hepatitis • Oxibendazole chronic hepatitis • Leptospirosis - associated chronic hepatitis • Infectious canine hepatitis-assoc. chronic hepatitis • Acidophilic cell hepatitis • Lobular-dissecting hepatitis • Idiopathic hepatoportal fibrosis • Lymphocytic &/or plasmacytic cholangiohepatitis	• **Optimum treatment not known** • See types of chronic hepatitis that follows ?
Idiopathic chronic active hepatitis, Chronic canine inflamatory hepatic diz M8k 340; Mk 138, 1207; SAP 743; H3B 388; I2M 535; IM-WW 305; E-hb 520; Sx4B 288; Pa-T 104 ***	• **Clinical signs & lab indications of hepatic diz** - Chronic portal inflammation - Nodular hepatic degeneration - Fibrosis - Bile duct proliferation - Progresses to cirrhosis & liver failure • Cause: idiopathic? - **Immunologic** probably: antigen-antibody complexes in liver • Female dogs > males • 5-6 years old	• **Nonspecific** - Depression - Weakness - Anorexia - Vomiting - PU/PD - Ascites - Weight loss - ± Icterus/jaundice	• **Requires 6 months of clinical data for definitive Dx** (cause may not be found) • ALT > 10x normal (inflammation) • ALP > 5x (intrahepatic cholestasis) • ↑ Bilirubin usually, ↑ BSP • Biopsy - confirms Dx - Nodular regeneration of cirrhosis - Portal inflammation (lymphocytes & plasma cells) - **Necrosis of hepatocytes** - **Fibrosis** usually	• **Depends on cause, which may not be found** • If thought to be immune-mediated - **Steroid: prednisolone** (PO BID) until clinical remission then tapered to lowest effective alternate-day maintenance dose . Monitor serum biochem. every 1-2 weeks, Follow up liver biopsy to ensure in remission - ± **Azathioprine** (Imuran®) + **steroid** if no improvement w/just steroid, PO SID. If improvement in 2 weeks continue for 2-3 months. Monitor CBS for bone marrow suppression . If no improvement reconsider diagnosis - Colchicine (0.03 mg/kg PO SID) if significant fibrosis - Supportive therapy - Re-evaluate (lab, bile acids) for hepatic failure - Try to discontinue all in 4-6 months. relapse may occur **Prognosis**: Variable because of heterogenous group of dizs. Some m/b taken off medication; others medication continued indefinitely & others fail to respond

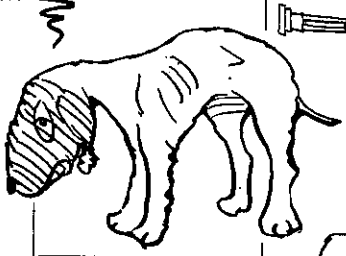
Immunologic?
CS: Nonspecific, ± Icterus/Jaundice
Dx: Lab, Difficult
Tx: Steroid, ± Imuran®, Supportive •Px: Variable

DDx:
See above

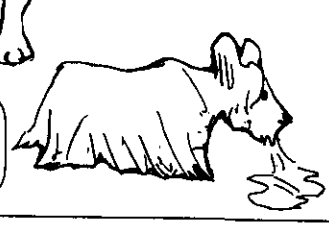
Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
***Copper associated hepatitis* of Bedlington terriers, Westies, Dobies, Sky terriers** M8k 339; E-hb 518; SAP 745, 748; H2B 442; H3B 394; I2M 531; IM 413; IM-WW 306; C12T 757; GI 525, 743, 749; GI-S 597, 743; Pa-T 90, Tox-X 187 *	• ***Metabolic defect causing accumulation of copper in liver*** • **Bedlington**: hereditary (autosomal recessive inability to excrete copper in bile). High incidence in breed, stress may lead to acute liver failure (e.g.) whelping may bring on • **West Highland White**: advanced before signs • **Dobie**: hereditary? immune? shows signs late in diz, advanced before signs • **Skye terriers**: chronic, genetic • Progressive accumulation of copper & chronic liver diz - > 2000 µg/g hepatic injury (focal hepatic necrosis, chronic hepatitis, cirrhosis)	• **Asymptomatic** until critical level reached • Depression, lethargy • Anorexia • Vomiting • **Jaundice** • ± Hemolytic anemia • Chronic: - **Weight loss** - **Ascites** - Small liver • PU/PD in dobies • Hepatic encephalopathies	• Hx (**breed**), CS of hepatic diz • Lab: - ↑ ALT (66%) & ALP - ± Hemolytic anemia - Chronic failure: Low BUN, ↓ albumin, ↓ glycemia, ↑ bilirubinemia, ↑ ammonium . ↑ **Serum bile acids** • **Radiology: small liver in chronic cases** • **Liver biopsy** - definitive diagnosis - Dark copper granules in hepatocytes, H&E stain - **Positive for copper stains** (rhodamine & rubeanic acid) - Copper assay: > 350 µg/g	• Supportive (fluids, electrolyte & acid base) • **Chelate copper** (controversial in doby) - **D-penicillamine** (Cuprimine®) chelates copper - Trientine hydrochloride (Syprine®) (but not penicillamine) chelate copper in circulation - Zinc acetate: chelates copper, least expensive, not to be used alone if active hepatitis - Lifelong therapy • Treat ascites, hepatic encephalopathy & coagulopathies • **Doby: no effective treatment established** - Immunosuppressive therapy (prednisolone ± azathioprine) in doby, usually poor response **Prevention:** Tx affected dogs w/ minimum hepatic injury, Zinc Tx less expensive than D-penicillinase **Prognosis:** • **Bedlington: Good** if mild to moderate failure -usually responds, can live out life, Poor if fulminating hepatic failure • **Doberman: Poor**, Tx usually unsuccessful, most die in weeks to months. More favorable if Dx in early stages

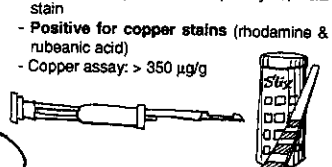
Metabolic defect = Copper in liver
CS: Asymptomatic to liver failure
Dx: Hx; ↑ ALT, ALP, BA; Biopsy
Tx: Supportive, Chelate
Px: Bedlington: Good; Doby: Poor



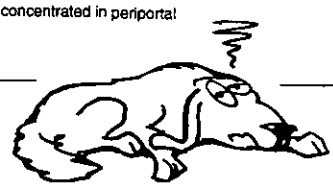


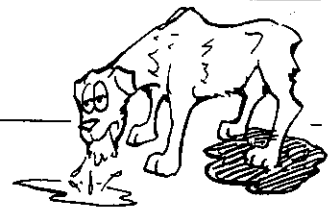
DDx:
• Von Willebrand's diz (bleeding in Dobies)





Condition	Facts/Causes
Lobular dissecting hepatitis * M8k 341; SAP 748	• **Rare** chronic hepatitis reported in a few dogs • CS: **Advanced hepatic failure & portal hypertension** • Dx: Histology: lobular hepatitis (inflammation & necrosis scattered in hepatic lobule rather than concentrated in periportal region, collagen & reticulin fibers subdivide lobules & progress to cirrhosis) • Tx: **Specific Tx not reported**, chronic liver failure Tx appropriate
Acidophil cell hepatitis E-hb 516; SAP 748 *	• **Described in Great Britain**, caused by unidentifiable agent, probably a virus • CS: Acute or chronic hepatitis progressing to cirrhosis, **chronic liver diz signs** • Dx: Histology: **acidophils**, represent dying hepatocytes • Tx: **Manage chronic liver failure**

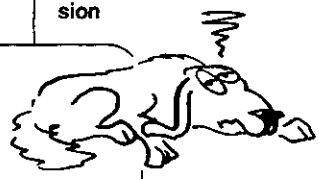


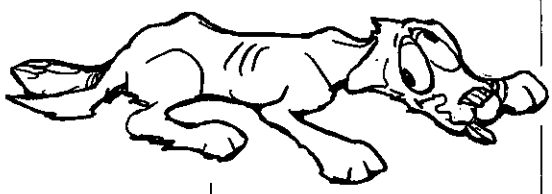


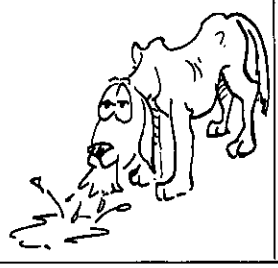
Cirrhosis - Shunts

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Cirrhosis & fibrosis E-hb 511; SAP 749; H2B 453; H3B 1129; I2M 163; IM-WW 308; GI 533; GI-S 718; E 1317; Sx4B 288 **	• **Irreversible end stage of chronic hepatitis** - Hepatocyte death & repair by **fibrosis** & nodular regeneration - Processes compromise adjacent area so eventually becomes **self-perpetuating**	• **Jaundice** • **Ascites** • **Hepatic encephalopathy** • Preceded by nonspecific liver diz CS: anorexia, lethargy, vomiting, diarrhea, **depression**	• Hx, CS • **Liver biopsy** - definitive - Laparotomy or laparoscopy better than needle - Fibrosis, regenerative nodules - Disruption of normal architecture • Lab: - ↑ Serum liver enzymes usually, but less than in active hepatitis - ↑ Serum bilirubin, ammonia & bile acids - Hypoalbuminemia - Low BUN - Hyperglobulinemia sometimes - Hemostatic abnormalities may reflect DIC • **Radiology:** - Microhepatica in dogs - Hepatomegaly in cats w/ biliary cirrhosis • **Ultrasound:** ↑ echogenicity (fibrosis) & ascites - Mixed hyper & hypoechoic pattern (nodular hyperplasia)	• **Irreversible - mainly supportive**, control ascites, encephalopathy, ulcers, coagulopathies & infections - **Fluids** - **Diuretics** (furosemide [Lasix®]), spironolactone (Alkdactone®) - **Hill's h/d or k/d diet** (↓ Na & protein) - **Endotoxemia: ABs** (amoxicillin-clavulanic acid [Clavamox], metronidazole - **Tx excessive bleeding**: Vit K1, transfusion - **Tx gastric ulcers**: Cimetidine, Sucralfate (Carafate®) • Slow progression if specific cause diagnosed - Adjust anticonvulsants drugs - Copper-positive biopsies . Chelating agents (D-penicillamine) - Chronic hepatitis - immunosuppressive drugs • Ursodiol: choleretic & immunomodulating • Colchicine (antifibrotic drug) benefits not proven in dogs • D-penicillamine; also antifibrotic • Prednisolone also antifibrotic, but risks may out weigh the benefits Prognosis: **Guarded; grave** for long term

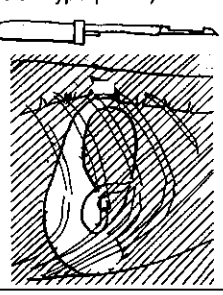
Causes of chronic hepatitis
- Idiopathic #1
- Infection (ICH)
- Hepatotoxins (copper, anticonvulsants)
- Immunologic injury (chronic hepatitis)
- Chronic cholestasis (chronic cholangiohepatitis in cats)

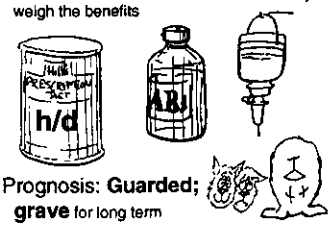




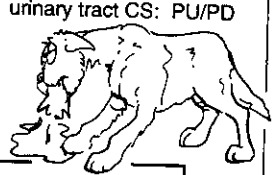


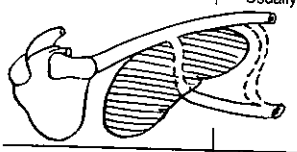
End stage of chronic hepatitis
CS: Jaundice, Ascites, Hepatic encephalopathy
Dx: Liver biopsy
Tx: Irreversible, Supportive





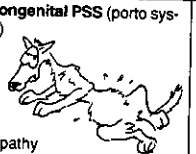
***Portovascular anomalies,* Portosystemic shunts, PSS** M8k 332, 130; E-hb 521; SAP 751, 763; H2B 437; H3B 383; I2M 523, 539; IM 407, 420; IM-WW 309; GI-S 650, 802; GI 541; E 1340; Sx-S-hb 237; Sx-S 660; Sx4B 292; Sx3B 295; Sx-WW 151; Sx-G 202; C12T 743 (f); PA-T 87; Neo 195 **	• ***Shunt between portal vein & systemic circulation, bypassing liver parenchyma*** - Encephalopathy from inadequate clearance of toxins (ammonia, mercaptans, short-chain FA, gamma aminobutyric acid) - Urate urolithiasis: a complication • Uncommon: dogs, cats • Types: single intrahepatic or extrahepatic or multiple extrahepatic • Congenital usually: < 1 yr old - **Large breeds**: single intrahepatic (doby, Irish wolfhound, Golden, Lab, Samoyed) - **Small breeds** & cats extrahepatic (Yorkshire terrier, Dachshund, miniature poodles) - Domestic shorthaired > purebred cats - Patent ductus venosus: (intrahepatic) large breeds, connects portal to caudal vena cava through liver - Single extrahepatic connect portal or left gastric or splenic v. with the caudal vena cava cranial to phrenicoabdominal veins or azygos vein (small breeds) • Acquired due to dizs (cirrhosis & chronic hepatitis causing portal hypertension) - Usually multiple extrahepatic	• **Hepatic encephalopathy** (HE) - **Depression** - stupor - coma - **Head pressing**, circling, blindness - **Personality changes** - Ataxia & paresis - Seizures or tremors - Hypersalivation in cats - Worse after feeding (postprandial) - Wax & wane w/ normal periods • Chronic "poor doers": stunted • **GI signs (75%)** - usually mild & intermittent, anorexia, salivation, vomiting, diarrhea • Prolonged anesthetic recovery • **Sequela:** - Recurrent urinary calculi - urinary tract CS: PU/PD	• Hx (**age**) CS: young w/ intermittent CNS, GI or urinary signs, - Dogs, except Dalmatians or cats w/ urolithiasis - Any age w/ encephalopathies • Lab: - ↑ **Bile acids - dramatic** - ↑ Serum uric acid - ↑ **Ammonium** - ↓ BUN below normal in 70% - UA: Ammonium urate crystalluria . Specific gravity low (44%) - Hematology nonspecific, mild anemia (may be microcytic), hypoproteinemia - BSP retention prolonged (93%) - ALT, AP, AST are normal or mild increase • Radiology: Microliver, Renomegaly - Urinary calculi - **Positive-contrast portography** procedure of choice . Isolate of loop of jejunum through a ventral midline incision. Inject contrast agent as a bolus into a jejunal vein • Needle biopsy often unremarkable, hepatocyte atrophy w/ small or absent portal veins, increased hepatic iron deposits • **Ultrasound** - Small liver, normal or ↓ intrahepatic veins - Intrahepatic shunt from porta to caudal vena cava	• **Partial ligation of shunting vessel** - Portal pressure < 20 cm of H_2O following shunt ligation (higher pressure associated with venous stagnation of bowel, shock & death). Ascites minor & transient complication . Urinary calculi removed at time of Sx or later or medically managed • Multiple shunt ligation contraindicated - Suture attenuation (banding) of abdominal vena cava may raise systemic pressure over portal pressure • Medical therapy: - **ABs**: penicillin or metronidazole for possible septicemia - Control hepatic encephalopathy . **Low protein diet**, Lactulose, Neomycin - Stabilize animal for surgery - Long term therapy if no surgery, may control signs for 2-3 years • **Complication of surgical ligation** - Seizures or status epilepticus occasionally . **Phenobarbital IV**, if phenobarbital doesn't work - general anesthesia w/ isoflurane . Mannitol may be for cerebral edema . Respirator may be for pO2 & pCO2 - **Portal hypertension**: septicemia, thrombosis of portal circulation Prognosis: **Excellent** if survives postoperative period; Poor if seizures following surgery • Dramatic improvement following Sx • Intrahepatic shunts poor to guarded



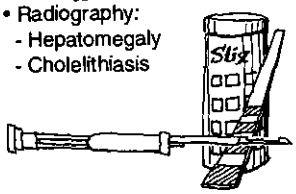
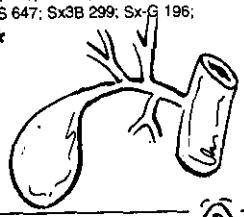
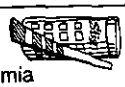
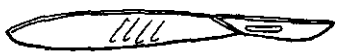


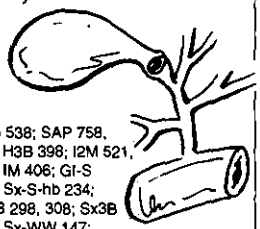
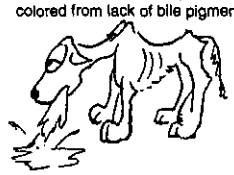
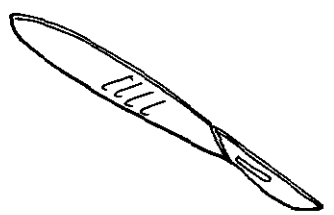
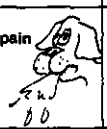
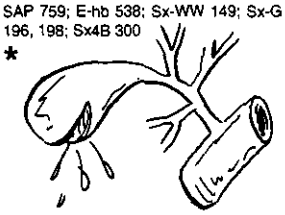
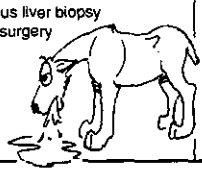
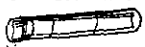
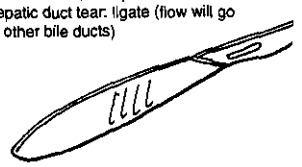
Shunt bypass liver, Urate urolithiasis
CS: Hepatic encephalopathy, PU/PD
Dx: Hx, CS, Lab, Portography
Tx: Partial ligation; Medical: ABs, diet

Hepatic arteriovenous (AV) fistula E-hb 524; GI-S 835; GI SAP 754; H3B 386; IM-WW 311; SX-WW 154 *	• **Vascular communication between hepatic artery & portal vein** - Results in hypertension, ascites & 2° portosystemic shunts • **Rare** in dogs & cats • Cause: congenital or acquired (trauma, Sx, neoplasia, cirrhosis or artery rupture)	• **Similar to congenital PSS** (porto systemic shunt) - Anorexia - Lethargy - Vomiting - Diarrhea - PU/PD - Encephalopathy • **Ascites**	• **Hx & CS similar to PSS**, except marked ascites a consistent finding • Auscultation over liver for continuous murmur (bruit) of arterial blood runoff into portal system • Lab: similar to PSS • Radiology: marked ascites - Celiac arteriography • Ultrasound: tortuous, anechoic tubular fistulas • Laparotomy: elevated hepatic capsule	• **Partial hepatectomy if only one lobe involved - TOC (treatment of choice)** • Dearterialization if multiple lobes involved - Revascularization usually occurs • Medical management of encephalopathy - Low-protein diet, lactulose, & neomycin • Vena cava banding recommended if AV fistula accompanied by multiple extrahepatic PSS Prognosis: **Guarded**



Bile

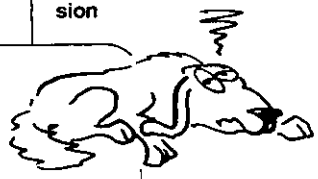
Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Cholangiohepatitis & cholangitis, Feline suppurative cholangiohepatitis M8k 338; E-hb 517; SAP 737; H2B 445; H3B 391; I2M 516; IM 402, 423; IM-WW 304, 308; GI 530; GI-S 874; Sx3B 299; Inf-G 148(f); Pa-T 105(f) ** **Cat, Bile duct Jaundice, GI, Fever Tx: ABs, Steroids**	• **Inflammation of bile ducts & adjacent hepatocytes** - Cholangitis: bile duct - Cholangiohepatitis: bile duct & hepatocytes • Uncommon in cats, less frequent in dogs • Cause: not understood, involves intrahepatic bile system • Often have concurrent disorders, especially inflammatory bowel diz, pancreatitis, extrahepatic bile duct obstruction	• **Anorexia** • **Depression** • **Weight loss** • **Fever** • **Vomiting** • **Yellow cat**: jaundice • Dehydration • Encephalopathy, ascites & bleeding uncommon **DDx:** • Hepatic FIP • Hepatic lipidosis • Neoplasia	• **Suspect in any cat w/ fever & jaundice &/or GI signs** • **Liver biopsy** - definitive - Histopath, aerobic & anaerobic culture • Lab: - ↑ ALT , AP, AST, BA, ± coagulopathy - ↓ BUN, albuminemia & hyperammonemia suggest advance stage • Radiography: - Hepatomegaly - Cholelithiasis 	• **Systemic ABs** (culture & sensitivity) - Aerobic gram +: ampicillin, amoxicillin, cephalosporins, chloramphenicol & aminoglycosides - **Anaerobic: metronidazole**, clindamycin, chlor amphenicol, ampicillin & amoxicillin - Ampicillin or amoxicillin 1st choice or combine w/ kanamycin or gentamicin • **Steroids** (prednisolone): empirically • **Dehydrocholic acid** (Decholin®) prevent bile slugging • Surgery if obstruction present • **General support** - Fluids, nutrition, vitamin supplementation • **Control complications** (ascites, hepatic encephalopathy, bleeding) Prognosis: ??
Cholecystitis M8k 344; E-hb 538; SAP 740, 765; IM-WW 303, 312; GI 558; GI-S 865; Sx-S-hb 234; Sx-S 647; Sx3B 299; Sx-G 196; **  **Gall bladder Cholecystectomy**	• **Inflammation of gallbladder** • Dogs & cat: uncommon • Cause: unclear - Enteric aerobic gram (-) bacteria	• **Anorexia** • **Lethargy** • **Abdominal pain** • **Vomiting** • **Diarrhea** • **Jaundice** • Sequela: rupture: septic bile peritonitis (abdominal distention, collapse & septic shock)	• Hx, CS • **Lab:** - Hyperbilirubinemia - Marked ↑ ALP, ALT, Bile acids, cholesterol - Inflammatory PMNs w/ left shift • Septic bile peritonitis, if ruptures • Radiology: Cholecystolithiasis, emphysema of gall bladder wall, abdominal effusion (rupture) Hepatomegaly • Exploratory & culture 	• **Cholecystectomy** (total removal of gall bladder) in most cases - Parenteral vit K1 prior to surgery - ABs 4-6 weeks - Fluids & electrolytes  Prognosis: • Good if survives immediate postoperative period, recurrence unlikely • Death usually attributed to sepsis & peritonitis
Liver fluke infection M8k 326, 345; Mk 247; SAP 740; Pa-T 85, 100; Neo 209 * 	• **Rare cats > dog** • ***Platynosomum concinnum*** (P. fastosum); others also found - Tropical & subtropical areas (Hawaii, Florida & Caribbean) - Snail 1st intermediate host - 2nd intermediate host: gecko, skink, lizard, Bufo toad or fish	• **Asymptomatic usually** • Occasionally: anorexia, weight loss, diarrhea, vomiting, jaundice, hepatomegaly, abdominal distention, & death	• Hx (location) • **Operculated egg in feces** (formalin-ether technique) • Laparotomy or necropsy often no visible abnormalities - Small adult flukes (< 12 mm)	• **Little information available** • **Praziquantel (Droncit®)** 40 mg/kg OP or parenterally SID for 3 days **Droncit**

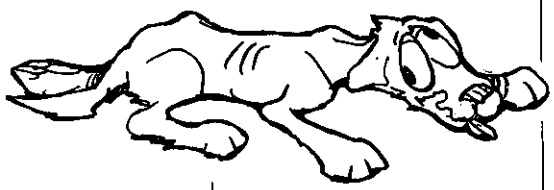
Extrahepatic biliary obstructive diz, EBOD **  E-hb 538; SAP 758, 766; H3B 398; I2M 521, 542; IM 406; GI-S 870; Sx-S-hb 234; Sx4B 298, 308; Sx3B 299; Sx-WW 147; Sx-G 194; Pa-T 108	• Disruption bile flow to intestine • Anorectic animals • 2° to obstruction of bile duct - **Pancreatic** diz #1 - Choleliths - Neoplasia: pancreatic, duodenal - Inflammation, infection & neoplasia of pancreas, duodenum & abdominal lymph nodes - Cholelithiasis 	• **Icterus** • **Vomiting** • Anorexia • Weight loss/emaciation • Abdominal pain • Depression • Dehydration • Excessive bleeding (↓ Vit K absorption) • Diarrhea & steatorrhea (tan-colored from lack of bile pigments) 	• Hx, CS • Lab: - **Marked ↑ ALP, cholesterol, bile acids & bilirubin** - **Moderately ↑ ALT** - ↑ serum bilirubin (1° conjugated) - Prolonged PT, APTT & active clotting time (ACT) - ↑ Amylase &/or lipase w/ pancreatic diz • UA (urinary analysis) - Absence of urobilinogen - Bilirubinuria • Radiology - frequently nondiagnostic - Enlarged gall bladder - Radiopaque calculi readily seen • Ultrasound: normally ducts are not seen, dilation allows then to be appreciated • Exploratory laparotomy - definitive 	• Tx 1° cause (**pancreatitis**, etc.) • **Cholecystoenterostomy**: redirect or re-estab lish flow - Cholecystoduodenostomy: anastomoses ga bladder to duodenum - Cholecystojejunostomy: anastomose gall bla der to jejunum 
Cholelithiasis, Calculi, Gallstones E-hb 538; SAP 756; IM-WW 313; H2B 455; GI-S 867; Sx-S-hb 234; Sx-S 647; Sx-WW 149; Sx-G 194; Sx4B 300; Pa-T 108 *	• **Extremely rare** (< 1% of dogs w/ liver diz) • Incidental & subclinical finding • May obstruct biliary system • **Choleliths**: insoluble bile pigments - Cholecystolithiasis: in gallbladder - Choledocholithiasis: bile duct	• **Often asymptomatic** • Jaundice, vomiting, anorexia, weight loss & dehydration • Achoic feces indicates complete bile duct obstruction	• **Radiology:** radiopaque calculi • Ultrasound for radiopaque & radiolucent & differentiate from liver calcification 	• **Nothing if asymptomatic** • **Sx removal** (cholecystotomy)
Emphysematous cholecystitis SAP 759; Inf-G 151 *	• ***Clostridium*** spp (gas-forming bacteria) • In gall bladder • M/b assoc w/ diabetes mellitus • May rupture & cause bile peritonitis	• Vague - **Cranial abdominal pain** - **Pyrexia** - **Anorexia** - **Vomiting** 	• **Radiology: Air in gall bladder** 	• Antibiotics ? for clostridium?
Biliary tract rupture SAP 759; E-hb 538; Sx-WW 149; Sx-G 196, 198; Sx4B 300 * 	• Cause: - **Blunt or sharp trauma** (hit by car) - Penetrating wound, gunshot - Pathologic rupture 2° to inflammation, neoplasia or choleliths - Percutaneous liver biopsy - Abdominal surgery 	• **Acute peritonitis** - Abdominal pain 1st 48 hrs - Anorexia, depression, fever - Abdominal distention - **Icterus** - **Shock** • Blunt trauma to biliary duct develop much slower signs & may be over shadowed by other traumatic injuries	• Hx (**trauma**) • PE - Achoic feces • Abdominocentesis: bile-stained modified transudate. Bile higher in abdomen fluid than in serum • Lab: - ↑ Total serum bilirubin - ↑ Liver enzymes (ALP, ALT) • Radiology/Ultrasound: Peritoneal effusion • Exploratory laparotomy to confirm, culture abdominal fluid 	• **Cholecystectomy** (total removal of gall-bladder & cystic duct) if extensive damage • **Cholecystoenterostomy**: for avulsion of co mon bile duct; **reimplant** in duodenum • Hepatic duct tear: ligate (flow will go to other bile ducts) 

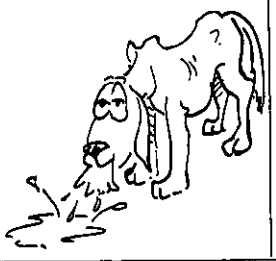
Cirrhosis - Shunts

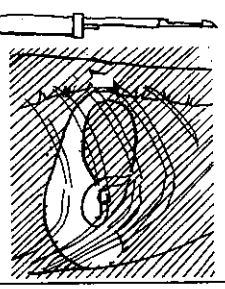
Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Cirrhosis & fibrosis E-hb 511; SAP 749; H2B 453; H3B 1129; I2M 163; IM-WW 308; GI 533; GI-S 718; E 1317; Sx4B 288 **	• **Irreversible end stage of chronic hepatitis** - Hepatocyte death & repair by **fibrosis** & nodular regeneration - Processes compromise adjacent area so eventually becomes **self-perpetuating**	• **Jaundice** • **Ascites** • **Hepatic encephalopathy** • Preceded by nonspecific liver diz CS: anorexia, lethargy, vomiting, diarrhea, **depression**	• Hx, CS • **Liver biopsy** - definitive - Laparotomy or laparoscopy better than needle - Fibrosis, regenerative nodules - Disruption of normal architecture • Lab: - ↑ Serum liver enzymes usually, but less than in active hepatitis - ↑ Serum bilirubin, ammonia & bile acids - Hypoalbuminemia - Low BUN - Hyperglobulinemia sometimes - Hemostatic abnormalities may reflect DIC • **Radiology:** - Microhepatica in dogs - Hepatomegaly in cats w/ biliary cirrhosis • **Ultrasound:** ↑ echogenicity (fibrosis) & ascites - Mixed hyper & hypoechoic pattern (nodular hyperplasia)	• **Irreversible - mainly supportive**, control ascites, encephalopathy, ulcers, coagulopathies & infections - **Fluids** - **Diuretics** (furosemide [Lasix®]), spironolactone (Alkdactone®) - **Hill's h/d or k/d diet** (↓ Na & protein) - **Endotoxemia: ABs** (amoxicillin-clavulanic acid [Clavamox], metronidazole - **Tx excessive bleeding**: Vit K1, transfusion - **Tx gastric ulcers**: Cimetidine, Sucralfate (Carafate®) • Slow progression if specific cause diagnosed - Adjust anticonvulsants drugs - Copper-positive biopsies . Chelating agents (D-penicillamine) - Chronic hepatitis - immunosuppressive drugs • Ursodiol: choleretic & immunomodulating • Colchicine (antifibrotic drug) benefits not proven in dogs • D-penicillamine; also antifibrotic • Prednisolone also antifibrotic, but risks may out weigh the benefits Prognosis: **Guarded; grave** for long term

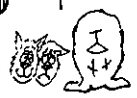
Causes of chronic hepatitis
- Idiopathic #1
- Infection (ICH)
- Hepatotoxins (copper, anticonvulsants)
- Immunologic injury (chronic hepatitis)
- Chronic cholestasis (chronic cholangiohepatitis in cats)





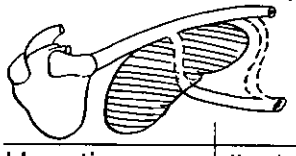


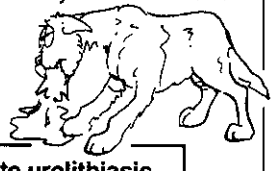




End stage of chronic hepatitis
CS: Jaundice, Ascites, Hepatic encephalopathy
Dx: Liver biopsy
Tx: Irreversible, Supportive

***Portovascular anomalies,* Portosystemic shunts, PSS** M8k 332, 130; E-hb 521; SAP 751, 763; H2B 437; H3B 383; I2M 523, 539; IM 407, 420; IM-WW 309; GI-S 650, 802; GI 541; E 1340; Sx-S-hb 237; Sx-S 660; Sx4B 292; Sx3B 295; Sx-WW 151; Sx-G 202; C12T 743 (f); PA-T 87; Neo 195 **	• ***Shunt between portal vein & systemic circulation, bypassing liver parenchyma*** - Encephalopathy from inadequate clearance of toxins (ammonia, mercaptans, short-chain FA, gamma aminobutyric acid) - Urate urolithiasis: a complication • Uncommon: dogs, cats • Types: single intrahepatic or extrahepatic or multiple extrahepatic • Congenital usually: < 1 yr old - **Large breeds**: single intrahepatic (doby, Irish wolfhound, Golden, Lab, Samoyed) - **Small breeds** & cats extrahepatic (Yorkshire terrier, Dachshund, miniature poodles) - Domestic shorthaired > purebred cats - Patent ductus venosus: (intrahepatic) large breeds, connects portal to caudal vena cava through liver - Single extrahepatic connect portal or left gastric or splenic v. with the caudal vena cava cranial to phrenicoabdominal veins or azygos vein (small breeds) • Acquired due to dizs (cirrhosis & chronic hepatitis causing portal hypertension) - Usually multiple extrahepatic	• **Hepatic encephalopathy** (HE) - **Depression** - stupor - coma - **Head pressing**, circling, blindness - **Personality changes** - Ataxia & paresis - Seizures or tremors - Hypersalivation in cats - Worse after feeding (postprandial) - Wax & wane w/ normal periods • Chronic "poor doers": stunted • **GI signs (75%)** - usually mild & intermittent, anorexia, salivation, vomiting, diarrhea • Prolonged anesthetic recovery • **Sequela:** - Recurrent urinary calculi - urinary tract CS: PU/PD	• Hx (**age**) CS: young w/ intermittent CNS, GI or urinary signs. - Dogs, except Dalmatians or cats w/ urolithiasis - Any age w/ encephalopathies • Lab: - **↑ Bile acids - dramatic** - ↑ Serum uric acid - **↑ Ammonium** - ↓ BUN below normal in 70% - UA: Ammonium urate crystalluria . Specific gravity low (44%) - Hematology nonspecific, mild anemia (may be microcytic), hypoproteinemia - BSP retention prolonged (93%) - ALT, AP, AST are normal or mild increase • Radiology: Microliver, Renomegaly - Urinary calculi - **Positive-contrast portography** procedure of choice . Isolate of loop of jejunum through a ventral midline incision. Inject contrast agent as a bolus into a jejunal vein • Needle biopsy often unremarkable, hepatocyte atrophy w/ small or absent portal veins, increased hepatic iron deposits • **Ultrasound** - Small liver, normal or ↓ intrahepatic veins - Intrahepatic shunt from porta to caudal vena cava	• **Partial ligation of shunting vessel** - Portal pressure < 20 cm of H_2O following shunt ligation (higher pressure associated with venous stagnation of bowel, shock & death). Ascites minor & transient complication . Urinary calculi removed at time of Sx or later or medically managed • Multiple shunt ligation contraindicated - Suture attenuation (banding) of abdominal vena cava may raise systemic pressure over portal pressure • Medical therapy: - **ABs**: penicillin or metronidazole for possible septicemia - Control hepatic encephalopathy . **Low protein diet**, Lactulose, Neomycin - Stabilize animal for surgery - Long term therapy if no surgery, may control signs for 2-3 years • **Complication of surgical ligation** - Seizures or status epilepticus occasionally . **Phenobarbital IV**, if phenobarbital doesn't work - general anesthesia w/ isoflurane . Mannitol may be for cerebral edema . Respirator may be for pO2 & pCO2 - **Portal hypertension**: septicemia, thrombosis of portal circulation Prognosis: **Excellent** if survives postoperative period; Poor if seizures following surgery • Dramatic improvement following Sx • Intrahepatic shunts poor to guarded
Hepatic arteriovenous (AV) fistula E-hb 524; GI-S 835; GI SAP 754; H3B 386; IM-WW 311; SX-WW 154 *	• **Vascular communication between hepatic artery & portal vein** - Results in hypertension, ascites & 2° portosystemic shunts • **Rare** in dogs & cats • Cause: congenital or acquired (trauma, Sx, neoplasia, cirrhosis or artery rupture)	• **Similar to congenital PSS** (porto systemic shunt) - Anorexia - Lethargy - Vomiting - Diarrhea - PU/PD - Encephalopathy • **Ascites**	• **Hx & CS similar to PSS**, except marked ascites a consistent finding • Auscultation over liver for continuous murmur (bruit) of arterial blood runoff into portal system • Lab: similar to PSS • Radiology: marked ascites - Celiac arteriography • Ultrasound: tortuous, anechoic tubular fistulas • Laparotomy: elevated hepatic capsule	• **Partial hepatectomy if only one lobe involved - TOC (treatment of choice)** • Dearterialization if multiple lobes involved - Revascularization usually occurs • Medical management of encephalopathy - Low-protein diet, lactulose, & neomycin • Vena cava banding recommended if AV fistula accompanied by multiple extrahepatic PSS Prognosis: **Guarded**





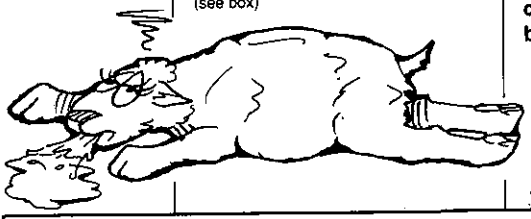
Shunt bypass liver, Urate urolithiasis
CS: Hepatic encephalopathy, PU/PD
Dx: Hx, CS, Lab, Portography
Tx: Partial ligation; Medical: ABs, diet

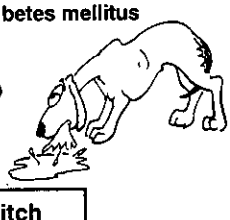
Bile

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Cholangiohepatitis & cholangitis, Feline suppurative cholangiohepatitis M8k 338; E-hb 517; SAP 737; H2B 445; H3B 391; I2M 516; IM 402, 423; IM-WW 304, 308; GI 530; GI-S 874; Sx3B 299; Inf-G 148(f); Pa-T 105(f) ** **Cat, Bile duct Jaundice, GI, Fever** **Tx: ABs, Steroids**	• **Inflammation of bile ducts & adjacent hepatocytes** - Cholangitis: bile duct - Cholangiohepatitis: bile duct & hepatocytes • Uncommon in cats, less frequent in dogs • Cause: not understood, involves intrahepatic bile system • Often have concurrent disorders, especially inflammatory bowel diz, pancreatitis, extrahepatic bile duct obstruction	• **Anorexia** • **Depression** • **Weight loss** • **Fever** • **Vomiting** • **Yellow cat**: jaundice • Dehydration • Encephalopathy, ascites & bleeding uncommon **DDx:** • Hepatic FIP • Hepatic lipidosis • Neoplasia	• **Suspect in any cat w/ fever & jaundice &/or GI signs** • **Liver biopsy** - definitive - Histopath, aerobic & anaerobic culture • Lab: - ↑ ALT , AP, AST, BA, ± coagulopathy - ↓ BUN, albuminemia & hyperammonemia suggest advance stage • Radiography: - Hepatomegaly - Cholelithiasis	• **Systemic ABs** (culture & sensitivity) - Aerobic gram +: ampicillin, amoxicillin, cephalosporins, chloramphenicol & aminoglycosides - **Anaerobic: metronidazole**, clindamycin, chloramphenicol, ampicillin & amoxicillin - Ampicillin or amoxicillin 1st choice or combine w/ kanamycin or gentamicin • **Steroids** (prednisolone): empirically • **Dehydrocholic acid** (Decholin®) prevent bile slugging • Surgery if obstruction present • **General support** - Fluids, nutrition, vitamin supplementation • **Control complications** (ascites, hepatic encephalopathy, bleeding) Prognosis: ??
Cholecystitis M8k 344; E-hb 538; SAP 740, 765; IM-WW 303, 312; GI 558; GI-S 865; Sx-S-hb 234; Sx-S 647; Sx3B 299; Sx-G 196; ** **Gall bladder Cholecystectomy**	• **Inflammation of gallbladder** • Dogs & cat: uncommon • Cause: unclear - Enteric aerobic gram (-) bacteria	• **Anorexia** • **Lethargy** • **Abdominal pain** • **Vomiting** • **Diarrhea** • **Jaundice** • Sequela: rupture: septic bile peritonitis (abdominal distention, collapse & septic shock)	• Hx, CS • **Lab:** - Hyperbilirubinemia - Marked ↑ ALP, ALT, Bile acids, cholesterol - Inflammatory PMNs w/ left shift • Septic bile peritonitis, if ruptures • Radiology: Cholecystolithiasis, emphysema of gall bladder wall, abdominal effusion (rupture) Hepatomegaly • Exploratory & culture	• **Cholecystectomy** (total removal of gall bladder) in most cases - Parenteral vit K1 prior to surgery - ABs 4-6 weeks - Fluids & electrolytes Prognosis: • Good if survives immediate postoperative period, recurrence unlikely • Death usually attributed to sepsis & peritonitis
Liver fluke infection M8k 326, 345; Mk 247; SAP 740; Pa-T 85, 100; Neo 209 *	• **Rare cats > dog** • ***Platynosomum concinnum*** (P. fastosum); others also found - Tropical & subtropical areas (Hawaii, Florida & Caribbean) - Snail 1st intermediate host - 2nd intermediate host: gecko, skink, lizard, Bufo toad or fish	• **Asymptomatic usually** • Occasionally: anorexia, weight loss, diarrhea, vomiting, jaundice, hepatomegaly, abdominal distention, & death	• Hx (location) • **Operculated egg in feces** (formalin-ether technique) • Laparotomy or necropsy often no visible abnormalities - Small adult flukes (< 12 mm)	• **Little information available** • **Praziquantel (Droncit®)** 40 mg/kg OP or parenterally SID for 3 days **Droncit**
Extrahepatic biliary obstructive diz, EBOD** E-hb 538; SAP 758, 766; H3B 398; I2M 521, 542; IM 406; GI-S 870; Sx-S-hb 234; Sx4B 298, 308; Sx3B 299; Sx-WW 147; Sx-G 194; Pa-T 108	• *Disruption bile flow to intestine* • Anorectic animals • 2° to obstruction of bile duct - **Pancreatic** diz #1 - Choleliths - Neoplasia: pancreatic, duodenal - Inflammation, infection & neoplasia of pancreas, duodenum & abdominal lymph nodes - Cholelithiasis	• **Icterus** • **Vomiting** • Anorexia • Weight loss/emaciation • Abdominal pain • Depression • Dehydration • Excessive bleeding (↓ Vit K absorption) • Diarrhea & steatorrhea (tan-colored from lack of bile pigments)	• Hx, CS • Lab: - **Marked ↑ ALP, cholesterol, bile acids & bilirubin** - **Moderately ↑ ALT** - ↑ serum bilirubin (1° conjugated) - Prolonged PT, APTT & active clotting time (ACT) - ↑ Amylase &/or lipase w/ pancreatic diz • UA (urinary analysis) - Absence of urobilinogen - Bilirubinuria • Radiology - frequently nondiagnostic - Enlarged gall bladder - Radiopaque calculi readily seen • Ultrasound: normally ducts are not seen, dilation allows then to be appreciated • Exploratory laparotomy - definitive	• Tx 1° cause (**pancreatitis**, etc.) • **Cholecystoenterostomy**: redirect or re-establish flow - Cholecystoduodenostomy: anastomoses gall bladder to duodenum - Cholecystojejunostomy: anastomose gall bladder to jejunum
Cholelithiasis, Calculi, Gallstones E-hb 538; SAP 756; IM-WW 313; H2B 455; GI-S 867; Sx-S-hb 234; Sx-S 647; Sx-WW 149; Sx-G 194; Sx4B 300; Pa-T 108 *	• **Extremely rare** (< 1% of dogs w/ liver diz) • Incidental & subclinical finding • May obstruct biliary system • **Choleliths**: insoluble bile pigments - Cholecystolithiasis: in gallbladder - Choledocholithiasis: bile duct	• **Often asymptomatic** • Jaundice, vomiting, anorexia, weight loss & dehydration • Achoic feces indicates complete bile duct obstruction	• **Radiology:** radiopaque calculi • Ultrasound for radiopaque & radiolucent & differentiate from liver calcification	• **Nothing if asymptomatic** • **Sx removal** (cholecystotomy)
Emphysematous cholecystitis SAP 759; Inf-G 151 *	• ***Clostridium*** spp (gas-forming bacteria) • In gall bladder • M/b assoc w/ diabetes mellitus • May rupture & cause bile peritonitis	• Vague - **Cranial abdominal pain** - **Pyrexia** - **Anorexia** - **Vomiting**	• **Radiology: Air in gall bladder**	• Antibiotics ? for clostridium?
Biliary tract rupture SAP 759; E-hb 538; Sx-WW 149; Sx-G 196, 198; Sx4B 300 *	• Cause: - **Blunt or sharp trauma** (hit by car) - Penetrating wound, gunshot - Pathologic rupture 2° to inflammation, neoplasia or choleliths - Percutaneous liver biopsy - Abdominal surgery	• **Acute peritonitis** - Abdominal pain 1st 48 hrs - Anorexia, depression, fever - Abdominal distention - **Icterus** - **Shock** • Blunt trauma to biliary duct develop much slower signs & may be over shadowed by other traumatic injuries	• Hx (**trauma**) • **PE** - Achoic feces • Abdominocentesis: bile-stained modified transudate. Bile higher in abdomen fluid than in serum • Lab: - ↑ Total serum bilirubin - ↑ Liver enzymes (ALP, ALT) • Radiology/Ultrasound: Peritoneal effusion • Exploratory laparotomy to confirm, culture abdominal fluid	• **Cholecystectomy** (total removal of gallbladder & cystic duct) if extensive damage • **Cholecystoenterostomy**: for avulsion of common bile duct; **reimplant** in duodenum • Hepatic duct tear: ligate (flow will go to other bile ducts)

Pancreatitis

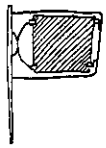
Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Pancreatitis M8k 311; Mk 127; E-hb 532; SAP 768; H2B 459, 86; H3B 403; I2M 555, 546; IM 432; IM-WW 313; GI-S 384; F3IM 91; C12T 732; C11T 631; Sx-S-hb 240; Sx-S 678; Sx3B 304; Sx-WW 190, 187; H-T/M 341; Pa-T 111; Neo 216; Emrg 319 ***	• Acute or chronic • Dog: autodigestion + inflammation • **Obese, middle aged, spayed, medium-sized bitch** • Working dogs rarely affected • Cat: associated w/ FIP or toxoplasmosis • Cause uncertain: - Trauma - **Hi fat in diet or meal** - **Lipemia** - Infection - Duct occlusion - Dexamethasone & insulin - Tumor (rare) • **Complications** of pancreatitis (see box)	• **Ill, Vomiting** • **Marked abdominal pain** ("praying mantis" stance, arched back) • ± **Shock** (due to hypovolemia, vomiting & toxins) • **Bloody feces** • Jaundice unusual, bile duct occlusion • Tachypnea • Weakness • Ileus • Acute: cat: vague anorexia & weight loss ± vomiting • **Sequela: Chronic pancreatitis (see EPI) ± diabetes mellitus**	• **Hx, CS, severely ill** • **PE: Abdominal pain** • **Lab:** - Hyperlipemia - ↑ **Serum amylase & lipase** (+ CS = definitive dx) - ↑ WBCs, hemoconcentration, ↑ BUN, protein casts in urine, azotemia, ↑ liver enzymes (ALT, AST, SAP), ↑ cholesterol - Bilirubin (blockage = emergency) • **Radiology (see box):** - **Focal "ground glass"**: loss of peritoneal detail (cranial rt quadrant) - Soft tissue density rt cranial quadrant - Stomach to left, duodenum to right (pyloric antrum displaced to left, proximal duodenum displaced right) - Static gas pattern of proximal duodenum & the transverse colon - Calcification w/in pancreas (uncommon) - Contrast rads: Barium . Stomach & duodenum to left . Thickening of bowel wall • **Ultrasound**, helps DDx pancreatitis, tumor, ileus effusion, hepatobiliary diz • Thoracic radiographs if respiratory signs • ECG if arrhythmias • Necropsy: often when diagnosed in cats	**Emergency; do not wait for lab work** • **NPO** (nothing per os) 3-4 days to prevent pancreatic stimulation • **Fluid: critical** (enough to cause mild diuresis so pancreatic perfusion good) - **Plasma** & plasma substitutes (for shock) - Lactated Ringer's & bicarbonate (for ↓ blood volume, blood press & renal function) • Inhibitors of pancreatic secretions (Propantheline bromide or atropine sulfate) to limit extension in mild cases • **Analgesics** (Meperidine [Demerol®] or butorphanol [Torbugesic®]) for pain, also rest & confine helps • **ABs:** Mild: broad spectrum effective against enteric bacterial 2° infections (ampicillin or cephalosporin (cicephalothin or cefazolin) - If sepsis or peritonitis: add gentamicin or amikacin if no renal failure • **IV feeding** (not orally, so pancreas not stimulated) in acute cases, NPO until 3-5 days after vomiting stops • **Nursing care**, monitor for renal failure • **Antiemetics:** phenothiazines (Chlopromazine) • Heparin (minimize thrombosis & intravascular coagulation)(DIC) • Sx indications: - Progressive jaundice (bile duct obstruction) - Progressive pancreatic necrosis or abscess formation - Intestinal obstruction (from adhesions & strictures) Thorazine Demerol Prognosis: • **Guarded** depending on severity, Poor if septic shock, DIC, acute renal failure or bowl infarction.





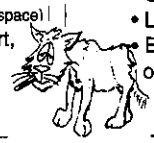
Obese, Middle aged, Spayed, Medium-sized bitch
+ Fat meal = Severely ill (Vomiting, Shock)
Dx: Hx, CS, ↑ Amylase & lipase, Rads
Tx: Acute: Emergency (NPO, Fluids, ABs)
Chronic: Enzymes, TID feeding
Px: Acute: Guarded; Chronic: Good

DDx:
- Acute renal failure (no abdominal pain)
- Intestinal obstruction (rads rule out)
- Gastroenteritis
- Uremia



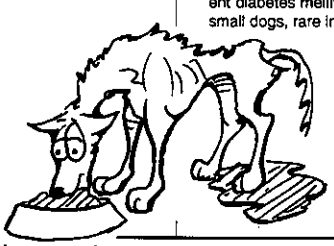
Pathophysiology of pancreatitis:
Dog: autodigestion of pancreas = inflammation
- Activation of trypsin, activates pancreatic proenzymes & vasoactive amines
- Activated pancreatic enzymes & vasoactive amines
  - Pancreatic autodigestion (w/ resulting release of more enzymes, vicious cycle)
  - Systemic effect: hypovolemia (due to capillary vasodilation, venous pooling & loss of fluid into intravascular space)
  - Damage to abdominal organs (liver, intestine, peritoneum, etc.) & other organs (heart, lungs, kidney, etc.) due to leakage of enzymes into abdominal cavity & into blood
- Chronically: fibrosis of pancreas & no enzymes to release (Diabetes mellitus)

Cat: associated w/ FIP or toxoplasmosis

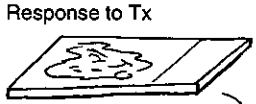


Complications of pancreatitis
- Acute renal failure
- DIC
- Peritonitis
- Septicemia
- Liver diz
- Extrahepatic bile duct obstruction
- Hypocalcemia
- Cardiac arrhythmias
- Pulmonary insufficiency
- Chronic sequelae
- Fibrosis
- Exocrine pancreatic insufficiency (EPI)
- Diabetes mellitus

Exocrine pancreatic insufficiency, EPI M8k 313; E-hb 534; H2B 466; H3B 409; I2M 448, 564; SAP 773; IM-WW 313, 316; GI-S 393; Pa-T 109 **??	• **Loss of exocrine pancreatic acinar cells** - ↓ **Digestive enzymes** - **Results in failure of absorption** • Cause: - Pancreatic acinar atrophy (PAA): spontaneously develops in some young dogs for unknown reasons (G. shepherds) - Chronic pancreatitis: rare cause, coexistent diabetes mellitus; middle aged or old small dogs, rare in cat	• CS when large part of organ destroyed • **Weight loss**, mild to moderate • **Polyphagia** (↑ appetite) • Coprophagia & pica • Poor hair coat • ± Foul odor • PU/PD (polyuria & polydipsia) if Diabetes mellitus • **Diarrhea**: semi-formed or watery • ± Vomiting, borborygmus & flatulence • Sequelae: - Coexistent diabetes mellitus W/ chronic pancreatitis - Bacterial overgrowth	• Hx (**weight loss + ↑ appetite & diarrhea**) • Routine lab test not helpful - Serum amylase & lipase are not ↑ • **Sudan & iodine stained fecal smear** for steatorrhea (excess fat), amylorrhea (excess starch) low sensitivity & specificity - screening test • Serum trypsin-like immunoreactivity (TLI) assay: highly sensitive & specific, measures circulation trypsinogen & trypsin, EPI < 2.5 µg/L • X-ray film digestion test unreliable • Response to Tx	• **Hill's i/d diet**, TID feedings, highly digestible, low fiber, low fat • **Enzyme replacement**: dried pancreatic enzymes (Viokase®, Pancrezyme®) mix 1-2 tsp per meal for life, titrate to minimum dose when diarrhea stops & animal gaining weight (1 tsp in 2 meals per day usually enough) • ± Medium chain triglycerides (MCT Oil®) • ± Vitamin supplementation: cobalamin (vit B12, SQ 1-2/months) & tocopherol (vit E OP sid) • If no response (diarrhea & no weight gain) try the following in order - ± ABs: if bacterial overgrowth causes malabsorption & diarrhea (oxytetracycline, metronidazole or tylosin) - usually corrected by pancreatic enzymes alone - ± Oral H2 blockers (cimetidine (Tagamet®) to ↓ acid inactivation of enzymes - ± Steroids (prednisolone PO) in the few that don't respond to above - Reevaluate diagnosis if all fails, endoscopic biopsy of intestinal mucosa i/d Viokase Prognosis: **Good** unless concurrent diabetes (Px then poor)



Loss of exocrine pancreatic cells, PAA or Chronic pancreatitis
CS: Weight loss, Polyphagia, Diarrhea
Dx: Hx, Fat & meat in feces
Tx: i/d, Pancreatic enzymes • Px: Good



DDx:
- Other cause of chronic diarrhea

Pancreatitis

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Pancreatic exocrine neoplasia M8k 314; Mk 128, SAP 775; H2B 469; H3B 413; I2M 567; IM-WW 316; GI-S 402; Sx-WW 191; Sx-G 206; Pa-T 113 **	• **Uncommon in dogs & cats** • Islet cell tumors: insulinoma & gastrinoma that excrete hormones are discussed elsewhere • Benign exocrine: adenoma, rare • #1 adenocarcinoma - Highly malignant: metastasis (#1 liver, regional lymph nodes, mesentery, duodenum, may obstruct bile duct) • Older dogs & cats, Airedale may be predisposed, females slightly more	• **Signs of liver diz or GI obstruction** m/ precede pancreatic malfunction - Loss of weight - Anorexia - Depression - Vomiting - Icterus: blocking bile duct • Abdominal tenderness	• **Difficult, DDx from liver or GI obstruction** • Palpate mass in rt. cranial quadrant • ± ↑ ALT & SAP indicating liver diz • ↑ plasma amylase & lipase & BSP liver function test may help point at pancreas & not liver • **Radiology:** - Mass in right cranial abdomen - Duodenum & stomach displaced to right - Ascites & carcinomatosis w/ metastatic diz - Contrast radiology . Duodenum & stomach displacement . Irregularity of duodenal mucosa due to neoplastic infiltrate • Laparotomy m/b only means to Dx	• **Nothing very effective** - Pancreatectomy (surgical resection m/b palliative for obstruction of bile duct or duodenum but never curative) - Cholecystojejunostomy or gastrojejunostomy if cause blockage of bile or stomach - Adjunctive chemotherapy - minimum benefit & efficacy Prognosis: **Grave** unless single resectable mass that is treated early
#1 adenocarcinoma: Highly malignant **CS: Weight loss, Vomiting, Icterus, Colic** **Dx: Difficult, DDx liver or GI obstruction, Palpate mass, Rads, Sx** **Tx: Not effective • Px: Grave**				
Pancreatic parasites H3B 413	• Rare, Fluke: *Eurytrema procyonis*, Raccoon - host • Dx: Incidental finding egg in feces, Necropsy: trematode in pancreas • Tx: Fenbendazole, praziquantel			

Gastrinoma, Zollinger-Ellison syndrome, APUDomas, Hypergastrinemia

M8k 398; E-hb 603; H2B 380; 412; SAP 661, 662; IM 586, 297, 331; IM-WW 410; E 1597; C11T 370; E&R-F 442, Cat 1464; Sx-WW 189; Sx-G 206

*

Rare; Malignant Islet cell tumors of pancreas, ↑ gastrin = ↑ HCl = gastric ulcers, metastasis to liver before Dx
CS: **Severely ill (vomiting, emaciated**, intermittent diarrhea); Ulceration; Sequelae: gastric perforation/peritonitis
Dx: **Severe ulcers + thick mucosa**, Responsive ulcers that relapse, Rads, US, Endoscope
Tx: Pancreatectomy, H2 blockers • Px: **Grave** for long term

Insulinoma, Islet cell neoplasia; Beta cell neoplasia, Pancreatic neoplasia, Beta cell carcinoma, Islet cell adenocarcinoma

** M8k 397; H2B 548; E-hb 572; E 1501; SAP 257; IM 562; Cat 1464; E&R-F 422; E&R-M 198; Phys-B 872; Lab-S 332; Pa-T 279; Dx 553; Sx-S-hb 515, 683, 756; Sx-S 1536; SX-WW 188

Karo syrup

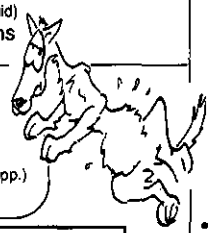
See Endo pg 669; Old dogs, Malignant beta cell tumor, Hypoglycemia; metastasizes to liver
CS: Episodic, Seizures, CNS (proprioceptive deficits, atrophy)
Dx: Whipple's triad (1. spontaneous hypoglycemia, 2. CNS signs, 3. Glucose resolves), Hi insulin w/ low glucose
Tx: Emergency: Karo syrup, Medical or Sx (remove 1/2 of pancreas); Phenobarbital for seizures.• Px: Poor

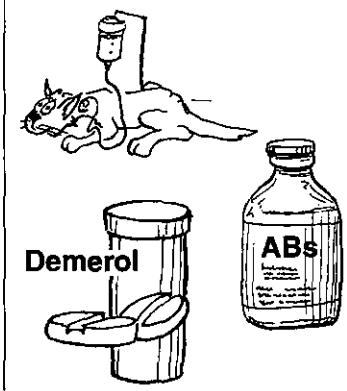
Carcinomatosis, Mesothelioma H3B 199, 430, 432; I2M 471; IM 362; E-hb 39; E 69 *	• ***Rare*** • Widespread dissemination of cancer to peritoneal surfaces (omentum, mesenteries, parietal peritoneum) • 2° causes >>> 1° • Associated w/ metastasis of: - Hemangiosarcoma - Pancreatic carcinoma - Ovarian carcinoma - Intestinal carcinoma	• **Abdominal distention** (ascites) • **Weakness** • **Debilitation** • **Cachexia, emaciation** • Pallor DDx: • Bowel perforation • Peritonitis • FIP (not usually nodular)	• **CS** • **Radiographs** -**"Ground glass"** appearance: generalized loss of peritoneal detail (fluid), indistinct serosal detail - **Blotch appearance** in cranial & mid abdominal, small metastatic nodules (5-10 mm) - Pneumoperitoneogram: remove fluid & inject air to see masses • Abdominocentesis: nonseptic exudate or modified transudate - Hi specific gravity, ↑ protein, RBCs - Cytology: neoplastic cells usually not found ("Signet ring" cells - glandular neoplastic cells, anaplastic epithelia cells) • **Exploratory laparotomy usually needed to diagnose**	• Intracavitary chemotherapy successful in some Chemo Prognosis: **Guarded to poor**
Peritoneal hernia M8k 128; Mk 99, 467; E-hb 539, 362, 450; H3B 418; H2B 6, 8, 225, 479; IM-WW 236; Sx-S-hb 167; Sx-S 431; Sx3B 438 ***	• **Protrusion of abdominal contents through an opening in wall** • Congenital: - Umbilical hernia - Femoral or inguinal hernia - Peritoneal-pericardial hernia - Scrotal hernia • Acquired: trauma - Diaphragmatic - Ventral or lateral abd. hernias - Mesenteric hernia - Perineal • **Reducible or irreducible** • **Strangulated:** piece of gut, may cause obstruction & may cut off blood supply to hernial contents • **Parts of a hernia: ring, sac & contents**	• **Variable** dep on organ herniated & degree of incarceration • **Mass under skin** of abdominal wall • **Reducible:** can be pushed back into abdomen - Noninflammatory, painless, soft, elastic, compressible swelling - Varies in size from time to time • **Irreducible:** can't be returned to abdominal cavity • **Strangulation:** pain, vomiting & depression	• **Hx (age), CS** • **Palpable mass** under skin • **Radiography:** - Gas filled loop beyond abdomen - Solid organ or fluid filled (uterus, liver bladder) - Soft tissue mass outside abdomen - Internal hernia (mesenteric hernia) . Loop of bowel dilated & filled w/ gas &/or fluid obstructive ileus • Contrast rads (Barium or Iodinated upper GI study • Pneumoperitoneography • Positive contrast peritoneography • Urethrocystography • Intravenous urography DDx: • Hematoma	• **If reducible & small: push back in repeatedly until defect heals** • **Irreducible: Sx reduction** - Return viable contents to normal location - Close hernia - Obliterate redundant tissue in sac Prognosis: • **Good** if uncomplicated • Guarded to poor if strangulated
Abdominal contents through wall, Reducible, Strangulated **CS: Mass under skin, ± Reducible, ± Strangulated** **Dx: Hx, PE, Rads** **Tx: Spontaneous or Sx • Px: Good to poor**				

Peritonitis - FIP

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Peritonitis M8k 484; Mk 146; E-hb 38; SAP 793; H3B 430; H2B 489; I2M 381, 469; IM 360; GI-S 515; C12T 764; E 68; Sx-S-hb 163; Sx-S 415; Sx3B 315; Sx-WW 137; Sx4B 330; Inf-G 143; X4T 442 ***	• **Inflammation of peritoneum** • **Omentum** tries to wall off resulting in localized peritonitis or abscesses or generalized peritonitis if it doesn't work • **Types** - **Local peritonitis** - **Generalized peritonitis** . Fibrinous exudate . Adhesions between organs • Addition of blood, barium to bacterial peritonitis can cause severe fatal peritonitis	• **Abdominal pain** (stiff walk, tachycardia, tachypnea) . Praying mantis posture . Tucked up appearance • ± Fever • **Anorexia** • Gut stasis, paralytic ileus • **Vomiting** • **Abdominal distention** • No feces • **Shock** (loss of fluid, endotoxemia) • Icterus (if bile peritonitis) • CS of 1° illness if present (e.g., intussusception) • Sequelae: - Toxemia - Septicemia - Shock - Peritoneal exudate (loss of fluid) • Adhesions	• Hx & CS - Abdominal pain - Stasis of gut • Palpation for pain, adhesions • **Abdominocentesis**/ diagnostic peritoneal lavage - PMNs (> 500/µl) - Bacteria in macrophages: septic - Absence of bacteria: sterile - Cytology & culture • ↑ **PMNs** ± toxic PMNs/neutrophils - Left shift: more significant infection - Degenerative left shift (more bands then segmented PMNs) indicates overwhelming, life threatening inflammation • Serum chemistry: many altered depending on cause • Radiology: - **"Ground glass"** appearance, loss of organ detail, local or general - Gas- & fluid-filled loops of bowel - Serosal detail not seen - Free gas: rupture of viscus . Small amounts of gas undetectable . Horizontal beam: gas between liver & diaphragm . Serosal surfaces more distinct - Contrast studies: urethrography, cystography &/or IV pyelography if uroperitoneum suspected . Avoid barium if leakage suspected • Ultrasound: detect fluid - Valuable for pancreatitis - Soft tissue masses or abscesses • Exploratory laparotomy	• **Support & correct cause** • Medical or surgical? • Medical: - **Broad spectrum ABs** immediately, pending culture & sensitivity - **IV electrolytes & fluids** (lactated Ringer's sol., supplemented w/ potassium, plasma or whole blood (for cardiac output) - **Lavage & drainage** (very important) • Treat cause - Repair ruptured viscus - Peritoneal lavage (streptomycin) - Postop: continue IV antibiotics, frequent peritoneal lavage • **Pain** (Meperidine [Demerol®]) • Withhold food until improves, then slowly reintroduce • IV feeding, including vitamins

Causes - Peritonitis:
- **GI perforation or rupture** #1 cause
- **Rupture:** stomach, bowel, urinary bladder, uterus, gall bladder
- Gastroduodenal ulcers
- Pancreatitis
- Strangulation
- Incarcerated hernia
- Volvulus & rupture
- Neoplastic ruptures
- FIP (feline infectious peritonitis) 1°
- Hepatitis
- Ruptured (abd/liver/prostate) abscess
- Infection (*E. coli*, Staph., Strep., Nocardiosis, Mycobacterium spp.)
- Iatrogenic (Sx), dehiscence, surgical sponges





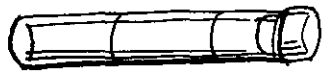
Inflammation, Local or generalized
CS: Pain, vomiting, Distention, Shock
Dx: Abdominocentesis, Rads, US, Sx
Tx: Support & correct cause, ABs, IV fluids & feed, Lavage, NPO

Feline infectious peritonitis, FIP, Coronavirus

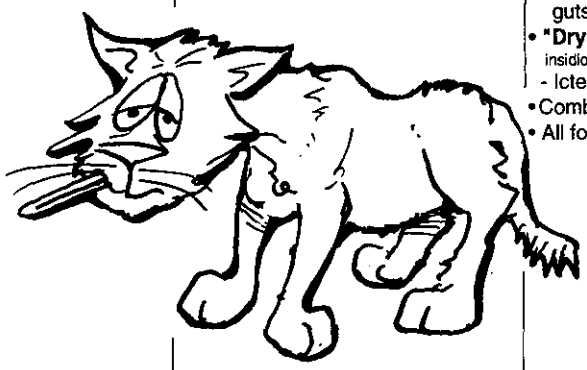
M8k 551; Mk 588; E-hb 39, 282, 608, 248, 630; SAP 94; H3B 1136; H2B 1196; E 70; I2M 471; IM 981, 388, 372; IM-WW 131, 466; F3IM 352; Inf-B 63; Inf-G 300; Neo 210

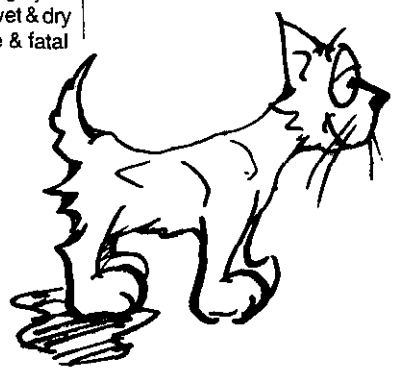
**,

Facts/Causes	Presentation/CS	Diagnosis	Treatment
• **See Systemic dizs pg 688** • **Progressive & fatal systemic immune-mediated diz** - **Cats** & wild cats • Causes pyogranulomatous enteritis & other systemic signs • **Coronavirus** (FIP virus [RIPV]) - Systemic infection of macrophages - Widespread immune complex-mediated vasculitis • Effusive & noneffusive forms • See elsewhere for respiratory, CNS, kidney & eye involvement	• **Initially nonspecific** (fever, anorexia, inactivity, weight loss, vomiting, diarrhea, dehydration & pallor [anemia]) • **Chronic fluctuating fever** that is unresponsive to ABs • **"Wet" form** (acute) - Body cavity effusions . Peritonitis - 85% .. Progressive painful distension of abdomen .. ± Scrotal swelling from direct extension - GI CS (vomiting, diarrhea) - Hepatic (jaundice) - Pancreas (vomiting) - Adhesions: large mass of guts • **"Dry" form** (noneffusive) (slow, insidious & smoldering) - Icterus or hepatomegaly • Combination of both wet & dry • All forms progressive & fatal	• Hx, CS • Lab: unspecific - strong circumstantial evidence • Radiology/ ultrasound - Confirm body cavity effusions - Organ enlargement (kidney, liver) • Fluid analysis - strongly supportive - Low cell count) sticky - fibrin, high protein content 4-10g/dl - Protein electrophoresis • Corona virus serology - Doesn't differentiate FIP coronavirus from non-FIP coronavirus	• **No known cure for FIP** • **No Tx effective in prolonging life** • **Once clinical signs develop - nearly always fatal, regardless of Tx** - Rare remissions in mildly affected or only ocular involvement • Palliative chemotherapy: beneficial in < 10% - High dosage of corticosteroid w/ cytotoxic alkylating agents • Supportive Tx, may improve quality of life



No Cure





- Vaccination:
  - **Intranasal (IN)** vaccine
    . 2 doses IM 3-4 weeks apart at 16 weeks of age or older
    . Annual boosters
  - Efficacy - not 100%

Prognosis: **Grave:** nearly always fatal

Immune-mediated diz, Wet & dry forms
CS: Unresponsive fever, Peritonitis, Progressive to death
Dx: CS, Rads/ US, Fluid analysis
Tx: None, Vaccinate • Px: Grave

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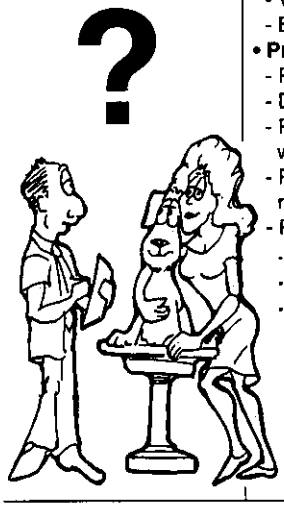
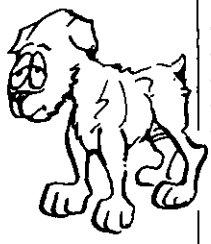
General respiratory dizs: History

From Dr. John Hoover's class notes: M8k 1113, 1051; H3B 136; H2B 161; I2M 206; IM-WW 207; E-hb 333; SAP 525; E 738; F3IM 292; Sx-WW 61; X-RB 89

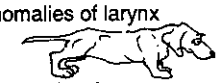


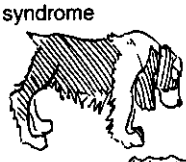
History/Signalment:

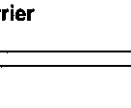
- Species - predispositions do occur:
  - Canine: collapsed trachea
  - Feline: laryngeal edema, bronchial asthma
- Breed (see box)
- **Age:**
  - -Young: Viral respiratory infections
  - Older: Chronic obstructive pulmonary diz
- Sex: few, if any, predispositions
- **Past medical history:**
  - Previous illnesses, surgeries, etc.
  - Vaccination history?
  - Environmental: lived elsewhere?
- **Present medical history:**
  - Present complaint(s)?
  - Duration: acute vs. chronic?
  - Progression: rapid/slow, waxing/waning?
  - Previous treatment & response if any?
  - Present environment:
    - . Housing?
    - . Exercise?
    - . Surroundings: i.e., urban vs. rural, desert vs. forest, etc.?

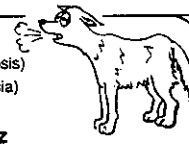


Breed predilections	Condition
• **Afghan:**	Lung lobe torsion
• **Amer. cocker spaniels**	Laryngeal collapse
• **Burmese mountain dogs**	Lung neoplasia
• **Boston terriers**	Laryngeal collapse
• **Bouvier des Flanders**	Laryngeal paralysis, Anomalies of larynx
• **Boxer**	Lung tumor
• **Brachiocephalic breeds**	Laryngeal edema, Everted laryngeal saccules, Laryngeal collapse; Brachycephalic syndrome, Tracheal hypoplasia
• **Bull terrier**	Laryngeal paralysis, Anomalies of larynx
• **Chihuahua**	Tracheal collapse
• **Dachshund**	Laryngeal collapse
• **Dolichocephalic breeds**	Viral rhinitis, Fungal rhinitis, Nasal tumor
• **English bulldogs**	Laryngeal edema, Everted laryngeal saccules; Brachiocephalic syndrome
• **English pointers**	Ciliary dyskinesia
• **English springer spaniels**	Ciliary dyskinesia
• **Golden retrievers**	Ciliary dyskinesia
• **Hunting dog**	Fungal rhinitis
• **Irish wolfhound**	Viral rhinitis
• **Large, deep-chested dogs**	Lung lobe torsion
• **Pomeranians**	Chronic bronchitis
• **Pug**	Laryngeal collapse
• **Pekingese**	Laryngeal collapse
• **Sheltie**	Chronic bronchitis
• **Siberian husky**	Laryngeal paralysis, Anomalies of larynx
• **Rottweilers**	Ciliary dyskinesia
• **Toy poodle**	Tracheal collapse; Chronic bronchitis
• **West Highland White t.**	Pulmonary alveolitis
• **Yorkshire terrier**	Tracheal collapse





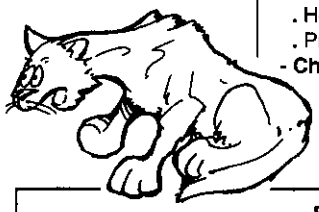




General respiratory dizs, Presentation/ Clinical Signs

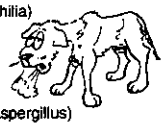
From Dr. John Hoover's class notes

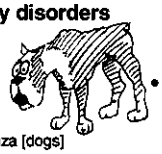
- ***Cardinal signs of respiratory diz***
  - **Coughing** (see box)
  - **Sneezing** (nasal cavity)
  - **Exercise intolerance**
  - **Respiratory distress** = dyspnea –> breathing characteristics:
    - . Tachypnea (rapid) / polypnea (panting)
    - . Hyperpnea (deep) / hypopnea (shallow)
    - . Orthopnea (positional)
  - **Abnormal secretions:**
    - . External nares
    - . Hemoptysis
    - . Productive cough
  - **Change in vocalization**

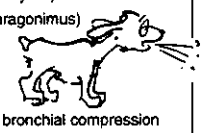


Cough - Causes

- **Nasal cavity & sinuses diz w/ postnasal drip**
- **Pharyngeal & laryngeal disorders**
  - Trauma
  - Foreign bodies
  - Infections (bacterial, viral, fungal or parasitic)
  - Neoplasia
  - Laryngeal paralysis
  - Everting laryngeal saccules
  - Laryngeal collapse
- **Tracheal & lower airway disorders**
  - Trauma
  - Foreign body
  - Allergy
  - Infection
    - . Viral (distemper, parainfluenza [dogs] herpes & calicivirus [cat])
    - . Bacterial (*Bordetella bronchiseptica*)
    - . Parasitic (Filaroides, Capillaria sp.)
  - Anomalies (collapse, hypoplasia, 1° ciliary dyskinesia, segmental stenosis)
  - Neoplasia (osteochondral dysplasia)
  - Bronchiectasis
- **Pulmonary parenchymal diz**
  - Trauma
  - Allergy (pulmonary infiltrates w/ eosinophilia)
  - Infection
    - . Viral
    - . Bacterial
    - . Fungal (Blastomyces, Cryptococcus, Aspergillus)
    - . Protozoal (Toxoplasmosis, Pneumocystis)
    - . Parasitic (Filaroides, Dirofilaria, Paragonimus)
  - Neoplasia (1° or 2°)
- **Cardiac diz**
  - Pulmonary edema
  - Left atrial enlargement causing bronchial compression
- **Mediastinal diz** (causing airway compression)
  - Lymphosarcoma (esp. cats)
  - Thymomas
  - Tracheobronchial lymphadenopathy







Respiratory distress (dyspnea) & Breathing patterns

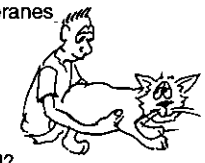
- **Slow & Shallow** (Neuro) → **Miscellaneous 2 breathing pattern**
- **Normal/Fast & Deep**
  - No obstruction (exercise, low O2, fever, etc.) → **Miscellaneous 1 breathing pattern**
  - ↑ Inspiratory effort → **Obstruction upper airway**
  - ↑ Expiratory effort → **Obstruction lower airway**
- **Fast & Shallow** → **Restrictive breathing** Lungs, mediastinum, pleural spaces

Breathing pattern chart

DIAGNOSIS - respiratory problems

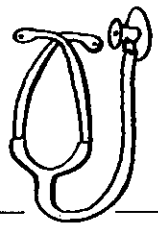
Physical exam (PE):

- **Inspection**:
  - **Breathing pattern**: rate & depth
    - **Obstructive breathing pattern:**
      - .. Inspiratory dyspnea: extrathoracic lesion
      - .. Expiratory dyspnea: intrathoracic lesion
    - **"Restrictive" breathing pattern**
      - .. Hypopnea & tachypnea = shallow & rapid
    - **Miscellaneous breathing pattern**: see DDx
  - External nares: conformation & ± secretions
  - Eyes: conjunctiva, palpebral fissure
  - Oral cavity & pharynx
    - Hard palate, teeth, soft palate, tonsils, pharynx
  - Mucous membranes
- **Palpation:**
  - Nose
  - Larynx
  - Trachea
    - Collapse
    - Cough elicited?
  - Thoracic wall



- **Auscultation:**
  - Sites of auscultation:
    - Larynx
    - Trachea
    - Thoracic inlet
    - Systematically over both hemothoraxes: ventral, mid-thorax & dorsally every 2-3 intercostal spaces
  - **Normal breath** (bronchovesicular) sounds always accompany air movement in trachea & bronchi
    - Bronchial sounds: harsher, blowing sounds
    - Vesicular sounds: soft, rustling sounds
  - **Adventitious sounds** (abnormal breath): added sounds, superimposed on breath sounds
    - **Crackles**: nonmusical, interrupted; due to abrupt opening of airways occluded by fluid, mucus, etc. or fibrosis
      - .. Fine crackle: soft, high pitched
      - .. Medium crackle: moderate, medium pitched
      - .. Coarse crackle: loud, low pitched
      - .. Smaller airways: late inspiration
      - .. Larger airways: early inspiration/early expiration
    - **Wheezes:** musical, continuous
      - .. Longer duration than crackles due to narrowing of airway
      - .. Can be high or low pitched
    - **Stridor**: inspiratory, high-pitched wheeze, generally: due to stenosis of laryngeal lumen
    - **Pleural friction rub**: resembling crackling of new leather, or rubbing of sheets of paper together

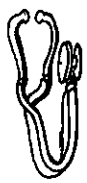
- **Percussion**:
  - Paranasal sinuses
  - Thoracic cavity
    - Fluid line
    - Regional dullness
    - Generalized dullness
    - Tympany



Classification of lung sounds:

Type of Sound	Description
• Breath sounds	Always accompany air movement (normal)
• Adventitious sounds	Added sounds, superimposed on breath sounds
- Crackles	Nonmusical, interrupted
- Wheezes	Musical, continuous

Adventitious sounds - crackles or wheezes

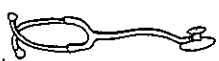


Loud	Soft
• Increased ventilation	• Hyperinflation
• Consolidation	• Emphysema
• Lung mass	• Pleural effusion
• Obstructive respiratory diz	• Pneumothorax
	• Diaphragmatic hernia

Crackles (formerly rales)

Smaller airways	Larger Airways
Late Inspiratory	Early inspir./Early expir.
• Restrictive diseases	• Obstructive diseases
- Pulmonary edema	• Bronchopneumonia
- Interstitial pneumonia/infiltrates	• Tracheobronchial fluid
- Diffuse interstitial diseases	
• Tumors: lung, pleura or chest wall	

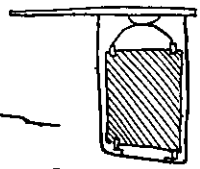
Wheezes (formerly rhonchi)



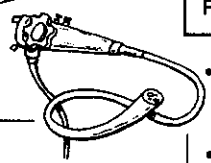
Inspiratory	Expiratory
• Extrathoracic airway obstruction	• Intrathoracic airway obstruction
- Laryngeal paralysis	- Chronic obstructive pulmonary diz (polyphonic)
- Collapsing extrathoracic trachea	- Collapsing intrathoracic trachea
- Extrathoracic tracheal stenosis	- Intrathoracic foreign body obstruction
- Extrathoracic foreign body obstruction	

Respiratory diagnostics:

- **Radiology of the respiratory tract**:
  - Nasal cavity & sinuses: done under general anesthesia
    - Views: lateral, dorsoventral occlusal, ventrodorsal open mouth & anterior-posterior frontal sinus
  - Pharynx, larynx, trachea & hyoid apparatus
    - Cervical soft tissue radiographs
    - Lateral & VD projections
  - Thoracic radiographs (lateral & DV)
  - Contrast radiography
    - Bronchogram
    - Pulmonary arteriogram

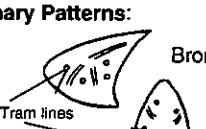


- **Fluoroscopy**:
  - Valuable where respiratory dynamics need to be observed
  - Most commonly used to diagnose collapsed trachea



Abnormal Radiographic Pulmonary Patterns:

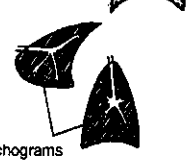
- **Bronchial pattern:**
  - Peribronchiolar cuffing
  - "Donuts" & "Tram lines"
- **Interstitial pattern:**
  - Slightly denser lung field (variable)
  - Air evident in lung
  - Vessels fuzzy, but evident
- **Alveolar pattern:**
  - Air bronchograms
    - "Black worm holes & tracts in white apple"
- **Vascular pattern:**
  - Abnormal pulmonary vasculature
  - Enlarged or smaller; or
  - Loss of symmetry between veins & arteries
- **Pleural effusions:**
  - Scalloped or leafing of lung borders
  - Fluid lines in lung fissures
  - Loss of detail



Bronchial pattern

Donut & Tram lines

Interstitial pattern

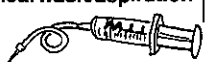


Bronchograms

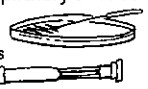
Alveolar pattern

Sounds	Phase	Maximum Intensity	Significance
Normal Sounds - bronchovesicular:			
"Vesicular"	Louder on inspiration	Peripheral lungs	Normal
"Bronchial"	Louder on expiration	Trachea, thoracic inlet	Normal
Abnormal Sounds			
Adventitious:			
Crackles	Usually inspiration	Usually pulmonary	Occluded airways
Wheezes	Usually expiration	Pulmonary &/or trachea	Narrowed airways
Stridor	Inspiration	Larynx	Laryngeal stenosis
Friction rub	Inspiration or expir.	Chest wall	Inflamed pleura

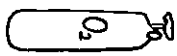
- **Respiratory endoscopy**: Rhinoscopy, Pharyngoscopy, Laryngoscopy, Tracheoscopy, Bronchoscopy
- **Transtracheal wash/aspiration** (TTW)



- **Biopsy** of respiratory tissues
- **Cytology** of respiratory tissues:
  - Tracheal aspirates
  - Flush cytology
  - Pulmonary aspirates



- **Culture**: Bacteria, Viral, Mycoplasma, Fungal
- **Pulmonary function testing**:
  - Arterial blood gases - probably the most practical in animals
  - Oxygen response test
    - Take baseline blood gases
    - Administer 100% oxygen for 5-10 minutes
    - Obtain additional blood gas values
    - Normal post-sample should exceed 350-400 mmHg of 02.
    - Used to document or diagnose ventilation/perfusion mismatching, right to left shunts



- **Serology:**
  - Fungal: histoplasmosis, blastomycosis, cryptococcosis, coccidioidomycosis, aspergillosis
  - Occult heartworm
  - Viral: FVR, FCV, FeLV, FIV, FIP, CD, CA2V, PI, etc.
  - Ehrlichia

Normal Values of Arterial Blood Gases

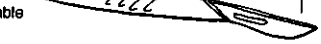
Value	Mean	Range
pH	7.40	7.37–7.42
pO_2 (mm Hg)	100	80–110
pCO_2 (mm Hg)	40	35–45
$[HCO_3^-]$ (mEq/L)	24	22–26
O_2 content (ml/100 ml)	20	18–22
O_2 saturation (%)	95	93–98

Respiratory treatment:

- **Basis for therapy: accurate diagnosis & clinical assessment of the patient**

- Therapy should consist of:
  1. **Supportive Tx:** maintain & promote homeostasis
  2. **Symptomatic Tx:** relieve clinical signs
  3. **Specific Tx:** directed at eliminating or controlling a definitive cause

- **Supportive Tx/care:** integral & essential
  - **Good nursing care:** can determine ultimate response to therapy
  - **Hydration & electrolytes:**
    1. Considerable fluid & electrolytes (Na^+, K^+, Cl^-, etc.) may accompany respiratory diz with compromised ventilation (hyperpnea, tachypnea & open mouth breathing)
    2. Intravenous therapy w/ isotonic electrolyte solutions is often warranted
    3. Fluid requirements in milliliters/day are essentially equal to or slightly higher than the energy requirements in calories/day for the patient.
  - **Nutrition:**
    1. Energy & nutrient requirements ↑ w/ severe illness —> 1.5 X's resting energy requirement - 1.5 up to 2 for dogs, & 1.25 up to 1.5 for cats, times the Resting Energy Requirement (RER) in **Kcal** = 30 x Body Weight (kg) + 70
    2. Adequate nutrition can seldom be maintained by oral means when severe respiratory diz is present
    3. Nutritional support warranted when severe illness & anorexia are present > 2-4 days, especially in very young or debilitated animals, geriatrics & cats (prone to hepatic lipidosis syndrome)
       . Parenteral feeding: central vein must be used & is expensive
       - Enteral feeding: nasogastric tube, pharyngostomy tube or gastrotomy tube (percutaneous endoscopic gastrotomy)
         . Can use regular food
         . Special formulation available



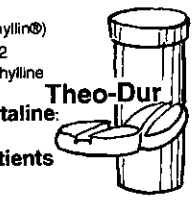
- **Surgical treatment:** may be curative, palliative, or an adjunct to medical therapy in respiratory dizs

- **Medical therapy** - objectives:
  1. Reduce intensity/severity of coughing (especially nonproductive coughs)
  2. Promote removal of airway secretions
  3. ↓ Airway resistance
  4. Control inflammatory or allergic responses
  5. Maintain or improve oxygenation
  6. Treat infection

- **Cough suppressants-antitussive therapy:**
  - Rule of thumb: suppress a cough only if nonproductive. Contraindicated if lobar pneumonia
  - **Hycodan® (hydrocodone):** narcotic antitussive, central acting; titrate to lowest effective dose
    . Use with caution in cats
  - Butorphanol (Torbutrol®): controlled drug (IV), less potent for reducing cough
  - **Dextromethorphan (Benylin®)**

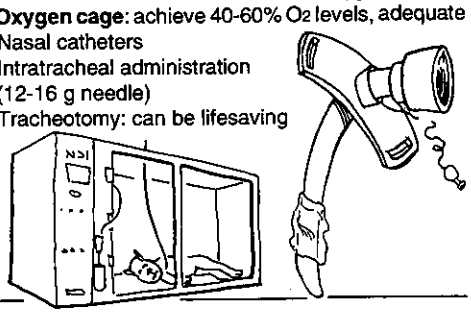
- **Expectorants:** removing airway secretions:
  - Maintain patient's normal hydration
  - **Geocolate® (guaifenesin/glyceryl guiacolate):**
    . Oral therapy, used in combination with antitussives
    . Promotes serous secretions of airway, which liquefies contents
  - **Water nebulizer therapy:** effective expectorant if droplets proper sizes (0.5–5 microns diameter)
    . Ultrasonic nebulizers
  - **Acetylcysteine (Mucomyst®):** a mucolytic agent

- **Bronchodilator therapy:** ↓ airway resistance
  - **Theophylline (Theo Dur®,** Slo–Bid®) a methylxantine
    . Sustained release products are best - PO, also comes in for IV
    . Side effects: anxiety, restlessness, tachycardia, vomiting, PU (polyuria)
  - Aminophytline (Aminophylline®, Somophyllin®)
  - **Terbutaline (Brethine®):** beta 2 agonist, PO, same side effects as theophylline
  - Isoproterenol (Isuprel®): beta 3 agonist
  - **Combo theophylline + terbutaline:** for those that can't tolerate either alone
  - **Weight reduction: obese patients**



- **Controlling Inflammatory/allergic responses:**
  - **Steroids** (corticosteroids): most popular drugs
    .. **Prednisone or prednisolone;** strive to find the lowest beneficial dose; also has cough reduction effect
  - Nonsteroidal anti-inflammatory drugs (NSAIDs):
    .. Aspirin not commonly used
    .. Flunixin meglumine (Banamine®)
  - Antihistamines: of limited value
    .. **Diphenhydramine (Benadryl®)**

- **Maintain/improve oxygenation:**
  - Facemask: 100% O_2 short-term therapy only!
  - **Oxygen cage:** achieve 40-60% O_2 levels, adequate
  - Nasal catheters
  - Intratracheal administration (12-16 g needle)
  - Tracheotomy: can be lifesaving

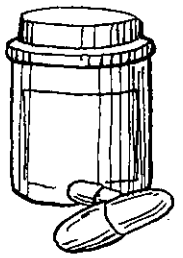


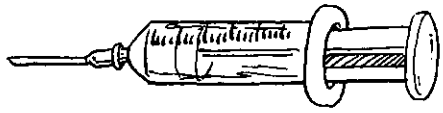
- ***Bacterial infections:***
  - **Antibiotics (ABs):** bactericidal drugs whenever possible & base therapy on culture & sensitivity (C&S) when available
    . Full therapeutic dosages & avoid prolonged therapy with broad-spectrum ABs, unless clinical diz warrants it (resistant organisms)
    . Reculture if no quick response (72 hours)
  - Empirical choice w/o Culture & Sensitivity

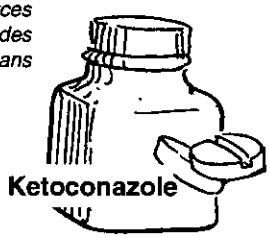
Organism	Drugs of Choice
Principle pathogens	
Staphylococcus	Penicillins, cephalosporins
Streptococcus	Penicillins, cephalosporins
Bordetella	Tetracycline, chloramphenicol
Mycoplasma	Tetracycline
Bacteroides	Clindamycin, metronidazole
Fusobacterium	Penicillin, clindamycin
Less-common pathogens	
Klebsiella	Gentamicin
Pseudomonas	Gentamicin
E. coli	Cephalosporins, tetracycline
Pasteurella	Trimethoprimsulfa, amoxicillin
Actinomyces	Penicillins
Nocardia	Trimethoprim sulfa, sulfonamides

- ***Parasite infections***
  - **Fenbendazole (Panacur®):** effective for most lung nematodes, but may result in a rapid parasite kill & intense (fatal) inflammatory reaction
  - Praziquantel: fluke infections
  - Common parasites in dogs and cats: Filaroides sp, *Capillaria aerophilla, Paragonimus kellicotti, Aelurostronglylus abstrusus* (cat only)
  - Tx recommendations: change constantly as better anthelmintics become available; consult a veterinary parasitologist or the current literature

- **Mycotic infections:**
  - **Amphotericin B:** fungistatic & fungicidal
    . Very nephrotoxic
  - **Ketoconazole (Nizoral®):** antifungal, PO
  - **Itraconazole (Sporanox®):** relatively nontoxic, expensive $$$
    . Most effective as a sole agent & has fewer side effects (anorexia)
  - **Fluconazole** (Diflucan®): imidazole (antifungal) (cryptococcus)
  - **Ketoconazole & fluconazole** in conjunction w/or following Amphotericin B, Itraconazole
  - Fluorocytosine: potentially nephrotoxic
  - Common organisms, dogs & cats: *Blastomyces dermatitis, Histoplasma capsulatum, Coccidioides immitis,* Aspergillus sp., *Cryptococcus neoformans*





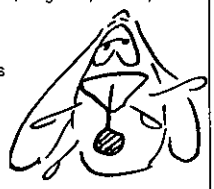
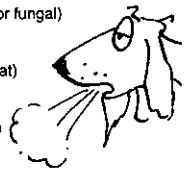


Condition	Facts/Cause	Presentation/CS	Diagnosis

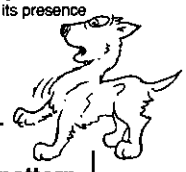
Dizs of upper airways, Obstructive/ Inspiratory pattern

1. External nares
2. Nasal cavity
3. Nasopharynx
4. Laryngopharynx
5. Larynx
6. Cervical trachea

Upper airway disorders
- **Nasal cavity**
  - Stenotic nares
  - Occlusive disorders
    - . Infectious (bacterial, viral, fungal or parasitic)
    - . Foreign bodies
    - . Fractures
    - . Hemorrhage
    - . Nasopharyngeal polyps
    - . Neoplasia
- **Pharynx & larynx**
  - Congenital disorders
    - . Laryngeal paralysis
    - . Laryngeal hypoplasia
    - . Subglottic stenosis
  - Infections (bacterial, viral or fungal)
  - Edema
  - Trauma
  - Nasopharyngeal polyps (cat)
  - Foreign bodies
  - Neoplasia
  - Brachiocephalic syndrome
    - . Elongated soft palate
    - . Laryngeal paralysis
    - . Everted laryngeal saccules (stenotic nares)
  - Acquired laryngeal paralysis (non-brachycephalic)
- **Cervical trachea**
  - Congenital disorders
    - . Primary ciliary dyskinesia
    - . Tracheal hypoplasia
  - Infection (bacterial, viral or parasitic)
  - Trauma
  - Osteochondral dysplasia
  - Foreign body
  - Neoplasia

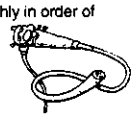
May include any of the following:
- **Coughing**:
  - Usually abrupt & hacking in nature
  - Gagging may follow
  - Usually nonproductive, exception tonsillitis
- **Sneezing** - nasal cavity
  - Usually denotes involvement of the nasal cavity
  - Droplets (serous, mucopurulent, or hemorrhagic)
- **Abnormal secretions:** most commonly nasal
  - Epistaxis - infection or neoplasia, coagulopathy
  - Serous or mucopurulent secretions
  - Unilateral or bilateral? "Rule of thumb" - infectious or allergic disease usually bilateral; neoplastic (& sometimes mycotic) often unilateral
- **"Obstructive respiratory pattern"** (dyspnea)
  - **↑ Inspiratory effort**
    - . Nasal cavity: many causes
    - . Nasopharyngeal obstruction
    - . Laryngeal obstruction
- **Change in vocalization:** larynx:
  - Almost always indicates laryngeal diz
    - . The owner may not attach much significance to this. It may take careful questioning to reveal its presence



Upper airways
- **Obstructive breathing pattern**
  - **Normal to Fast & Deep**
  - **↑ Inspiratory effort**

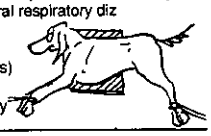
Physical Examination (PE):
- Inspection: external nares, hard palate & pharynx
- Palpation: soft tissues surrounding larynx for abnormalities
  - Pressure may induce coughing or respiratory difficulties
- Auscultation: laryngeal area for stridor, other abnormal sounds
  - Large dogs: nasal cavity &/or paranasal sinuses
- Percussion: can be performed on the paranasal sinuses

Diagnostic tests for upper airway (ranked roughly in order of cost effectiveness and safety) include:



- Visual inspection of the upper airway:
  - Rostral nasal cavity with otoscope
  - Nasopharynx, choanae with dental mirror
  - Pharynx, larynx w/ laryngoscope or tongue depressor, etc.
- Endoscopy: direct inspection, cultures, cytology or biopsy
  - Disadvantage: general anesthesia, hemorrhage from biopsy can cause aspiration pneumonia, etc.
- Culture/cytology/biopsy: often yield a definitive diagnosis
  - Cultures
  - Cytology can be obtained by brushing tissue
  - Biopsy (biopsy forceps, Withrow's catheter)
- **Radiology**:
  - Skull radiographs are often diagnostic
    - . Bony involvement, masses, diffuse increase in density
  - Cervical soft tissues (traumatized airway, abnormalities of soft palate, hyoid apparatus, or laryngeal lumen, trachea)

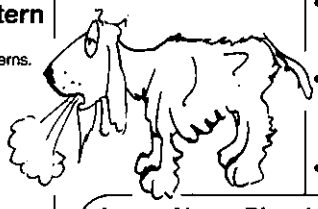
- Hematology:
  - Abnormalities usually only with extensive inflammatory, infectious, or allergic diz
  - ± Abnormalities w/ parasitic diz, neoplasia, or viral respiratory diz
- Serum chemistries: normally of little use
- Serology:
  - Helpful in some mycotic disease (Cryptococcosis)
  - Seldom diagnostic
    - . Rely more heavily on culture, cytology & biopsy



Dizs of lower airways, Obstructive/ expiratory pattern

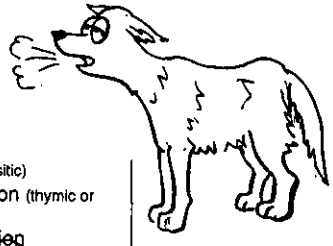
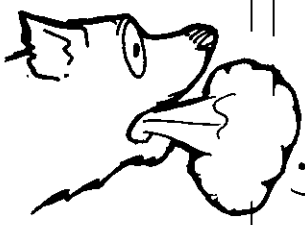
Turnwald GH, Hoover JP. Obstructive breathing patterns. Vet Med 117, Feb 1994

- **Lower airways:**
  - Thoracic trachea
  - Bronchi
  - Bronchioles

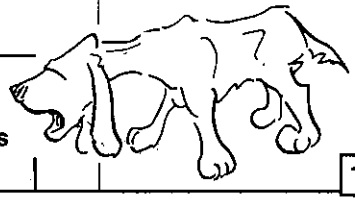


- **Cough**:
  - Honking
  - Wheezing (smoker's cough
  - Productive
- **Abnormal secretions:**
  - Hemoptysis
  - Mucopurulent
- **Obstructive breathing pattern** (dyspnea)
  - **Expiratory dyspnea**: intrathoracic lesion
  - Inspiratory dyspnea: extrathoracic lesion of cervical trachea (considered here as part of upper airway)
- **Exercise intolerance: tiring**

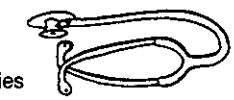
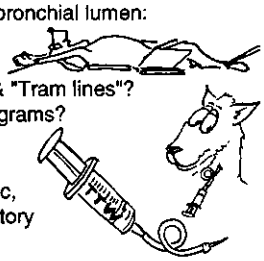
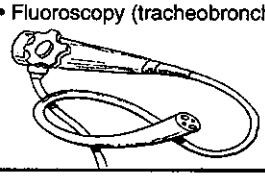
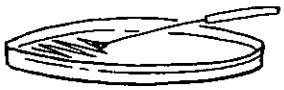
Lower Airway Disorders
- **Thoracic trachea & bronchi**
  - Congenital disorder
    - . Primary ciliary dyskinesia
    - . Tracheal hypoplasia
  - Allergy
  - Infection (bacteria, viral, fungal or parasitic)
  - Tracheal collapse or compression (thymic or mediastinal lymph node neoplasia)
  - Bronchial collapse or compression
  - Trauma
  - Osteochondral dysplasia
  - Foreign body
  - Neoplasia
- **Mediastinal diz - compression**

Lower airways: CS
- **Obstructive breathing pattern**
  - **Normal to Fast & Deep breaths**
  - **↑ Expiratory effort**



- **Hx** (history), **CS** (clinical signs)
- **Physical examination**:
  - Observe respiration: fast & deep, ↑ expiratory effort
  - Palpation: trachea: abnormalities, cough elicited?
- **Auscultation**:
  - Type of adventitious sounds
  - Site of maximum intensity
- Percussion usually on abnormalities
- Diagnostics: roughly descending order of safety & cost effectiveness:
  - **Thoracic radiographs**: do first
    - . Abnormalities of tracheal or bronchial lumen:
      - .. Stenosis?
      - .. Segmental deformities?
    - . Bronchial pattern: "Donuts" & "Tram lines"?
    - . Alveolar pattern: air bronchograms?
  - **Transtracheal aspirate:** (culture & cytology)
    - . Cytology may identify: allergic, bacterial, parasitic, inflammatory disease or neoplasia
  - **Tracheoscopy/bronchoscopy** (flexible fiber optic equipment)
    - . Medium-sized to large dog inspected to the level of tertiary bronchi
    - . Direct visualization, culture, cytology & biopsy
    - . Foreign bodies can often be removed
- Bronchography (outline tracheobronchial tree)
  - Intraluminal masses, demonstrating bronchiectasis
- Fluoroscopy (tracheobronchial dynamics)

Breathing Patterns

Condition	Facts/Cause	Presentation/CS	Diagnosis
Restrictive breathing: **Dizs of lungs, mediastinum & pleural spaces** Vet Med 130, Feb 1994	• **Areas** - Lungs - Mediastinum - Pleural spaces • **Disorders reduce lung compliance, thus restricting ability to inflate (shallow)** • Compensate by ↑ rate (fast)	• Normally nonspecific & does little to localize lesion • Cough • **"Restrictive" respiratory distress** - **Shallow, rapid breathing** - Hyperpnea: gasping or "air hunger" - Orthopnea: positional dyspnea • Cyanosis • ↓ Exercise tolerance	• **Physical Examination** - Inspection: respiratory abnormalities - Palpation: few, if any, abnormalities • Auscultation: adventitious sounds of pulmonary origin usually • Percussion: ± regional or diffuse abnormalities (dullness) • Radiographs (great value) - Both lateral views & VD or DV view should be taken • Transtracheal wash/aspirate: of less value than in airway disease, but often performed due to its simplicity & minimal risk • Endoscopy of limited value unless biopsies obtained • Pulmonary aspirates: - Can be used with disseminated pulmonary diz, masses of lung, mediastinum, or pleural spaces - Risks include pneumothorax (minimal chance), hemorrhage, and iatrogenic infection • **Thoracocentesis** - indicated for pleural effusions - Differentiating CHF, neoplasia, pyothorax, chylothorax • Thoracotomy: identify lesions, determine extent of diz, resect lesions, place drainage tubes, tissues for histopathology

DDx - Restrictive breathing pattern

- **Disorders of lung parenchyma**
  - Infections (bacterial, viral or parasitic)
  - Trauma
  - Aspiration pneumonia
  - Pulmonary edema
  - Pulmonary contusion
  - Pulmonary laceration
  - Bleeding disorders
  - Foreign bodies
  - Pulmonary cavitary lesions
  - Neoplasia
  - Respiratory distress syndrome
- **Disorders of pleural cavity**
  - Pleural effusion
  - Pneumothorax
- **Disorders of mediastinum**
  - Trauma
  - Effusion
  - Pneumomediastinum
  - Mediastinitis
  - Neoplasia
- **Disorders of diaphragm**
  - Congenital defects
    - . Pleuroperitoneal hernia
    - . Peritoneopericardial hernia
    - . Hiatal hernia
  - Acquired diaphragmatic hernia
- **Disorders of thoracic wall, sternum**
  - Congenital defects
    - . Rib abnormalities
    - . Pectus excavarum
    - . Flat pup syndrome
  - Acquired disorders
    - . Rib or sternum fractures
    - . Flail chest
- **Other disorders**
  - Shock

Lungs, Mediastinum & Pleural spaces
• Restrictive breathing pattern (fast & shallow)

Turnwald GH, Hoover JP. Restrictive breathing patterns. Vet Med 130, Feb 1994

Miscellaneous breathing patterns 1 & 2

Vet Med 142, Feb 1994

- Breathing patterns **not obstructive or restrictive**
- Subtypes:

1. Fast & deep (↑ rate & depth)
- Physiological: exercise, fear, excitement, heatstroke
- Impaired transfer of O_2
  - . Respiratory & other systems

2. Slow & shallow (↓ rate & depth)
- Cause usually narrowed to
  - . Brain
  - . Upper motor neuron
  - . Lower motor neuron

- **Type 1 - Fast & deep breathing**
  - Panting
  - ± Pallor
  - ± Systemically ill
- **Type 2 - Slow & shallow breathing**
  - Severe or terminal diz in most
  - ± Unconscious or semiconscious (brain)
  - Spastic paresis or paralysis (UMN)
  - Flaccid paresis or paralysis (LMN, neuromuscular junction)

Dx Subtype 1: Fast & deep - no obstruction
- History:
  - Physiologic (exercise, pain, excitement)
  - Heatstroke
- R/O physiologic response
- Look for respiratory diz, if none:
- Pursue nonrespiratory conditions
  - Pale mucous membranes
    - . CBC w/ reticulocyte count
  - Cardiac workup for delayed capillary refill time
  - Neurologic workup, ± CSF
- No abnormalities; but systemically ill
  - Serum chemistries
  - UA (urinary analysis)
  - Arterial gases
  - Serum carbon dioxide

Dx Subtype 2: Slow & shallow pattern (↓ rate & depth)
- Hx: toxins, trauma
- Clinical signs: slow & shallow
- Palpation (PE)
- Neuromuscular tests depending on Hx & PE

Fast & deep or normal breathing w/o obstruction (1)

- **Respiratory conditions**
  - Compensation for unilateral or focal pulmonary diz
  - Pulmonary vascular diz
    - . Dirofilariasis
    - . Hyperadrenocorticism
    - . DIC
- **Nonrespiratory conditions**
  - Exercise
  - Anemia
  - Methemoglobinemia
  - Cyanosis
  - Cardiac insufficiency
  - Pain
  - Fever
  - Heatstroke
  - Metabolic acidosis
    - . Ketoacidosis
    - . Renal diz
    - . Ethylene glycol poisoning
    - . Heart failure

Slow & shallow breathing (2)
- **Brain** (medullary) movement
  - Trauma (edema or hemorrhage)
  - Neoplasia
  - Drugs (barbiturates, narcotic)
- **Myelopathies**
  - Upper motor neuron (trauma)
  - Lower motor neuron (myelomalacia)
- **Neuropathies**
  - Idiopathic (including polyradiculoneuritis)
- **Neuromuscular junction**
  - Tick paralysis
  - Botulism
  - Chronic organophosphate
  - Bluegreen algae toxicity

Miscellaneous breathing patterns
1. Fast & deep, no obstruction
Exercise, ↓O_2, Fever, Pain, Pulmonatry diz
2. Slow & shallow - Nervous system

Turnwald GH, Hoover JP. Miscellaneous breathing patterns. Vet Med 142, Feb 1994

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Stenotic nares E-hb 259; H2B 164; SAP 550; Cat 456; Sx4B 310; Sx-WW 64 ***	• **Small brachycephalic breeds** - Also reported in cats • Obstructs airflow	• **Obstructive upper airway breathing pattern** - Mouth breathing - Stertorous breathing • ± Crusting or caking of nasal opening	• PE: **Direct inspection**	• **Surgical** - Alar fold resection - Nasal wedge resection Prognosis: Good
Cleft palate, Oronasal fistula, Hare lip E-hb 259; H2B 164t, 334t; Cat 957; Sx-S-hb 260; Sx-S 746; Sx-WW 69 *	• **Defect in hard & or soft palate** • Allows fluid or food to enter nasal cavity • **Brachycephalic breeds**, miniature schnauzers, cocker spaniels, beagles, persian cats • Oronasal fistula occurs 2° to tooth extraction, neoplasia or penetrating wounds	• **Ineffective nursing** • **Nasal discharge** • **Nasal regurgitation** • Rhinitis: occasionally respiratory distress • Sequela: **Aspiration pneumonia**	• Hx, CS • PE: **Direct inspection** of hard palate	• **Surgically close defects** - Elevation of flaps to cover defect • Systemic ABs 2 weeks Prognosis: Good

Brachycephalic
CS: Obstruction
Dx: PE
Tx: Surgical •Px: Good

Defect, Brachycephalic
CS: Ineffective nursing, Nasal discharge
Dx: Direct inspection
Tx: Surgery
Px: Good

*Neoplasia of nasal cavity & paranasal sinuses*** 1% of all tumors in dogs & cats

• **Benign fibrous polyps see pg 128**

• **Malignant endonasal neoplasia** M8k 1118; Mk 764; E-hb 262; SAP 542, 587; H2B 169; H3B 145; I2M 231; IM 166; IM-WW 212; 5min 601; Cat 960, 1095 **	• **80%** of all nasal rumors = malignant - Dog > cats - **Adenocarcinoma #1**, fibrosarcoma, chondrosarcoma, osteosarcoma & squamous cell carcinoma . All originate in ethmoidal concha . Invasion of maxilla, palatine & frontal sinus . **Rarely metastasis** (sometimes to brain) • Other tumors: transmissible venereal tumor reported	• **URT obstruction** - **Normal/fast & deep respiration** - **Inspiratory dyspnea** - ± Open mouth breathing - Stertorous breathing, snoring • **Sneezing** • Hemorrhage from destruction • 2° bacterial & possible fungal infections • Ocular discharge w/ erosion or obstruction of nasolacrimal duct • **Distortion of face** • Weight loss	• **Hx, CS** • **Radiology** - Soft tissue density - Malignancy: **bone destruction or proliferation** - Replacement of air space w/ soft tissue density • Rostral rhinoscopy • Nasal flush/aspiration for cytology, or • Biopsy for histology • Exploratory rhinotomy	• **Treatment m/not be practical** • Surgical excision: recurrence expected w/ curettage (debulking) • Radiotherapy & cytotoxic may be effective • Chemotherapy not effective Prognosis: • **Grave**: w/ surgery & or chemotherapy, recurrence to be expected w/in 3 months • Poor to guarded w/ radiation Tx, depending on degree of involvement
Lymphosarcoma: Cat E 782; E-hb 262; Cat 637, 766, 853; 5min 1078; **	• **Lymphosarcoma as part of multicentric tumor problem** • **#1 endonasal tumor of cat** • Also squamous cell carcinoma & adenocarcinoma	• URT obstruction - **Inspiratory dyspnea** - ± Open mouth breathing - Stertorous breathing, snoring • Purulent nasal discharge • Epistaxis, sneezing • ± Facial distortion	• Hx, CS • **FeLV serology** • Traumatic nasal flush/aspirate for cytology, or • Nasal biopsy for histopathology	• **Little published on Tx; Sx & radiotherapy may be tried** Prognosis: **Poor to guarded**: treatment is often unrewarding

80% Malignant
CS: URT obstruction
Dx: Rads, Rhinoscopy, Biopsy
Tx: ? • Px: Grave

#1 Endonasal tumor - cats

Rhinitis

Condition	Facts/Cause	Presentation	Diagnosis

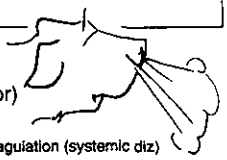
Rhinitis/ Sinusitis

M8k 1122Mk 767; H3B 139; H2B 163, SAP 574, 525, 541; E-hb 260; E 557; I2M 235; IM 169; IM-WW 212; 5min 1036; Cat 958, 1095; F-N 266; Sx4B 346; Sx-WW 65; Pa-T 124

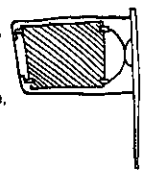
****

- **Infection or inflammation of nasal cavity/sinuses**
- Acute or chronic
- Often rhinitis & sinusitis occur together
- Causes (see box)

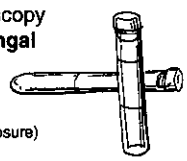
- **Sneezing**
- **Obstruction** (upper airway)
  - **Inspiratory dyspnea**
  - Open mouth breathing
  - Stertorous breathing, snoring
- **Nasal discharge:**
  - Serous: foreign body, allergic, viral
  - Mucopurulent/serosanguinous: infection, prolonged FB, chronic Ehrlichiosis (dogs), neoplasia
  - Hemorrhagic: trauma, chronic infection
  - Foodstuff: oronasal fistula
- Swelling & asymmetry of face: fungal, trauma
- Pain
- Ocular discharge: nasolacrimal inflammation or obstruction
- Ulcerations of external nares: nasal aspergillosis
- **Accompanying systemic signs**
  - Anorexia, especially in cats
  - Fever, lethargy, weakness,



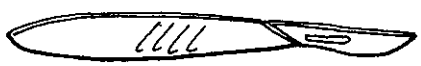
- **Hx, CS**
- **Physical exam**
  - Oral cavity (dental mirror)
  - Palpation (symmetry)
- Laboratory: CBC, chem & coagulation (systemic diz)
- **Cytology/biopsy**: aggressive nasal wash or endoscopic retrieval of tissue
- **Culture**: only valuable if endoscopic or surgical curettage (because of normal flora)



- **Radiology** (opened mouth, intraoral, frontal skyline, lateral, oblique [teeth])
  - Fluid/tissue density: infection, hemorrhage, FB, neoplasia
  - Asymmetry trauma, neoplasia, prolonged infection (esp. fungal)
  - Swelling/mass lesion: fungal infection
  - Turbinate/bone destruction: neoplasia, chronic infection
  - Loss of lamina dura: tooth root abscess
- **Rhinoscopy**/nasopharyngoscopy
- **Serology, especially for fungal**
  - AGID, DIE, ELISA



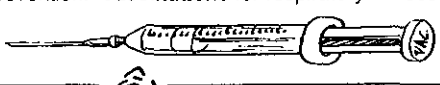
- ± Surgery for histopathology
  - Trephination
  - Rhinotomy w/ bone flap (greater exposure)



Rhinitis/Sinusitis - Causes

- Viral
  - Canine
    - . Parainfluenza
    - . Herpesvirus
    - . Distemper
    - . Adenovirus-2
  - Feline
    - . Feline herpesvirus
    - . Calicivirus virus
    - . FeLV/FIV
- **2° Bacterial**
  - Bordetella
- *Chlamydia psittasi*
- **Fungal**
  - Aspergillosis: dog
  - Penicilliosis: dog
  - Cryptococcosis: cat
  - *Rhinosporidium seeberi*: rare
- Salmon poisoning: rickettsial
- Lymphoplasmacytic rhinitis (rare)
- Allergy (hypersensitivity)
- **Foreign bodies** (grass awns)
- **Trauma**
  - **Hit by car**
  - **Bite wounds**
  - **Gunshots**
- Dental diz (Tooth root abscess)
- Ornonasal fistula
- Neoplasia
- Parasites (rare)
  - Cuterebra spp.
  - *Linguatala serrata* (tongue worm)
  - *Pneumonyssus (Pneumonyssoides) caninum* (nasal mites)
  - *Capillaria aerophilia* (usually lower respiratory tract

Prevention: **Vaccinations** for respiratory viruses



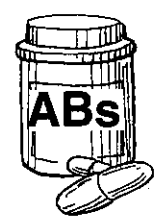
Prognosis:

- Good:
  - Bacterial
  - Respiratory viruses
  - Trauma
  - Foreign body
  - Some hypersensitivity
- Poor:
  - Neoplasia
  - FeLV, FIV
- Guarded:
  - Mycotic
  - Chronic rhinitis

Upper airway
CS: Inspiratory dyspnea, Sneezing, Nasal discharge
Dx: Hx, CS, PE
Tx: Treat cause • Px: Variable

- **Treat cause**
- **Supportive: nursing care**
  - Parenteral feeding & fluid therapy for anorexic animals
  - Elizabethan collar (self mutilation)

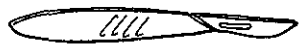
- **Repeat diagnostics**
  - Multiple problems w/in nasal cavity of same animal
    - . FB & 2° bacterial infection
  - Bacterial & fungal infection associated w/ neoplasia
- **Bacterial infections:**
  - **Oral ABs** (culture & sensitivity) 2-4 weeks, avoid prolonged use (fungal overgrowth)
  - **Decongestant**: pediatric **Afrin®** nasal drops sid-bid 4 days on 4 days off
  - Surgery for refractory or poorly managed cases
  - Sinus trephination (remove exudate & irrigate sinus & nasal passages)



- **Viral rhinitis:**
  - **Supportive care**: SQ fluids, Afrin®, **ABs** for 2° bacterial infections
  - Vaccine to prevent

- **Foreign body rhinitis: remove w/ rhinoscopy**, ± rhinotomy; **ABs**
- **Fungal rhinitis:**
  - **Aspergillosis/penicilliosis: Ketoconazole** (6-8 weeks), **itraconazole:** more effective; Topical enilconazole (surgical placed tubes); Surgery: open nasal cavity & sinus technique
  - **Nasal cryptococcosis:** low-dose combined Tx in cats: Ketoconazole + Flucytosine (12 weeks), **itraconazole (Sporanox®)**
  - **Rhinosporidiosis: surgical removal only choice**
- **Dental diz: surgically** remove tooth & curettage alveolus if osteomyelitis, **ABs** for 2 weeks

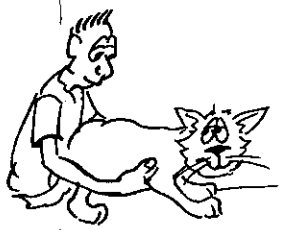
- **Steroids**: if above ineffective, prednisolone may help rare lymphocytic plasmacytic rhinitis or allergic rhinitis
- Surgical exploration via rhinotomy if refractory to chronic medical therapy
  - Turbinectomy in cats w/ chronic rhinitis
  - Surgery: remove infected & diseased tissue for obstruction & drainage, Sinus trephination & drainage, Rhinotomy w/ turbinectomy, Frontal sinus obliteration



- **Follow up care**: patient monitoring
  - Chronic nasal dizs m/ require long-term therapy, re-evaluate at 2 week intervals until CS resolve
  - Surgical patients evaluate weekly until healed

Rhinitis

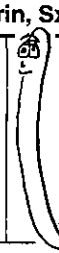
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Bacterial rhinitis/ sinusitis M8k 1122; Mk 767; H3B 139; H2B 163; E-hb 296; E 561; E 778; SAP 525; I2M 235; IM 169; IM-WW 212; 5min 1036 **	• **Infection of nasal cavity/ sinuses** • Acute or chronic • 1° uncommon • **2° to predisposing infection or damage** - Viral infection - Mycotic - Mycoplasmal infections - Foreign bodies - Trauma - Dental disease - Neoplasia - Immunosuppressants • ***Bordetella bronchiseptica*** & ***Pasteurella multocida*** • Hunting dogs	• **Acute or chronic** • **Sneezing** • **Nasal discharge: mucopurulent**/serosanguinous • **Upper airway: inspiratory dyspnea, open mouth breathing** • Pain • Stertorous breathing snoring (obstruction) • Accompanying systemic signs - **Anorexia especially in cats** - Fever, lethargy, weakness • Sequela: 2° pneumonia uncommon	• **Hx, CS** • **Physical exam:** - Oral cavity (dental mirror) - Palpation (symmetry) • Laboratory: CBC, chem & coagulation (systemic diz) • Cytology/biopsy: aggressive nasal wash or endoscopic retrieval of tissue • Culture: only valuable if endoscopic or surgical curettage (because of normal flora) • Radiology: fluid density • Rhinoscopy/nasopharyngoscopy • Surgical intervention for histopathology - Trephination - Rhinotomy w/ bone flap (greater exposure) • **Response to Tx**	**Canine:** • **Oral ABs** (culture & sensitivity) 2-4 weeks - Avoid prolonged use (fungal overgrowth) • **Decongestant** - Pediatric **Afrin®** nasal drops SID-BID 4 days on 4 days off • Surgery for refractory or poorly managed cases - Sinus trephination (remove exudate & irrigate sinus & nasal passages) • 2° pneumonia rare - aggressive therapy **Feline:** • Conservative - Decongestant (**Afrin®**) - **Broad spectrum ABs** 2-4 weeks - Once chronic low cure rates • Surgery: - Remove infected & diseased tissue for obstruction & drainage - Sinus trephination & drainage - Rhinotomy w/ turbinectomy - Frontal sinus obliteration Prognosis: • **Good** if 1° & acute in dogs & FeLV/FIV negative in cats • Guarded: chronic or FeLV/FIV (+)



Bordetella & Pasteurella
CS: Insp. dyspnea, Sneezing, Purulent discharge
Dx: Hx, CS, PE, etc.
Tx: ABs, Afrin, Sx • Px: Good

Parasitic rhinitis

Mk 815, 763, 769, 1016; E-hb 262; H3B 2139; H2B 163; SAP 541; I2M 236; 5min 1036; Cat 596 *



- **Parasitic rhinitis rare in dog & cat**
- ***Pneumonyssus caninum*** (nasal mites). Adult pale yellow body, transmission unknown
  - CS: Usually w/o or w/ only mild signs, sneezing, serous nasal discharge
  - Dx: most incidental finding at necropsy
  - Tx: Drive out mites with noxious gases or chemical (ether, inhalant anesthetics & dichlorvos), questionable efficacy & safety: Ivermectin
- **Cuterebra spp.**, larva of rodent or rabbit bot fly, Transmission: ingestion, respiratory, or skin lacerations; incidental parasites of dogs & cats, lesion of skin of neck & chest
- ***Linguatala serrata*** (tongue worm):
  - CS: Severe rhinitis (coughing & violent sneezing, blood stained discharge)
  - Tx: Physical removal only certain method of Tx
- ***Capillaria aerophilia***: Rare; (usually lower respiratory tract) have been found in nasal cavity, parasite of frontal sinus, trachea, bronchi & rarely nasal cavity of foxes • Tx: Ivermectin

Viral rhinitis/ sinusitis

Mk 767; H2B 163; E-hb 260; E 557; SAP 525, 542, 574; I2M 235; IM 169; IM-WW 212; 5min 1036
****

- **Very common**
- **Viral infection**
- **2° bacterial infection**
  - Dolichocephalic breeds (Irish wolf hounds)
  - 1° herpes virus w/ 2° *Bordetella bronchiseptica* & *Pasteurella multocida* involvement

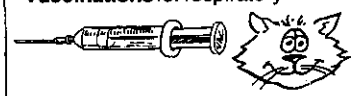
- **Sneezing**
- **Serous nasal discharge** (bilateral)
- URT obstruction
  - **Inspiratory dyspnea**
  - ± Open mouth breathing
  - Stertorous breathing, snoring
- Accompanying systemic signs
  - **Anorexia especially in cats**
  - Fever, lethargy, weakness
- Sequela: Chronic rhinitis

- **Hx, CS**
- **Physical exam**
- Libratory: CBC, chem & coagulation (systemic diz)

Viruses - rhinitis
- Canine
  - Parainfluenza
  - Herpesvirus
  - Distemper
  - Adenovirus-2
  - Reovirus
- Feline
  - Feline herpesvirus
  - Calicivirus virus
  - FeLV/FIV

- **Supportive care**
  - SQ fluids
  - Decongestants
  - Vitamins
- **Broad spectrum ABs** for 2° bacterial infections
- Turbinectomy in cats w/ chronic rhinitis

Prevention:
- **Vaccinations** for respiratory viruses



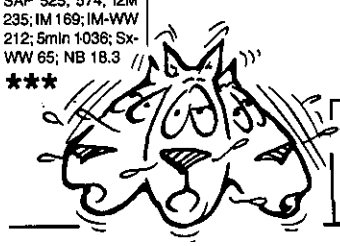
Prognosis: **Good** if FeLV/FIV negative

Viral + 2° Bacteria
CS: Sneezing, Serous, URT obstruction
Dx: Hx, CS, PE
Tx: Support, ABs

Foreign body rhinitis

Mk 767; H3B 139; H2B 163; E-hb 260; SAP 525, 574; I2M 235; IM 169; IM-WW 212; 5min 1036; Sx-WW 65; NB 18.3
***

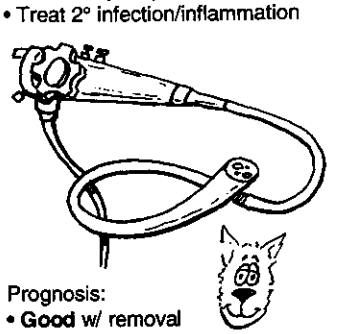
- **Foreign bodies (grass awns)**
- Seldom lodge in nostril
- Most find their way into ventral nasal concha & meatus



- **Violent sneezing**
- **Head-shaking & nose pawing**
- **Serous nasal discharge** (unilateral) w/ time mucopurulent, hemorrhage
  - **May be dislodged**
- URT obstruction:
  - **Inspiratory dyspnea**
  - ± Open mouth breathing
  - Stertorous breathing snoring

- Hx, CS
- Radiology: vegetable material doesn't show
- **Rhinoscopy/otoscope** under general anesthesia

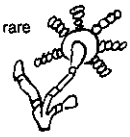
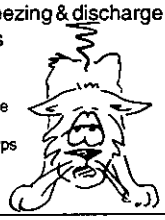
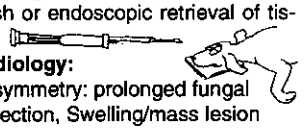
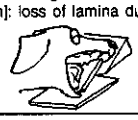
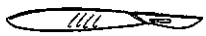
- **Remove w/ rhinoscopy**
- Rhinotomy may be necessary
- Treat 2° infection/inflammation



Prognosis:
- **Good** w/ removal

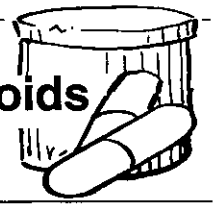
Grass awns
CS: Violent sneezing, Head-shaking
Dx: Otoscope
Tx: Remove • Px: Good

Rhinitis — RESPIRATORY SYSTEM

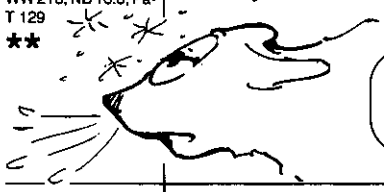
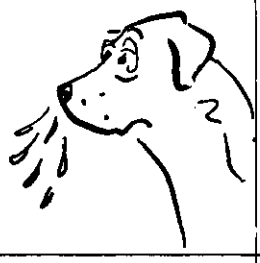
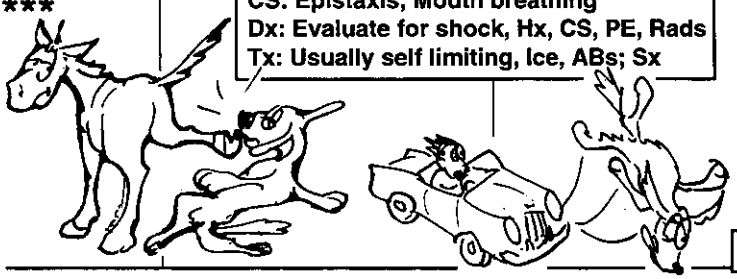
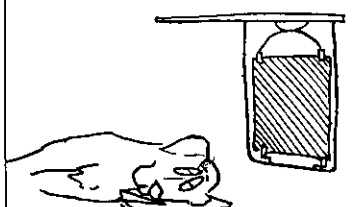
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Fungal rhinitis/ sinusitis M8k 1122; H3B 139; H2B 163; E-hb 261; SAP 525, 542, 574; I2M 232; IM 167; IM-WW 210; 5min 1036; Sx-WW 65; NB 18.3	• **Dog > cat** • **Aspergillosis**: 1° in dog - Young to middle aged - Dolichocephalic dogs >>> brachycephalic (hunting dogs) - Invasive more common than noninvasive • Penicilliosis: 1° in dog • *Cryptococcosis neoformans*: - Older cats, other body systems may be involved • *Rhinosporidium seeberi*: rare  DDx for cryptococcosis • FeLV (feline leukemia virus) • Neoplasia • Immune suppression	**Aspergillosis/penicilliosis - Dog** • **Sneezing** • **Nasal discharge (bilateral)** - Mucopurulent - Hemorrhagic (destructive) • **Swelling & asymmetry** of face • Pain • URT obstruction - **Inspiratory dyspnea** - ± Open mouth breathing - Stertorous breathing, snoring • Ulcerations of external nares: aspergillosis • Accompanying systemic signs - Anorexia, especially in cats - Fever, lethargy, weakness **Nasal cryptococcosis - Cat** • Severe chronic rhinitis - Persistent sneezing & discharge • Systemic signs • Lungs, CNS Rhinosporidiosis - rare • Causes chronic granulomatous polyps 	• **Hx, CS** • **Percussion**: dull paranasal sinuses • Lab: CBC, chem & coagulation (systemic diz) • **Cytology/biopsy**: aggressive nasal wash or endoscopic retrieval of tissue  • **Radiology:** - Asymmetry: prolonged fungal infection, Swelling/mass lesion - Turbinate/bone destruction • **Rhinoscopy/nasopharyngoscopy** - Normal mucosa: shiny pink w/ minimum serous discharge - Mycotic: white, yellow or light green fluffy plaques - Noninvasive aspergillosis: "fungal balls" (masses of mycella) filling conchal air spaces • Serology: - Agar gel immunodiffusion (AGID) tests . Aspergillosis, Penicilliosis, & cryptococcosis - Counter immunoelectrophoresis (DIE) . Up to 15% false positives - Enzyme-linked immunosorbent assay (ELISA) • Surgery for histopathology - Trephination - Rhinotomy w/ bone flap (greater exposure) 	**Aspergillosis/penicilliosis:** • Ketoconazole PO BID, eliminates in 50% if used for 6-8 weeks • **Itraconazole**: more effective • Thiabendazole, success rate very low • Topical enilconazole: administrated through surgical placed tubes • Surgery: open nasal cavity & sinus technique **Enilconazole** **Itraconazole** **Nasal cryptococcosis:** • Low-dose combined Tx in cats - Ketoconazole - Flucytosine **Ketoconazole** • Continue Tx for 12 weeks • **Itraconazole (Sporanox®)** **Rhinosporidiosis:** • Cannot be treated medically • **Surgical removal only choice** - Recurrence likely Prognosis: **Poor to guarded**: depending on chronicity
Dog > Cat, Aspergillosis **CS: Sneezing, Discharge, Asymmetry** **Dx: Hx, CS, PE, Biopsy, Rads, Serology** **Tx: Antifungals • Px: Poor to guarded**				
Dental diz rhinitis ★ M8k 1122; Mk 767; SAP 608; H2B 168; E-hb 260; Sx-WW 65; 5min 1036; NB 18.3	• Periodontal diz although common, seldom associated w/ rhinitis 	• **Signs of periodontal diz** • **Oronasal fistula** • **Nasal discharge: serous to mucopurulent** - May be unilateral or bilateral • Difficult eating (mastication) - Weight loss	• Hx, CS • Physical exam: crowns for damage • Radiology (oblique [teeth]: loss of lamina dura: tooth root abscess 	• **Surgically** remove tooth & curettage alveolus if osteomyelitis • **Systemic ABs** for 2 weeks • Repair oral nasal fistula  Prognosis: **Good** w/ appropriate Tx

Lymphocytic-plasmacytic rhinitis H2B 168; I2M 236; IM 170; IM-WW 213

★



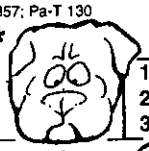
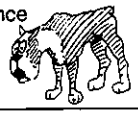
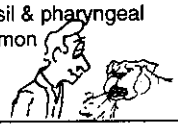
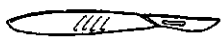
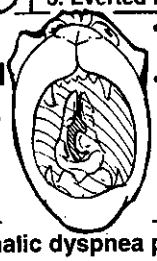
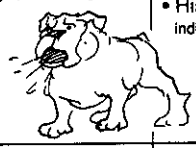
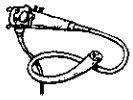
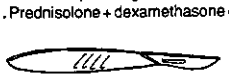
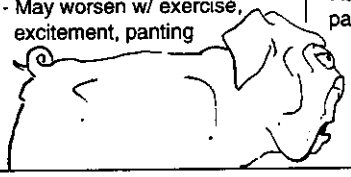
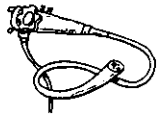
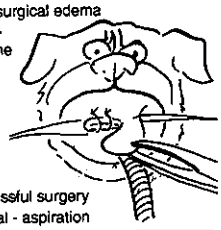
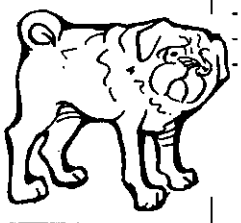
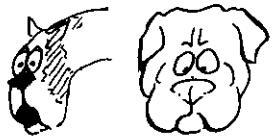
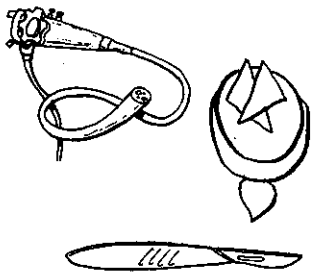
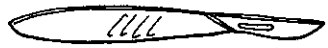
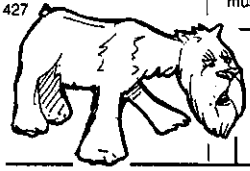
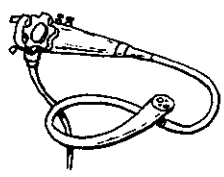
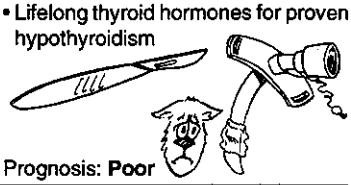
- **Rare**, Reported
- CS: **Sneezing**; Nasal discharge (serous, mucopurulent & hemorrhagic)
- Dx: Hx (CS w/ no improvement w/ ABs), Nasal **biopsy** (lymphocytes & plasma cells infiltration)
- DDx: Infectious nasal diz (fungal: aspergillosis or penicilliosis); Neoplasia
- Tx: **Immunosuppressive doses of steroids (prednisone)**, gradually reduce dosage over 4-6 weeks (positive response expected in 2 weeks; if no response: Add azathioprine (**Imuran®**) to regime, may need long term Tx at lowest dose possible. If CS continue stop Tx & re-evaluate
- Prognosis: Not known because to few cases

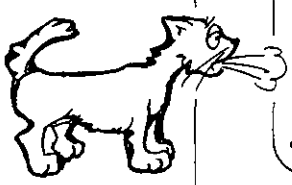
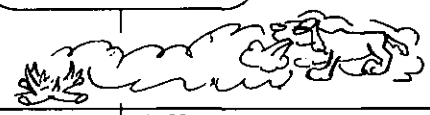
Allergic rhinitis H3B 139; H2B 168; I2M 236; IM 170; IM-WW 213; NB 18.3; Pa-T 129 ★★	• Uncommon in dog & cat • Not well characterized • Cause: hypersensitivity to air born allergens • **Usually seasonal**  **DDx:** • Neoplasia • Infectious diz	• **Sneezing** • ± Mucopurulent nasal discharge 	• **Hx (allergin introduction), CS** - Remove from environment • Full diagnostic workup • Nasal biopsy: eosinophilic inflammation 	• Remove allergen if identified • **Steroid: prednisone**, once eliminated or controlled, lower dose to alternate day Tx • Antihistamines: chlorpheniramine (Chlor-Trimeton®, Novahistine®) • Decongestant pediatric nasal drops (Afrin®) 4 day on & 4 day off **Steroid** Prognosis: • Excellent if allergen eliminated • Excellent for control, but cure unlikely
Nasal trauma H2B 168; E-hb 260; E 557; Cat 955; Sx4B 343 ★★★	• Trauma: - HBC (hit by car) - 5 point landing in cat fall **Trauma: HBC** **CS: Epistaxis, Mouth breathing** **Dx: Evaluate for shock, Hx, CS, PE, Rads** **Tx: Usually self limiting, Ice, ABs; Sx** 	• **Epistaxis** (bleeding from nose) • Mouth breathing (obstruction)	• **Evaluate for shock** • Hx (trauma) • CS (hemorrhage) • Radiology: - Fractures - Necrosis of conchae if infected 	• **Usually self limiting** - Cage rest & ice packs if mild - Sedation w/ acepromazine - Topical epinephrine 1:100,00) nasal drops to stop hemorrhaging • **Broad spectrum ABs** 2° bacterial • Severe: pressure pack nasal cavity • Surgery: malformation of septum - Sequestration & osteomyelitis - Sinus mucocele Prognosis: good usually

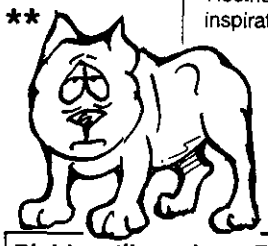
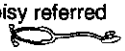
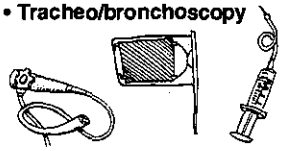
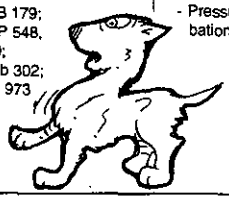
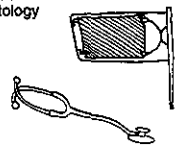
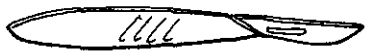
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Obstructive upper airway dizs SAP 548; H2B 173; I2M 335; IM 245; IM-WW 215; Cat 965; 5min 158; SX-WW 64 **	• Congenital diz of brachycephalic dogs ("**brachycephalic syndrome**") • Others acquired - Middle-aged & older dogs • Dogs >> cats **Causes:** • Brachycephalic syndrome ± Everted laryngeal saccules • Nasopharyngeal polyps • Congenital laryngeal anomalies • Laryngeal collapse, trauma • Laryngeal paralysis • Nasopharyngeal polyps • Tracheal collapse, stenosis • 1° tracheal neoplasia • Extraluminal compression of trachea **URT obstruction** **Tx: Cause • Px: Guarded to poor**	• **URT obstruction** **- Inspiratory dyspnea** - ± Open mouth breathing - Noisy breathing . Stertorous - snoring . **Stridor**: high pitched **inspiration** - Cyanosis & syncope - "Pulling" or drawing of thoracic inlet, intercostal areas & abdominal muscles • **Voice changes** (hoarseness or loss) • Choking, gagging, coughing • Exercise intolerance • Sequelae: **- Aspiration pneumonia** **- Heat prostration**	• Hx, CS, PE • Auscultation: localize obstruction at loudest area • Palpation • Neurologic exam • **Laryngoscope** (light anesthesia) • Radiology: rarely diagnostic - Dilated saccules - Soft tissue swelling - Elongated soft palate • Fluoroscopy • Electromyography • Thyroid stimulating hormone test (TSH) for laryngeal paralysis	• **Tx depends on cause** **Post surgical monitoring** • Monitor for hemorrhage &/or edema • Tracheotomy if needed • Monitor for pulmonary edema, aspiration pneumonia & fever **Prognosis** • **Guarded to poor**: tends to be progressive w/ most causes (degenerative dizs)
Nasopharyngeal polyps M8k 1118; Mk 764; E-hb 262; I2M 230; IM 166; IM-WW 212; SAP 542, 587; 5min 868; H2B 169; H3B 145; C11T 802; Cat 960; Pa-T 129; Sx-WW 65; NB 18.3 ** **Cats, Benign masses** **CS: Obstructive breathing pattern** **Dx: Hx, CS, PE** **Tx: Surgical excision • Px: Excellent**	• **Benign, inflammatory masses** (epithelium) - Nasopharynx, auditory tube or tympanic cavity (middle ear) • **Cats & kittens** • Rare in dog	• **Obstructive breathing pattern** - Deep, normal or fast respiration - Stertorous breathing • Serous-to-mucopurulent nasal discharge • **Hemorrhage** from pressure induced destruction Otitis externa or otitis media/interna - Head tilt, nystagmus or Horner's syndrome	• **Hx, CS** • Retract soft palpate to expose • Radiology: soft tissue density in naso-pharynx or ↑ radiodensity of osseous bulla (cats) • Rostral rhinoscopy • Biopsy & histo (inflammatory tissue, fibrous connective tissue & epithelium)	• **Surgical excision** through oral cavity - Pull soft palate out of way; grab polyp w/ Allis forceps - steady traction until removed • Rhinotomy for complete removal, occasionally • Ventral bulla osteotomy Prognosis: **Excellent** • Regrowth if all not removed

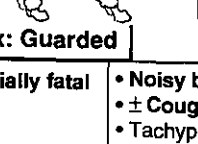
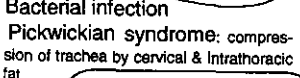
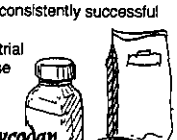
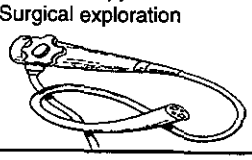
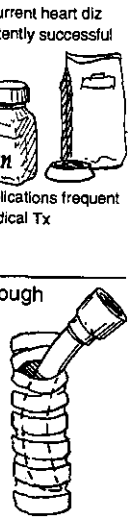
Congenital anomalies of larynx H3B 148; H2B 173 *	• *Congenital paralysis (Bouvier, Bull terriers, Siberian husky)* • Enlarged, rigid epiglottis • Flaccid epiglottis, aryepiglottic folds - Usually asymptomatic Collapse of epiglottis Familial laryngeal hypoplasia	• **Noisy breathing** - URT obstruction • Choking, gagging, coughing • Obstruction - Cyanosis & syncope - "Pulling" or drawing of thoracic inlet, intercostal areas & abdominal muscles	• Hx (young) • CS, PE • **Laryngoscope**	• Rigid epiglottis: Conservative, Sedation Avoid precipitating causes (overheating) • Flaccid epiglottis: resection of cranial third • Congenital laryngeal paralysis
Trauma of larynx H3B 153; H2B 173; E-hb 266; 5min 758; Cat 968 ** **#1 Bite wounds = Edema** **CS: URT obstruction** **Dx: Hx, CS, PE, Auscultation, Scope** **Tx: ± Tracheotomy • Px: Poor to good**	• **Trauma:** - #1 bite wounds (fights) - Choke chain trauma - Gunshot wounds/projectiles - Anything in cat • Causes laryngeal edema	• **URT obstruction** **- Inspiratory dyspnea** - ± Open mouth breathing - Noisy breathing (rasp to stridor) • **Voice changes** (hoarseness or loss) • Choking, gagging, coughing	• Hx, CS, PE • Auscultation: localize obstruction at loudest area • Palpation • Neurologic exam • **Laryngoscope** (light anesthesia) • Radiology: rarely diagnostic - Soft tissue swelling • Electromyography	• **Possible emergency** • **Tracheotomy if obstruction** • **Wound debridement** • **Establish drainage** Prognosis: • **Poor to good** depending on severity • Possibly delayed signs of recurrent nerve injury & subsequent obstruction
Laryngeal spasm H2B 173; E-hb 266; Cat 968 *** **Cat, Intubation; Prevent: Spray**	• Dog: uncommon; usually not a problem • **Cat**: common, may be severe & life-threatening - Overzealous manipulation under light anesthesia	• **Shutting of larynx when intubation attempted**	• Hx (**cat intubation**) • Direct visualization while intubating • **Laryngoscope**	• **Prevent:** **- Spray local 1-2% lidocaine** (only) anesthetic into pharynx or swab on laryngeal opening (auditis) before manipulation
Laryngeal edema M8k 1259; H2B 176; E-hb 266; Cat 968 *** **Tx: Cool, Sedate, Steroids, ± Intubate**	• Causes - Panting (overheating or excitement) - Trauma - Anything in a cat • Predisposed: **- Brachiocephalic breeds** (English bulldogs) - Obese animals - Laryngeal spasms (cats)	• URT obstruction - Deep breathing **- Inspiratory dyspnea** - ± Open mouth breathing - Noisy breathing: stridor	• Hx, CS • Visualize: **Laryngoscopy**	• **Cool animal** (air conditioning, tepid water, alcohol bath) • **Tranquilize**: Acetylpromazine, Butorphanol • **Steroid**: **dexamethasone**: single injection • **Intubate if severe** **Steroids** **Prognosis: Guarded**

Larynx — RESPIRATORY SYSTEM

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Brachycephalic syndrome SAP 548, 549; H3B 138; H2B 173; E-hb 263; I2M 246; IM 177; IM-WW 215; 5min 400; Sx-WW 64; Sx-S-hb 262; Sx4B 357; Pa-T 130 ***	• **Brachycephalic breeds** (English bulldog) • Consists of: **1. Stenotic nares** **2. Elongated soft palate** **3. Everted laryngeal saccules** (consequence of upper airway obstruction)  **1. Stenotic nares** **2. Elongated soft palate** **3. Everted laryngeal saccules**	• **URT obstruction** - **Inspiratory dyspnea** - ± Open mouth breathing - Noisy breathing (owner may not know abnormal) • Stertorous "gurgling" sound, elongated soft palate • ↓ Exercise tolerance • Gagging (elongated soft palate) 	• Hx (history), CS (clinical signs) • **Oral/pharyngeal exam** (sedation), laryngoscope - Soft palpate overlaps epiglottis - Everted laryngeal saccules - oval masses project medially in front of vocal cords into larynx • Enlarged tonsil & pharyngeal edema common 	• **Nasal: wedge resection** - To increase size of nostril opening • **Soft palate staphylectomy** (shorten soft palate) - Soft palate should appose or slight overlap tip of epiglottis proximally - Too much removed & aspiration pneumonia • **Laryngeal sacculectomy** (removal)  Prognosis: **Poor to guarded**, depending on whether hypoplastic trachea is also present
Everted laryngeal saccules SAP 548; H2B 173; Sx-S-hb 262; Sx4B 360 	• **Brachycephalic breeds** • **Part of brachycephalic syndrome** - ↑ Inspiratory effort pulls saccules of the lateral ventricles into glottis, further impeding air flow **Brachycephalic dyspnea pulls saccules out; Amputate**	• **Airway obstruction** (stridor) - **Inspiratory dyspnea** - ± Open mouth breathing - Noisy breathing (owner may not know abnormal) 	• Hx, CS • **Laryngoscopy** - saccules of lateral ventricles protrude into laryngeal lumen - ± Edema of the saccules • Histopathology of excised tissue may indicate edema & fibrosis 	• **Laryngeal sacculectomy**: surgically amputate saccule - Corticosteroids before surgery, if severe obstruction & edema is present - Treat secondary infections, if present - Monitor for postsurgical edema . Prednisolone + dexamethasone (3–5 d) postop  Prognosis: **Good** w/ surgery
Elongated soft palate SAP 551; H2B 173; Sx4B 358 ** Hypoplastic soft palate: rare	• **Brachycephalic breeds** • **Part of brachycepahlic syndrome** **Brachycephalic breeds** **CS: URT obstruction** **Dx: Hx, CS; PE** **Tx: Sx - Staphylectomy**	• **Obstructive respiratory dyspnea (URT obstruction)** - Normal/fast & deep breathing - Rattling stridor - May worsen w/ exercise, excitement, panting 	• Hx, CS • Inspect soft palate (override the epiglottis &/or occlude the glottis), laryngoscope • Radiography: ± Overriding of palate, thickening of tissue 	• **Staphylectomy**, cut off caudal edge of soft palate - Monitor for postsurgical edema . Prednisolone + dexamethasone  **Prognosis** • **Good** w/ successful surgery • Excessive removal - aspiration
Laryngeal collapse H2B 175; SAP 548, 550, 554; Sx-S-hb 262; Sx-WW 74; Sx4B 358 ** 	• *Anatomical conformation* - **Brachycephalic** & other breeds: Boston terriers, pug, pekingese, dachshund, Amer. cocker spaniels - Processes of arytenoid cartilage (corniculate & cuneiform) overlap causing collapse • May be seen in chronic end-stage upper airway diz also • Predisposing factors - - "Brachycephalic syndrome" - Stenotic nares - Everted laryngeal saccules - Elongated soft palate **Brachycephalic syndrome to arytenoid overlap** **CS: URT obstruction** **Dx: Hx, CS, Scope** **Tx: Sx excision of block • Px: Poor**	• **URT obstruction** - **Inspiratory dyspnea** - ± Open mouth breathing - Noisy breathing (owner may not know abnormal) . Stertorous "gurgling" sound - elongated soft palate • ↓ Exercise tolerance • Gagging (elongated soft palate) 	• Hx, CS • **Laryngoscope**: opposed or overlapping arytenoid processes - No abduction of arytenoids on inspiration • Surgical correction of "brachycephalic syndrome" w/ continued problems 	• **Treat predisposing factors** - **"Brachycephalic syndrome"** • **Surgical excision** or "tie back" of offending tissues - Excise everted saccules - Unilateral excision of arytenoid cartilage, aryepiglottic fold & vocal cord for laryngeal collapse - Partial resection of soft palate if elongated - Corticosteroids for postop edema • Permanent tracheostomy if signs persist after surgical correction of predisposing problems  Prognosis: **Poor**
Laryngeal paralysis ** M8k 1060; E-hb 322; SAP 548, H3B 151; H2B 306, 173; I2M 244; IM 176; IM-WW 214; 5min 758, 34; E 711; Cat 969, 1098; Sx-G 60; Sx-WW 72; Sx4B 362; N-C 260; N-W 224; N-hb 236; N-Pa 450; N-O 357; N-L 111, 107; DDx 427 	• **Failure of glottic cleft to open** • **Congenital**: Bouvier des Flandres & Siberian husky, Bull terrier • **Acquired: Idiopathic #1** - Posttraumatic - Generalized polyneuropathy • Rare in cats • Pathophysiology: Recurrent laryngeal nerves-Wallerian degeneration = dysfunction of dorsal cricoarytenoideus muscle **Bouvier, Congenital or Acquired** **CS: URT obstruction** **Dx: Hx, CS, PE, Scope, Lab** **Tx: Sx - Enlarge glottic cleft • Px: Poor**	• **URT obstruction** - **Inspiratory dyspnea** - ± Open mouth breathing - Noisy breathing - Stertorous "gurgling" (snoring) sound • Exercise intolerance • Cough during eating or drinking • Vomiting • Voice changes 	• Hx, CS, PE • **Laryngoscope**: hyperemia & edema & failure of abduction of vocal folds • TSH stimulation • EMG (electromyograms) & NCV (nerve conduction velocities) are abnormal • Histo: mild to moderate type 1 & 2 myofiber atrophy 	• **± Emergency tracheostomy** • **Steroid** - reduce edema - early • **Surgical enlarging glottic cleft** for moderate to severe CS - Unilateral arytenoid lateralization - Partial laryngectomy per os - Castellated laryngofissure & vocal fold resection • Lifelong thyroid hormones for proven hypothyroidism  Prognosis: **Poor**

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Laryngitis M8K 1059; Mk 712; E-hb 265; H3B 149; H2B 176; Pa-T 131 **	• Inflammation of larynx **Causes: Laryngitis** - **Viruses** . **Dog: adenovirus, K9 distemper** . **Cat: rhinotracheitis, calicivirus** - **Smoke inhalation**, irritating gases - Trauma (tracheal intubation) - Toxic causes - Foreign body • Chronic barking  **Cough, Voice change** **Tx: ABs, Steroids, Suppressants • Px: Guarded to good**	• **Cough**, gagging, dysphagia • **Voice change** (horse bark) • Anorexia, malaise, fever • Other signs or upper resp. tract infection - Ocular & nasal discharge, sneezing **DDx:** • Obstructive laryngeal dizs • Laryngeal neoplasia • Tracheobronchitis 

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Canine tracheal hypoplasia HsB 155; H2B 179; E-hb 302; 5min 400; X-RP 92; X-Gr 144 **  **Rigid cartilage rings, Bull dogs** **CS: URT obstruction** **Dx: Rads** **Tx: None • Px: Guarded**	• **Congenital defect** - Small, rigid cartilage rings - Free side of "C" ring may be in opposition • Causes: Inherited? - Brachycephalic breeds (especially **Bull dogs**) • Restricts air movement: inspiration & expiration	• **Obstructive breathing pattern** - **Deep, normal/fast breathing** - **↑ Inspiratory effort** - ± Open mouth breathing - Noisy breathing (loud sounds over trachea) • Cough (loud, harsh, & unproductive) • Dyspnea: • Cyanosis, syncope w/ stress • Exercise intolerance • Sequela: - **Heat prostration** **DDx:** • Segmental tracheal stenosis • Stenotic nares • Elongated soft palate • Obstructive laryngeal dizs • Infectious tracheobronchitis	• Hx (**young, brachycephalic**), CS • Physical exam - Palpable small, rigid trachea • Auscultation: noisy referred airway sounds  - Pulmonary crackles • **Radiology**: small diameter trachea entire length - normal: 3x diameter of 3rd rib in lateral view • Transtracheal wash/aspirate: - Chronic infection/inflammation usually - Culture indicated • Fluoroscopy: may differentiate from segmental tracheal collapse • **Tracheo/bronchoscopy** 	• **No known procedure** • Control obesity • Intermittent ABs for 2° infections • ± Bronchodilators **None** Prognosis: **Guarded** - life & activity may be compromised
Segmental tracheal stenosis H2B 179; SAP 548, 559; E-hb 302; Cat 973 * 	• **Rare** in cats & dogs • Restricted air flow • Acquired > congenital, 2° to: - Granulation or scar tissue (tracheostomy, bite wound, whiplash injury) - Pressure necrosis after prolonged intubation w/ overinflated cuff	• **Obstructive breathing pattern** - **Deep, fast/normal breathing** - **↑ Inspiratory effort** - ± Open mouth breathing - Noisy breathing (loud stridor over trachea) • Cough (loud, harsh & unproductive) • Cyanosis, syncope w/ exercise • Exercise intolerance • Sequela: - Heat prostration **DDx:** • Tracheal hypoplasia • Stenotic nares • Elongated soft palate • Obstructive laryngeal dizs • Infectious tracheobronchitis	• Hx (young, brachycephalic), CS • PE: Palpable small, rigid trachea • Auscultation: noisy referred upper airway sounds or **stridor** • **Radiology** - Small diameter trachea section • **Tracheoscopy** to localize stenosis • Culture & cytology 	• **Surgical resection & anastomoses** sometimes - Difficult if large segment must be removed • Control obesity • Intermittent ABs for 2° infections • Bronchodilators  Prognosis: • **Poor w/o surgery** • **Guarded w/ surgery** - Postoperative complication common (stricture)

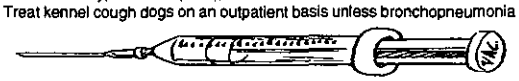
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Collapsed trachea H3B 156; H2B 180; SAP 548, 556; E-hb 339; I2M 287; IM 208; 5min 1112; Cat 973; Sx-WW 75; Sx4B 377; Pa-T 131; X-RP 92; X-Gr 144; NB 18.7 *** **Obese toy or miniature** **CS: "Honking", Resp distress** **Dx: PE: "Goose honk"** **Tx: Diet, Cough suppressants • Px: Guarded**	• ***Dorsoventral flattening of cervical or thoracic trachea*** • **Signalment** - **Middle-aged to older** - **Often obese** - **Toy & miniature breeds** .Toy poodle, Yorkshire terrier, Pomeranians, Chihuahua • Cause poorly defined - **Obesity**, Hereditary - Chronic inflammation of lung, tracheitis - *Bordetella* - Neurological abnormalities - Chronic bronchitis • Pathophys.: loss of rigidity of tracheal rings • Many cases exacerbated by cardiac changes 2° to mitral valve endocardiosis & insufficiency - Enlarged left atrium impinges upon & collapses left mainstem br 	• **Chronic dry, "honking"** cough • Intermittent attacks of dyspnea - Excitement, pressure of eating • **Resp. distress syndrome: dyspnea**: inspiratory if cervical, expiratory if intrathoracic & bronchial collapse, Both inspiratory **& expiratory** if entire trachea involved • **Cyanosis**  • Sequela: - Bacterial infection - Pickwickian syndrome: compression of trachea by cervical & intrathoracic fat **DDx:** • Tracheal neoplasia • Chronic bronchitis • Chronic heart diz • 1° parenchymal diz • Tracheal stricture (rare)	• Hx, CS • **Palpation of collapsing cervical** trach elicits **"goose honk"** • Auscultation - ↑ Respiratory sounds - Inspiratory crackles & expiratory **wheezes** - Occasionally split S2 • **Radiology**: expiratory & inspiratory - Narrowing of tracheal lumen - Collapse of mainstem bronchi - ↑ Bronchial pattern • Fluoroscopy: dynamic airway collapse • Transtracheal wash (TTW) • Tracheoscopy w/ extreme caution • ECG: marked sinus arrhythmias - ± Tall, peaked p waves (p pulmonale) Grading of severity of collapse • Grade 1: slight deflection of dorsal membrane ventrally • Grade 2: < 1/2 normal lumen loss • Grade 3: 1/2 normal lumen lost • Grade 4: > 1/2 normal lumen lost	• **Medical: most cases** - **Weight loss** (relieve pressure on trachea) - Harness instead of collar - **Reduce activity** &/or excitement - **ABs** for bacterial complications - **Steroids** initially to reduce inflammation . Prednisolone 7-10 days - **Bronchodilators** - tracheal collapse . Aminophylline, theophylline (Theo Dur®), Terbutaline (Brethine®) - **Cough suppressants** most important part of Tx; Hycodan® (hydrocodone), Torbutrol® (butorphanol) - Diuretic Tx, especially if concurrent heart diz • Surgery last resort, not been consistently successful - Total ring prosthesis • Vasodilator therapy to ↓ left atrial enlargement & lessen collapse of airway  **Prognosis** • **Guarded**: progressive diz, complications frequent • **Good** for acceptable **control** w/ medical Tx (decreased coughing 75-90%) • Poor w/ surgery
Tracheal trauma H3B;162, 160; H2B 184; E-hb 341; IM-WW 221; Cat 971, 1100; Sx-G 68; Sx4B 385; Sx-WW 77 ** **Potentially fatal** **CS: Dyspnea, SQ emphysema** **Tx: Rest or Surgery**	• **Uncommon, potentially fatal** • Causes: - Bite wounds - Foreign bodies (grass awns, nails, pins) - Whiplash injuries in cats from high rise trauma or automobile accidents (HBC)	• **Noisy breathing** • **± Cough** • Tachypnea, dyspnea ± cyanosis • **SQ emphysema** (crackling under skin) • Sequelae: - Pneumothorax - Hemothorax **DDx:** • Aspiration for FB • Acute allergic bronchitis (cat asthma) • Other causes of SQ emphysema	• Hx (fall, HBC) • PE: Laceration, SQ emphysema, swelling • Radiology: peritracheal, intramuscular, SQ **emphysema** & pneumomediastinum • Tracheoscopy • Surgical exploration 	• **Cage rest only** may be enough • Temporary tracheostomy • Endoscopy: removal of FB • Primary closure of tracheal injuries  Prognosis: • Tracheal stricture: poor w/o surgery • Monitor for 2° infection, strictures, persistent cough, wound dehiscence for 3 weeks

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Tracheitis M8k 1053; Mk 768; H3B 258; H2B 182; E-hb 338; E 756; SAP 575t, 532; Pa-T 131 ***	• **Inflammation of tracheal mucosa** **Causes or tracheitis** • Infectious dizs - Canine parainfluenza virus - Canine adenovirus 1 & 2 - Canine reovirus - Canine herpesvirus - Mycoplasma - Bordetella • **Noninfectious or irritative** - Prolonged barking - Coughing assoc. w/ collapsible trachea or cardiac diz - Inhalation of smoke or noxious gas - Parasite infestation: Filaroides - Allergies - Postanesthetic intubation	• **Coughing #1** • Usually unproductive initially • Sequela: - Pulmonary parenchymal diz - Bronchitis - Bronchopneumonia	• Hx, CS • **PE: Elicit cough on palpation** • Laboratory - CBC - unspecific . Leukocytosis - stress or 2° infection . Eosinophilia - parasitic or allergic • Tracheal wash: chronic inflammatory cells only (PMNs & macrophages) • Radiology: unremarkable unless 2° bacteria (bronchitis or bronchopneumonia) **DDx:** • Pulmonary parenchymal diz • Primary cardiac diz • Collapsing trachea	• **Broad spectrum ABs** 7-10 days • **Cough suppressants** (antitussive) - Hycodan® (hydrocodone) - Contraindicated if lobar pneumonia - Torbutrol® (butorphanol) less potent • ± Short term corticosteroid Tx - Careful in infections & heart failure • Nebulization or vaporization Prevention • Vaccinate for respiratory viruses & Bordetellosis Prognosis: **Good to excellent** if not chronic; may be self limiting
Inflammation **CS: Cough** **Dx: CS, TTW** **Tx: ABs, Antitussive • Px: Good**				
Tracheal foreign bodies/ mass SAP 533, 548, 559; 340; Cat 971, 1099 **	• **Uncommon** • Usually small enough to pass tracheal bifurcation • Large object at tracheal carina (bifurcation)	• **Obstructive breathing pattern** - Fast, normal/fast respiration - Stridor & loud wheezes (rattling in throat) • Chronic cough • Sequela: obstruction & pulmonary abscessation (inhalant pneumonia)	• Hx, CS • **Unresponsiveness to symptomatic treatment** • Radiology: soft tissue or mineral-dense objects w/in tracheal lumen - Atelectatic lung lobe • Bronchoscopy	• **Remove** - Hold animal upside down & shake - Bronchoscopy & snare - Thoracotomy & removal
Obstruction, Rads, Remove				
Extra-luminal compression SAP 549; H3B 161; H2B 231; X-RP 95; X-Gr 144; X3T 266 **	• See mediastinal masses • **Tracheal obstruction, esophageal &/or vena caval compression** **Space occupying lesion** • Dog: thyroid hyperplasia & neoplasia • Cat: Cranial mediastinal masses • Abscess or granuloma • Mediastinal lymphadenopathy • Neoplasia • Cysts (uncommon)	• Reflect underlying cause • **Asymptomatic** • **Cough** • **URT &/or LRT obstruction** - ↑ Expiratory effort or gasping if intrathoracic - ↑ Inspiratory effort if cervical • Dysphagia, drooling • Edema of neck, face & forelimbs (vena cava syndrome) • Laryngeal paralysis (upper airway obstruction: stridor & voice changes) • ± Horner's syndrome	• Hx, PE • **Auscultation** - Displaced cardiac apex beat • **Radiology** - Densities in mediastinum - Compression &/or displacement of trachea, heart or esophagus - Esophagram • Ultrasound • Cytology, culture & sensitivity (C&S) • Serology for infectious diz • Bronchoscopy (exam, culture or lavage) • Mediastinoscopy • Thoracotomy biopsy	• **Abscess or granuloma** - ABs, antifungal agents - Surgical drainage or excision • Neoplasia: - **Lymphosarcoma: chemotherapy** - Surgical excision - Radiation therapy adjunctive • Cysts: Extrathoracic drainage Prognosis: Poor to guarded
Tracheal, esophageal &/or vena cava **CS: Cough, obstruction** **Dx: Rads** **Tx: Abs, Chemo, Sx, Radiation •Px: Poor to guarded**				
Tracheal parasites, Lung worms M8k 1066, 1117; H3B 159; H2B 183; E-hb 339; I2M 295, 301; IM 219; IM-WW 225; 5min 1024 **	• **Uncommon, Greyhound kennels** • Parasites - ***Filaroides osleri*** (*Osleurus osleri*) (lung worms): Larvae in nodules (granulomas) in trachea & bronchi & rarely in lungs - *F. milksi* & *F. hirthi*: larvae in lungs - *Aelurostrongylus abstrusus*: cats - *Crenosoma vulpis*: rare - *Capillaria aerophilia*: unusual finding in dogs, but is known to occur in cats . Requires severe infestation to produce signs	• **Asymptomatic** • **Coughing**: productive or nonproductive	• Radiology: - Occasionally nodular tracheal & bronchial pattern for *Filaroides osleri* - ↑ Bronchial & interstitial pattern w/ others • **TTW** (transtracheal wash) - Cytology for larvae or eggs • CBC: eosinophilia & basophilia • Baermann technique for fecal ova, fecal flotation rarely positive • ± Tracheoscopy/bronchoscopy	• *Filaroides osleri* - **Drug therapy usually effective** . **Ivermectin** PO once, caution in Collies . Thiabendazole PO . Levamisole PO BID - Surgical removal of nodules Prognosis: • **Good**: usually resolves • Guarded: depends on severity of infestation
***Filaroides osleri*, Greyhound kennels** **CS: Asymptomatic** **Tx: Ivermectin PO • Px: Good**				

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Canine infectious tracheo-bronchitis, Kennel cough, Canine upper respiratory infection complex M8k 1123; Mk 769; H3B 1158; H2B 1215; E-hb 339; I2M 285; IM 207; IM-WW 218; 5min 32, 1114; Pa-T 166; NB 18.6 ****	• **Very contagious respiratory disease of dogs** • Lasts days to weeks & may recur • Cause: # of organisms isolated - ***Bordetella bronchiseptica* #1** - **Canine parainfluenza virus** requires concurrent infection for CS - Canine adenovirus type 2 (CAV-2) - Canine herpes virus, Reoviruses - Mycoplasma: role is uncertain • **History** of boarding at kennel or contact w/ other dogs typically	• **Usually mild, self-limiting (5-14 days)** • **Dry, harsh, hacking cough # 1** (especially when excited) - Appears to be choking - Paroxysm of coughing, m/b followed by retching of phlegm or vomitus • ± Nasal discharge & conjunctivitis may be seen • Systemic signs uncommon • Usually continue to eat • Sequela: **Severe broncho-pneumonia & death** in 10-20% - Young unvaccinated dogs - Canine distemper associated	• **Hx of exposure 5-10 days before CS** • Physical exam (normal lung sounds, no fever) **- Cough elicited on light cervical tracheal pressure** • Laboratory: usually normal in uncomplicated cases • If evidence of pneumonia - Obtain specimens for bacterial & viral isolation (TTW or bronchoscopy) - Paired acute & convalescent sera • Radiology: ± Bronchial patterns - ± Interstitial pattern in concurrent distemper	• **Time, supportive care if CS mild** - Don't excite or excessively exercise - Loosen collar - Confine to draft-free, dry area - Consider cough suppressants • Maintain airway patency: clean external nares with warm water soaks, use humidifier to liquefy airway secretions • **Persistent, dry, hacking cough** **- Antitussive** (cough suppressants) . Hycodan® (hydrocodone), Torbutrol® (butorphanol) - Discontinue if cough becomes productive or if an expectorant is required • **ABs** for *B. bronchiseptica* or if pneumonia or systemic signs or if aspiration, 2° infection - Initial Tx: chloramphenicol, tetracycline, amoxicillin, clavamox, trimethoprim sulfas - Culture & sensitivity (C&S) (ideal)

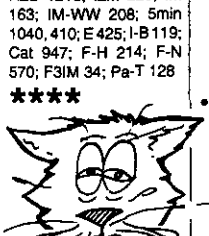
Very contagious, Bordetella, parainfluenza
CS: Dry, harsh cough
Dx: Hx, CS, Tracheal pressure
Tx: Supportive, Hycodan, ABs
Px: Good - Self limiting

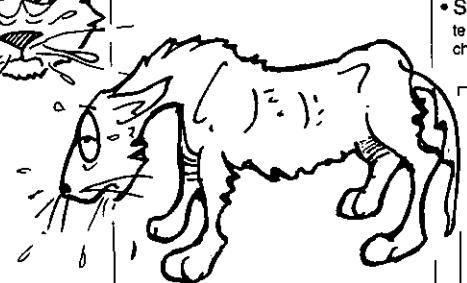
- **Vaccination:** prevention
  - *Bordetella bronchiseptica* vaccine (intranasal & parenteral)
    . Intranasal vaccine w/ *B. bronchiseptica* w/ or w/o Parainfluenza virus: reduce incidence of diz 8-40%
    . Injectable 10 days before anticipated exposure, intranasal 72 hours before
    .. Annual revaccination (more frequent for those at continued risk)
    . Vaccines protect against disease, but not infection or spread
- Minimize transmission
  - Quarantine unvaccinated dogs before entering kennel or hospital
  - Ventilation (12-15 air changes/hour) in kennel or hospital
  - Keep humidity low
  - Disinfect w/ hypochlorite (1:30), chlorhexidine, or benzalkonium chloride
  - Treat kennel cough dogs on an outpatient basis unless bronchopneumonia

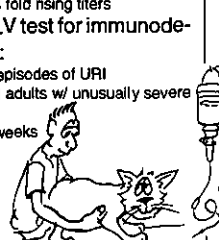


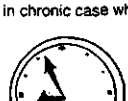
Prognosis:
- **Good:** most self limiting in 5-14 days
- May develop bronchopneumonia (10-20%)

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Feline upper respiratory infection complex; URI M8k 1115; Mk 760; E-hb 208; SAP 100; H3B 1160; H2B 1216; I2M 225; IM 163; IM-WW 208; 5min 1040, 410; E 425; I-B 119; Cat 947; F-H 214; F-N 570; F3IM 34; Pa-T 128 ****	• Cause: 1 or more contagious infectious agents (FRV & FCV: 90%) **- Feline rhinotracheitis virus**, (FRV) (herpesvirus) **- Feline calicivirus (FCV)** **- *Chlamydia psittaci*** (nonviral) - Mycoplasma spp - Reovirus - *Bordetella bronchiseptica* • **2° bacterial infection complicates virtually all** • Transmission: direct contact (cats, fomites) - Recrudescence of FHV when kitten's passive immunity fading (5-7 weeks) - Carrier state in up to 80% • Young kittens & unvaccinated cats, catteries most at risk	• **Sneezing & coughing** • **Naso-ocular discharge** (conjunctivitis, rhinitis) • **Anorexia, gagging,** weight loss • Fever, depression • Hypersalivation, oral ulcers • ± Ocular diz w/o respiratory signs • **FRV: ulcerative keratitis:** numerous small, punctate epithelial ulcers or linear dendritic ulcers, **Abortions, Fetal infections:** born w/ generalized infection (fatal encephalitis or focal necrotizing hepatitis) or asymptomatic & develop CS shortly after birth, **Bacterial pneumonia** • **FCV: ulcerative stomatitis** (paw-&-mouth diz), mild interstitial pneumonia, enteritis (see GI), cute arthritis: limping kitten syndrome (see musculoskeletal) • Chlamydiosis: CS: usually limited to **conjunctivitis** • Sequela: **"Chronic snuffler"** (intermittent sneezing, mucopurulent nasal discharge & gingivitis)	• Hx, **Clinical signs usually enough for individual cats** - Corneal ulcers: FRV - Oral ulcers: FCV - Persistent conjunctivitis: chlamydiosis • Dehydration • Identification of specific agent difficult - Important in catteries & individual w/ recurrent signs - Viral isolation in special labs - IF on nasal or conjunctival smears - Intranuclear inclusions in cells or conjunctival or nasal scrapings - Serology: 4 fold rising titers • FIV & FeLV test for immunodeficiency if: - Recurrent episodes of URI - Vaccinated adults w/ unusually severe signs - Signs > 2 weeks	• **Self-limiting in 5-7 days usually** • **Support #1** **- Outpatient** - eating w/ normal hydration . Keep nose & eye free of discharge (maintain airway patency): warm water soaks . Humidifier or vaporizer (confine to bathroom w/ shower running) liquefy airway secretions . Warm, well-ventilated area . Highly palatable food (warm) . Oxymetazoline nasal spray (**Afrin®**) . Exogenous B_{12} . Low-dose diazepam (Valium®) to improve appetite **- Hospitalize** only in severe cases w/ prolonged anorexia, dehydration, pneumonia (ulcers) . Fluid (balanced electrolyte sol SQ or PO) . Force feed liquid diet, stomach tube or indwelling nasogastric tube • **ABs** (broad spectrum): 2° bacterial infection (Amoxicillin, Tetracyclines, Chloramphenicol) - Pregnant queens w/ Chlamydia: Erythromycin • Topical ophthalmic agent if ocular involvement - Antiherpes drugs: trifluridine eye drops • Steroids contraindicated in acute cases, may be tried in chronic case where above Tx not beneficial

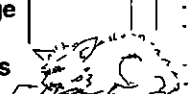








- **Vaccination:** complete protection not guaranteed
  - **Rhinotracheitis & calicivirus routine** vaccinations recommended
    . Parenteral or intranasal
    . 8-12 weeks & 14-16 weeks of age
    . Annual boosters
  - Chlamydia: routine vaccination not recommended in single cat houses, but is in catteries & research facilities, Booster every 6 months
  - MLV vaccines contraindicated in pregnant queens
  - Intranasal vaccine in outbreak situation
- Minimize exposure
  - Management (hygiene)
  - House cats in separate cages w/ solid partitions at least 4 feet apart
  - Vaccinate & quarantine all incoming cats for 3 weeks
  - Liquid bleach (sodium hypochlorite, 1 parts to 30 parts H2O) all cages (10 minute contact) & leave vacant for 2 days (right!)
  - 12 air exchanges/hour minimum
  - Wash hands & change smocks after handling infected cats



Contagious, Virus + Bacteria
CS: Fever, Naso-ocular discharge
Dx: Hx, CS
Tx: Self limiting, Support #1, ABs
Px: Good - Self limiting

Prognosis: Good: self limiting, with adequate supportive care
- Chronic infection can have good quality of life w/ appropriate supportive care

Bronchitis

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Primary ciliary dyskinesia, Immotile cilia syndrome, Kartagener's syndrome H3B 164; H2B 187, 191; E-hb 345; 5min 452; IM-WW 221 *	• Congenital defects or ultrastructure of cilia (respiratory, middle ear, sperm) • Only reported in dog & man • Pathophys.: impaired **"mucociliary escalator"**, chronic airway inflammation - Predisposes to airway & lung bacterial/ viral infections • Dogs < 18 months old • **Purebred sporting & working breeds** (Eng. Pointers & Springers, Goldens, Rottweilers), Chow, Dalmatian, Doby, Elkhound, Border collie, Eng. sheepdog • Kartagener's syndrome: + situs inversus • Acquired ciliary motility defect in dogs - 2° Adenovirus - 2° Bordetellosis	• Restrictive to obstructive breathing pattern • **Mucopurulent nasal discharge** • **Chronic productive cough** • Enlarged lymph nodes • Sequela: - Bronchiolitis, bronchiectasis - Bronchopneumonia (± fever, general debilitation, weight loss)	• Hx young w/ respiratory infections, CS • Auscultation of chest: ± ↑ airway sounds ventrocranially - Inspiratory crackles & expiratory wheezes • **Radiology**: bronchitis, bronchiectasis or bronchopneumonia - "Situs inversus" in Kartagener's syndrome • Transtracheal wash/bronchial wash culture • Bronchoscopy • **Biopsy & EM** (electron microscope) of ciliary structure - definitive Dx - Sperm motility can also be checked • Abnormal sperm (motility), Usually sterile	• **NO primary treatment** • ABs: culture & sensitivity • Nebulization • Chest physical therapy (see bronchiectasis) **Prognosis** • **Poor**: most succumb to chronic infections early in life • Some maintained on long term ABs
Acute bronchitis Mk 768; E-hb 343; H3B 165; H2B 188; NB 18.7 ***	• **Inflammation of bronchi** - Short duration w/ reversible changes • Dog < 2 yrs old • Cats: usually young	• **Acute onset of dry, hacking, paroxysmal cough** - High pitched or "honking" - May terminate in vomiting or gag • BAR (Bright, alert & responsive), except for possible low grade fever • ± Conjunctivitis or rhinitis	• Hx, PE, CS • **Palpation of trachea often elicits cough** • Auscultation: occasional inspiratory & expiratory wheezing • Radiographs: normal or peribronchial infiltrates (esp. in cat) • Laboratory: generally unremarkable • Bronchoscopy: marked erythema of tracheo-bronchial mucosa • Transtracheal wash or bronchial lavage - Cytology: ± ↑ PMNs maybe - Culture may be positive for aerobic bacteria or Mycoplasma spp.	• **Generally self-limiting in 10-14 days** • If persists or stresses owner: **ABs** • **ABs** - cat: - Clavamox® (amoxicillin/clavulanic acid), Baytril®, Cephalosporins, Amoxicillin, tetracyclines - Chloramphenicol (if tolerated) for mycoplasmosis • ABs - dog: - Amoxicillin, Baytril®, Trimethoprim sulfa, Clavamox, Chloramphenicol • **Cough suppressants** (antitussive): Hycodan®, Tussionex® (hydrocodone bitartrate), Torbutrol® (butorphanol) • Humidification & nebulization • Anti-inflammatory: steroids, controversial • **Bronchodilators**: Theo-Dur®, Slo-Bid® (theophylline), Brethine® (terbutaline), Aminophylline Prognosis: **Good**

Causes: Acute bronchitis
- **Viral infections**
  - Dog: parainfluenza, adenovirus-2, herpesvirus, reovirus
  - Cat: calicivirus, herpesvirus
- **Bacterial form**
  - Dogs: *Bordetella bronchiseptica*
  - Cat: Pasteurella sp., alpha hemolytic Streptococcus sp.
- **Inhalation of irritants**: smoke, pollen, dust, etc.
- **Hypersensitivity** (allergy) (see cat asthma)

DDx:
- Foreign body
- Tracheobronchial trauma
- Collapsing trachea

CS: Dry, hacking cough, BAR
Dx: PE of trachea = Cough
Tx: Self-limiting, Hycodan, Theo Dur • Px: Good

Chronic bronchitis - dog COPD M8k 1053; Mk 768; SAP 561; H3B 166; H2B 189; E-hb 344; I2M 293; IM 212; IM-WW 220; 5min 406; X-RP 94, 106; X-Gr 144 ***	• **Persistent inflammation of bronchial tree, 2-3 months** • Adult small or medium-sized breeds ≥ 8 yrs - Toy/small breeds (Poodle, Sheltie, Pomeranian) • Common in geriatric small breed dogs • Often cough for years before seek vet • **Cause: unknown??** - *Bordetella bronchiseptica* - younger dogs w/ lingering kennel cough - Abnormality in local immunity - Irritants: air pollutants, smoke, etc. - Migrating larvae? - Allergic? • Predisposing conditions - Collapsing trachea - Primary ciliary dyskinesia - Obesity? with airway (thoracic inlet) & uncompression: Pickwickian syndrome • May have compromised respiratory immune system w/ abnormal respiratory epithelium (metaplasia, goblet cell & bronchial gland hyperplasia, primary or 2° immotile cilia)	• **Cough!!! - hallmark** - Usually progressive in frequency & severity - Dry, or productive cough (depending if sputum swallowed or not) - Poorly responsive to therapy - Excitement & exertion exacerbate • **Obstructive breathing pattern** - Deep, fast breathing - Expiratory effort • Exercise intolerance - Shortness of breath w/ exercise • Intermittent expectoration or gagging (mistaken for vomiting) • Wheezing, esp. following exertion • **Severely affected** - Cyanosis w/ exertion - Faint after coughing - Barrel chested • Good appetite, no weight loss • Sequelae: - Pneumonia (anorexia, depression or fever) - Obesity: Pickwickian syndrome w/ bronchial collapse - Collapsing trachea/bronchi - Bronchiectasis - Bronchiolitis obliterans	• Hx (age), CS • **Elicit cough by tracheal palpation** (not specific) - ± Collapse cervical trachea • Auscultation: **crackles, wheezing, snapping on deep breathing** • **Radiology:** - **Bronchiolar pattern: "donuts" & "tram lines"** - Variable bronchiectasis - ± Atelectasis • Bronchoscope: excessive mucus; hyperemia & thickening of mucosa • **TTW** (transtracheal wash)/ bronchial lavage - Cytology . Normal: small # of PMNs, alveolar macrophages, epithelia & goblet cells & rarely lymphocytes & eosinophils . Mixed inflammatory cells: PMNs, reactive epithelial cells, eosinophils (< 15%) & macrophages - Culture & sensitivity (C&S): most sterile • Laboratory: CBC usually normal • ECG: may see ↑ P wave amplitude & marked sinus arrhythmia	• Tx underlying condition(s) when possible • **Steroid: prednisolone or prednisone: mainstay of Tx**, especially for eosinophilic bronchitis - Taper to reach lowest effective maintenance dose • **Supportive:** - Nutritional & hydration support - Humidify air (vaporizer or nebulizer) - Dental hygiene - Remove any underlying causes (smoke, parasites) • Diet for obese dog (Hill's r/d) • **Cough suppressants (antitussive)** - Hycodan® (hydrocodone): taper off to minimum effective dose - stop cough cycle - Contraindicated if lobar pneumonia - Torbutrol® (butorphanol): less potent • **Bronchodilator**: Theo-Dur®, Slo-Bid® (theophylline), Choledyl® or Brondecon® (oxtriphylline), Brethine® (terbutaline), Proventil®, Ventolin® (albuterol), Aminophylline • **ABs if 2°** bacterial infection (culture & sensitivity): minimum 3 weeks - Until results back, broad spectrum: amoxicillin-clavulanic acid, Trimethoprim-sulfonamide, cephalothin, enrofloxacin (Baytril®) or tetracycline - Avoid prophylactic or long-term Tx, bacteria resistant strains

DDx:
- Chronic infectious tracheobronchitis (< 1 yr-old)
- CHF (weight loss)
- Pneumonia
- Bronchopulmonary neoplasia
- Extrathoracic tracheal collapse
- Heartworm diz

Bronchitis > 2-3 months, Toys, Cause: ?
CS: Cough, Expiratory effort
Dx: Hx, "Donuts" & "Tram lines"
Tx: Steroid, Hycodan, Theo Dur, ABs • Px: Guarded

Prognosis: Guarded - cure is rare, but significant improvement is possible, **progressive diz** generally

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Bronchiectasis H3B 168; H2B 191; E-hb 345;5min 404 Pa-T 140X-RP 94; X-Gr 144 **	• **Irreversible dilation of bronchi due to destruction of airway wall** • Common finding in dogs w/ severe chronic bronchitis; Rare disorder in cats • Congenital or acquired • **↓ Clearance of airways distal to dilation, 2° infection common** • Causes: - 1° bronchial infection (viral, bacterial, fungal) - 2° infection as seen w/ 1° ciliary dyskinesia - Obstructive airways (neoplasia, FB, inspissated mucus) - Chronic inflammation (aspiration of noxious substances, chronic pulmonary diz) - Congenital bronchiectasis: reported in dog, w/ other congenital abnormalities [Kartagener's syndrome])	• **Chronic cough** - Productive often purulent - Temporary remission after ABs - Hemoptysis • **Systemic signs of infections**: fever, anorexia, halatosis, general debilitation - ± Enlarged lymph nodes	• Hx, CS • Auscultation: ↑ airway sounds, especially over affected bronchi/lung • Purulent bronchial secretions • **Radiology** - required for diagnosis - **Big airways, don't taper** - Bronchography if surgical resection contemplated • TTW (transtracheal wash) for culture No taper	• **Goal**: sterilize retained secretion & promote removal by cough reflex • **ABs** (culture & sensitivity) 14-21 days - Repeat at first sign of exacerbation • **Bronchodilators** • **Postural drainage**: position in left, right, sternal & dorsal recumbency & rotate at 30 minute intervals - **Percussion ("coupage")**: series of cupped hand thumps to chest to dislodge secretions • Surgery (partial lobectomy) if severe localized diz Theo-Dur Prognosis: • **Poor** long term: incurable, usually temporary response to Tx, **progressive diz**
Irreversible dilated bronchi, ↓ Clearance, 2° Infection **CS: Chronic cough, Infections** **Dx: Rad: Big airways** **Tx: ABs , Postural drainage, "Coupage" • Px: Poor**			**DDx:** • Chronic bronchitis w/o bronchiectasis • Occult pneumonia w/ purulent productive cough • Bronchial tumor + 2° infection	
Emphysema H3B 169; H2B 192, M8k 1068; Pa-T 136; X-RP 104; X-Gr 144 *	• **Enlarged air spaces distal to terminal bronchioles & destruction of alveolar walls w/o fibrosis.** Rarely occurs w/o airway diz (bronchitis) • **Only important as a component of chronic airway dizs** • Cause: unknown in dogs & cats - Chronic bronchitis (dogs) - Bronchial asthma (cats) • Pathophysiology: **↑ airflow resistance on expiration & air trapping in the lung(s)** - Hypoxemia, pulmonary hypertension & potential cor pulmonale - Reduced airway diameter w/ loss of elasticity & ↑ lung recoil	• CS reflect underlying bronchial diz • **Coughing** • **Wheezing** • **Expiratory dyspnea** • Gagging or vomiting (expectoration) • Sneezing • Cyanosis in some, pale mucous membranes in others from decreased cardiac output • Complication: - Bacterial infection: fever - Pneumonia - Bullae (coalescence) - Pneumothorax (rupture)	• **Lung biopsy/histo** - definitive • Percussion: hyperresonant thorax • **Radiology**: Hyperinflated lung fields w/ flattened diaphragm & attenuated pulmonary vasculature • Necropsy: frequent finding in chronic bronchitis & bronchial asthma **DDx:** • Chronic bronchitis • Bronchial asthma (cat) • Bronchiectasis • Heartworm • Pulmonary hypertension • Airway obstruction • Radiographic artifacts	• **Treat underlying bronchial diz** • Bronchodilators • Oxygen (28-40%) Theo-Dur **Prognosis: Guarded to poor** long term, irreversible, expect condition to progress

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Cat asthma, **Feline bronchitis,** **Feline chronic bronchial asthma,** **Allergic bronchitis** M8k 575; SAP 567; H3B 170; H2B 193; E-hb 342; I2M 289; IM 210; IM-WW 219; 5min 370; Cat1019; F-N231; F3IM 303; X-RP 103; X-Gr 144 **	• **Cats** • Types - Asthma: acute bronchoconstriction - Acute or chronic bronchitis • Cause: unknown? - **Hypersensitivity** - Environmental pollutants - Genetic predisposition (Siamese?) - Infectious agents (bacteria, mycoplasma, viruses) • Pathophysiology: - **Acute bronchial constriction & ↑ mucus**, proliferation of goblet cells, inflammation, smooth muscle hypertrophy - Recurrent bronchopulmonary infection	• **Respiratory distress** - **Coughing** - **Wheezing** - **Expiratory dyspnea** - Gagging or vomiting (expectoration) - Sneezing • **Asthma: acute episodes, ±asymptomatic between** • **Chronic bronchitis** • Cyanosis in some • Complications: - **Bacterial infection** . Fever - Pneumonia - Emphysema	• **Hx, CS** • Physical exam • **Auscultation**: loud bronchial sounds, expiratory wheezes & crackles in advanced cases • Percussion: ± hyperresonant thorax • Radiology: - Normal bronchial pattern (classically) or interstitial or pulmonary hyperinflation (flattened diaphragm, peribronchial infiltration & mild, diffuse interstitial infiltrates) - Aerophagia • Laboratory: inconsistent - **Eosinophilia < 1/3rd** - Hyperglobulinemia in some - R/O parasites: Heartworm, fecal flotation & fecal sedimentation • **TTW** (Transtracheal wash) - C&S (culture & sensitivity): 1° bacterial bronchitis or 2° (*Pasteurella multocida*), Mycoplasma - **↑ Mucus, eosinophils, PMNs & mucus**: allergic pulmonary diz or parasites . Eosinophilia not diagnostic for asthma (normals m/ have 25% eosinophils) - √ for parasitic larvae (Aelurostrongylus) or ova (Capillaria, Paragonimus) - √ for bacteria, Toxoplasma, fungus, malignancy • Bronchoscopy: if refractory to Tx - Mucosal edema & ↑ mucus in bronchitis	• **Emergency Tx** - asthma attack - **O_2 + rest + steroid usually stabilizes** . **Oxygen cage rest until stabilized** (40%) . **Steroids:** prednisolone or prednisone (SoluDeltaCortef®) . Followed by oral prednisolone - **Bronchodilator:** . **Theophylline** (Theo Dur®) slowly IV over 30-60 min followed by oral Tx; or . Ephinephrine, 1:10,000, 1-2 ml SQ . ± Atropine, if still no response IM (↓ cholinergic tone) (controversial) Steroid Theo-Dur • **Intermediate & long term Tx**, some only when exacerbation, others need chronic Tx - Treat cause if found . Eliminate dust, smoke, powders . Indoor cats . Diet for fat cats . Fenbendazole (Panacur®) if eosinophilia - **Bronchodilators**: **Theo-Dur tablets** (theophylline)(monitor) or Brethine® (terbutaline); monitor for anxiety, tachycardia, hypotension . Combination of Brethine® & Theo-Dur® for refractory cases - **Steroids: prednisone** PO bid; use chronically, not intermittently; taper to lowest alternate day therapy; side effects: insulin resistant diabetes mellitus - ± **ABs** if bacteria or mycoplasma cultured or suspected (fever, CS); Culture & Sensitivity . Empirical: Pasteurella (ampicillin, cephalosporins) mycoplasma (enrofloxacin [Baytril®])
DDx: • Nonrespiratory cause of panting (fear, excitement, hyperthermia, fever, anemia) • Congestive heart failure (CHF) • Pneumonia • Pleural space diz (pneumothorax, pyothorax, diaphragmatic hernia) • Acute viral respiratory infection • Pulmonary parasites • Nasopharyngeal polyp • Laryngeal diz • Major airway obstruction • Intraluminal foreign body • Mucosal tumor (adenocarcinoma)				
Allergy? Bronchoconstriction, ↑ Mucus **CS: Respiratory distress** **Dx: Hx, CS, Auscultation, TTW** **Tx: Emergency (O_2, Steroids, Rest), Chronic Tx** **Px: Always guarded**				Prognosis: **Always guarded**, recurrence of episodes likely Theo-Dur Steroid

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Canine distemper E-hb 198; H2B 1187; E 400; IM 277; IM-WW 222; Pa-T 165 **	• **See Syst pg 689: Severe, highly contagious, multisystem viral diz (see multi-systemic diz)** • Dogs & other carnivores • **Unvaccinated 6-12 wk-old pups** • Transmission: 1° aerosol, transplacental rare • Pathogenesis: - Airborne to tonsil then systemic lymphoid tissue, viremia, dissemination to epithelial tissue - Immunosuppressive **Unvaccinated puppies** **CS: Multisystems** **Tx: ABs, Nursing • Px: Guarded**	• **Subclinical in 50%** • **Multisytemic & extremely variable** • Systemic: malaise, fever (diphasic) • **Respiratory CS:** - **Rhinitis & conjunctivitis** - **Pneumonia**: interstitial to bronchopneumonia (2° bacteria) - **Cough, dyspnea** • GI, Eye, CNS ("chewing gum" fits) • Dental enamel hypoplasia • Hyperkeratosis of foot pads, planum of nose	• Hx (**young unvaccinated dog**, possible exposure), CS • Auscultable ↑ lung sounds w/ crackles • Lymphopenia, early leukopenia, later ↑ PMNs • Radiology: pneumonia • CSF analysis if neurologic CS • Fundic exam, IFA conjunctival smears **Vaccination: prevention** • MLV CDV nearly 100% protective • Measles virus vaccine • Annual boosters recommended	• **ABs** for 2° bacterial infections • Humidification of airways • Pneumonia - Expectorants - Bronchodilators (Hycodan®) • GI & CNS (see elsewhere) • **Good nursing** - Keep eyes & nose free of discharge - Nutritional support, Fluids • **Isolate animal**, 1 week before dog on new premises **Prognosis: Guarded**: depends on vac. status, complications & stage of infection; Grave to poor w/ CNS CS
Feline infectious peritonitis, FIP, **Coronavirus** IM-WW 223 **	• **See sytemic pg 688** • **Progressive & fatal systemic immune-mediated diz (see multi-systemic diz)** • Pyogranulomatous endarteritis & varying systemic signs • Coronavirus (FIP virus) Morbidity: 20%, mortality: 90% - < 3 or > 11 years (all ages) - Catteries > single cats Risk factors (crowding, FeLV or FIV concurrent infections) **Catteries** **CS: Multi-Systems: Fever, Dry & Wet** **Dx elusive: Fluid analysis** **Tx/Px: Fatal, IN vaccine**	• **Initially nonspecific (fever, anorexia**, inactivity, weight loss, vomiting, diarrhea, dehydration & pallor - **Chronic fluctuating fever**, unresponsive to ABs • **"Wet" form** (generally acute) - Effusive - ascites - **Pleuritis: thoracic effusion: 35%** • "Dry" form (generally chronic): granulomatous kidney, pancreas, liver, ocular, CNS, etc. • Combination of both wet & dry forms • **All forms progressive & fatal**	• **Dx elusive**: Hx, CS • Lab: nonspecific - circumstantial evidence - Hematology & serum: **hyperglobulinemia** - Chemistry: noneffusive FIP • Radiology/Ultrasound - Confirm body cavity **effusions** - Organ infiltration (lungs) • **Fluid analysis**: strongly supportive - **Straw colored, thick & visible fibrin strands** - **Hi specific gravity > 1.018, protein > 4 g/dl** • Serology: not definitive (FIP & non-FIP corona virus) • Fundic exam • Histopathology, biopsy or necropsy: only definitive tests	• **No known cure for FIP** - None effective in prolonging life • **Once signs develop - nearly always fatal**: 90% regardless of treatment - Rare remissions in mildly affected or only ocular involvement • Supportive Tx, may improve quality of life **None - Fatal** • **Vaccination: Intranasal** (IN) vaccine (Primucell FIP®) 2 doses 3-4 weeks apart at 16 weeks of age or older, Annual boosters 78% Prognosis: **Grave**
Mycobacterial diz, **Feline leprosy** M8k 492; H3B 177; H2B 202; E-hb 184, 349; E 369; Cat 539, 1947; F-H 284; Pa-T 166 *	• *Involves regional lymph nodes or disseminates throughout body* • Causes: ***Mycobacterium tuberculosis***, *M. bovis*, *M. avium* - Saprophytic mycobacterium, *M. fortuitum*	• Depends on organs/systems affected • Cats: usually intestinal tract • Dogs: usually pulmonary involvement • Rarely are pulmonary signs 1° complaint • Lack of response to ABs • **Debilitation & weight loss** • ± Fever **DDx:** • Neoplasia • Severe nontuberculous bacterial pneumonia • Mycotic pulmonary diz	• Hx, CS (clinical signs) • Radiology (thorax) - Hilar lymphadenopathy & nodular interstitial pattern - Granulomas, mineralized masses - Hypertrophic pulmonary osteopathy • Cytology (TTW): ± Intracellular organisms, usually nonspecific mixed inflammation, Acid fast stains • Culture: respiratory, urine, lymph node aspirate, joint fluid, feces - slow growing • Histopath definitive (biopsy or postmortem) • TB skin test: unreliable, false negatives & positives	• **Euthanize: zoonotic** • **Long term therapy #1**: Isoniazid (Laniazid®), Rifampin (Rifadin®), Isoniazid combined w/ rifampin (Rifamate®), Streptomycin, Ethambutol (Myambutol®) • Saprophytic mycobacterium: Kanamycin, Amikacin, Minocycline, Doxycycline, Trimethoprim sulfadiazine, Amoxicillin/clavulanate • Surgical excision of large granulomas or consolidated lung lobes Prognosis: • Grave for true pathogenic TB • Guarded for saprophytic forms • Zoonosis possible, but not reported
Mycotic/ fungal lung diz, M8k 1065; H3B 178; H2B 202, 1175; E-hb 350; IM 216; I2M 300; IM-WW 2124; 5min 954; Pa-T 166; X-RP 100; X-Gr 144 ** to ***	• **Fungal or fungal-like pulmonary infection** • Uncommon to common depending on location of practice • Lung involvement in disseminated fungal infection common • *Coccidioides immitis* ("yellow fever"): Cutaneous, pulmonary & disseminated forms • *Blastomyces dermatitidis*: 85% pulmonary, 60% lymphadenopathy, other systems also • *Histoplasma capsulatum*: River valleys of central USA - **1° pulmonary in cats, 1° GI in dogs,** but any organ system • *Cryptococcus neoformans*: Cat: 1° in nasal cavity, nasal sinuses, skin, or brain - Pulmonary in 50% of cat cases - Dog: 1° - CNS • *Aspergillus flavus* - Dog: 1° nasal cavity & sinuses - Pulmonary involvement only in severe infection or immunosuppression (steroids)	• Depends on route of entry, localization or dissemination - **Asymptomatic** - Acute sign of localized diz - Chronic signs: chest • Multisystemic signs (± lymphadenopathy, weight loss, etc.) • Nasal signs may predominate in aspergillosis & cryptococcosis • Pulmonary signs: - **Restrictive breathing**: rapid, ± shallow - **Cough** (usually unproductive) - ± Fever **DDx:** • Pulmonary neoplasia • Bacterial pneumonia • Parasitic pneumonia • Eosinophilic lung diz	• Hx, CS • Auscultation: crackles on inspiration & wheezing on expiration (lower airway narrowing of compression) - Loss of breath sounds w/ consolidation or pleural effusions • **Radiology (thorax)** - **Disseminated, nodular interstitial pattern** - ± Hilar lymphadenopathy (tracheobronchial lymph nodes) - ± Cavitary lesions • **TTW** (transtracheal wash): Fungal organisms (not always rewarding) • Pulmonary aspirates: organisms • Serology: Unreliable: false-positive & negative • Biopsy/histopathology: m/b necessary for diagnosis; requires thoracotomy • Culture may be unrewarding (difficult)	• **Itraconazole**: expensive $$$ • **Ketoconazole** • **Flucytosine** (Aspergillosis) • Amphotericin B, may be used w/ ketoconazole or Itraconazole initially for quick reduction in organism numbers • **Combination of amphotericin B & itraconazole or ketoconazole** - Blastomycosis - Histoplasmosis - ± Coccidioidomycosis • **Combination of Flucytosine & amphotericin B** - Cryptococcosis: cats w/ CNS Ketoconazole **Prognosis**: Poor to **guarded**

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

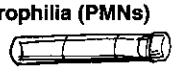
Bacterial pneumonia

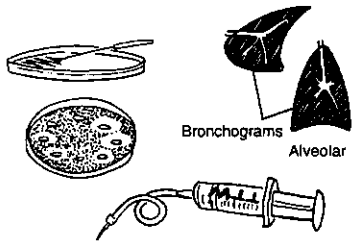
Bronchopneumonia
M8k 1121; Mk 766; SAP 577; H3B 176; H2B 200; E-hb 348; I2M 297; IM 214; IM-WW 223; 5min 952; Cat 1028; Pa-T 145, 166, 168; X-RP 97; X-Gr 144
***

- **Lower Respiratory Diz:** mostly bacterial, usually 2° to viral respiratory diz
- **Causes:**
  - ***Bordetella bronchiseptica***
  - **Gram positive: *Streptococcus zooepidemicus,*** Staphylococcus, Mycoplasmas spp.
  - Gram negative: Pasteurella spp, Klebsiella spp, *E. coli*, Pseudomonas
  - Anaerobes: Actinomyces, Nocardia, Bacteroides, Fusobacterium, Clostridium
- **Pathophysiology: overwhelming or compromising normal defense mechanism**
  - Cilia clearance, phagocytic cells, mucous membrane barrier

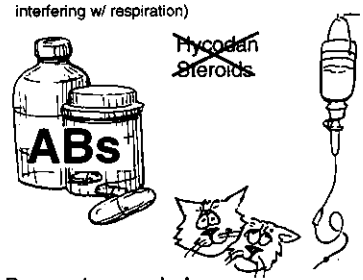
- **Restrictive breathing**
  - **Fast & shallow**
- ± Fever
- **Mucopurulent nasal discharge**
- **Productive coughing**
- Exercise intolerance
- Anorexia, depression, listlessness
- Chronic: weight loss
- Enlarged lymph nodes
- ± Cyanotic gums

- **Hx (predisposing factor)**
- **CS, Physical exam**
- **Auscultation: ↑ lung sounds, crackles**
- Percussion: ± dull sound
- **Laboratory - inflammation**
  - **↑ WBCs w/ neutrophilia (PMNs)**
- **Radiology**
  - **↑ Lung density:**
    - **Alveolar = air bronchograms**
    - Interstitial (initially)
  - **Cranioventral distribution**
  - Lobar pneumonia: regional alveolar w/ air bronchogram
  - Interstitial pneumonia: diffuse reticular pattern
    - Uncommon in bacterial pneumonia: hilar lymphadenopathy, pleural effusion
- **TTW** (transtracheal wash), bronchoalveolar lavage, fine needle aspiration, or specimens obtained from surgery for aerobic & anaerobic cultures
  - Cocci - streptococci, rods - gram neg.
  - Degen. PMNs w/ engulfed bacteria
  - **Culture & sensitivity** (C&S)
- Tests for other predisposing conditions





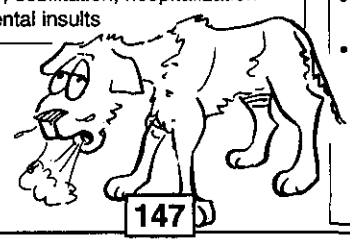
- **Fluids - hydration**
- **Vigorous ABs** (C&S important)
  - **Minimum 3 weeks,** well beyond duration of signs, usually 3-6 weeks
  - Initially (while waiting for C&S):
    - Cephalosporin, Sulfadiazine-trimethoprim, enrofloxacin (Baytril®), amoxicillin-clavulanic acid, tetracycline (mature dog), chloramphenicol (not in cats)
  - **If life threatening sepsis:** combination of IV cephalosporin or ampicillin plus amikacin
  - **Monitoring:** discontinue ABs on basis of:
    - WBC counts
    - Rads: resolution of pneumonia (rad findings last longer than diz)
  - Temporarily stop ABs for 24-48 hr & re-culture; if WBC count returns to normal & rads resolving, stop ABs
- **Thoracic coupage** 4-6/day
- Airway humidification
- **Bronchodilators: controversial**
- Cough suppressants & steroids contraindicated
- Surgical lobectomy infrequently for refractory patient
- Thoracocentesis drainage (if pleural fluid interfering w/ respiration)



Prognosis: **guarded**; depends on the chronicity & severity of any underlying conditions

DDx:
- Infectious
  - Viral (usually upper)
  - Fungal & parasitic
- Noninfectious
  - 1° neoplasms
  - Metastatic neoplasms
  - Thoracic lymphosarcoma

Predisposing factors - Pneumonia
- Pre-existing bronchopulmonary diz (lungworms, heartworms, systemic mycosis, smoke inhalation, thromboembolic diz, lung contusion)
- **Immunosuppression/immunity status**
  - Virus (FeLV, FIV, canine distemper, parvovirus)
  - Hyperadrenocorticism, diabetes mellitus, generalized demodicosis)
  - Drug therapy
  - Inadequate vaccination status
- Abnormal respiratory defenses
  - Cushing's diz, chronic bronchitis, ciliary dyskinesia, PMN dysfunction syndromes
- Bronchial foreign body
- **Aspiration/inhalation**
  - Upper respiratory infection
  - Oronasal sources of infection (sinusitis, dental disorders)
  - Food, liquid, barium - megaesophagus
  - Anesthesia - aspiration
- Catheter sepsis
- Contaminated endotracheal, tracheostomy tubes or bronchoscopy
- Inactivity, prolonged recumbency
  - Following surgery, debilitation, hospitalization
- Trauma/environmental insults

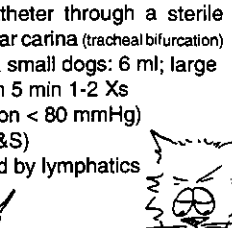


Transtracheal wash (TTW)

SAP 529

- Simple, inexpensive procedure
- For bronchopulmonary diz
- Technique:
  - **Percutaneous** - Dog
    - Long, through needle catheter (10-14") through tracheal rings
    - Advance catheter into lower airway near carina
  - **Transtracheal:** dog & cat
    - Place an open-end urinary catheter through a sterile endotracheal tube & advance near carina (tracheal bifurcation)
  - Inject warm, sterile saline (cats & small dogs: 6 ml; large dogs: up to 20 ml); can repeat in 5 min 1-2 Xs
  - Retrieve fluid by aspiration (suction < 80 mmHg)
  - Cytology, culture & sensitivity (C&S)
- Fluid remaining is rapidly absorbed by lymphatics

Bronchoscopy & bronchoalveolar lavage

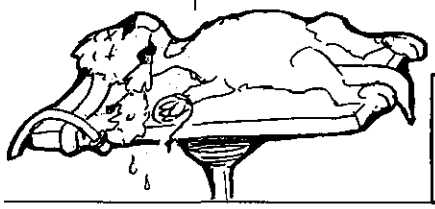


- Especially useful in alveolar-interstitial diz & dyspnea w/o cough
- Technique:
  - Flexible fiber-optic bronchoscope into bronchial tree
  - Visualize diseased area & wedge bronchoscope or catheter via biopsy channel w/in bronchus
  - Inject 20-30 ml of warm saline (30# dog)
  - Retrieve fluid (mild suction < 80 mmHg)
  - Cytology or quantitative cell counts, culture & sensitivity

Lower Respiratory Diz, Bordetella, Strep.
CS: Fast & Shallow, ± Fever, Nasal discharge
Dx: CS, PE, Lab, TTW - C&S
Tx: Fluids, ABs • Px: Guarded

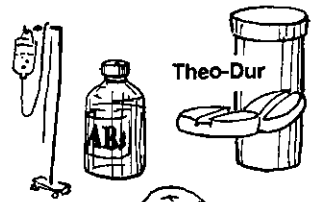
Aspiration - Parasites — RESPIRATORY SYSTEM

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Aspiration, Inhalation, Gangrenous pneumonia M8k 1056; Mk 709; H3B 179; H2B 203; I2M 303; IM 221; IM-WW 227; Cat 1031; Pa-T 168; X-RP 97; X-Gr 144 **	• **Pneumonia due to foreign material passing down trachea into lungs** • **Causes:** - **Ingesta:** . Pharyngeal abnormalities . Following laryngectomy . Esophageal disorders w/ regurgitation (megaesophagus) . Vomiting . Recumbency or unconsciousness .. Gastric reflux - **Foreign material:** . Aerosolization: asbestos, lime dust, chemical, noxious gas . Oral secretion from dental diz, abscesses, necrotic infections, tumors - **Iatrogenic:** . **Intubation**: barium, mineral oil, foodstuffs . Oral medications . **Surgery**: removing intubation tube too soon	• **Peracute death** • **Acute aspiration** - Dyspnea varies from mild tachypnea to marked inspiratory dyspnea w/ orthopnea - Tachycardia - Hypotension - Wheezing, coughing, gagging - Rapid progression: fever, malaise, cyanosis • **Subacute or chronic aspiration** - Gradual onset of CS - Cough (productive) - **Restrictive breathing** (fast & shallow) - ± Cyanosis - Depression, anorexia - Exercise intolerance - Fever, malaise	• **History, CS - presumptive Dx** • **CS - dysphagia**, presence of FB • Auscultation: **crackles & wheezes** over effected lung lobes - **Silence** due to consolidation • **Laboratory** (repeat in 24-72 hours) - Dramatic leukocytosis w/ left shift • **Radiology** (repeat 24-72 hours after aspiration) - Patchy or focal distribution - Ventral (dependent) apical & middle lobes - Alveolar infiltrate w/ air bronchograms (peripheral) - ± Pleural effusion • **TTW** (transtracheal/bronchial wash) - Purulent material/feed - Cytology: degenerative epithelial cells, toxic PMNs ± bacteria - Culture: pathogens or sterile • Blood gases: ± hypoxemia if severe • Postmortem - Acute: Pulmonary edema, Hemorrhagic necrotizing pneumonia - Chronic: Granulomas & abscesses	• **Prevent further aspiration** - Intubate if altered consciousness - Reposition feeding tubes • **Oxygen** (O2 cage or nasal cannula): PEEP if necessary (i.e., obstruction or edema) • **ABs** (culture & sensitivity) - Minimum of 3 weeks, see bacterial pneumonia • **Bronchodilators** • **Fluids - hydration** • Thoracic coupage 4-6/day • Shock therapy if needed • Airway humidification • Surgical lobectomy infrequently for refractory patient w/ lobar involvement, especially if anaerobic infection • Thoracocentesis drainage (if pleural fluid interfering w/ respiration) • Steroids?



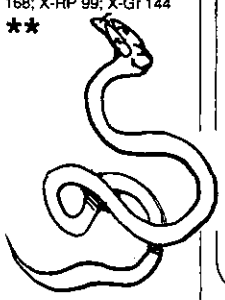
CS: Dyspnea / Death
Dx: Hx
Tx: Support, ABs
Px: Grave/Guarded

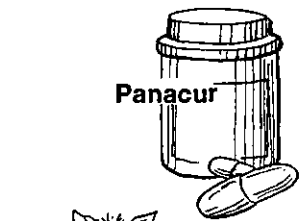
DDx:
• Hematogenous pneumonia
• Lobar bronchopneumonia
- Acute respiratory distress syndrome
• Pulmonary edema



Prognosis:
• **Grave to guarded**
- Grave with acid or particulate material (necrosis or granulomatous pneumonia)
- Guarded w/ neutral or lipids

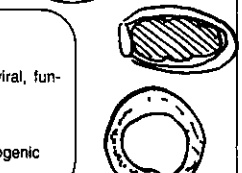
Parasitic lung diz, **Verminous pneumonia, Lungworms, Lung fluke** Mk 763; SAP 578; H3B 135; H2B 209; E-hb 350; IM 191; 5min 908, 1024; Pa-T 167, 168; X-RP 99; X-Gr 144 **	• Normal phase of parasite development or aberrant migration • Young animals < 2 yrs - CS **Number of respiratory parasites:** • ***Aelurostrongylus abstrusus***: Cat nematode; intermediate host: snail; transport hosts - birds, small mammals & reptiles • ***Paragonimus kellicotti***: Fluke of dog & cat; intermediate host: crayfish, aquatic snail; transport host: raccoon • ***Capillaria aerophilia***: Nematode of dog & cat - **direct life cycle** • **Filaroides spp.** (*F. [osleru] osleri, F. milksi, F. hirthi*) nematode: **direct life cycle** • *Crenosoma vulpis* • *Angiostrongylus vasorum* • **Larval migration** - *Ancylostoma caninum* - Uncinaria - *Toxocara canis* - *Toxocara cati* - ± Tricuris - *Dirofilaria immitis* - arteries or granuloma	• CS depend on parasite • **Mild cases: asymptomatic** • Clinical cases - Cough - Weight loss - Exercise intolerance	• **Hx, CS** • **TTW** (Transtracheal wash or aspiration) - **Parasitic ova or larvae** - **Eosinophils** in airway • **Peripheral eosinophilia** common w/ lung worms or flukes • Radiology: - Aelurostongylosis: indistinct interstitial-nodular pattern . Miliary lesions - Filaroides: no obvious signs **Fecal flotation** - Paragonimus: operculated egg - Capillaria: double operculated egg - Aelurostrongylus or Filaroides . Embryonated eggs or Larvae	• **Fenbendazole (Panacur®):** generally safest for all • Albendazole • Tetramisole - filaroides • Thiabendazole - filaroides • Levamisole (Ripercol®) - aleurostrongylus, filaroides - Poorly tolerated in cat • Ivermectin dog PO once • Droncit® - Paragonimiasis • Oral ivermectin - *Filaroides (osleru) osleri* **Prognosis: Good** • Guarded to poor: granulomatous diz • Superinfection may develop in parasites w/ direct life cycles • Fulminating pneumonia may result from Tx (rapid death of worms & intense inflammation)

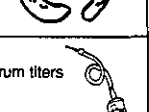




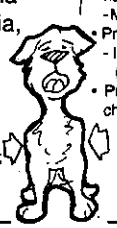
Phase or aberrant migration
CS: Asymptomatic, Cough
Dx: TTW, Fecal
Tx: Panacur

DDx:
• Chronic bronchitis
• Pneumonia (bact., viral, fungal, protozoal)
• Eosinophilic lung diz
• Neoplasia
• Nonparasitic bronchogenic cysts & granulomas

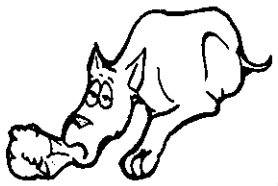
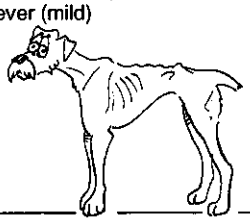
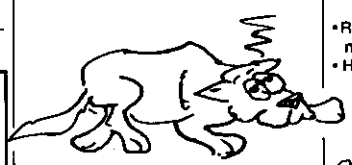
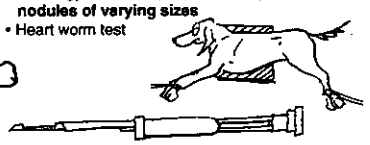
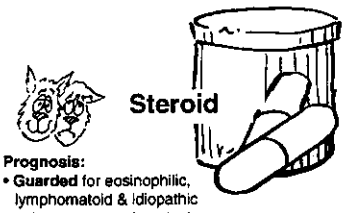


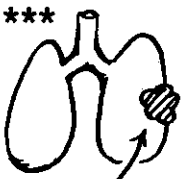
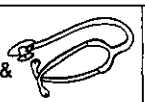
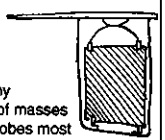
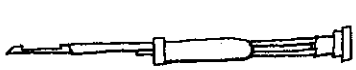
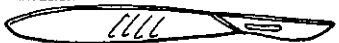


Toxoplasmosis, * **Toxoplasma pneumonia, Protozoal lung diz** H3B 179; H2B 203; SAP 141, 578; E-hb 192; I2M 300; IM 191; 5min 1024; F-H 369; Pa-T 167; X-RP 167	• ***Toxoplasma gondi:*** cat definitive host (30% have been infected), can occur in dogs - Multisystem protozoal (often subclinical in cats) • Predispose: - Immune deficient diz or concurrent infections (FeLV & canine distemper) • Pulmonary diz more common w/ acute than chronic toxoplasmosis	• **Most asymptomatic** • **Acute necrotizing pneumonia** - Restrictive breathing (shallow & rapid) - Fever • **Multisystem** - CNS - Anterior uveitis, chorioretinitis - Hepatitis • Generalize lymph node enlargement	• History, Clinical signs • Serologic evaluation - serum titers - IgG - prior exposure - **IgM - active infection** • PE: lymph node enlargement • **Radiology:** - **Fluffy interstitial & alveolar densities** - Nodular consolidation • TTW (transtracheal & bronchial wash): ± Organisms, nonspecific mixed inflammation • Fundic exam	• **No treatment is consistently effective** • Clindamycin TOC (Tx of choice) **Prognosis: Guarded**: 60% w/ clinical illness recover **Public health:** • **Pregnant women** should avoid contact w/ soil, cat litter & raw meat (ocular lesion in newborn child) - Transmission by petting cat unlikely



Neoplasia - Lung

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Allergic pneumonia, **Pneumonitis (hypersensitivity) PIE, Pulmonary infiltrates w/ eosinophilia, Eosinophilic pneumonitis, Eosinophilic lung diz** M8k 1114; SAP 571; H3B 183; H2B 208; E-hb 352; IM-WW 231; 5min 950; X-RP 98; NB 18.8 **	• Uncommon • **Idiopathic**: resembles pulmonary hypersensitivity in humans • **Pulmonary infiltrate & 2° lung dysfunction** 	• **Cough!!!!!** • **Weight loss** • Fast RR (tachypnea) • Fever (mild)  **DDx** - pulmonary eosinophilia • Parasites (heartworms, lungworms, lung flukes, migrating intestinal parasites) • Drug allergies or inhaled antigens • Fungal infection (histoplasmosis & bronchial aspergillosis) • Lymphosarcoma (eosinophilic chemotaxis, hypereosinophilic syndrome) • Pulmonary eosinophilic granulomas	• Hx, CS • Laboratory: **peripheral eosinophilia** (often > 10,000/µl) • **Radiology:** mixed alveolar, interstitial, bronchial patterns - ↑ Vascularity of lung (cor pulmonale) • **TTW** (tracheal wash) or bronchoalveolar lavage - **Eosinophilia usually** • Bronchoscopy: greenish-yellow secretions • Heartworm: Knotts' test, serology (occult) • **Response to corticosteroids** • **R/O (rule out)** all known causes of pulmonary eosinophilia 	• **Steroids: prednisolone** (CCS) (immunosuppressive doses) - Usually see dramatic improvement in 2-5 days • **ABs** for 2° infections **Prognosis: Guarded to good** - Relapses occur - Some dogs recover fully
?, Eosinophilia - Lung infiltrates **CS: Cough, Weight loss** **Dx: Eosinophilia - R/O** **Tx: Steroids • Px: Guarded to good**				
Granulomatous pulmonary disorders, **Lymphomatoid granulomatosis** SAP 571; E-hb 352; I2M 307; IM 220; IM-WW 232; Pa-T 149; NB 18.8 +	• **Granulomatous inflammation, hilar lymphadenopathy & ↑ lung density** • **Pulmonary disorders** - Systemic mycosis - Eosinophilic pulmonary granulomatosis - Lymphomatoid pulmonary granulomatosis (Burmese Mt. dog) - Pulmonary tuberculosis (rare) - Idiopathic granulomatosis (immune-mediated?)	• **Systemic illness** (inappetence, weight loss, lethargy & fever) • **Pulmonary diz CS** - Cough - Tachypnea • Hx of progression & death or spontaneous resolution 	• Hx, CS • Serology for systemic mycosis (aspergillosis or cryptococcosis) • Lung fluids: eosinophils & PMNs & reactive macrophages • Lung biopsy (thoracotomy): definitive, thoracotomy - Hilar lymphadenopathy - Pulmonary infiltration & pulmonary parenchymal lesions • Radiology: interstitial pattern + **multiple, ill-defined nodules of varying sizes** • Heart worm test 	• **Steroids**: prednisolone (CCS) (immunosuppressive doses) • Cytoxan® (cyclophosphamide)  **Prognosis:** • **Guarded** for eosinophilic, lymphomatoid & idiopathic pulmonary granulomatosis - Good response in some w/ aggressive therapy
Granulomas in lung **CS: Systemic & Lung** **Dx: Hx, CS, biopsy, Rads** **Tx: Steroid • Px: Guarded**				

Neoplasia of the lungs M8k 1119, 1120; Mk 765; SAP 590; E-hb 353; H3B 188; H2B 212; I2M 305; IM 223; IM-WW 228; Cat 1042; F-H 468; Sx-WW 80; Pa-T 169; X-RP 103; X3T 382; X-Gr 144 *** 	• *Primary pulmonary tumors* - 1% of dog tumors - 0.5% of cats - May metastasize to bronchial lymph nodes, lungs, brain or bone - Carcinomas #1 in dog - Adenocarcinomas: 50% metastasized at Dx - Epidermoid carcinomas: 80% metastasized at Dx • **Metastatic pulm. neoplasms** - **More common than 1°** - Tumor emboli spread by lymphatics or blood vessels • Older animals >10 yrs - Except lymphomatoid granulomatosis: young dogs 1-6 yrs • Boxers & Bernese mt. dogs 	• ± Asymptomatic when discovered • **Cough** (harsh nonproductive) - Hemoptysis (blood) • **Dyspnea variable,** None early - **Restrictive breathing** w/ diffuse or large neoplasia . Rapid (tachypnea) & shallow • ± Cyanosis • ↓ Exercise tolerance • Less common signs (anorexia, fever, weight loss, dysphagia, vomiting, regurgitation) • Sequelae: - **Lameness**: hypertrophic osteopathy a paraneoplastic syndrome seen in 3-15% of animals w/ pulmonary neoplasm . Others (paraplegia & subclinical neuromyopathy, hypercalcemia, neutrophilic leukocytosis, hyperadrenocorticism	• Hx, CS • Auscultation:  - ± Inspiratory crackles & expiratory wheezes - Diminished or abnormal lung sounds • Percussion: regional or diffuse dullness may occur, depending on distribution of lesions • **Radiography usually diagnostic** (VD, right & left lateral) - 10% missed on plain films due to: small lesions, hidden, pleural fluid, atelectasis of 1 or more lobes - Patterns vary tremendously: . **Solitary or multiple nodules** . Diffuse pattern: alveolar, interstitial or bronchial - Hypertrophic pulmonary osteopathy of extremities  - Other radiographic signs . Pleural effusions . Pleural thickening . Thoracic lymphadenopathy . Calcification & cavitation of masses . Right side & caudal lung lobes most common site in dog 1° . Left lung in cats • **Percutaneous transthoracic fine needle aspiration** or biopsy diagnostic in 50% of cases) • Cytologic: TTW (transtracheal wash), bronchoalveolar lavage & pleural fluids for neoplastic cells • **Histo: bronchoscopy & biopsy** if perihilar masses • **Exploratory thoracotomy & biopsy** - Definitive diagnosis & aid in staging tumor 	• **Surgical excision &/or lobectomy TOC** (Tx of choice) **for solitary lung tumors** - Biopsy regional lymph nodes - Submit lung tumors or biopsy for diagnosis & prognosis - Adjunctive chemotherapy - metastasis or local invasion  • **Chemotherapy**: may be beneficial in some - Lymphomatoid granulomatosis: prednisolone, vincristine, cyclophosphamide - Malignant histiocytosis in Bernese mountain dogs: doxorubicin, cyclophosphamide, vincristine - Complete or partial response reported for metastatic tumors (hemangiosarcoma, thyroid carcinomas, squamous cell carcinoma, mammary adenocarcinomas) doxorubicins, cyclophosphamide & vincristine • Follow up thoracic radiographs every 1-3 months Prognosis: • **Poor** - >75% of 1° tumors inoperable • Survival > 1 year small (< 5 cm, 2") solitary 1° tumor w/o metastasis or malignant effusion • Survival > 6 months large lobar mass w/ excision if no metastasis

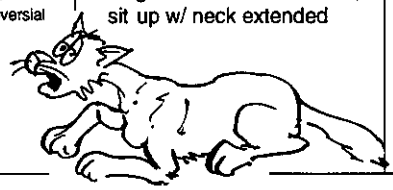
Types of pulmonary neoplasms

- **Metastatic tumors in dogs & cats**
  - Mammary carcinoma
  - Osteosarcoma
  - Thyroid carcinoma
  - Transitional cell carcinoma
  - Melanoma
  - Hemangiosarcoma
  - Squamous cell carcinoma
- Primary tumors in dogs
  - Carcinoma
    - . Bronchoalveolar adenocarcinomas (> 70%)
    - . Epidermoid (squamous cell)
    - . Bronchogenic or branchial gland
    - . Anaplastic or alveolar
  - Sarcoma (uncommon)
    - . Lymphoma
    - . Fibrosarcoma
    - . Hemangiosarcoma
    - . Osteosarcoma
  - Lymphoid granulomatosis
  - Malignant histiocytosis (Bernese mt. dog)
- Primary tumors in cats
  - Carcinoma
    - . Adenocarcinoma (papillary, bronchoalveolar)
    - . Epidermoid (squamous cell)
    - . Bronchial gland
  - Sarcoma (rare)
    - . Hemangiosarcoma
    - . Spindle cell
    - . Reticulum cell
  - Benign (rare)
    - . Bronchial adenoma
    - . Hemangioma

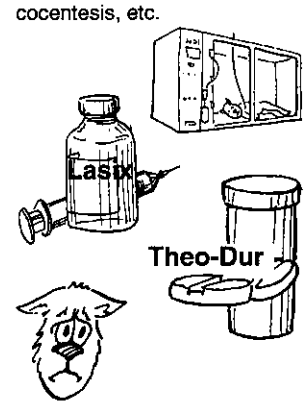
Metastatic > 1°
CS: Respiratory
Dx: Rads, Biopsy
Tx: Sx removal, Chemo • Px: Poor

Pulmonary Edema — RESPIRATORY SYSTEM

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Pulmonary edema, **Noncardiogenic pulmonary edema,NCPE** **Adult or acute respiratory distress syndrome,** **Shock lungs** SAP 572; H3B 173, 182; H2B 197, 206; E-hb 356; I2M 310; IM 226; 5min 984, 1022; Cat 1036; Pa-T 137; X-RP 101 ***	• ↑ Lung water & solute • **#1: left-sided heart failure** • **#2: over infusion of crystalloid fluids** • Noncardiac pulmonary edema (NCPE) - #1 Injury in pulmonary capillaries; other causes controversial	• **Restrictive breathing pattern** **- Rapid & shallow** • Coughing only if fulminate alveolar edema - Cats: sternal recumbency/ abducted elbows - Dogs: reluctant to lie down, sit up w/ neck extended	• **Auscultation:** **- Inspiratory fine crackles** • Mucus membranes: dusky or cyanotic • **Radiology:** - ↑ Lung density or interstitial & alveolar nature . Heart failure - perihilar . NCPE: diffuse, but often dorsal & peripheral - Lag of 12-24 hrs between onset of CS & radiographic changes • ECG (echocardiography) to R/O heart failure	• **Noncardiogenic edema** - Treat underlying condition - **Oxygen**: cage or nasal oxygen or mechanical ventilation - Maintain patent airway - Stop or minimize IV fluids - **Lasix®** (furosemide) - Morphine in dog or acepromazine in cats if sedation is needed -? Steroids: consider 1 shock dose of prednisolone - **Bronchodilators** (Theo-Dur®) - Correct metabolic acidosis - ABs prophylactic (consider) • Cardiogenic pulmonary edema: see Circulation: O_2, Lasix, thoracocentesis, etc.



Causes of pulmonary edema
SAP 572; IM 227
- High-capillary pressure
  - **Left-sided heart failure**
  - **Over infusion of crystalloid fluids**
- ↑ Pulmonary capillary permeability
  - Sepsis
  - Shock
  - Pulmonary thrombocytopenia
  - DIC (disseminated intravascular coagulopathy)
  - Inhalation of smoke/noxious gases
  - Aspiration of gastric juices
  - Uremia
  - Near drowning
  - Immunologic reactions
  - Pancreatitis
  - Snake bite
  - Toxins
  - Pulmonary infection
- Lymphatic insufficiency
  - Pulmonary neoplasia
- Undetermined or multiple origin
  - Neurogenic
    . Seizure
    . Head trauma
  - Electrocution
  - Upper airway obstruction (brachiocephalic)
  - Re-expansion lung edema (rapid removal of pleural fluid or air)
  - Drug-induced (ketamine, narcotic over dosage)

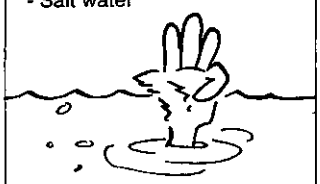


CHF > NonCHF
CS: Restrictive breathing
Dx: Radiology: ↑ Lung density
Tx: NonCHF: O_2, Lasix®, Theo-dur® • Px: Poor

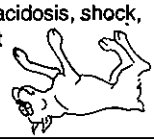
Prognosis: **Poor**

Near drowning
H3B 175; H2B 199
**

- **Near drowning**
  - Fresh water
  - Salt water

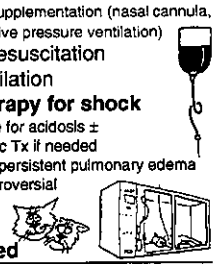


- **Loss of consciousness**
- Respiratory distress
  - ↑ **Inspiratory effort,** or
  - **Respiratory arrest** (apnea)
- Hypothermia
- Hypoxemia, acidosis, shock, cardiac arrest



- Hx (**near drowning**)
- Radiology
  - Perform immediately if stable
  - Serial films for 2° pneumonia, consolidation or abscessation
  - Alveolar pattern: air bronchograms (salt water), alveolar flooding
- TTW (transtracheal wash): culture & sens.
- Acidosis & hypoxemia
- Hyponatremia (hypervolemia) in fresh water

- **Oxygen** supplementation (nasal cannula, cage or positive pressure ventilation)
- Artificial resuscitation
- Bronchodilation
- **Fluid therapy for shock**
  - Bicarbonate for acidosis ±
- Antiarrhythmic Tx if needed
- Diuretic Tx if persistent pulmonary edema
- Steroids controversial

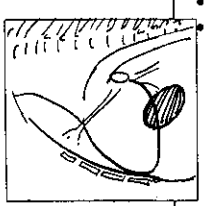


Px: **Guarded**

Solitary lung lesions;
Cystic/bullous diz
H3B 180; H2B 205; E-hb 357
**

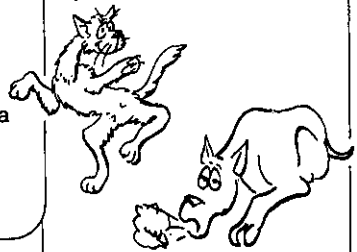
- Radiographic finding: cavitation 1° radiodense focus w/ radiolucent center

DDx for solitary lung lesions
- Bullae & blebs (destruction of alveolar wall)
- Abscesses:
  - Focal pneumonia
  - Foreign body, punctures
  - Chronic bronchitis or bronchiectasis
  - 1° mycotic or parasitic infections
- Neoplasia
- Parasitic lesions
  - Dirofilariasis
  - Aleurostrongylus (rare)
  - Paragonimiasis (flukes)
  - Eosinophilic lung diz
    . Chronic eosinophilic pneumonia (cats)
    . Granulomatous diz - dogs
    . Focal pneumonia
- Bronchogenic cysts

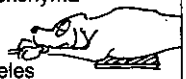


- **Asymptomatic**, noted on routine thoracic radiography
- **Dyspnea: fast RR** (tachypnea)
- **Cough**
- ± Fever from infection or necrosis
- ± Systemic signs: lethargy, malaise, anorexia, exercise intolerance

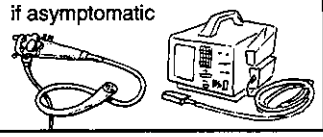
- **Sequela:**
  - **Hypertrophic pulmonary osteoarthropathy**
  - Pneumothorax or pneumomediastinum



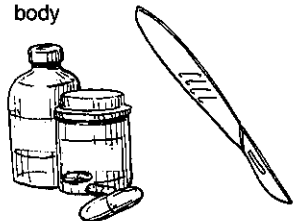
- Hx, CS
- **Radiology:**
  - Thick-walled lesions w/ gas & fluid densities
    . Abscesses
    . Cavitation of a neoplasm
    . Infarcts (rare)
  - Thin-walled w/ usually normal adjacent parenchyma
    . Blebs
    . Cysts
    . Pneumatoceles



  - No distinct wall & no fluid density
    . Bullae
    . Loculated pneumothorax
- Bronchoscopy - airway secretions
  - Cytology for infec. or neoplasia
- Ultrasound: evaluate or guide biopsy
- Exploratory thoracotomy
- Repeat radiology at 1 & 6 months if asymptomatic



- **Cysts, bullae & blebs**
  - No immediate treatment
  - Monitor for spontaneous pneumothorax
- ABs, antifungal, anthelmintic: culture, cytology or histology
- Surgical:
  - Most solid lung lesions, persistent localized infection of a suspected abscess
  - Neoplasia
  - Persistent pneumothorax
    . Confirm bullous lesions
    . Suspected or confirmed foreign body

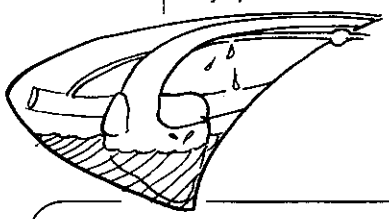


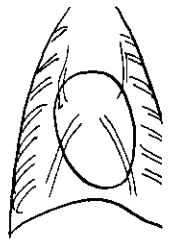
Prognosis:
- **Guarded to good**

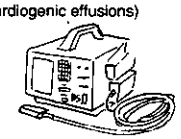
Rads; Tx: Med or Sx

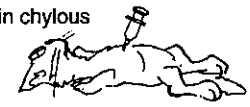
Pleural Effusions

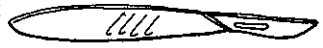
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Pleural effusions SAP 580; E 873; E-hb 363; E 817; I2M 314, 336; IM 229, 245; IM-WW 229; H3B 193; Cat 1053; F3IM 300; Pa-T 172; X-RP 109; X-Gr 144; Lab-C 246 ***	• **Abnormal accumulation of fluid in pleural space** • Normally just a small amount of fluid for lubrication • Causes (see box) - Changes in hydrostatic & oncotic pressures - ↑ Vascular or lymphatic permeability - Lymphatic obstruction	• Variable • **Restrictive breathing pattern** - **Rapid & shallow,** or • **Inspiratory dyspnea** w/ open mouth breathing, cyanosis • Preference for sternal recumbency • Coughing (uncommon) • Jugular venous distention/ pulsation • Nonspecific findings (fever, depression, anorexia, weight loss, pale mucous membranes)	• Hx, CS, PE • **Auscultation:** - **↑ Heart, ↓ Lung sounds ventrally** - **↑ Lung sounds dorsally** • Percussion - dullness • Radiology: - Blurring of cardiac silhouette - **Fluid-filled interlobar fissures** - **Rounding or blunting of lung margins at costodiaphragmatic angles** - Scalloping of lung margins at sternal border (lateral view) - Widening mediastinum - **Separation of lung borders from thoracic wall by fluid density** - Horizontal beam views to see fluid line - Underlying CS (cardiomegaly, intrapulmonary lesions, diaphragmatic hernia, lung lobar torsion, thoracic trauma) • **Ultrasound** (do before fluid removal) - Cardiac function (cardiogenic vs noncardiogenic effusions) - Valvular lesions - Congenital cardiac abnormalities - Pericardial effusion - Mediastinal & cardiac masses • **Thoracocentesis** - Fluid analysis characterize effusion (see box) • Ether clearance test: rapid screening test for chyle • Triglyceride concentration in fluid > than in serum in chylous • **Exploratory thoracotomy** - Migrating foreign bodies - Biopsy of lung or mediastinal lesions - Tx of pyothorax or chylothorax	• **Depends on underlying cause** Prognosis: • Grave to guarded • Neoplasia: grave • Trauma: guarded











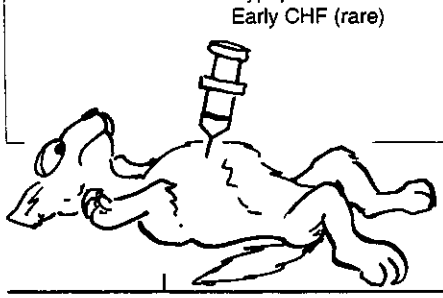
Causes of pleural effusions

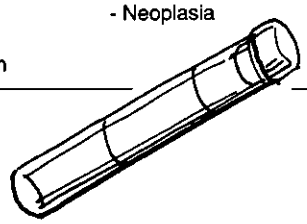
SAP 581

- ↑ Hydrostatic pressure
  - Congestive heart failure (cardiomyopathy, valvular diz, pericardial effusion)
  - Over infusion of fluids
  - Intrathoracic neoplasia
- ↓ Oncotic pressure (due to hypoalbuminemia)
  - Protein losing enteropathy
  - Liver diz
  - Protein losing nephropathy (nephrotic syndrome)
- ↑ Vascular/lymphatic permeability or obstruction
  - Infectious pleuritis (bacterial, viral, fungal)
  - Noninfectious pleuritis (uremia, pancreatitis)
  - Foreign body penetration
  - Hemorrhage
  - Diaphragmatic hernia
  - Lung lobe torsion
  - Pulmonary thromboembolism
  - Neoplasia
    - Mediastinal lymphosarcoma
    - Metastatic neoplasia
    - Primary lung tumor
    - Mesothelioma
  - Chylothorax (idiopathic or 2° to primary diz)

Pleural effusions - Characteristics

	Transudate	Modified transudate	Nonseptic exudate	Septic exudate	Chylous exudate	Hemorrhagic
Color	Colorless/pale yellow	Yellow/pink	Yellow/pink	Yellow/red-brown	**Milky white**	**Red**
Turbidity	Clear	Clear/Cloudy	Clear/cloudy	Cloudy/opaque	Opaque	Opaque
Protein (g/dl)	**< 1.5**	**1.5-3.0**	2.5-6.0	**3.0-7.0**	2.5-6.0	> 3.0
Bacteria	-	-	-	**+ Bacteria**	-	-
Fibrin	-	-	**Fibrin**	**Fibrin**	Variable	Fibrin
Triglycerides	-	-	-	-	**Triglycerides**	-
Nucleated cells/µl	**< 1000**	**1000-5000**	1000-20,000	**5,000- 300,000**	500-20,000	**As in peripheral blood**
Cytology	Mesothelial cells	Macrophages & Mesothelial cells Neoplastic cells m/b	**Nondegenerate PMNs**, macrophages Neoplastic cells m/b	**Degenerate PMNs** Macrophages	**Lymphocytes** PMNs & macrophages	RBCs & WBCs
Diz associations	Hypoproteinemia Early CHF (rare)	Chronic CHF Neoplasia Diaphragmatic hernia	FIP Neoplasia Diaphragmatic hernia Lung lobe torsion	**Septic pleuritis** (pyothorax)	**Chylothorax** - Obstructed duct - Ruptured duct - CHF - Neoplasia - Heartworm	**Hemothorax** - Trauma - Hemostatic disorders - Neoplasia





Pleural Effusions

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Chylothorax

M8k 1054; SAP 584; Enb 367; H3B 195; H2B 221, 220t; I2M 331; IM 232, 242; IM-WW 235; 5min 450; Cat 1077, 1105; F-N 287; Sx-G 112; Sx4B 403; Pa-T 172; Lab-C 247

**

Facts/Cause

- **Accumulation of chyle in pleural space**
  - Escapes from thoracic duct
- Cause:
  - **Idiopathic?**
  - **Trauma**: HBC (hit by car), surgery, foreign body, bite wound
  - Cough
  - Congestive heart failure/ cardiomyopathy
  - Thrombosis
  - Heartworms
  - Mediastinal lymphoma
  - Congenital in Afghan

Presentation/CS

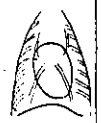
- **Restrictive breathing pattern**
  - **Rapid & shallow**
  - **↑ Inspiratory effort**
- Orthopneic
- ? Fever
- ? Cough

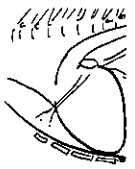
DDx:
- See pleural effusions

- **Chylous effusion**
  - **Milky white**, Opaque
  - Protein < 2.5-6.0 g/dl
  - Fibrin: variable
  - **Triglyceride: high (> serum)**
  - Bacteria: absent
  - Cells (nucleated): 500 - 20,000
  - Lymphocytes, PMN, & macrophages

Diagnosis

- Hx, CS
- Palpation: usually normal
- Auscultation: ↓ pulmonary & ↑ cardiac sounds ventrally
- Percussion:
  - ↑ dullness
  - **Fluid line** often defined
- Radiography:
  - **Fluid line**
  - "Leafing" of lung lobes
  - Obscuring of cardiac silhouette
  - Blunting of costophrenic angle
- **Thoracocentesis**:
  - Cytologic analysis: cause
  - Culture of fluid
  - **↑ Triglycerides & ↓ Cholesterol** compared to serum
  - Ether clearance: rapid screening test to DDx from pseudochylothorax: if chyle turns milky to clear
- **Once diagnosed, test for cause**: US (ultrasound) for mass, echo for heart problems, heartworm test, lymphangiograms
- Exploratory thoracotomy





Treatment

- **Thoracocentesis as needed**: remove effusion; chest tube installation & suction

  - **Low-fat diet**
    - **Hill's r/d or w/d,** or
    - Homemade diet: 1 cup boiled rice or potato, oatmeal or pasta + 1 cup low-fat (2%) cottage cheese + 1 vitamin/mineral tablet + 1/2 tsp. calcium carbonate (Tums®) & 15 ml MCT (medium & short chained fatty acids oil /15 lb dog)
- **Surgery** if above fails in 1-4 weeks
  - Lobectomy: resect torsed lung lobe
  - Ligate thoracic lymphatic duct
  - Fenestration of the diaphragm, etc.
  - Passive pleuroperitoneal shunting: holes in silastic sheeting covering a defect in diaphragm
  - Active pleuroperitoneal or pleurovenous shunting: pump connecting thorax & abdomen or vein
  - Pleurodesis: IP tetracycline to cause adhesions, not recommended?
- Prevent recurrence of effusion

Prognosis: **Guarded; poor** for chronic idiopathic chylothorax

Chyle in pleural space
CS: Restrictive breathing
Dx: Rads; Thoracocentesis
Tx: Med: thoracocentesis, Hill's r/d or Sx
Px: Poor to guarded

Hydrothorax

- Causes:
  - Cardiac diz
  - Lung torsion
  - Pancreatitis

Hemothorax

- Cause: Trauma

Pyothorax

SAP 586; E 879; E-hb 365; I2M 324; IM 240; IM-WW 234; H3B 195; 5min 1002; Cat 1063; F-N 454

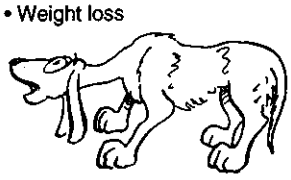
**

Facts/Cause

- ***Septic exudate in pleural cavity***
- Causes:
  - Systemic sepsis by way of blood or lymphatics
  - Spread from adjacent structures: pneumonia, rupture of esophagus, mediastinum or subpleural infection
  - Direct introduction (penetration, foreign body, thoracocentesis, surgery, foreign body)
  - Bite wound

Presentation/CS

- **Restrictive breathing pattern**
  - Rapid & shallow
  - ↑ Inspiratory effort
- **Fever**
- Anorexia
- Weight loss



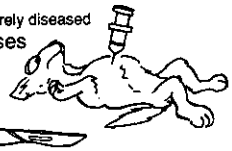
Diagnosis

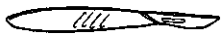
- Hx, CS
- Radiology: pleural effusion
- **Thoracocentesis necessary**
  - **Septic exudate**
    - Yellow to red-brown, cloudy to opaque, flocculent
    - Protein 3.9-7.0 g/dl
    - Fibrin - present
    - **Bacteria**
    - **Cells - 5000-300,000**, mostly degenerate PMNs, also macrophages
  - C&S (culture & sensitivity) (aerobic & anaerobic)
    - Gram stain: rapid assessment
- Exploratory

Treatment

- **Medical emergency**
- Treat underlying cause
- **Indwelling thoracic tube** (pleural drainage)

- **Thoracic lavage**
- **Systemic ABs** (culture & sensitivity) for minimum of 3-4 weeks
  - While waiting for C&S, penicillin
- ± Surgery in refractory cases (explore for intrapleural foreign bodies, break down intrapleural adhesions)
  - Lobotomize severely diseased
- Drain abscesses





Prognosis: **Poor**

Septic exudate in pleural cavity
CS: Restrictive breathing, Fever
Dx: Thoracocentesis: Bacteria & Cells
Tx: Emergency: drain & lavage, ABs, ± Sx • Px: Poor

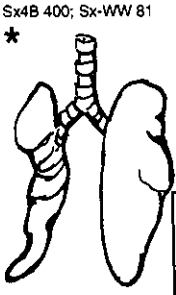
Lung lobe torsion

H3B 183; H2B 207; SAP 60; E-hb 367; 5min 780; Cat 1082; Sx-G 101; Sx4B 400; Sx-WW 81

*

Facts/Cause

- **Rare** cause of pleural effusions, cause or effect?
- Rotation of lung lobe around its long axis
  - Strangulation of bronchus & vascular pedicle (artery partially patent, **vein occluded = lobe expansion** or atelectasis)
    - Copious bloody effusion
- Mechanism: unknown
  - Spontaneous/idiopathic
  - Thoracic surgery
  - Trauma
  - 2° to pleural effusion
  - Pleural effusion & atelectasis of cr. & rt. middle lobes may predispose to torsion
- Dogs >> cats
- Large deep chested breeds: Afghan
- Results in pleural effusion



Rare
CS: Restrictive breathing
Dx: Rads, thoracocentesis
Tx: Surgical resection

Presentation/CS

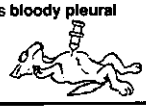
- Masking pre-existing pleural or pulmonary diz
- Acute & rapidly progressive CS
  - **Restrictive breathing pattern**
  - Rapid & shallow &/or ↑ inspiratory effort
  - ± Cyanosis
  - Cough ± hemoptysis
  - Hypotension & collapse
  - Systemic signs: fever, depression, weakness

DDx
- Causes of bloody pleural effusion
- Pulmonary parenchymal or pleural mass
- Diaphragmatic hernia
- Pneumonia
- Pulmonary contusion

Diagnosis

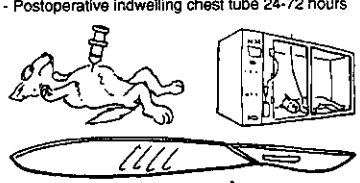
- Hx, CS
- **Pleural effusion**

- **Auscultation**
  - Displacement of cardiac apex beat
  - ↑ Heart sounds over affected lobe w/ absence of lung sounds
- Plain radiographs
  - Pleural effusion: remove (thoracocentesis)
  - **Repeat plain film**
    - Lobar consolidation or atelectasis
    - Displacement of cardia toward atelectatic lung
    - Air bronchograms early, resorbed late
    - Rounding of lung edges as expands
    - Misplacement of bronchus maybe
  - Contrast radiographs/bronchogram may enhance
- Thoracocentesis: Copious **bloody pleural effusion**
- Surgical exploration to confirm



Treatment

- ↑ Oxygenation & stabilize
  - Oxygen
  - IV fluid
  - Thoracocentesis: remove free effusion
  - Indwelling chest tube as needed
- Surgical resection TOC (Tx of choice)
  - **Remove affected lung lobes**
  - Higher incidence of respiratory arrest on induction
  - Postoperative indwelling chest tube 24-72 hours



Prognosis:
- **Good:** w/ surgical correction
- **Grave:** w/o surgical correction

Thoracic Trauma

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Thoracic trauma, Lung contusion SAP 593; E-hb 367; I2M 308; IM 224; IM-WW 231; 5min 980; Cat 1039; Sx-WW 81; Sx-S-hb 152; Sx-S 374; X-RP 103; X-Gr144 ***	• **Cause:** - **#1 automobile accident** - Kick, falling from heights - Penetrating trauma . Gunshot . Sharp instrument . Esophageal penetration	• **Restricted breathing pattern w/ hemothorax** (rapid & shallow) • **↑ Inspiratory effort w/ pneumothorax** • Anxious or distressed • **Hypovolemic shock** - ↑ Heart rate - Weak peripheral pulse - Cold extremities - Pale mucous membranes - Depressed or stuporous • Diaphragmatic hernia - GI signs - Diarrhea or vomiting (obstruction)	• **Treatment of shock takes precedence over evaluation** • Hx (trauma) • **Physical exam** (PE): vital signs (HR, RR, mucosa color & refill, temp., level of consciousness) • Respiratory rate, depth & effort - Flail chest: paradoxical motion of chest wall • **Palpation:** - Fractures, flail chest, hematomas, SQ emphysema (crepitus), position of cardiac apex beat - Abdomen for concurrent injuries • Auscultation: - Absence of lung sounds indicates lung displacement by air, fluid or abdominal viscera - Heart displacement • Percussion: for ↑ or ↓ resonance - Air more resonant - Fluid or solid viscera dull & less resonant • Surface wound & abrasions, clip, immediately seal wounds that communicate freely w/ pleural space • **Radiology** (see box) • Thoracocentesis: - RBCs & protein for hemorrhage - Centrifuge - bacteria, degenerate PMNs & organic matter (perforation) • Blood: PCV & PPC for baseline of hemorrhage, Arterial pH & Blood gas tension • ECG (electrocardiography): Serial to check for arrhythmias associated w/ myocardial injury	• Modify to situation • **Maintain at least 1 IV catheter**, severely traumatized - 2 catheters for rapid IV fluids • **ABC approach:** - **A (patent Airway):** clear trachea & bronchi . Endotracheal tube . Tracheostomy if pharynx, larynx or cranial trachea damaged - **B (breathing)** . **Oxygen** (10-20 ml/kg/min (endotracheal tube, tracheostomy tube, O2 cage, nasal catheter) .. Seal sucking chest wounds (occlusive dressing) .. Stabilize flail chest - **C (circulation)** . **IV fluids** to ↑ volume & cardiac output . Hypovolemic shock: 90 ml/kg - dogs, 65 ml/kg - cats as rapidly as gravity allows .. If shock abated & hemorrhage ceased 66-88 ml/kg/24 hours .. If no improvement continue rapid fluid .. Monitor for pulmonary edema (auscultation, chemosis [edema of ocular conjunctiva], tearing, tissue swelling, ↓ PCV & PPC) .. CVP (central venous pressure) if ↑ of 7-10 cm H2O slow fluid rate .. 3 ml of crystalloid fluid for every 1 ml of blood loss • **Pleural space drainage** - Hypodermic needle thoracocentesis - Thoracostomy tube Prognosis: **Good to grave** depending on severity & response to Tx for hypovolemic shock if present

Radiology:
- Full severity of pulmonary contusion may not be apparent on radiographs for 1-2 hours
- May take 6-12 hours for fluid/hemorrhage to reach peak levels
- Evaluate:
  - Cardiac silhouette (narrowed - hypovolemia)
  - Pleural space: fluid, air or abdominal viscera
  - Diaphragm for integrity
  - Fractures: ribs, vertebrae
  - SQ emphysema: leakage of air
  - Pneumomediastinum: tracheobronchial rupture
  - Remove any obscuring fluid & retake radiographs

#1 HBC
CS: Dyspnea, ± Shock
Dx: Tx shock 1st, Hx, PE, Rads
Tx: ABC approach

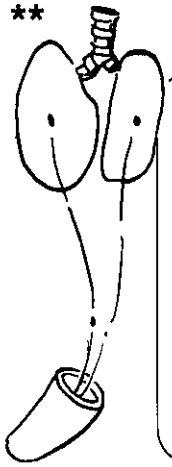
Rib fractures, Flail chest * SAP 598; H3B202; H2B 227; Cat 1114; Sx4B 421; Sx-S-hb 152; Sx-S 374; X-RP 113; X3T 289; X-Gr 144	• **Trauma: HBC (hit by car)** • **Complication of rib fxs** - Pneumothorax - Pulmonary contusions - Hemothorax - Flail chest (unstable chest wall), 2 or more adjacent ribs fractured or dislocated both dorsally & ventrally	• **± Shock, dyspnea** • **Flail chest:** paradoxical movement (segment moves inward on inspiration & outward on expiration) - ↑ Inspiratory effort • Sequela: Lung contusions & laceration	• Hx, CS • **Palpation** • **Radiography**	• **Simple, nondisplaced fxs: rest** • **Multiple unstable fxs: internal fixation** (pins or wires) • **Flail chest:** external frame, percutaneous suture around ribs; keep frame in place for 3 weeks • Do not apply tight bandages: ↓ thoracic volume permanently • Analgesia, intrapleural infusion & intercostal nerve blocks for pain Prognosis: **Guarded**
HBC, Flail chest, Rest or Sx				
Diaphragmatic hernia M8k 1058; Mk 111; H3B 200; H2B 225; SAP 598; Ehb 310; IM-WW 236; 5min 522; Cat 1085, 1110; Sx-S-hb 173; Sx-S 455; X-RP 114; X3T 297 **	• **Protrusion of abdominal organs though an abnormal hole in the diaphragm** • Traumatic: Acquired - **#1 HBC (hit by car)** - Kicks, blunt blows, falls from high elevation • Congenital: - Most open communication between pleuroperitoneal membrane & pericardial sac (peritoneopericardial), others peritoneopleural - Weimaraners & Cocker spaniels may be predisposed Failure of fusion of diaphragmatic parts or compression during parturition - Sometimes not diagnosed until middle aged	• **Shock frequently** if traumatic (pallor, tachypnea, dyspnea, tachycardia & oliguria) • GI (anorexia, depression, vomiting, diarrhea, weight loss) • Respiratory: **restrictive breathing** (wheezing, exercise intolerance) - Orthopnea: difficult breathing except in upright position (dog sitting) • ± Thin appearing animal • Cardiac arrhythmias • Liver most commonly herniated - Hydrothorax (entrapment & venous occlusion)	• Hx, CS • **Auscultation: gut sounds in chest** • Radiology: - **Gas or barium-filled intestines in thorax** - Enlarged cardiac silhouette (congenital) - Dorsal displacement of trachea (congenital) - Dorsal or lat. displacement of lungs - Overlap of diaphragmatic & caudal heart borders - Discontinuity of diaphragmatic silhouette • Ultrasound: - Discontinuity of diaphragm may be detected - Gas filled intestines	• **Traumatic: delay repair until stabilized** - Surgical repair: ventral midline abdominal incision • **Congenital: surgical repair** as soon as possible (8-16 weeks of age); approach same as for acquired Prognosis: **Guarded** • Re-expansion pulmonary edema: complication following surgery • Aggressive positive pressure ventilation (20 mmHg or > 30 cm H2O) to inflate or reinflate lungs; may rupture alveoli & cause bullae formation, alveolitis &/or emphysema

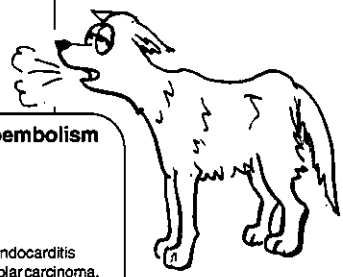
Abdominal organs in chest (rads), Congenital or HBC
CS: ± Shock, Restrictive breathing
Tx: Sx repair when stabilized or old enough • Px: Guarded

Pectus excavatum 5min 916; Sx4B 424; Sx-S 374; X-RP 113; X3T 292 *
- **Congenital, Dorsal displacement of the sternum**
- CS: Incidental finding on radiographs or respiratory distress & collapse
- Dx: Palpation, Radiology, usually incidental finding
- Tx: **Surgical intervention not recommended**

Pneumothorax

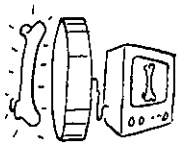
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Pulmonary thrombo-embolism H3B 180; H2B 211; E-hb 366; I2M 308; IM 225; IM-WW 230; Cat 1083; Sx-S-hb 22; Pa-T 138 **	• **Occlusion of pulmonary vessels by a clot** • Pathophysiology: may cause pulmonary hypertension & result in pleural effusion • ↑ Incidence where heartworm prevalent	• Nonspecific • **↑ Depth & rate** (hyperpnea) - ↑ Inspiratory effort - ↑ Rate (tachypnea) • **Cough** (hemoptysis occasionally, esp. w/ heartworm)	• Hx (vague), CS (nonspecific) • Auscultation: crackles (rare) - ± ↑ lung (airway) sounds - ± Split 2nd heart sound due to hypertension • **Radiology** - Normal - Diminution or loss of peripheral vessels - ↑ Size of central pulmonary a. - Mild right heart enlargement - ± Mild pleural effusions • Arterial blood gas analysis - Hypoxemia - Hypocapnia, hypercapnia in severe diz - Respiratory alkalosis 2° to tachypnea & hyperpnea • Electrocardiography: depends on heart diz - ST segment abnormalities - hypoxia - Sinus bradycardia 2° to pulmonary hypertension • Pulmonary angiography - Definitive antemortem Dx - Positive: filling defect or sudden termination of blood flow • Nuclear perfusion scintigraphy: safe & sensitive nonspecific test	• **#1 Treat underlying cause** • **Supportive care:** - Oxygen supplementation - Strict cage confinement - Careful parenteral fluid Tx • **Anticoagulant therapy** - Coumadin® (Warfarin or coumarin derivatives) - Heparin (rapid onset, short-term effects) - Aspirin - ↓ platelet function ("thins blood") - Prednisolone may be better choice in cats w/ heartworm diz • Fibrinolytic therapy: lack selectivity, extremely expensive $$$ - Streptokinase, urokinase, tissue plasminogen activator • Embolectomy: - High mortality risk - Only considered for central pulmonary artery obstruction

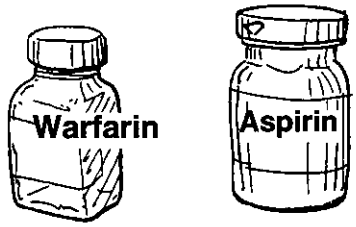




Causes - pulmonary thromboembolism
- Cardiac diz
  - **Heartworm diz**
  - **Heartworm adulticide Tx**
  - Dilative cardiomyopathy
  - Chronic mitral valvular insufficiency, endocarditis
- Neoplasia (lymphosarcoma, bronchoalveolar carcinoma, pancreatic carcinoma)
- DIC (disseminated intravascular coagulation)
- Sepsis
- Hyperadrenocorticism
- Renal diz (amyloidosis, glomerulonephritis)
- Pancreatitis
- Eosinophilic lung
- Air emboli (rare)
- Immune-mediated diz (autoimmune hemolytic anemia)
- Iatrogenic: indwelling vascular catheters, transfusions
- Idiopathic causes

DDx:
- Airway obstruction
- Other forms parenchymal diz
- Pulmonary hypertension

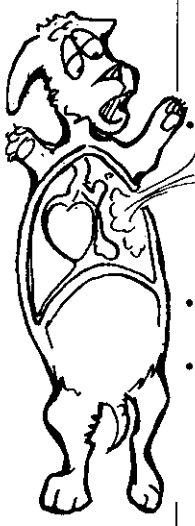


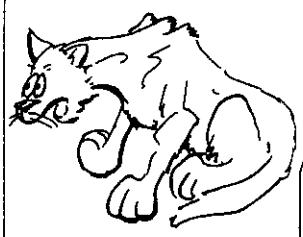


Prognosis:
- **Poor (cats) to guarded** (dogs)
- Recurrence possible, especially if cause not resolved
- Guarded for central pulmonary artery obstruction

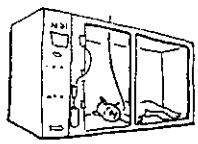
Plugged pulmonary vessels, ↑ w/ heartworm
CS: Dyspnea, Cough
Dx: Difficult
Tx: Treat cause, Supportive, Anticoagulant • Px: Poor-cats; Guarded-dogs

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Pneumo-thorax Mk 635, 708; H3B 191; H2B 215; E-hb 368; I2M 333, 317, 336; IM 233, 245; IM-WW 234; 5min 956; Cat 1083; Sx-WW 82; Pa-T 171; X-RP 112; X3T 329 **	• ***Gas or air in pleural space*** • Causes: - **#1 trauma** (bite, puncture, car trauma) . Rib fxs., puncture of chest wall, trachea, lung, esophagus - Spontaneous: occurs in absence of Hx of trauma . Rupture of air containing space: bulla, bleb . Associated w/ underlying pulmonary diz .. Neoplasia, granulomatous lesions, pneumonia, fungal infection, parasites - Iatrogenic . Diagnostic procedure (pulmonary aspirate, TTW, bronchoscopy) . Surgery • **Types of pneumothorax** 1. Closed: air trapped in thorax 2. Open: air out of thorax through wound 3. Tension pneumothorax: flap of tissue allows air in thorax, but stops escape • **SQ emphysema**: air under skin from outside, pleural space, mediastinum, cervical trachea, or esophagus • 2 sides of thorax communicate, air usually in both sides	• **± External wound** • Severity depends on amount of air • **SQ emphysema** • **Restrictive dyspnea** - Shallow & rapid (tachypnea) - ↑ Inspiratory effort & depth w/ short expiratory phase - Gasping, "air hunger" (hyperpnea) • ± Cyanosis • Orthopneic position (dyspnea at rest, standing w/ elbows abducted & head & neck elevated) • ± Open mouth breathing (severe or tension pneumothorax) • ↓ Movement of chest wall w/ fully expanded chest • ± Unable to rise, cyanotic • Shock	• Hx (trauma), CS • **Auscultation:** - **Reduced or absence of lung sounds** (lung partially collapsed) - May hear referred upper airway gasping sounds - Muffled heart sounds ventrally • Percussion: **Hyperresonance** over area of pneumothorax (dorsally) • **Palpation: for trauma, wounds, broken rib, etc.** • **Needle thoracocentesis: aspiration of air** from thorax, do before radiographs to stabilize animal • **Radiographs**: free pleural air - Retraction of lungs from chest wall & sternum - ↓ Peripheral pulmonary vessels - Most obvious on expiration - **Check for fxs & pulmonary diz** • Ultrasound (SQ emphysema m/ prevent use) • Exploratory thoracotomy, median sternotomy) - For spontaneous or traumatic pneumothorax unresponsive to therapy	• **Spontaneous recovery** • **Mild: cage rest until resorption** - Monitor for shock or increased dyspnea • **Moderate: needle thoracocentesis** • **Severe dyspnea:** - **Needle thoracocentesis** followed by . Chest drain (if air continues) . Oxygen cage . Continuous suction w/ water tap, Heimlich valve • **Opened thorax** - **Occlusive bandage** over wound - Thoracocentesis once covered - 1° closure once animal stable - Surgery if leakage > 5-6 days or any esophageal leakage • **Tension pneumothorax** - **Chest drain & continuous negative pressure** (15 cm H2O or 10 mmHg) - Surgical Tx: median sternotomy (allows both sides to be explored); Automatic stapling device: partial lobectomy . Pleurodesis (abrade visceral & parietal pleura so fuse together)





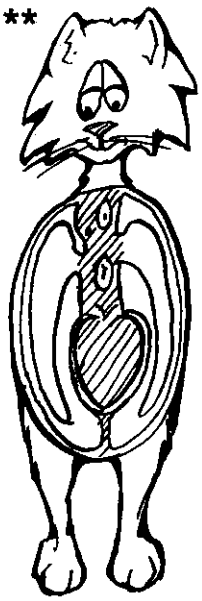
DDx:
- Pleural effusion
- Diaphragmatic hernia
- Pulmonary contusion
- Thromboembolism
- Pneumonia
- Asthma (cat)



Prognosis:
- **Good** if seals & air removed
- **Poor** if air leaking from pulmonary or esophageal lesions

Air in pleural space, #1 trauma, Closed, Open or Tension
CS: SQ emphysema, Restrictive dyspnea
Dx: Rads
Tx: Cage rest to Sx • Px: Good to poor

Condition	Facts/Cause	Presentation	Diagnosis	Treatment
Mediastinitis H3B 206; H2B 230; E-hb 370; 5min 807 **	• **Inflammation of mediastinum** • **Acute**: usually **bacterial** - Strep., Staph. & *E. coli* - Anaerobic important if esophageal perforation - Diffuse or localized (abscess/es) • **Chronic:** usually **fungal** - Histoplasmosis, coccidioidomycosis, blastomycosis & cryptococcosis - Bacterial also may cause (Actinomyces, Nocardia & Corynebacterium spp.) - Commonly abscess or granulomas	• Acute (rapid onset, profound CS) • **↑ Inspiratory &/or expiratory effort** • **Dysphagia** - Thoracic pain - Fever - Concurrent pneumothorax or hydrothorax • **Edema** of neck, head &/or forelegs (cranial vena cava syndrome)	• Hx, CS, PE • **Radiology:** - Initially: maybe no findings - Widening of mediastinum w/ loss of detail - Air in mediastinum if esophageal rupture - Deviation of trachea or esophagus ± abscesses or granulomas - Contrast to evaluate esophagus - Concurrent pneumothorax or hydrothorax • Fine needle aspiration (culture & sensitivity, cytology) • Surgical biopsy (mediastinoscopy, thoracotomy) • Re-radiograph weekly for bacterial diz, 2-3 weeks for fungal diz	• **Treat cause** • **Medicine** - Broad spectrum **ABs** (suspect bacteria) 3-6 weeks - **Antifungal** if fungal 3-6 months • Surgery, consider if med. ineffective - Esophageal or tracheal perforation - For culture & biopsy - Establish pleural drainage (if conservative Tx failure) - Abscess or granuloma causing obstruction • Radiograph every 2-4 weeks to evaluate • Monitor hemogram weekly



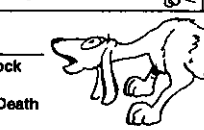
Bacterial or Fungal
CS: Dyspnea, Dysphagia, Edema
Dx: Rads
Tx: ABs or Antifungals

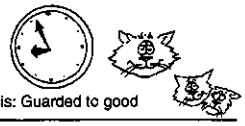
• **Causes of mediastinitis**
- Esophageal rupture or perforation
. 2° to foreign bodies
. Trauma
. Iatrogenic (endoscope, biopsy, bougienage)
. 1° neoplasia
- Tracheal rupture or perforation
. Trauma:
. Iatrogenic (intubation stylet, bronchoscopy)
- Penetrating wound of thorax
. Bite wound
. Migrating foreign body (grass awn, needle)
- Extension from adjacent tissue (neck, head & axilla)
- Tube thoracostomy
- Thoracic surgery
- 2° to bacteremia (rare)

DDx:
• Mediastinal masses - neoplasia
• Mediastinal hemorrhage (surgery, trauma, coagulopathies, thymic vascular disruption
• Mediastinal edema (infection, trauma)

Prognosis: **Guarded**

Pneumomediastinum, Mediastinal emphysema H3B 205; H2B 229; E-hb 370; I2M 318; IM 234; IM-WW 237; X-RP 106; X-Gr 144; X3T 317 *	• **Free gas in mediastinum: radiographic finding** **Causes: Pneumomediastinum:** • Penetrating wound of head, neck, or cranial thorax, Air dissects through thoracic inlet • Airway or alveolar rupture - Iatrogenic (bronchoscopy, TTW, Tracheostomy) - External trauma • Esophageal rupture (FB, trauma, ulceration & perforation, neoplasia) • Abdominal surgery • Mediastinoscopy • Gas producing bacteria (rare)	• **Asymptomatic** • SQ emphysema mild to profound • Pneumothorax: Dyspnea & coughing • Esophageal rupture: thoracic pain, fever & dysphagia • ± **Restrictive dyspnea** (↑ inspiratory effort, shallow & rapid) - If severe: orthopnea (position breathing), open mouth gasping • ± Ballooning of thoracic inlet on expiration if severe • Sequelae to elevated mediastinal pressure - Pneumothorax, Hypotension, Ventilatory failure, Diminished venous return, Engorged neck veins	• Hx, CS • Physical exam (PE) • **Radiology:** - **Visualization of structures not normally seen** (cranial vena cava, azygos vein, brachiocephalic trunk, right subclavian & carotid arteries, esophagus & tracheal wall) - SQ emphysema - Facial planes of neck visible - Concurrent pneumothorax, pneumoretroperitoneum, hydrothorax - Pneumopericardium (rare) - Esophageal FB	• **Uncomplicated cases: self-limiting usually** • Dyspnea & concurrent pneumothorax: thoracocentesis, tube thoracostomy w/ manual evacuation • Close neck wounds • Tracheal injuries: surgically seal if not self-limiting • Esophageal perforation: immediate Sx • Localized SQ emphysema: needle aspiration Prognosis: Guarded to good



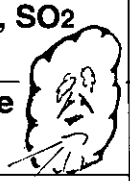


Toxicology - Respiratory

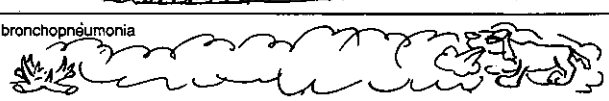
PCP, penta *
M8k 2097; Mk 1696; Tox 239; Tox-WW 273
• **Pentachlorophenol; Pressure wood treatment (fungicide), Rare since EPA restricted use in 1980's, Livestock lick "leaky" wood, ↑ O2 demand;** Irritating to skin & respiratory tract; Not street dust see pg 737
• CS: **Gasping; Nervousness; Rapid pulse & respiration; Weakness, Muscle tremors; Fever; Convulsions - Death**
• Dx: **Rapid rigor mortis; Blood**
• Tx: **No specific therapy**, Fluids to flush kidney, Bath, Activated charcoal & support; Anticonvulsants • Px: **Guarded**

H_2S Hydrogen sulfide *
• **See Tox pg 725: Toxic gas, "Rotten egg" smell, Agitation of liquid manure holding pits,** Irritant to eyes & respiratory system
• CS: **Pulmonary edema,** Hyperpnea, Apnea, Asphyxia
• Tx: **Fresh air,** Artificial respiration
• Px: **Guarded to poor** depending on severity

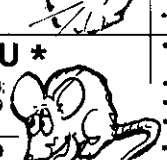
Smog, SO_2 *
• **See Tox pg 725: Smog,** Sulfur oxides + H_2SO_4
• CS: **Eye irritation & Salivation,** Emphysema, Respiratory distress
• Tx: **No specific Tx**
• Px: Guarded to poor depending on severity

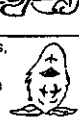


Smoke *
• **See Tox pg 725: Fires:** Alveolar damage, interstitial edema, hypoxia & 2° bronchopneumonia
• CS: Oral burns, **Respiratory problems** (cough, stridor, tachypnea)
• Tx: **Patent airway, O2 therapy, Bronchodilators**
• Px: **Guarded to poor** depending on severity



ANTU *
M8k 2143; H2B 1309
• **Rare:** (alpha-Naphthylthiourea); Use declining because of more effective rodenticides, bread or sausage baits; ↑ permeability of pulmonary capillaries, Strong emetic (protects some animals that vomit), rodents unable to vomit
• CS: Pulmonary edema: **"drowns in own fluid"**, sits w/ forelegs extended & elbows out, head & neck extended to breath, Ataxia, low temp, Death
• Tx: **No specific Tx:** Emetics early before edema, n-amyl mercaptan or Na thiosulfate; + O2; Mannitol; Atropine; Nebulization
• Px: **Grave**, better prognosis if survive beyond 12 hours





Zn_3P_2 *
M8k 2147; H2B 1310
• **Zinc phosphide;** Kilrat®, Goph-rid®, Release of **phosphine gas** on contact w/ water (more rapid at low pH), Odor of rotted fish, Emetic
• CS/Dx: **Exposure, Running & yelping fits, Rapid death, Dyspnea, Garlic smell** to stomach
• Tx: **No specific Tx,** Gastric lavage, oral bicarbonate, NPO for 24hours, symptomatic • Px: **Guarded**

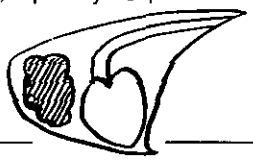
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Mass lesion of mediastinum

H3B 207; H2B 231; I2M 317; IM 233; IM-WW 236; Cat 1075, 1112; X-RP 107; X-Gr 144; X3T 313

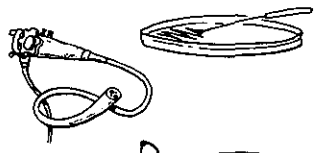
**

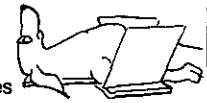
- Space occupying lesion, includes lymph node enlargement
- **Causes compression of:**
  - Trachea
  - Esophagus
  - Cranial vena cava
- Reduce ability for lungs to expand, especially if 2° pleural effusion



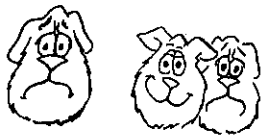
- Reflect underlying cause
- **Asymptomatic**
- **Cough**
- **Obstructive/restrictive breathing patterns ±↑ Expiratory effort**
- Dysphagia, drooling
- Regurgitation (cat > dog)
- Edema of neck, face & fore limbs (vena cava syndrome)
- Laryngeal paralysis (upper airway obstruction: stridor & voice changes)
- ± Horner's syndrome (cat > dog)

- Hx (history), PE (physical exam)
- Auscultation: displaced cardiac apex beat, wheezes
- **Radiology:**
  - **Densities in mediastinum**
  - **Compression &/or displacement** of trachea, heart or esophagus
    - Esophagram (pathology, displacement or compression)
  - **Widening of mediastinum** (VD)
- Ultrasound: differentiate abscess, cyst or tumor
  - Radioisotope for ectopic thyroid tissue
- Cytology, culture & sensitivity
  - Lung, lymph node aspiration, pleural fluid or biopsy
- Serology for infectious diz
- Bronchoscopy (exam, culture or lavage)
- Thoracotomy: biopsy





- **Abscess or granuloma**
  - ABs, antifungal agents
  - Surgical drainage or excision
- **Neoplasia:**
  - **Lymphosarcoma** & some others: **chemotherapy**
  - Surgical excision (thymomas, chemodectoma, lipoma, teratoma, thyroid & parathyroid tumors)
  - Radiation therapy adjunctive
- **Cysts:**
  - Extrathoracic drainage via needle aspiration
  - Surgery if fails
- Supportive: oxygenation
- Hydration
- Nutrition



Space occupying lesions

- **Neoplasia**
  - **Lymphosarcoma**
    - **Anterior mediastinal - cat**
    - Multicentric - dog
    - Lymphomatoid granulomas
  - Metastatic neoplasia
  - Thymic tumor
  - Tracheal tumor
- Abscess or granuloma (bacterial or fungal)
  - Systemic diz
  - Bite wound or esophageal perforation
- Mediastinal lymphadenopathy
  - Infectious
    - Bacteria (mediastinitis, pyothorax)
    - Fungal (Coccidioidomycosis, histoplasmosis, blastomycosis, cryptococcus)
    - Mycobacteria (rare in USA)
- Cysts (uncommon)
  - Pleural, lymphatic, bronchogenic & thymic; usually benign, ventral compartment
- Noninfectious granulomas w/ eosinophilia

DDx:
- Lung masses
- Cardiac masses
- Diaphragmatic hernia

Compression
CS: Asymptomatic, Cough, Obstructive/Restrictive breathing
Dx: Rads
Tx cause • Px: Poor to guarded

Prognosis: **Poor to guarded**

Feline anterior mediastinal lymphosarcoma, Feline lymphoma/ leukemia/ lymphosarcoma

M8k 555; Mk 39; H3B 207; H2B 1197; SAP 82; E-hb 371; IM 862, 235; Cat 1075; X-RP 107; X-Gr 144; X3T 314

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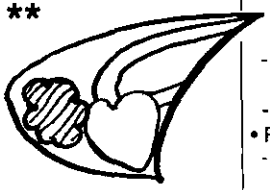
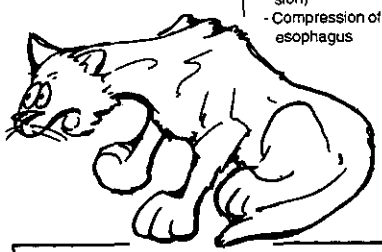


- **See Circ pg 315 & Syst pg 692**
- **Lymphoma: #1 neoplasm of cats**
- **#1 cause of severe illness & death**
- Forms:
  - Mediastinal form (young cats)
  - Multicentric
  - Alimentary (older cats)
- **Feline leukemia virus (FeLV)**
  - FOCMA antigen on surface of FeLV-induced neoplastic cells
    - Anti-FOCMA antibody involved in immunity to tumor development
  - Demonstrated in 90% of mediastinal lymphomas
  - Doesn't survive in environment
- Pathophysiology:
  - Transmission: **contact**, bites via saliva, ± milk & transplacental (horizontal >> vertical)
  - Viremia (FeLV +) predisposes to neoplasia or other associated dizs (immunosuppression)
  - Compression of trachea, cranial vena cava, esophagus

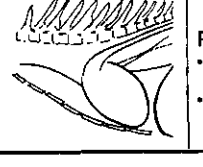
- Anterior mediastinal
  - **Obstructive/restrictive breathing**
  - ±↑ Expiratory effort
  - **Cough**
  - Regurgitation
  - ± Horner's syndrome
  - Vena caval syndrome: facial, neck & forelimb edema
- CS of other systems: GI, kidney, liver, spleen, bone marrow, eye, CNS, cutaneous, reproduction, heart, lungs, urinary bladder



DDx:
- Ectopic thyroid tumor
- Heart base tumors
- Thymomas
- Pulmonary lymphomatoid granulomatosis

- Hx, CS
- Physical exam: **noncompressible cranial mediastinum**

- Auscultation
  - ↓ Bronchovesicular sounds
  - ± Wheezes
  - Displacement of pulmonary sounds to caudal thorax
- Percussion: dull cranial thorax
- **Radiology:**
  - **Anterior mediastinal mass**
    - Dorsal displacement of trachea
    - ± Pleural effusions
    - Esophagram (pathology, displacement or compression)
    - Widening of mediastinum (VD)
- **Thoracocentesis: fluids**
  - Immature lymphocytes (blast form) in pleural effusion
  - Histo/cytology
- Laboratory: Anemia (nonregenerative), persistent leukopenia or lymphocytosis or circulating lymphoblasts
- **FeLV test for antigens**
  - IFA (indirect fluorescent antibody test)
  - ELISA (enzyme-linked immunosorbent assay) circulating excess p27 core antigen
    - More sensitive than IFA
    - In clinic test kits
    - More false-positive results
  - Both ELISA & IFA show if viremic, don't Dx leukemia, lymphoma or any diz

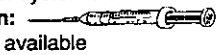


FeLV+

- Chemotherapy may extend life
  - **COP (Cytoxan, oncovin, prednisolone)**

Management of FeLV+ cats
- Keep indoors
- Current vaccines
- Monitor for systemic diz

Prevention:



- Vaccines available
  - Efficacy controversial < 100%
  - MLVs recommended
    - 2 initial doses & annual boosters
    - Little benefit in FeLV+, retest in 2-3 months & only vaccinate if negative

Eradicate from cattery
- Remove positive cats
- Vaccinate all negative cats
- Retest & remove + cats every 3 months
- FeLV free once all cats negative on 2 successive testings 3 months apart

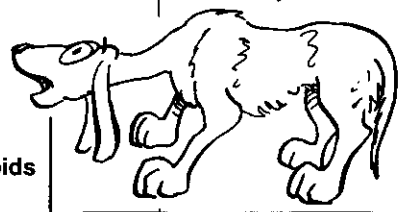
Control FeLV negative catteries
- Replacement cats from FeLV(-) source
- Screen w/ ELISA & vaccinate negative cats, reject positive cats
- Isolate & retest in 3 months
- Disinfection not necessary, virus doesn't survive in environment

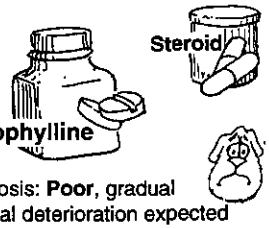
Prognosis: **Guarded to poor**
- Long-term remission (> 1 year) in 10-15%, Median remission 6 months
- Cats may have less favorable response to chemotherapy than dogs (complication: anorexia)

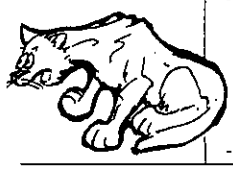
#1 Neoplasm of cats, FeLV
CS: Dyspnea, Cough
Dx: PE, Rads, Centesis, FeLV test
Tx: COP • Px: Guarded to poor

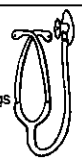
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Pulmonary alveolitis & interstitial fibrosis - Dog Mk 759; SAP 569 **	• **Progressive interstitial inflammatory diz resulting in fibrosis** • Cause: unknown - Injury or allergen causes lung alveolitis, destruction of alveolar tissue & end stage **fibrosis** • **Aged & older dogs** • Small terrier breeds (West Highland White terriers)	• **Restricted breathing (rapid & shallow)** - Shortness of breath • **Exercise intolerance** - Long & progressive history • Cough: slight or absent unless bronchitis • Sequela: - Severe hypoxemia - Progressive right-sided cardiac dysfunction	• Hx, CS • **Auscultation: bilateral, ventral, end-inspiratory & early-expiratory crackles** (most evident on full inspiration) - Advanced cases crackles audible w/o stethoscope • Forced exercise: tachypnea or gasping, cyanosis • Radiology: usually mild, diffuse interstitial lung density - Retraction of lungs, flat diaphragm - Mild cardiomegaly (cor pulmonale or incomplete lung expansion) - ± Signs of concurrent bronchial diz • Laboratory - CBC normal - Arterial blood gas: hypocarbia (hyperventilation) & hypoxemia, improvement w/ oxygen, indicates ventilation perfusion inequality - Biopsy invasive & not required in most cases • Bronchoalveolar lavage: normal predominant alveolar macrophages & low PMN count (< 12%) **- Alveolitis: PMNs > 25% w/ reactive macrophages;** invalid if concurrent bronchitis & exudates	• **Tx frustrating, no cure** • Eliminate smoke, dust or fumes • Control obesity • **Trial bronchodilators** - Sustained release theophylline, Aminophylline or oxtriphylline • **Steroids** (CCS) **initially**: prednisolone (immunosuppressive), then taper; may ↓ ongoing alveolitis • Cyclophosphamide used in humans • Treat bronchitis if cough prominent sign Prognosis: **Poor**, gradual clinical deterioration expected
Pleuritis, Pleurisy M8k 1054; Mk 741; SAP 575; 5min 1002; Pa-T 172 *	• **Pleuritis & pleural effusion** • Causes: **- Often early form of effusive diz** - May be present when effusive diz resolves - Traumatic: perforating wounds or open chest wounds - Esophageal perforations - Infections: . Feline infectious peritonitis . Anaerobic bacteria . Aerobic bacteria (Pasteurella, *E. coli*, etc.) . *Nocardia asteroides* . Actinomyces spp . *Blastomyces dermatididis* . *Toxoplasma gondii* - Iatrogenic: chest drains, thoracocentesis	• **Restrictive breathing** (pleural effusion) - Shallow & rapid breathing (pain) • Lethargy (reluctance to move) • ± Fever • ± Anorexia	• **CS: Respiratory distress & pain** • Auscultation - Pleural friction rub - No lung sounds ventrally (effusion) • Few if any pathologic or radiographic findings • **Diagnosis by ruling out (R/O) other dizs** • **Ultrasound:** picks up small amount of fluid • **Thoracocentesis:** - Cytology, Culture & Sensitivity (include anaerobic) - Gram stain for tentative bacteria **- Cloudiness: ↑ # of WBCs**	• **Treat underlying cause if identified** • **ABs** - Empirically until C&S, ABs - Follow IV or IM w/ oral ABs • **± Steroids** • **Analgesics: torbugesic, pleural infusion of local anesthetic** • **Pleural drainage** (see box) • Anti-inflammatory Rx for pain & ↓ product (Banamine®, Bute) • **Rest** **Prognosis: Guarded** in all cases

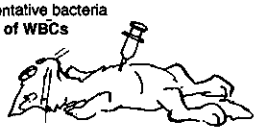
Fibrosis, Old dogs
CS: Restricted breathing
Dx: Hx, CS, Auscultation
Tx: Diet, Bronchodilators, Steroids
Px: Poor

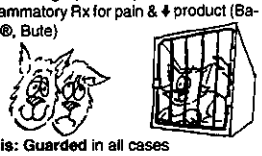












CIRCULATORY SYSTEM

Abbreviations Used in the Circulatory System

APCs	Atrial premature contractions
ASD	Atrial septal defect
AV	Atrioventricular
CHD	Congenital heart defect
CM	Cardiomyopathy
CO	Cardiac output
CPA	Cardiopulmonary arrest
DCM	Dilated cardiomyopathy
DDx	Differential Diagnosis
DV	Dorsoventral view
Echo	Echocardiography
ECG	Electrocardiography
FUS	Feline urological syndrome
HCM	Hypertrophic cardiomyopathy
HR	Heart rate
HWD	Heartworm disease
LVA	Left ventricular enlargement
MI	Mitral insufficiency
PDA	Patent ductus arteriosus
PMI	Point of maximum intensity
PPDH	Peritoneopericardial diaphragmatic hernia
PRAA	Persistent right aortic arch
PS	Pulmonic stenosis
Q	Cardiac output
RAE	Right atrial enlargement
RCM	Restrictive cardiomyopathy
RVE	Right ventricular enlargement
SAS	Subaortic stenosis
SV	Preload
TE	Thromboembolism
TF	Tetralogy of Fallot
TI	Tricuspid insufficiency
VD	Ventrodorsal view
VPCs	Ventricular premature contractions
VSD	Ventricular septal defect

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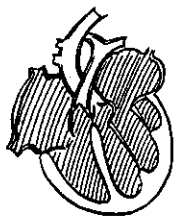
Cardiovascular diz, Heart failure,



Congestive heart diz

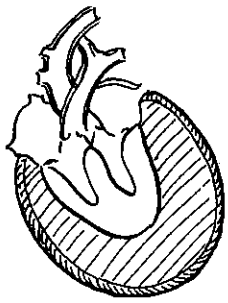
M8k 81, 64; Mk 8; I2M 48; IM 42; E-hb 373; SAP 444; IM-WW 147; 5min 470; H-Pic 1; Cat 846; H-F 15, 159; C12T 780; C11T 647; Sx-S 826; Pys 172, 245; H-T/M 469

- **Prevalence of heart diz**
  - **Heart diz - Dogs: 10%, Cats: 5-8%**
  - **Congenital heart diz (CHD) - 0.5%**

- **Signs of heart diz may be present even if patient is not in heart failure**

Clinical approach to diagnosis:

1. **Identify problems** - clinical presentation
   - Complete history & thorough physical examination
2. **Propose differential diagnoses** - alternatives
3. **Implement diagnostic plan** - evaluate patient:
   - Initial data base
   - Specific procedures - confirm or disprove
4. **Integrate findings** - make diagnosis
5. **Treat**
6. **Re-evaluate patient**:
   - Response to therapy
   - Progression of disease

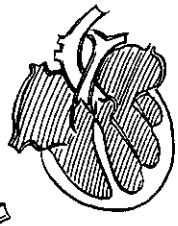


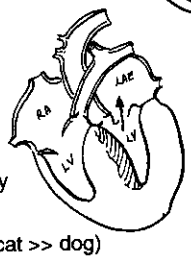
Causes of heart disease - Summary

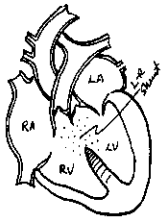
- Congenital heart diz
  - Valvular anomalies & shunts
  - Peritoneopericardial hernia
- Cardiac arrhythmias
  - Tachycardias
  - Bradycardias
- Myocardial diz
  - Cardiomyopathy (dilated, hypertrophic)
  - Myocarditis
- Endocardial diz
  - Bacterial endocarditis
  - Endocardiosis (chronic valvular diz)
- Pericardial diz
  - Pericardial effusions
  - Constrictive pericarditis
- Vascular diz
  - Thromboembolism
  - Heartworm
- 2° to other organ systems
  - Brain
  - GI: gastric dilatation & volvulus (GDV)
  - Kidneys: hypertension
  - Lungs: cor pulmonale & hypoxia
  - Pancreas: necrotizing pancreatitis
  - Endocrine: thyroid, adrenal, etc.

Expanded list of heart failure

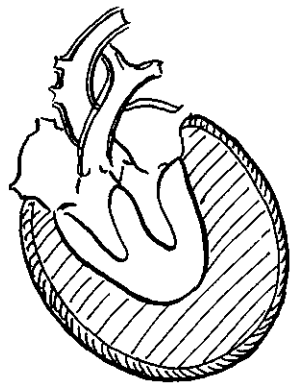
- **Congenital heart diz (anamolies)**
  - Shunts
    - **Patent ductus arteriosus**
    - Atrial & ventricular septal defects
      - Endocardial cushion defect
      - Tetralogy of Fallot
  - Congenital valve malformation
    - Pulmonic stenosis
    - Subaortic stenosis
    - AV valve regurgitation
  - Congenital endocardial fibroelastosis
- **Acquired heart dizs**
  - Cardiomyopathy
    - **Dilated cardiomyopathy**
      - Idiopathic dilated cardiomyopathy
      - Taurine defc (cats)
      - Carnitine defc (dog)
    - **Hypertrophic cardiomyopathy** (cat >> dog)
      - Feline restrictive cardiomyopathy
  - Myocardial infarction
  - 2° myocardial diz
    - Myocardial trauma
    - Thyrotoxicosis
    - Hypertension (renal failure)
    - Myocarditis (parvo)
    - Chronic anemia
    - Doxorubicin toxicity
    - Enterotoxemia
  - **Endocardial & valvular dizs**
    - **Endocardiosis** (chronic valvular diz) (dog)
    - **Bacterial endocarditis**
    - Ruptured chordae tendineae
- **Cardiac arrhythmias**
  - Tachyarrhythmias
    - Atrial arrhythmias (tachycardia, flutter & fibrillation)
    - Ventricular tachycardia

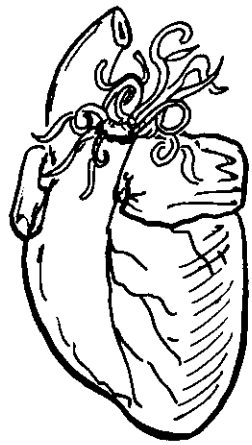






  - Bradyarrhythmias
    - **Hyperkalemia**
      - Iatrogenic
      - FUS (cat)
      - Hypoadrenocorticism
    - Sick sinus
    - SA block/arrest
    - Silent atrium
    - 2nd° heart block
    - 3rd° heart block
  - Brain-heart syndrome
  - Dysautonomia
- **Pericardial dizs**
  - Pericardial effusions
    - Idiopathic
    - Infectious
  - Constrictive pericarditis
  - Cardiac/pericardial neoplasia
- **Vascular diz, Ischemia/hypoxia**
  - **Heartworm diz**
  - Vascular occlusion/thrombosis/infarction
  - Anemia
  - Shock
- **Other organ systems**:
  - Brain
  - GI: gastric dilatation & volvulus (GDV)
  - Kidneys: hypertension
  - Lungs: cor pulmonale & hypoxia
  - Pancreas: necrotizing pancreatitis
  - Endocrine:
    - Hypothyroidism (dog)
    - Hyperthyroidism (cat)
    - Hypoadrenocorticism





Diagnosis of heart problems & heart failure

M8k 65; H-T/M 473

Signalment & common heart problems

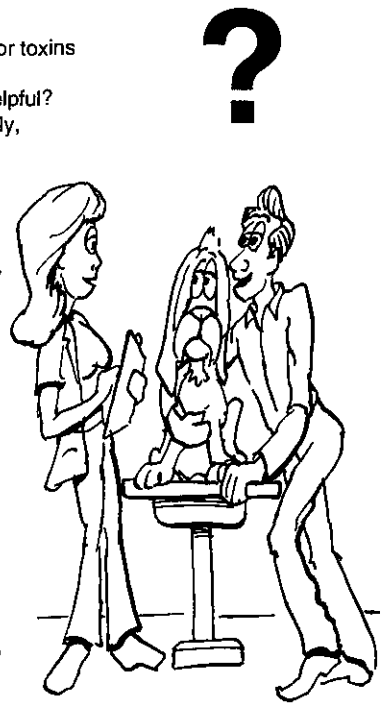
- **Age:**
  - Young animals (< 2 yrs): infections or congenital cardiac diz
  - Older patients (> 5-7 yrs): usually acquired, degenerative or neoplastic diz
  - Exceptions occur:
    - . Cardiomyopathy possible at 6 months of age
    - . Congenital defects may not be diagnosed until older
- Breed: congenital heart defects are more common in certain breeds
  - Large breeds: dilated (congestive) cardiomyopathy (DCM)
  - Boxers: neoplasms & myocarditis
  - Siamese & Persian cats: cardiomyopathy
- Sex:
  - Females:male - patent ductus arteriosus (PDA) (3:1)
    - . Sick sinus syndrome - female Schnauzers
  - Males: valvular diz, aortic stenosis & cardiomyopathy
- Utilization of the animal:
  - Athletic animal may not be able to perform
  - A house pet may not be affected as much by the same diz process
  - Congenital heart diz: don't use for breeding

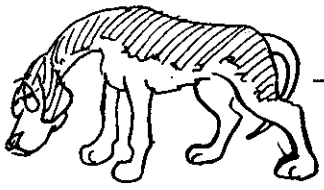
Young	• PDA, PS, SAS, AV dysplasia, TF
Middle aged to older	• AV diz, Atrial rupture, Pericardial effusion, Neoplasia, HCM, DCM, Hypothyroidism, Constrictive pericarditis
Older	• Heart failure, hypertension (renal diz), Pheochromocytoma, Neoplasia

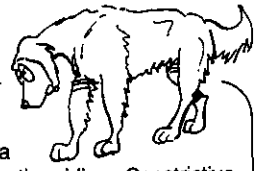
History (obtain as much as possible)

Questions to ask:

- Reason for presentation (chief complaint)?
  - Onset & duration of problem?
  - Progression of diz?
  - Environment & exposure to infectious dizs or toxins
  - Vaccination history?
  - Current or past medication for problem? Helpful?
  - Patient attitude - alert & playful or tires easily, depressed & listless?
    - . Normal activity level of animal?
- Tiring?
  - Fainting or weakness?
  - Relationship to exercise?
  - Recent changes in attitude or activity level?
- Appetite: what & how much is being fed?
- Changes in water consumption & urination?
- Coughing? Character? When?
  - Associated with any stimulus?
  - Panting, heavy breathing?
- Signalment - age, breed, sex?
  - Where was patient obtained?
  - History of littermates, dam & sire?
  - Smallest of litter?
- Diet, recent changes in eating & drinking?
- Indoor or outdoor animal?
- Concurrent medical problems:
  - Diarrhea? Vomiting or gagging?
  - Seizures or syncopal episodes?
  - Coughing, sneezing, or difficulty breathing?
  - Lameness?
  - Reproductive status?

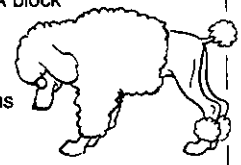


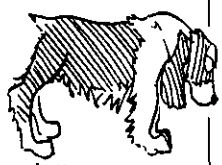


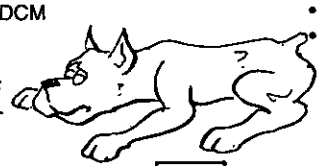


Breed predilection

• Beagle	PS; VSD
• Bichon Frise	PDA
• Boston terrier	PRAA
• Boxer	**DCM**, SAS, ASD, TF, Sick sinus, neoplasms, myocarditis
• Brachycephalic breeds	SA block
• Bull mastiff	DCM
• Bull terrier	SAS, AV dysplasia
• Cavalier King Charles	AV diz (Mitral AV), BE
• Chihuahua	PDA, PS, AV dysplasia
• Cocker spaniel	PDA, SA block, AV diz
• Collie	PDA
• Dachshund	SA block, Sick sinus, Tricuspid AV
• Dalmation	SA block
• Doberman	**DCM, Digitalis sensitivity**, ASD
• Eng. bulldog	PS, VSD, AV dysplasia; TF
• Eng. springer spaniel	PDA, SA standstill,
• Eng. sheepdog	SA standstill
• Fox terrier	PS
• Golden retrievers	SAS; VSD
• G. shepherd	PDA, SAS, AV dysplasia; PRAA, BE, HCM, DCM, Pericardial effusion
• G. shorthaired pointer	SAS
• Great Dane	AV dysplasia, DCM
• Irish setter	VSD, PRAA
• Irish wolfhound	DCM
• Keeshond	PDA, VSD, TF
• Labrador	PS, AV dysplasia
• Large breed dogs	HCM, DCM, Hypothyroidism, Constrictive pericarditis, Pericardial effusion
• Newfoundland	SAS, DCM
• Maltese	PDA
• Middle to large dogs	Hypothyroidism
• Miniature poodle	PDA
• Miniature schnauzer	PS, **Sick sinus**, SA block
• Outdoor dog	Heartworm
• Pomeranian	PDA
• Poodle	VSD
• Pug	SA block, Sick sinus
• Rottweiler	SAS
• Samoyed	PS, ASD
• Shetland sheepdog	PDA
• Shih Tzu	AS standstill
• Small dog	AV diz (Mitral AV)
• Standard poodle	PDA, DCM
• St. Bernard	DCM
• Terriers	VSD
• Toy & small breeds	AV diz (Mitral), Atrial rupture
• Toy poodle	PDA, AV diz
• Weimaraner	AV dysplasia
• Wirehaired terrier	TF
• Yorkshire terrier	PDA





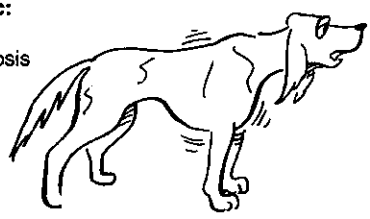


Clinical signs (CS) - Heart diz:

- **Cough #1** presenting complaint (dog)
- **Asymptomatic** in many
- **Restrictive breathing pattern** (fast & shallow)
- **Fainting** (syncope)
- **Tiring** (exercise intolerance)
- Weight loss
- Lameness:
  - Thromboembolism - cats; & septic embolism - dogs

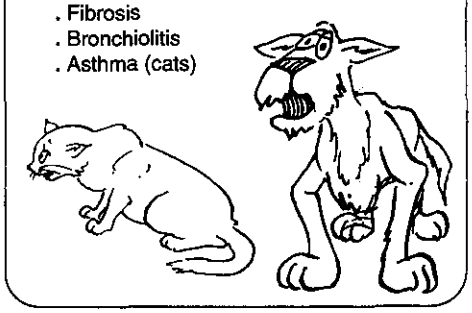
DDx - Cough #1 presenting complaint

- **Cardiogenic:**
  - Left atrial enlargement
  - Pulmonary artery enlargement
  - Pulmonary edema
- **Noncardiogenic:**
  - Airway disease
  - Pulmonary fibrosis
  - Alveolitis
  - Neoplasia



DDx - Dyspnea: inspiratory or expiratory

- **Cardiogenic:**
  - Pulmonary edema w/ left heart failure
    - . Inspiratory & expiratory
  - Pleural effusion w/ right or biventricular failure
    - . Inspiratory effort > expiratory
- **Noncardiogenic:**
  - Pulmonary edema
    - . Respiratory distress syndrome
    - . Electrocution
    - . Brain trauma
    - . Toxins
  - Pleural effusion
    - . Inflammatory
    - . Infectious
    - . Neoplastic
  - Pneumothorax: spontaneous & traumatic
  - Upper airway obstructions
    - . Elongated soft palate
    - . Laryngeal paralysis
  - Lower airway obstructions
    - . Fibrosis
    - . Bronchiolitis
    - . Asthma (cats)



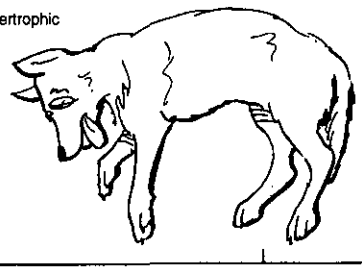
Status of heart patient - functional classifications:

- **Class 1:** Minimal evidence of myocardial dysfunction (e.g., murmur)
  No clinical signs of failure
- **Class 2:** Failure CS with or following exercise
  - Class 2 Without appropriate therapy (Tx)
  - Class 2a With Tx
- **Class 3:** Failure CS with normal activity or at night
  - Class 3 Without Tx
  - Class 3a With Tx
- **Class 4:** Failure CS present at rest
  - Class 4 Without Tx
  - Class 4a With Tx
  - Class 4b Life-threatening signs of failure
    Requires emergency Tx & continuous monitoring

Asymptomatic

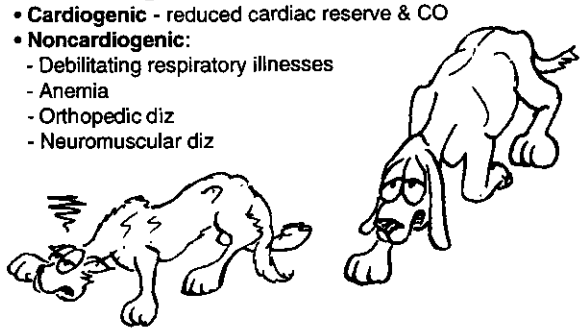
DDx - Syncope (fainting)

- **Cardiac causes:**
  - Bradycardia (AV blocks, Sinus arrest, Sick sinus syndrome, Atrial standstill)
  - Tachyarrhythmias (paroxysmal atrial or ventricular tachycardia, reentrant supraventricular tachycardia, atrial fibrillation or flutter)
  - Congenital ventricular outflow obstruction (**pulmonic stenosis, subaortic stenosis**)
  - Acquired ventricular outflow obstruction (**heartworm**, hypertrophic obstructive cardiomyopathy, thrombus, tumor)
  - Cyanotic heart diz (tetralogy of Fallot, reversed PDA)
  - Impaired cardiac output (AV valve insufficiency, dilated cardiomyopathy, arrhythmias, myocardial infarction, heartworms)
  - Pericardial effusion/tamponade
  - Constrictive pericarditis
  - Cardiovascular drugs (diuretics, vasodilators)
  - Vasopressive reflexes
- **Pulmonary causes:**
  - Hypoxia
  - Cough-syncope
  - Pulmonary hypertension
- **Metabolic or hematologic causes:**
  - Hypoglycemia
  - Hypoadrenocorticism
  - Electrolyte imbalance (potassium, calcium)
  - Anemia
  - Sudden hemorrhage
- **Neurological causes:**
  - **Seizures** (aura, ictus & postictal signs)
  - Neuromuscular diz
  - Cerebrovascular accident
  - Narcolepsy, cataplexy



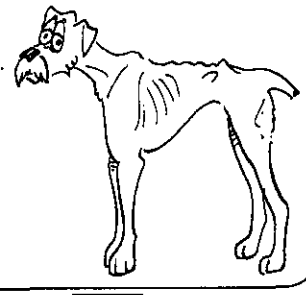
DDx - Tiring/Exercise intolerance see pg 535

- **Cardiogenic** - reduced cardiac reserve & CO
- **Noncardiogenic:**
  - Debilitating respiratory illnesses
  - Anemia
  - Orthopedic diz
  - Neuromuscular diz



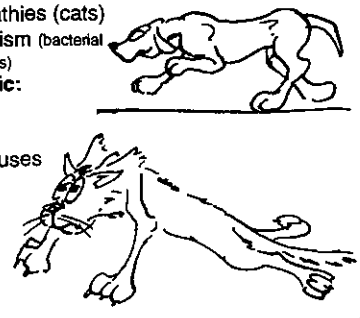
DDx - Weight loss pg 709

- **Cardiogenic** - eventually associated w/ most causes of heart failure
- **Noncardiogenic**
  - GI
  - Resp
  - Neoplasia, etc.



DDx - Lameness

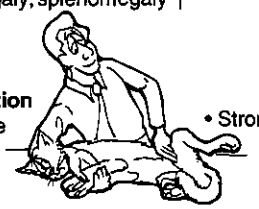
- **Cardiogenic:**
  - Thromboembolism
    - . Cardiomyopathies (cats)
    - . Septic embolism (bacterial endocarditis (dogs)
- **Noncardiogenic:**
  - Orthopedic
  - Trauma
  - Neurologic causes



Physical exam - heart problems

I2M 4; Cat 821; IM-WW 137; H-Plc 21; H-T/M 473; VC-Dx 201; NB 3.2

- Complete general physical, from a distance & up close
  - Attitude & behavior
  - Posture: refusal to lie down, standing with abducted elbows, head & neck extended
  - Open-mouthed breathing, cough
  - Rate & rhythm of respirations (fast & shallow - CHF)
  - Edema (dependent ventral edema - severe CHF)
  - Fever (if present, infectious)
  - Examine nares for patency or discharge
  - Mucous membranes (MM)
    . Pale MM indicate poor perfusion (shock) or anemia
  - Capillary refill time (CRT)
    . Cyanosis: shunting of blood past lungs
    . Hyperemic
  - Palpation for tracheal masses or collapse
    . Abdominal palpation: hepatomegaly, splenomegaly & ascites (ballottement)



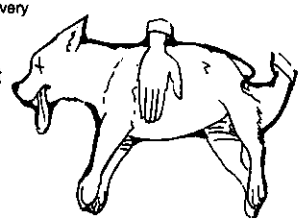
- **Cardiac examination:**
  - **Jugular vein distension/pulsation** (pulsation higher than 1/3rd of the way up neck)
  - **Altered arterial pulse:** (normal cat pulses can be difficult to palpate)
    . Excessively strong (hyperkinetic)
    . Excessively weak pulse (hypokinetic)
    .. Obesity, pleural or pericardial effusion, masses, or pneumothorax
    . Compare both rt. & lt. to be sure they are equal
    . Correlate w/ heart beat (pulse deficits)
  - Ocular fundic exam: systemic hypertension may cause dilated tortuous vessels or retinal hemorrhages & detachment

- **Cardiac exam** (cont.)
  - **Precordial pulse** (palm & fingers of each hand on each side of patient's chest over heart)
    . Normally strongest beat at left apex (lt. 5-6th ICS* at CCJ†)
    . Precordial thrill ("buzzing"): palpable vibrations of a very loud cardiac murmur
  - **Fluid accumulations**
    . Ballottement of abdomen, percussion of chest & palpation of dependent skin areas

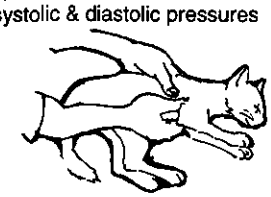
* ICS = Intercostal space
† CCJ = Costochondral junction

Heart rate:

Dog (depends on size)	70-180 bpm
Puppies (higher)	≤ 220 bpm
Cat	120-200 bpm



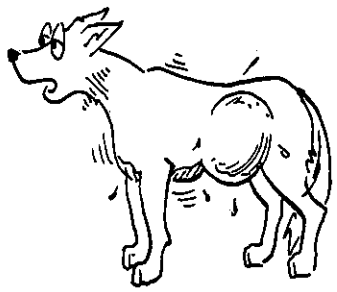
Pulse	Findings	Conditions
• Weak pulse	• Low heart output, ↑ peripheral resistance, little differences in systolic & diastolic pressures	• Left ventricular failure (dilatative cardiomyopathy) • Subaortic stenosis • Shock, hypovolemia
• Strong pulse	• High output states	• Hyperthyroidism, anemia, excitement, fever/sepsis, hypertension, etc.
• Bounding pulse	• Large systolic & diastolic pressure differences • High output states	• PDA • Aortic insufficiencies • Hyperthyroidism • Anemia, etc.
• Pulse deficits	• Insufficient time for ventricles to fill before contraction	• Atrial fibrillation • Ventricular premature contractions



DDx - Jugular vein distention/pulsation

IM 7

- Distention alone
  - Dilated cardiomyopathy
  - Pericardial effusion/tamponade
  - Right atrial mass/inflow obstruction
  - Cranial mediastinal mass
  - Jugular vein/cranial vena cava thrombosis
- Pulsation ± distention
  - Right (tricuspid) AV regurgitation
    . Cardiomyopathy
    . Congenital
    . Endocardiosis
  - Pulmonic stenosis
  - Pulmonary hypertension
  - Premature ventricular contractions
  - Heartworm diz
  - Complete 3rd° heart block



DDx - Mucous membrane color

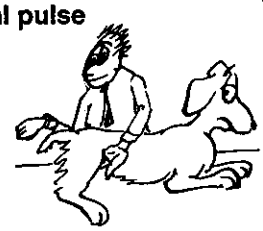
IM 6

- Pale - pallor
  - Anemia
  - Poor cardiac output
  - Shock (hypovolemia, bradycardia, etc.)

DDx - Abnormal arterial pulse

IM 7

- Weak pulses
  - Dilated cardiomyopathy
  - Subaortic stenosis
  - Shock
  - Hypovolemia
- Strong pulse
  - Excitement
  - Hypertrophic cardiomyopathy (cat) ±
  - Hyperthyroidism
  - Fever/sepsis
- Very strong, bounding pulse
  - PDA (patent ductus arteriosus)
  - Fever/sepsis
- Pulse deficits
  - Atrial fibrillation
  - Ventricular premature contractions

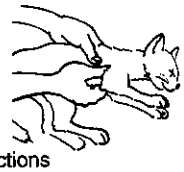


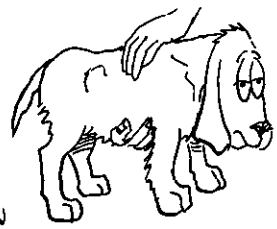
DDx - Change in location of precordial pulse

- Displacement of heart
  - Mass lesions
  - Lung atelectasis
  - Chest deformity
  - Right ventricular hypertrophy

DDx - Reduced intensity of precordial pulse

- Obesity
- Pericardial effusions
- Intrathoracic masses
- Pleural effusions
- Pneumothorax
- Weak cardiac contractions



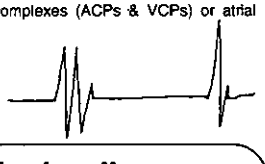


Auscultation of thorax

IM-WW 139; I2M 8; Cat 822; H-Pic 24; H-T/M 9; VC-Dx 208; H2B 6; H-hb 7; Pys-B 180; NB 3.4

- Heart auscultation essential - standing
  - Artifacts (respiratory sounds, shivering & twitching, purring, crackling due to hair coat & external noises in the room)
  - Heart rate (HR) & rhythm
    . Changes in HR & rhythm due to respiration (normal)
  - Heart sounds: normal & abnormal, loudness
  - Listen at 4 valve areas - PMI, thoracic inlet & sternum
- Lung auscultation in heart problems:
  - ↑ Pulmonary sounds (crackles & wheezes)
- Pulse (femoral) & heart rate
  - Normal: pulse for every heart beat or something is wrong (pulse deficit = arrhythmia), caused by heartbeat before complete filling of ventricles
  - Pulse deficits: indicate incomplete ventricular filling (atrial fibrillation, ventricular premature complexes & atrial premature complexes)
  - Pulse irregularities: cyclic in sinus arrhythmias & noncyclic w/ other arrhythmias (atrial fibrillation)
  - Low intensity pulse - premature complexes (ACPs & VCPs) or atrial fibrillation

Percussion of thorax: difficult
- Determine masses or fluid lines
- Requires practice - difficult technique



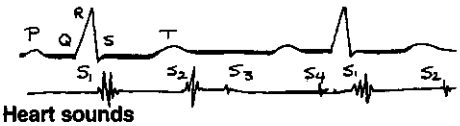
Valvular dizs

- Endocardiosis
- Congenital aortic stenosis
- Congenital pulmonic stenosis
- Congenital AV valve dysplasia
- Bacterial endocarditis
- AV valvular regurgitation due to cardiomegaly

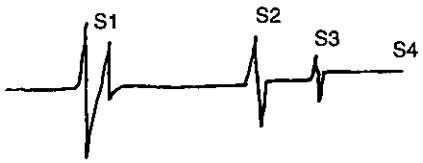
PMI heart valves (point of maximum intensity)

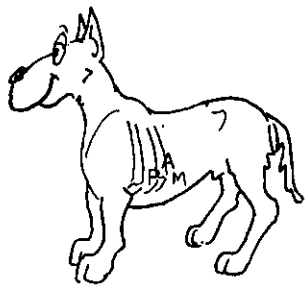
(Rule of thumb: left $P^{A}M$ $3^{4}5$)

- Pulmonic valve - low lt. 3rd ICS (intercostal space)
- Aortic valve - high lt. 4th ICS
- Lt. AV (mitral) valve - low lt. 5th ICS
- Rt. AV (tricuspid) valve - **rt.** low 4th ICS



Heart sounds
- Normal
  - **S1 (lub)**: closure of AV valves (start of ventricular systole)
  - **S2 (dub)**: closure of semilunar (aortic & pulmonic) valves (start of ventricular diastole)
- **Abnormal heart sounds**
  - Split S2 due to delayed closure of a semilunar (aortic or pulmonic) valve, most commonly w/ HWD (heartworm diz)
  - S2 may be absent in arrhythmias if the ventricles do not fill adequately (semilunar valves don't open)
  - **Diastolic**
    . Gallop rhythm S3 & S4 sounds (early heart failure)
    .. S3: associated w/ rapid ventricular filling - dilated ventricle (mitral insufficiency or cardiomyopathy)
    .. S4: due to atrial contraction (hypertrophy or AV dysplasia)
    .. Low frequency - bell of stethoscope
  - Systolic clicks (may suggest lt. AV [mitral] valve problems)





Left $P^{A}M$ $3^{4}5$

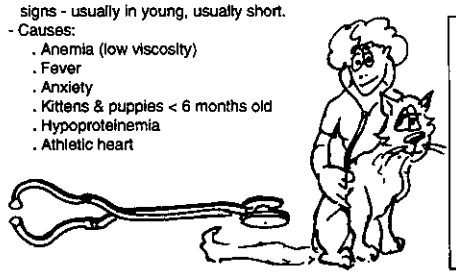
Valves of heart: prevents retrograde (regurgitation) flow
- Rt. & lt. atrioventricular valves (AV): prevent backflow of blood into atria during ventricular systole
  - Rt. AV ("tricuspid") valve — Rt. 4th low
  - Lt. AV ("mitral/bicuspid") valve — Lt. 5th low
- Pulmonic & aortic semilunar valves, prevent backflow of blood into ventricles during ventricular diastole
  - Pulmonic valve — Lt. 3rd low
  - Aortic valve — Lt. 4th high

Valve dysfunction
- Stenosis: obstruction of flow (usually congenital)
- Regurgitation (insufficiency): incomplete closure of valve (congenital or acquired)

Murmurs

M8k 76; H2B 95t; IM 10; SAP 453; Pys-B 180; NB 3.4;

- **Hallmark of valvular diz**
- Due to turbulent blood flow over valve
  - Severity of diz & severity of murmur are not correlated
  - Progression of murmur over time indicates progression of diz
- Innocent or physiologic murmurs needn't be worked up, note & check over time
  - Examples would be low grade murmur with no other cardiac signs - usually in young, usually short.
  - Causes:
    . Anemia (low viscosity)
    . Fever
    . Anxiety
    . Kittens & puppies < 6 months old
    . Hypoproteinemia
    . Athletic heart

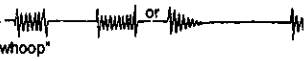
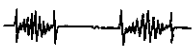
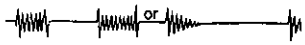
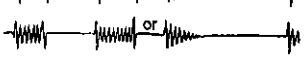


- **Murmurs to work up with ECG, Rads, Echo**
  - +Cardiac diz CS
  - Continuous or diastolic murmur
  - Gallop rhythm
  - Pulse deficit
  - Progression of murmur
- Murmur when anesthesia contemplated (↑ risk)
  - Grade 2-6: check for cardiac diz (enlarged atria)
    . Extra caution if clinical signs of heart diz

Grading of cardiac murmurs

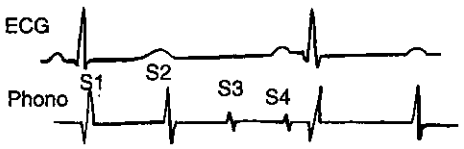
Grade 1/6	Very soft, minutes to hear in a quiet room
Grade 2/6	Soft murmur, but definite
Grade 3/6	Moderate
Grade 4/6	Loud, no precordial thrill
Grade 5/6	Loud w/ palpable precordial thrill
Grade 6/6	Loud, precordial thrill & heard w/ stethoscope off chest wall

Pathologic murmurs: stenosis, regurgitation, shunts

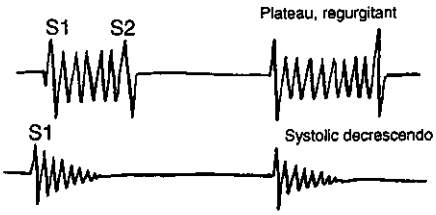
• Systolic murmur			
- Lt. AV (mitral) regurgitation	Lt. 5th low (Lt. apex)	Plateau or decrescendo Harsh, blowing, rarely musical "whoop"	
- Aortic stenosis	Lt. 4th high	Diamond (crescendo-decrescendo)	
- Pulmonic stenosis	Lt. 3th low	Diamond (crescendo-decrescendo)	
- Rt. AV regurgitation	Rt. 4th low	Plateau or decrescendo (Low-pitched harsh blowing)	
- VSD (ventricular septal defect)	Right side	Plateau or decrescendo	
• Diastolic murmur			
- Aortic valve regurgitation	Left side	Decrescendo (prominent pulse)	
• Continuous (diastolic - systolic)			
- Patent ductus arteriosus	Left side	#1 CHD (dog), "machinery murmur"	

Atrial septal defect, pulmonic regurgitation, Tetralogy of Fallot are rare causes of murmurs

Shapes of murmur (phonocardiogram)



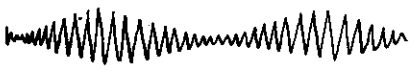
- Systolic - Plateau, regurgitant
- Systolic - Decrescendo
  - AV valve regurgitation, ventricular septal defect



- Crescendo-decrescendo (diamond)
  - Aortic or pulmonic stenosis

- Diastolic decrescendo - uncommon
  - Aortic regurgitation

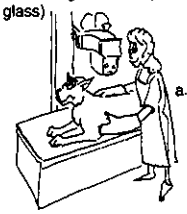
- Continuous (machinery)
  - Patent ductus arteriosus



Radiographs - Heart:

X4T 335; X-Ger 144, 234(f); Cat 826; F3IM 249; IM-WW 144; H-Pic 32

- At least 2 views - Lat. (lateral) & DV (dorsoventral) - at peak inspiration
- Survey films for:
  - Cardiac enlargement (true or distention of pericardial sac)
  - Chamber enlargement (rarely just one - usually 2 or all 4)
  - Pulmonary edema (alveolar pattern/air bronchograms)
  - Pleural effusion (interstitial pattern: more opaque, vessels fuzzy)
  - Pulmonary congestion (vascular pattern, enlarged vessels)
  - Peritoneal effusion (ascites) (ground glass)
  - Hepatomegaly



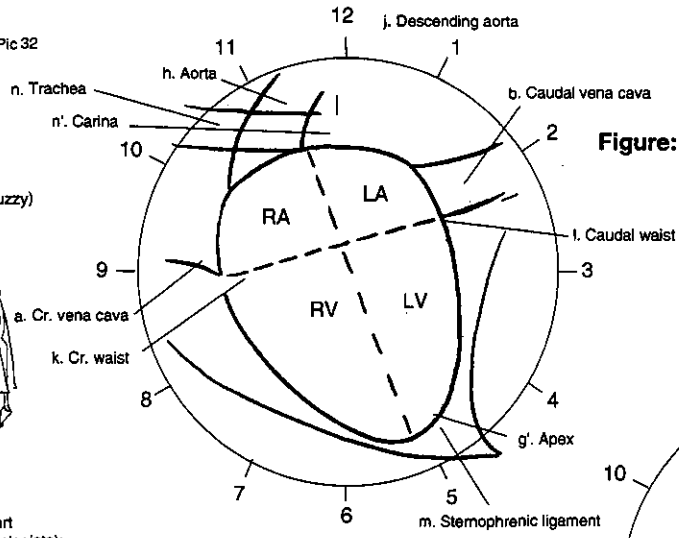
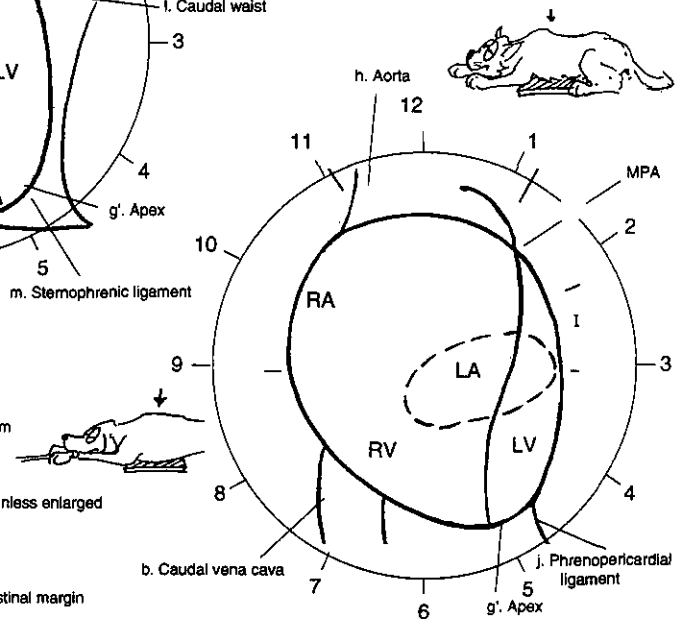


Figure: lateral radiographic view

LATERAL VIEW

a. Cranial vena cava: ventral edge seen
b. Caudal vena cava: between heart & diaphragm
c-e. Right side heart: 6 to 11 o'clock - cranial aspect
  c. Right atria (RA): upper part of the cranial heart
  d. Right ventricle (RV): 6 to 9 o'clock - lower cranial heart
  e. Pulmonary trunk (main pulmonary artery [MPA] to radiologists): not seen on lat. view (superimposed)
f-g. Left heart: 1 to 6 o'clock - caudal aspect
  f. Left atrium: 1 to 3 o'clock - upper, caudal heart
  g. Left ventricle: 3 to 6 o'clock - ventral, caudal heart & apex
  g'. Apex: 5 o'clock
h. Aortic arch: 11 to 12 o'clock - out of heart base
i. Brachiocephalic trunk & lt. subclavian a.: not seen, unless pneumomediastinum
j. Descending aorta: high against the vertebrae
k. Cranial waist: 9 o'clock - between the cranial vena cava & right atrium
l. Caudal waist: 3 o'clock - coronary groove
m. Sternopericardiac ligament: pericardium to sternal floor
n. Trachea
  n' "Carina": bifurcation of trachea

Figure: DV radiographic view

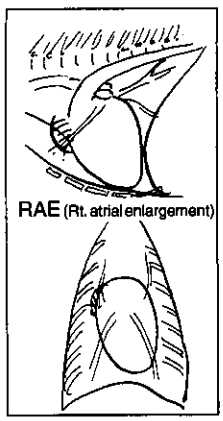


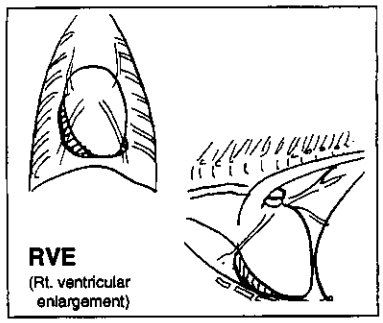
DV VIEW:

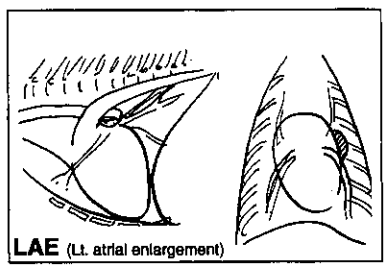
a. Cranial vena cava: not seen
b. Caudal vena cava: right heart to diaphragm
c. Right atria: 9 to 11 o'clock
d. Right ventricle: 6 to 9 o'clock
e. Pulmonary trunk (MPA): 1 to 2 o'clock
f. Left atrium: 2 to 3 o'clock, superimposed unless enlarged
g. Left ventricle: 2 to 6 o'clock
  g'. Apex: 5 o'clock - points to the left
h. Aortic arch: not 11 - 1 o'clock position
i. Descending aorta: left edge seen
j. Phrenicopericardiac ligament: left mediastinal margin

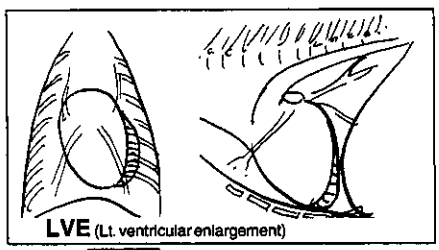
Heart chamber enlargement - indicates:

Lateral view	
- Elevation of trachea	Any chamber
- Loss of cranial waist	RAE
- Apex off the sternum	RVE
- Backwards "D"	RVE
- Apex off sternum	RVE
- Separation of main stem bronchi	LAE
- Loss of caudal cardiac waist	LAE
- Bowing caudally - 3 to 5 o'clock	LVE
- > 3 sternebrae contact	RVE
DV view	
- 9 to 11 o'clock bulge	RAE
- Backwards "D" - 6-9 o'clock	RVE
- Apex to left	RVE
- "Cowboy legs" (main bronchi)	LAE
- 3 to 5 o'clock bulge	LVE
- Apex to right	LVE









RAE Lat view: Elevation of trachea (carina); Loss of the cranial waist
DV view: 9 to 11 o'clock bulge

RVE Lat. view: 6 to 9 o'clock bulging; More sternal contact; Trachea & carina elevation; Apex elevation off sternum
DV view: 6 to 9 o'clock bulge (backwards or reverse "D"); Apex more to left

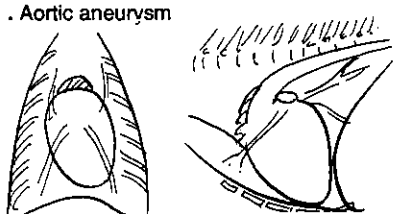
LAE Lat. view: Elevated trachea & carina; Separation of mainstem bronchi (left above right)
DV view: 2 to 3 o'clock bulge (auricle); "Cowboy legs" (spread mainstem bronchi)

LVE Lat. view: Loss of caudal waist; 3 to 6 o'clock bulging
DV view: Rounding 3 to 5 o'clock; Apex shifted to right

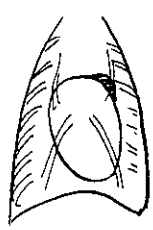
2/5-3/5 rule: Draw a line from the "carina" of the trachea to heart apex (lateral view)
- > 2/5th of the heart in back of the line = lt. heart enlargement
- > 3/5th of the heart in front of the line infers rt. heart enlargement

Major vessels

- **Enlarged aortic arch**
  - Findings:
    . Lat.: elongated cardiac silhouette, protrusion of cranial heart border 11-1 o'clock
    . DV: widened aortic arch 11-1 o'clock
  - Causes
    . Patent ductus arteriosus
    . Aortic stenosis
    . Aortic aneurysm



- **Enlarged pulmonary trunk** (MPA/main pulmonary artery, pulmonary artery segment)
  - Findings
    . DV/VD: **1-2 o'clock bulge**
  - Causes:
    . Pulmonic stenosis
    . Heartworm
    . Patent ductus arteriosus
    . Septal defects w/ left to right shunting (VSD, ASD)

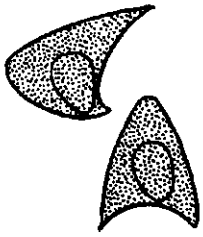


Radiographs - Chest & Abdomen

X-RP 101, 109, 123; X-T 353; I2M 30

- Chest is evaluated for air & fluid in lungs & fluid in pleural space
- Abdomen is evaluated for ascites (peritoneal fluid) due to right heart failure & back up of fluid into abdomen
- If labored breathing (dyspnea) take a DV view instead of a VD view so animal is not further compromised

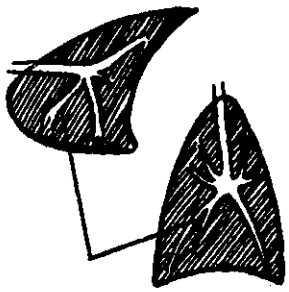
Interstitial pattern



Pulmonary edema

- Usually caused by congestive left heart failure - fluid backs up into the pulmonic circulation, may also have noncardiogenic causes
- Types of pulmonary edema
  - **Interstitial edema** - fluid in lung tissue (parenchyma)
    - . **Vessels fuzzy, but evident**
    - . More opaque lung field - linear or nodular, greater in perihilar area
    - . Air still evident in lung
  - **Alveolar edema** - alveoli filled w/ fluid
    - . Opaque lung field - "fluffy", ill defined radiopacity
    - . No air in lungs
    - . **Air bronchograms** (black worm holes in white patches)
    - . **No vasculature seen**

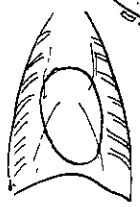
Alveolar pattern



Pulmonary circulation

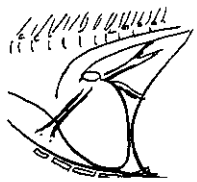
• Under circulation (hypovascularity)

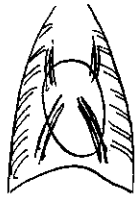
- Findings: more radiolucent lung fields
  - . **Pulmonary arteries smaller than veins**
- Causes:
  - . Right to left shunt
  - . Pulmonic stenosis
  - . Hypovolemic shock (small heart)
  - . Adrenal insufficiency (small heart)
- DDx:
  - . Emphysema
  - . Over inflation
  - . Overexposure



• Overcirculation

- Findings
  - . **Arteries larger than veins**
  - . More opaque lungs
- Causes:
  - . Heartworm
  - . PDA (patent ductus arteriosus)
  - . Left to right shunts (VSD, ASD)
  - . Congestive heart failure
  - . Fluid overload
- DDx
  - . Expiratory radiograph
  - . Underexposure

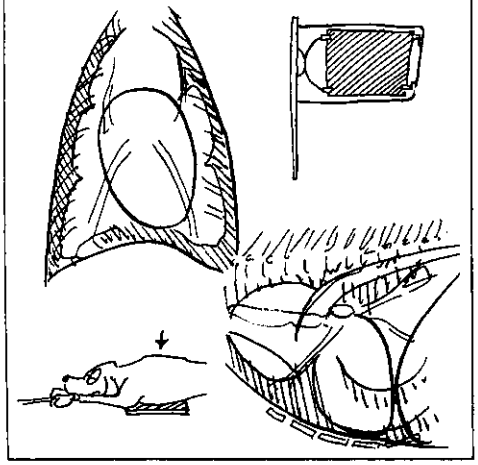




Memory aid :
Veins are ventral & central

Pleural (hydrothorax) effusion

- Right heart failure causes blood to back up into pleural space as well as the rest of body
  - Lateral view - recumbent
    - . ↑ Opacity to ventral thorax
    - . Scalloped appearance (fluid in fissures of lungs)
  - DV view
    - . **Retraction of lungs from thoracic wall**
    - . Blunting of costophrenic angles
    - . Widening of mediastinum
    - . **Scalloped appearance**
    - . Blurring/disappearance of cardiac shadow

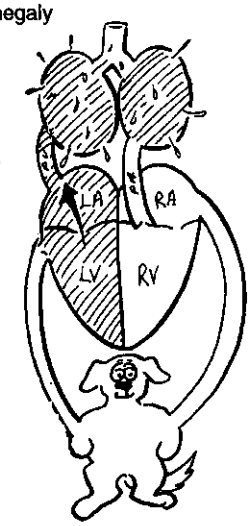


Ascites (fluid in peritoneal cavity) & hepatomegaly

- Right heart failure causes fluid to back up into the body (systemic veins)

DDx - Pulmonary edema

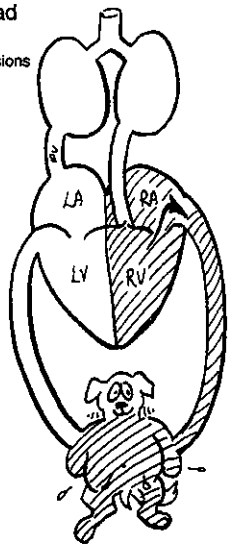
- **Cardiac causes - left side failure** (backs up into lungs)
  - Cardiogenic edema w/ visible cardiomegaly
    - . Chronic mitral valve diz
    - . Cardiomyopathy
    - . Ruptured chordae tendineae
    - . Heart block
    - . Left to right shunts
  - Cardiogenic edema w/o cardiomegaly
    - . Electrical shock
    - . Cardiomyopathy in some cases
    - . Trauma
    - . Tachyarrhythmias or heart block
    - . Myocardial depressants
- **Noncardiogenic edema**
  - Infection
  - Toxic (smoke, endotoxins, venom, ANTU)
  - Allergy, anaphylaxis
  - Trauma
  - Uremia
  - Over transfusion
  - Lymphatic obstruction
  - Venous obstruction (tumors masses)
  - Hypoalbuminemia (nephrosis, liver failure, enteropathies)
  - Neurogenic (head trauma, encephalitis, brain tumors)
- ↑ Tissue density, not fluid mistaken for edema
  - Interstitial fibrosis
  - Interstitial pneumonia
  - Atelectasis
  - Allergic conditions
  - Lung worms



DDx - Pleural effusions - hydrothorax - Ascites

- **Right sided failure**
  - Rt. AV (tricuspid) valve regurgitation
  - Pulmonic stenosis
  - Heartworm
  - Pericardial effusion or pericarditis
  - Tetralogy of Fallot
- Uremia
- Hypoproteinemia
- Fluid overload

Other pleural effusions not considered:
- Pyothorax
- Hemothorax
- Chylothorax
- Neoplasia
- Pleuritis

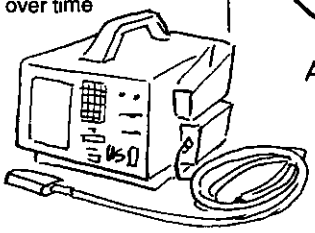


Echocardiography (Cardiac Ultrasound/US/Echo)

H-T/M 80, 474; H-hb 31; IM 30; SAP 448, 501; I2M 40; Cat 835; IM-WW 146; H-Pic 43

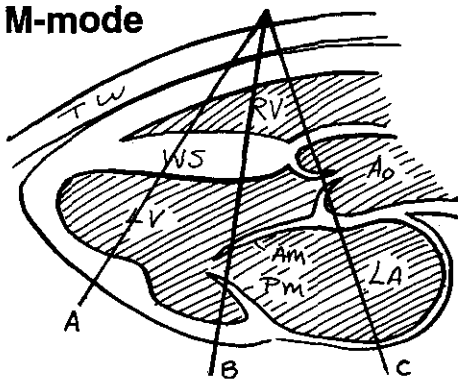
Types of cardiac US (ultrasound)

- **M-mode (motion)**
  - **Ice pick images** of heart
    - . Gives lines for ventricles, left atria, aorta, valves
  - Requires viewing movement of heart over time
  - Uses:
    - . Measuring cardiac wall thickness
    - . Chamber size
    - . Cardiac contractility (i.e., fractional shortening)
    - . Valve in motion
- **2D (two-dimensional) or grey scale**
  - **"Pie section"** view of heart
  - Both real time & static images
  - Uses:
    - . Overall impression of cardiac chamber size & motion
    - . Valvular structure & function

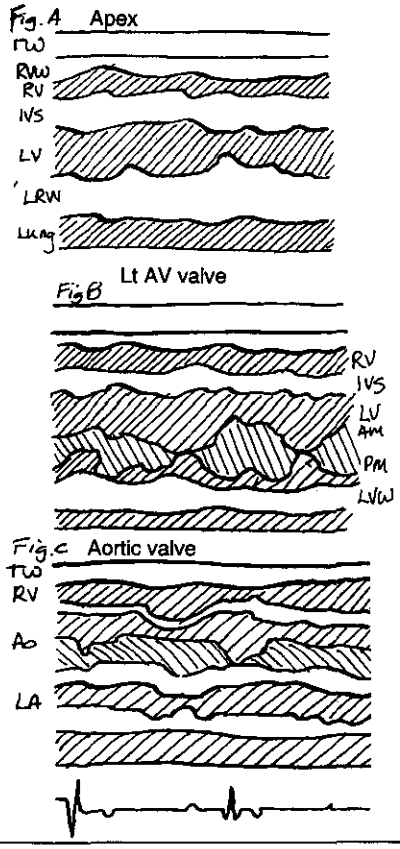


- Doppler: ultrasonic cinetoarteriography
  - Compares frequency of transmitted ultrasound w/ received US of moving cells (blood cells), cells moving towards transducer have higher frequency than those moving away
  - Used to estimate velocity of blood flow

M-mode

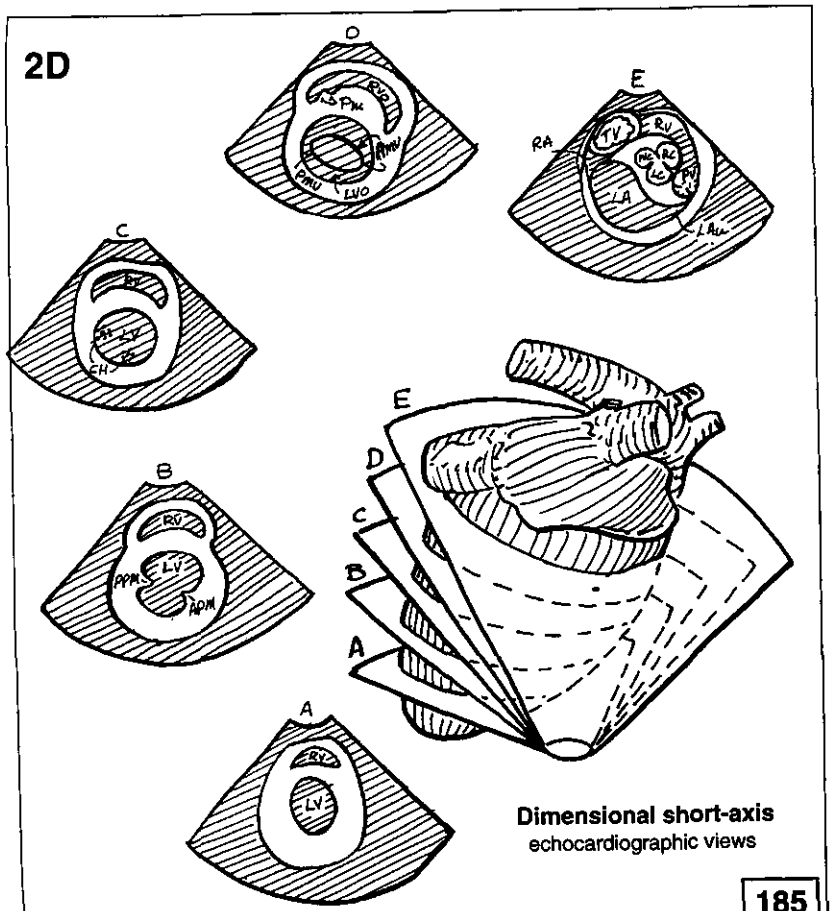


Common M-mode views



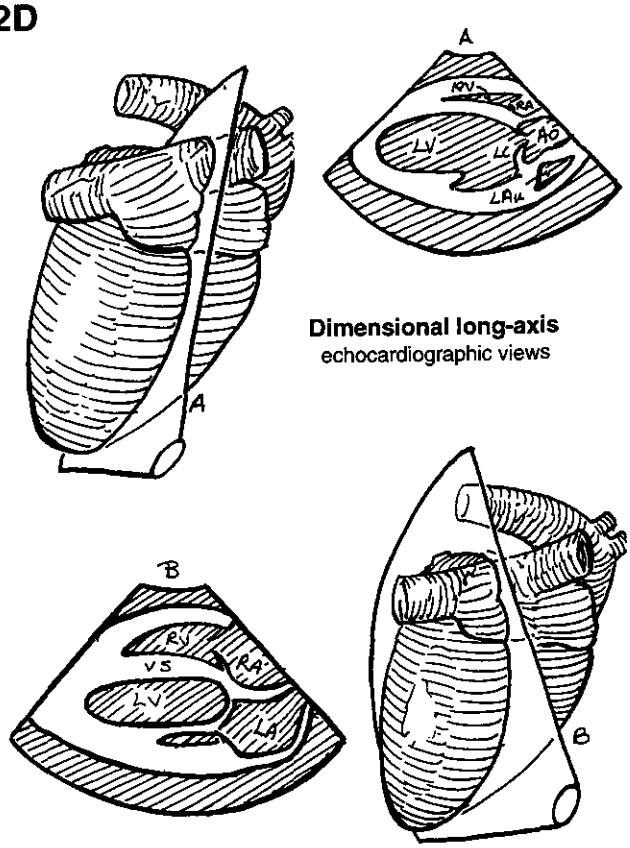
AMV	Anterior septal mitral valve cusp
Ao	Aorta (M)
APM	Anterior papillary muscle
IVS	Interventricular septum
LA	Left atrium
LC	Left cusp of aortic valve (2D)
LV	Left ventricle
LVW	Left ventricular wall
NC	Noncoronary cusp of aortic valve (2D)
PMV	Posterior mitral valve cusp
PPM	Posterior papillary muscle
PV	Pulmonic valve (2D)
RA	Right atrium
RC	Right cusp of aortic valve (2D)
RVW	Right ventricular wall
TV	Tricuspid (Rt AV) valve
TW	Thoracic wall

2D



Dimensional short-axis echocardiographic views

2D



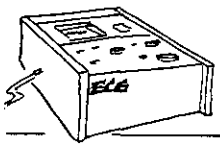
Dimensional long-axis echocardiographic views

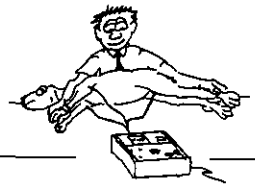
Electrocardiography, ECG

SAP 412; H-T/M 47, 474; H2B 72; I2M 13; IM-WW 140; CAT 837; H-HB 17; H-F 43, 113; H-T 8; H-Plc 37; Pys-B 142, 159, VC-Dx 217

- Graphic representation of electrical activity of the heart
- Electrocardiograms (ECGs): graphs of activity
- **ECG analysis**: evaluate **from left to right in basic limb leads (I, II, III, aVR, aVL & aVF)**, compare to normal values

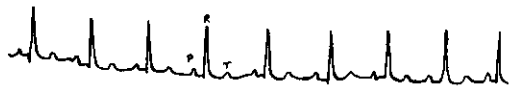
1. **Calculate heart rate** (50 mm/sec): count complexes between 3 markers (3 sec), multiply by 20
2. **Determine rhythm** (measure & compare distance between successive R waves)
   - Sinus rhythm = "P" wave for every "QRS" complex; normal & consistent "P-R" & "R-R" intervals, Sinus arrhythmia: constant P-R interval, but variable R-R intervals
   - Dysrhythmia = no "P" wave for every "QRS" complex, short, long or inconsistent "P-R" intervals
3. **Measure complexes & intervals** for height & duration
   - P-R interval - determine
   - QT interval - determine
   - S-T segment - evaluate
   - Compare to normal values (heart rate, rhythm & sizes)
4. **Determine mean electrical axis** (MEA) in frontal plane for ventricular chamber enlargement (find isoelectric lead [equally positive or negative, or 0], find perpendicular lead, if negative or positive deflection indicates direction of MEA)

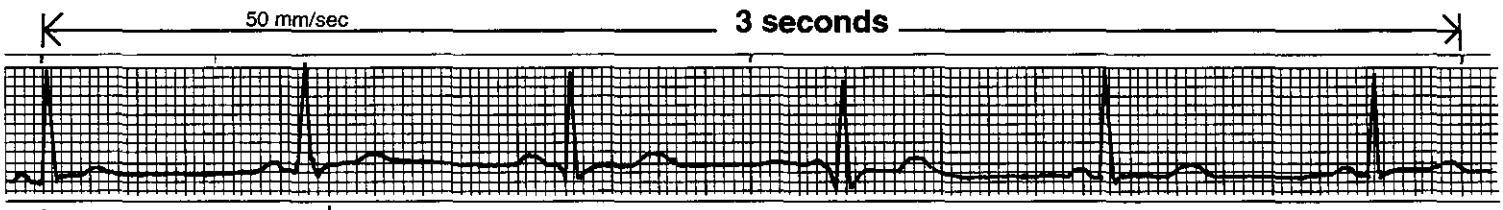




Normal dog & cat ECG values (T 60) Speed: 50 mm/sec, Sensitivity: 1 mv = 10 mm

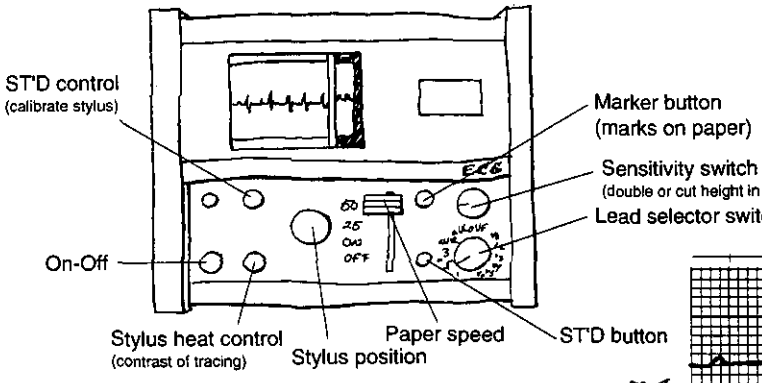
	Canine	Feline
Heart rate (HR) bpm (beats per min)	Standard: 70-160 bpm Puppies: up to 220 bpm Toy breeds: up to 180 bpm Giant breeds: 60-140 bpm	120-200 bpm
Rhythm	Sinus rhythm Sinus arrhythmia Wandering pacemaker	Sinus rhythm
P wave		
Height	≤ 0.4 mV (< 4 boxes)	≤ 0.2 mV (< 1 box)
Width	0.04 sec (< 2 boxes)	≤ 0.04 sec (< 2 boxes)
PR interval	0.06-0.13 sec (3-6.5 boxes) > 0.13 in giant breeds (> 6.5 boxes)	0.05-0.09 sec (2.5- 4.5 boxes)
QRS complex		
Height	Small breeds: ≤ 2.5 mV 3rd° 25 boxes) Large breeds: ≤ 3.0 mV (≤ 30 boxes)	≤ 0.9 mV (≤ 9)
Width	Small breeds: ≤ 0.05 sec (≤ 2.5 boxes) Large breeds: ≤ 0.06 sec (≤ 3 boxes)	< 0.04 sec (2 boxes)
S-T segment		
Depression	No more than 0.2 mV (2 boxes)	None
Elevation	No more than 0.15 mV (1.5 boxes)	None
Q-T interval	0.15-0.25 sec (normal HR) (7.5-12.5 boxes)	0.12-0.18 sec (normal HR) (6-9 boxes)
T wave	Positive or negative	Usually positive
Electrical axis	+ 40 to + 100°	0° to + 160°

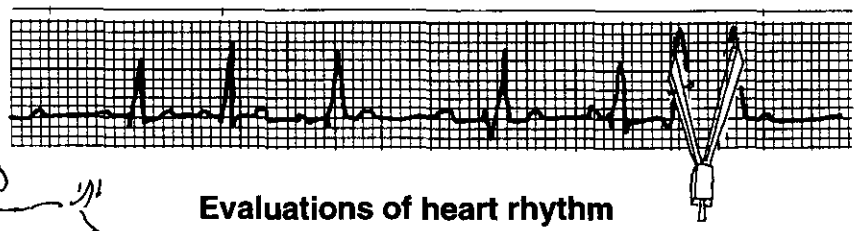




Calculate HR (heart rate) T 44

- Irregular rates
  - Count R-R intervals in 3 seconds (2 sets of time markers at 50 mm/sec)
    . Multiply by 20 ..... 6 complexes x 20 =120
- Regular rates
  - Count number of large boxes in 1 R-R interval
    . Divide into 600 ..... 600/6 = 100
  - Count number of small boxes in one R-R interval
    . Divide into 3000 ..... 3000/27 = 111





Technique to record an ECG

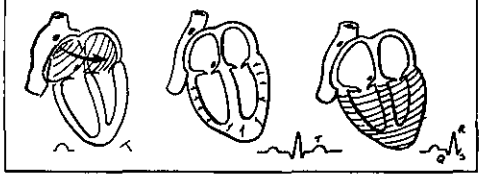
- Right lateral recumbency (if dyspnic or if restraint is dangerous, any comfortable position is used for lead II)
- Wet skin w/ alcohol or ECG electrode gel
- Attach electrodes at elbows & stifles
- Hold upper limbs perpendicular to long axis of animal & parallel to floor so limbs don't contact
  - Thoracic limbs must be parallel or alters mean electrical axis
- Record: push standard calibration button at beginning of each recording
  - ≥ 3-4 complexes in each of 6 limb leads
  - A long lead 2 [II] strip for rhythm evaluation

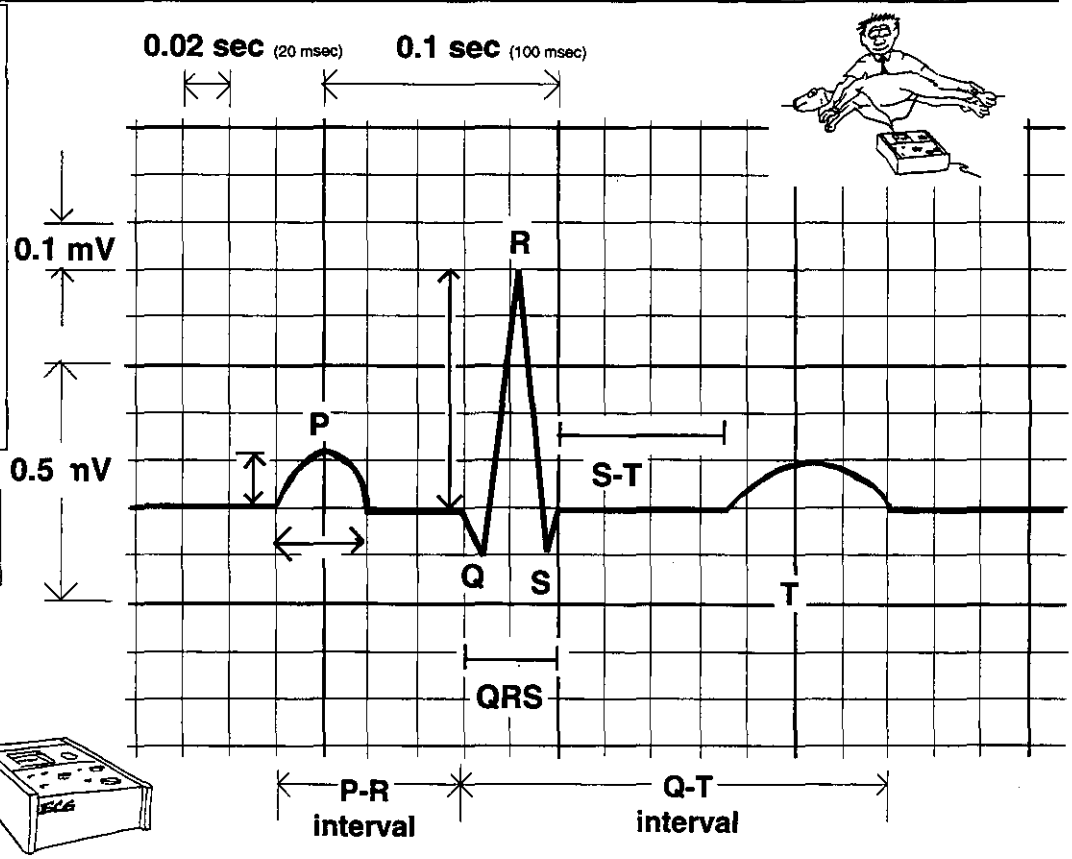
Evaluations of heart rhythm

- General inspection: for normal sinus rhythm or cardiac arrhythmia
- Identify P waves & QRS complexes
- Measure between successive R waves or P waves (w/ calipers or marks on a card)
- Compare distances between other waves

ECG - What it indicates T-10, 48; I2M 13; CAT 837

P wave:	Depolarization of atria
P-R interval:	Delay of impulse through AV node & bundle of His
QRS complex:	Ventricular depolarization
- Q wave:	Depolarization of septum
- R wave:	Depolarization of left ventricle
- S wave:	Depolarization of right ventricle
S-T segment:	Interval of ventricular systole
T wave:	Repolarization of ventricles
Q-T interval:	Ventricular depolarization & repolarization

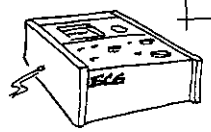




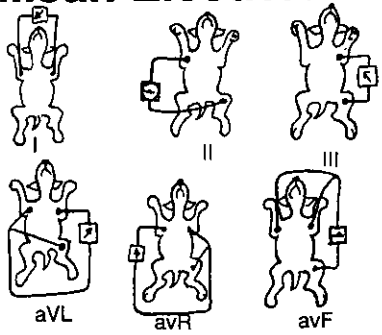
Evaluation of this ECG

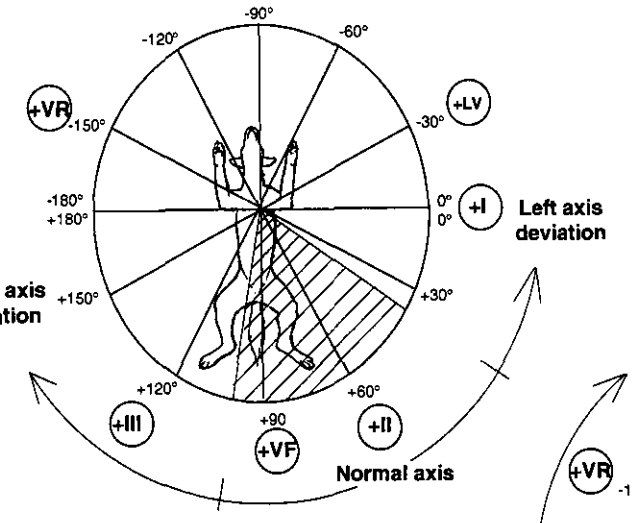
Paper speed of 50 mm/sec
Time in sec.: horizontal axis 0.02 sec (20 msec)
Voltage: vertical axis 0.1 mV/box

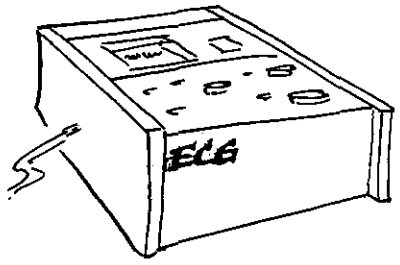
P wave	0.04 sec (40 msec), 0.12 mV
P-R interval	0.08 sec (80 msec)
R	0.5 mv
Q	-0.1 mv
S	-0.1 mv
QRS complex	0.04 sec (40 msec)
S-T segment	No depression or elevation
Q-T interval	0.18 sec (180 msec)
T wave	Positive (0.1 mv)
HR	Need at least 2 QRS complexes to calculate



Mean Electrical Axis

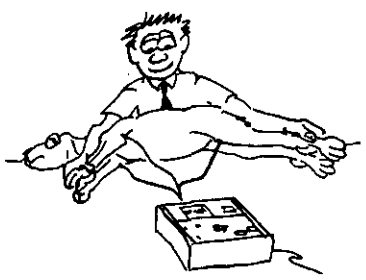


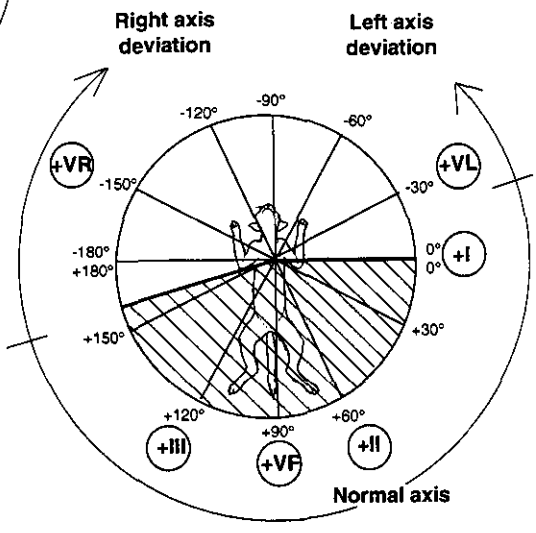




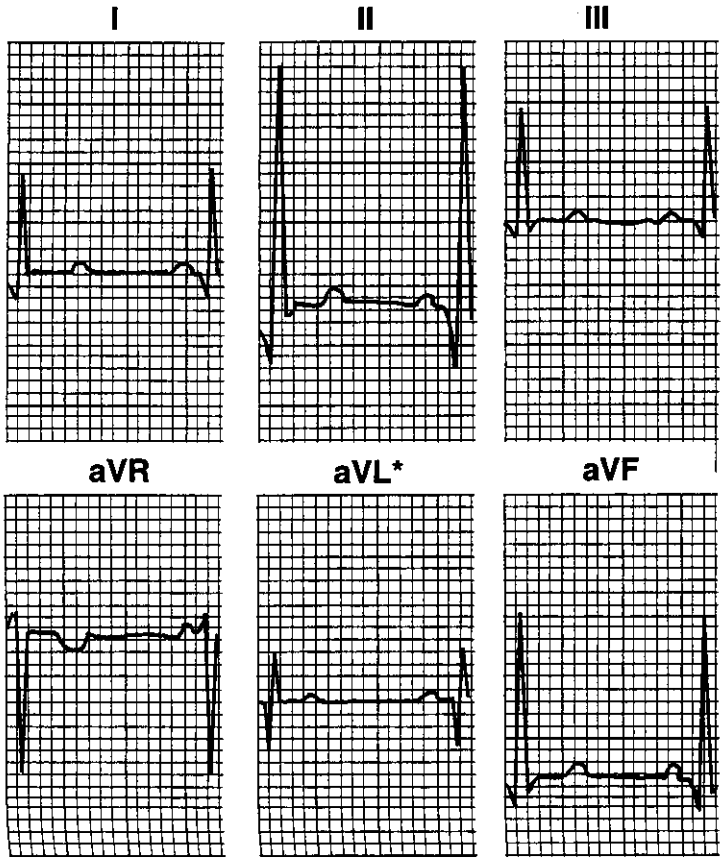
Lead system H-F 46; H-T 13, 50; Pys-B 164

- Lead: different angle or pair of electrodes
- Bipolar standard leads
  - Lead I: rt arm (-) compared w/ lt arm (+)
  - Lead II: rt arm (-) compared to lt leg (+)
  - Lead III: lt arm (-) compared to lt leg (+)
- Augmented unipolar limb leads
  - Lead aVR: rt arm (+) compared w/ lt arm (-) & leg (-)
  - Lead aVL: lt arm (+) compared to rt arm & lt leg (-)
  - aVF: lt leg (+) compared w/ rt & lt arms (-)
- Chest leads
  - Lead V10: over dorsal spinous process of 7th thoracic vertebrae
  - rV2 (CV5RL): rt 5th ICS* near sternum
  - V2 (CV6LL): lt 6th ICS near sternum
  - V4 (CV6LU): lt 6th ICS at costochondral junction
- Minimum leads to be recorded for dog & cat : 3 standard leads & 3 augmented unipolar leads
- Lead selector switch to select different combinations
- Other lead systems used for specific conditions
  - Chest leads not needed for every patient
    . Useful when ECG complexes in limb leads are small & difficult to evaluate & to evaluate right heart enlargement



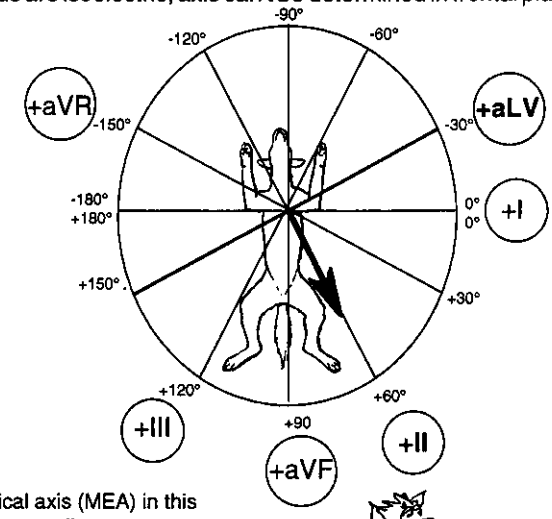


* ICS = intercostal space



Estimate the mean electrical axis, frontal plane H-hb 22; H-F 53; T 42

- Identify the isoelectric lead (sum of positive & negative deflections of QRS complexes closest to zero)
- Identify perpendicular lead
- Axis direction of the perpendicular lead - positive or negative
- If all leads are isoelectric, axis can't be determined in frontal plane

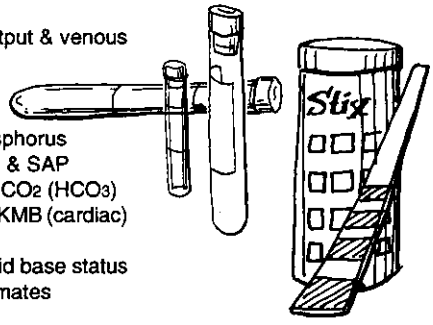


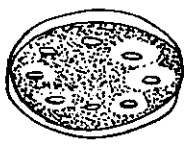
Mean electrical axis (MEA) in this canine electrocardiogram
- aVL* is the isoelectrical lead
- II is perpendicular to aVL
- II is positive to axis
- Therefore MEA is +60 (a normal axis)

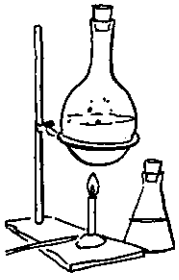
Clinical laboratory (concurrent or contributing dizs)

Lab-C 215

- ± BUN & SGPT (ALT) due to cardiac output & venous congestion
- **CBC**: WBC, PCV & total protein
- **Serum chemistries**:
  - Renal function: BUN, creatinine & phosphorus
  - Hepatic function: albumin, SGPT (ALT) & SAP
  - Electrolytes: K+, Na+, Ca++, Cl & total CO_2 (HCO_3)
  - Muscle enzymes - SGOT (AST), CK & CKMB (cardiac)
- Blood gases:
  - Arterial: oxygenation (hypoxemia) & acid base status
  - Venous: pO_2 levels cardiac output estimates
    - . 35–45 mm Hg - normal
    - . < 30 mm Hg - inadequate cardiac output
    - . < 25 mm Hg - overt failure
  - Medication serum levels (e.g. digitalis)
- **Urinalysis** (pretreatment): renal function & prerenal azotemia
- Heartworm: occult (serologic), microfilaria ±
- Fluid analysis (pleural effusion or hydroperitoneum)
  - Chemistries, cell numbers & types, cultures & serology to characterize type of fluid (transudate, modified transudate, exudate, hemorrhage, etc.) or identify etiologic agents (infectious or neoplastic).
- Thyroid/adrenal: T4 levels & TSH stimulation/Dexamethasone suppression & ACTH stimulation







Invasive procedures

Nonselective angiography

H-T/M 118; VC-DxH 259

- Ultrasound is safer than angiography & provides the same information in most cases
  - Exception: visualization of vasculature in feline heartworm better w/ angiography
- Useful in feline cardiomyopathy, feline heartworm diz, severe pulmonic or subaortic stenosis, PDA & tetralogy of Fallot
- Not helpful usually for atrial or septal defects & valvular regurgitation
- Protocol:
  - No food for 12 hours prior to procedure
  - Sedation to minimize stress & improve patient cooperation
  - Large bore catheter in jugular or cephalic vein
  - Lateral recumbency
  - Inject 1-2 ml/kg into central (jugular) catheter as rapidly as possible
  - Start exposures as end of injection. If a rapid film changer is available multiple films may be taken at variable intervals
  - With no special equipment take exposures at 1-8 seconds after end of bolus injection
  - Additional studies are possible, do not exceed 6.6 ml/kg total dose
  - Contrast media: Hypaque 50, Renografin 60, Isovue 370

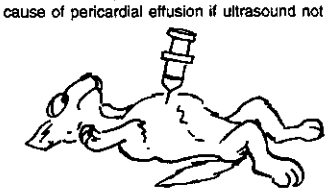
Catheterization & selective angiography H-T/M 119

- Catheter in specific area of heart
- Uses:
  - Identification of anatomic abnormalities
  - Direct arterial pressure measurements (transvalvular & chamber)
  - Cardiac output measurements
  - Chamber size & morphology

Pericardiocentesis: to remove constrictive fluids & laboratory sample

- Pneumopericardiography: useful for identifying cause of pericardial effusion if ultrasound not available

Thoracotomy



Histopathology: biopsy used in referral centers to study myocardial diz

- Endomyocardial: transvascular (intracardiac)
- Epimyocardial: transthoracic (extracardiac)

Nuclear cardiology (radionuclide, MRI) available in some referral centers

Necropsy
VC-DxH 379

Treatment of heart diz - summary

M8k 66; Mk 13; E-hb 331, SAP 448; IM 148

Treatment remains largely symptomatic

- Major causes of heart failure are still largely unknown (chronic valvular diz [endocardiosis] & cardiomyopathies)
- Some congenital malformations & some pericardial dizs are medically or surgically correctable
- Most heartworm cases are managed medically
- Treatments vary with the stage of diz & the specific cause involved

Goals of heart failure management

- **Symptomatic Tx**
  1. Maintain or ↑ cardiac output
  2. Minimize myocardial oxygen demand
  3. Reduce activity & anxiety
  4. Relieve fluid accumulation (edema)
  5. Control rhythm disturbances
- **Specific Tx: See each disorder**

Desired results of successful Tx

- Comfortable with normal activity or if sedentary existence

Antiarrhythmias H-T/M 376

	Treatment
• Bradycardia	
- Sinus bradycardia, arrest or block	**Glycopyrrolate** (Robinul®)
- Atrial/Sinoatrial standstill	**0.9% NaCl fluid** IV
- Sick sinus syndrome (min. schnauzer)	Pacemaker
- 1st degree AV block (asymptomatic)	None
- 2nd degree	
. Mobitz 1	Propantheline (Pro-Banthine®)
. Mobitz 2 (QRS drops)	Pacemaker
- 3rd degree (complete block)	Pacemaker
- Junctional rhythm (neg P waves)	Propantheline, Stop digitalis
- Branch blocks (wide QRSs)	None to Tx underlying cause
• Tachycardia	
- Atrial tachycardia (≥ 4 APCs in a row)	Digitalis
- Atrial fibrillation ("f" waves / no "P" waves)	Digoxin
- Junctional tachycardia (neg P waves)	Digoxin
- Ventricular pre-excitement	
- WPW syndrome (Delta waves)	Propranolol (Inderal®) (not digoxin)
- Ventricular tachycardia (> 3 PVCs in a row)	Lidocaine
- Ventricular fibrillation (bizarre oscillations)	Cardiopulmonary resuscitation
- Cardiac arrest	CPR - direct current

Stages of Congestive Heart Failure

- **Class 1:**
  - **No CS of failure, ±murmur**
- **Class 2:**
  - **CS w/ exercise**
- **Class 3:**
  - **CS w/ normal activity or at night**
- **Class 4:**
  - **CS at rest**

Treatment summary

(see below for complete)

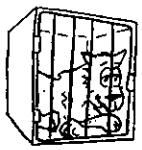
- **None necessary**
- Consider low Na diet
- **Rest** (exercise restriction)
- **Diet**: low Na diet
- **Diuretics**
- ± (Vaso)**Dilators** (enalapril)
- **Rest + 3 Ds**
  - Rest (exercise restriction)
  - **Diuretics** (Lasix®)
  - (Vaso)**Dilators** (enalapril)
  - **Diet** - low sodium
- ± Antiarrhythmics & antitussives
- ± Bronchodilators ± Digoxin
- **Rest + 3 Ds +**
  - **Strict rest**
    - **Diet**: low sodium
    - **Diuretics**
    - (Vaso)**Dilators**: (**enalapril**)
- Oxygen
- If ↓ contractility (Echo)
  - ± Positive inotropes **(Digoxin)**
- ± Bronchodilators
- ± Antiarrhythmics

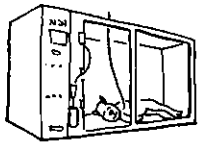
Treatment of heart diz/heart failure

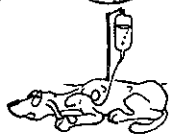
- **Rest + "3 Ds", ± O_2, ± digoxin, ± antiarrhythmics**

Rule of thumb (modify to specific Dx)

- **Rest** & stress management: to lower demand on heart
- Diuretics **(furosemide/Lasix®):** mainstay of heart failure Tx
  - . Relieve fluid accumulation & excessive preload
  - . Other diuretics: hydrochlorothiazide, spironolactone
- (Vaso)Dilators: **ACE angiotensin-converting enzyme inhibitors**
  - . **Enalapril (Enacard®):** vasodilation & ↓ water & Na retention
  - . Other vasodilators:
    - .. **Nitroglycerine** & other nitrates: acute treatment of pulmonary edema
    - .. **Nitroprusside (Nipride®)**: emergency reduction of blood pressure
    - .. Hydralazine (Apresoline®): be careful of rebound hypotension
    - .. Prazosin (Minipress®): alpha 1 blocker (very hypotensive)
    - .. β adrenergic blockers (propranolol): used for arrhythmias
    - .. **Calcium channel blockers** (diltiazem) vasodilation & slows heart (↓ O2 demand): used for hypertrophic cardiomyopathy & arrhythmias
- Dietary restriction of salt (sodium): Hill's h/d diet
  - . Difficult: nonpalatable, gradually introduce to new diet
- ± **Oxygen therapy**: in acute severe pulmonary edema
- ± **Digoxin** (Lanoxin®, Cardoxin®/digitoxin (Crystodigin®) /positive inotropes (digitalis): improve contractibility, backbone of chronic Tx of myocardial failure & most supraventricular arrhythmias
  - Only **if** ↓ contractility (Echo ± show CRT & weak pulse) or supraventricular tachycardia (slows rate)
  - Other positive inotrope:
    - . Dobutamine (Dobutrex®), catecholamines (short term only), isoproterenol, dopamine
    - . Diltiazem (Cardizem®) also a vasodilator used in arrhythmias & hypertrophic cardiomyopathy
- **Ancillary therapy:**
  - ± **Bronchodilators**
    - . Theophylline (Theo-Dur®)(®) for cough or dyspnea of pulmonary edema
  - ± Fluid therapy: especially if anorexic (low Na fluids with K^+, dextrose supplementation)
  - ± Cough suppressants (antitussive): Dihydrocodeinone (Hycodan®)
  - ± Sedation to minimize anxiety
    - . Morphine for dogs, ± cat (1/10 dose)





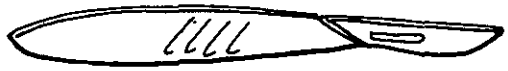


Dizs requiring other Tx

- **Hypertrophic cardiomyopathy**
  - NO digoxin (not a contractile problem)
  - **Diltiazem (Cardizem®)** to cause relaxation (↑ ventricular filling)
- **Bacterial endocarditis (BE) & infective myocarditis** (Lyme diz, trypanosomiasis)
  - ABs (Antibiotics), months for BE

- **Nutritional dilative cardiomyopathies**
  - Taurine (cats) & carnitine (dogs) supplementation
- **Severe pulmonary edema**
  - **Nitroglycerine** & other nitrates: acute treatment of pulmonary edema, ointment to pinna for pulmonary edema
- **Pulmonary hypertension - cor pulmonale**
  - **Nitroprusside**: emergency reduction of blood pressure
  - Thromboembolic, Sx therapy for pulmonary embolism?
- **Heartworm**: Thiacetarsamide chemotherapy
- **Thromboembolism**: thromboembolectomy (surgical therapy?)
  - Aspirin, Heparin
- **Pericarditis**: pericardiocentesis, pericardiectomy
- Thoracocentesis or abdominocentesis: may be lifesaving in severe pleural or peritoneal effusion

- **Cardiac arrest**: Epinephrine, O_2, Cardiac massage (CPR)
- **Surgical** - stabilize patient medically first if at all possible:
  - Congenital defects with 2° heart failure:
    - . **PDA** (patent ductus arteriosus): ligate before reversal
    - . PPHD (pericardioperitoneal heart defect)
    - . PS (pulmonic stenosis): balloon valvulotomy or patch graft
    - . Large septal defects?
    - . Persistent right aortic arch: ligate & cut



Congenital Heart Diz

Condition	Facts/Cause	Presentation/SC	Diagnosis

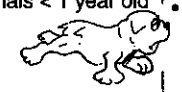
Congenital heart diz, CHD

M8k 67, 63; Mk 34; H-T/M 271; SAP 500; I2M 145; IM 114; **E-hb 386**; IM-WW 165; F3-IM 263; H-F 136, 357, 391; E 892; Cat 859; C12T 833; C11T 647; Pys 470; S-WW 84; Sx-S 856; WB 3.29

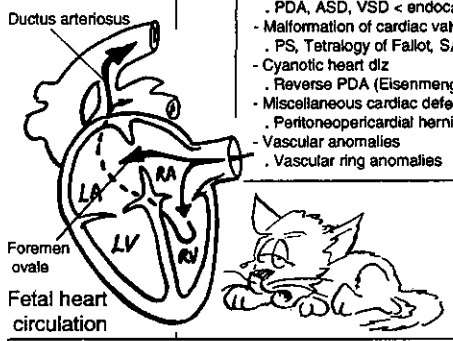
***

Facts/Cause

- **Abnormality of the heart at birth** which can be hereditary (genetically linked) or originate during gestation (in utero fetal diz)
- Small percentage of cardiac cases (< 10%)
  - **< 1% incidence in population**
  - #1 cardiovascular diz in animals < 1 year old
- Dogs >> cats
- Cause:
  - Genetic (polygenetic)
  - Environmental, chromosomal, infectious, nutritional, drug related or toxicologic



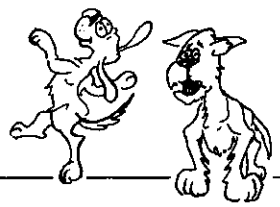
Classification (common conditions)
- Systemic to pulmonary shunting
  - . PDA, ASD, VSD < endocardial cushion diz
- Malformation of cardiac valves
  - . PS, Tetralogy of Fallot, SAS, AV valve dysplasia
- Cyanotic heart diz
  - . Reverse PDA (Eisenmenger), tetralogy of Fallot
- Miscellaneous cardiac defects
  - . Peritoneopericardial hernia
- Vascular anomalies
  - . Vascular ring anomalies



< 1% of Population: Dogs > Cats
CS: Asymptomatic, Stunting, Fainting, Tiring
Dx: Hx, CS, PE, ECG, Rads, Echo
Tx: Sx, Symptomatic, CHF Tx

Presentation/SC

- **Most asymptomatic**
- **Stunted growth**
  - Mostly associated w/ lt-to-rt shunt or CHF
- Respiratory distress
- **Exercise intolerance**
- **Fainting** (syncope) & exertional collapse
  - Right-to-left shunts
  - Paroxysmal arrhythmias
  - Ventricular outflow obstruction (aortic or pulmonic stenosis)
  - Congestive heart failure

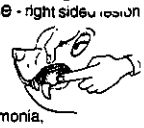


ECG findings:
- **Atrial enlargement:** P wave > 0.04 sec > 0.4 mV
- **Left ventricular enlargement** (LVE): **Tall R wave** > 2.5-3.0 mV in lead II or **left-axis deviation** (PDA, VSD, rt. AV dysplasia, subaortic stenosis)
- **Right ventricular hypertrophy: right axis deviation,** prominent **S** wave (leads I, II, III, aVF), ± **Widened QRS** (right bundle branched block) (PS, ASD, VSD, rt. AV dysplasia, tetralogy of Fallot, pulmonary hypertension [rt-to-lt shunt])

Diagnosis

- **History (Hx):** breeds; Clinical signs (CS)
- **Physical exam**
  - Precordial palpation (thorax over heart)
    - . Strong apical impulses suggest ventricular hypertrophy
    - . Right-side ≥ than left suggests rt ventricular hypertrophy
    - . Precordial thrill: vibration that identifies PMI (point of max intensity) of a loud murmur
  - Arterial pulse - what they suggest

    - . Often normal
    - . Weak (hypokinetic): lt ventricular outflow obstruction or CHF
    - . Bounding (hyperkinetic) - PDA or aortic insufficiency
  - Distention or pulsation of jugular venous pulse - right sided lesion (PS, Rt AV dysplasia or pulmonary hypertension)



  - Mucous membrane
    - . Normal: pink membranes
    - . Pallor w/ long refill time: CHF or concurrent anemia
    - . Cyanotic: pulmonary dysfunction, left-sided CHF or pneumonia, rt-lt-shunt (tetralogy of Fallot, Reversed ASD, VSD, PDA)
    - . Differential cyanosis: oral: pink; vulva: cyanotic - suggests reversed PDA
- **Auscultation**
  - **Murmur** in puppy or kitten may indicate congenital diz or be insignificant
    - . Innocent murmurs common (soft systolic which disappear in time)
    - . Congenital diz murmur: persists & may get louder
    - .. Periodically recheck for 6-12 months

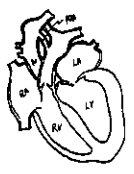
- **Electrocardiography (ECG):** good in moderate to severe CHD (see box)
- **Thoracic radiographs:**

  - Cardiac size & shape, Specific chamber enlargement
  - Great vessels (pulmonary trunk, aorta)
  - Pulmonary vascularity, over- & under circulation, left sided CHF
- **Echocardiography (US)**

  - Some anatomic abnormalities visualized (ASD, VSD, SAS)
  - Cardiac enlargement/hypertrophy
  - Saline ejection (contrast) into peripheral vein; rt-to-lt shunting
  - Doppler echocardiography: anatomical detail, blood flow information, intracardiac pressure estimates
- **Cardiac catheterization:** refer to cardiologist
  - Outline surgical anatomy, pressure measurements

Common defects (% of heart diz in dogs/cats)
- **Patent ductus arteriosus** (PDA) #1 dog: 30% (cat: 10%)
- **Pulmonic stenosis** (PS) (dog: 20%, cat: 3%)
- **Subaortic stenosis** (SAS) (dog: 20%)
- **Ventricular septal defect** (VSD) #2 cat: 15% (dog: 7%)
- Persistent right aortic arch (dog: 5%)
- **AV valvular dysplasia** (#1 cat: 15%, dog: 3%)
- Tetralogy of Fallot (TF) (dog: 3%, cat: 6%)
- Atrial septal defect (ASD) (cat: 4%, dog: 1%)
- Endocardial fibroelastosis (cat: 10%)
- Aortic stenosis (cat: 6%)
- Endocardial cushion defect (cat)
- Peritoneopericardial hernia
- Persistent left cranial vena cava (dog)

Uncommon defects
- Vascular anomalies (dog & cat: 8%)
- Aortic interruption/hypoplasia (dog)
- Aortic stenosis (valvular) (dog)
- Aorticopulmonary window (dog)
- Anomalous pulmonary venous return (dog)
- Atrial malformation (cat)
- Arteriovenous fistula (dog)
- Coarctation of aorta
- Cor triatriatum
- Double aortic arch
- Double chambered right ventricle
- Double outlet right ventricle (dog & cat: 4%)
- Ebstein's anomaly of lt AV valve
- Endocardial cushion diz (dog)
- Endocardial fibroelastosis (dog)
- Ostium secundum atrial septal defect (dog)
- Pulmonic valve insufficiency (dog)
- Retroesophageal subclavian artery (dog)
- Sinus inversus (dog)
- Truncus arteriosus (cat)
- Taussig-Bing complex (cat)



Murmur

Normal
- Innocent murmur
- Physiologic murmur
  - Fever, anemia
- Mild congenital defect

Abnormal

Systolic

Cyanotic
- Pulmonary hypertension (reversed PDA, VSD, ASD)
- Tetralogy of Fallot

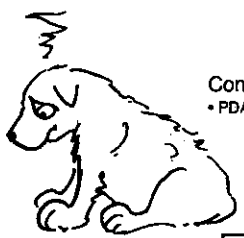
Acyanotic

Lt. side	Rt. side
• PS	• VSD
• ASD	• ECD
• SAS	• Rt AV dysplasia
• Lt AV dysplasia	• PS

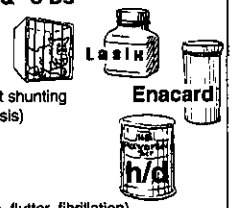
Systolic + diastolic

Continuous
- PDA (lt to rt shunt)

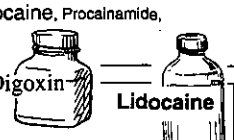
To & fro - soft
- SAS + aortic insufficiency
  VSD + aortic insufficiency



Treatment:
- **Asymptomatic - none may be required - monitor**
- **Surgical - definitive Tx, often not practical or not done**
  - **PDA** - Sx - TOC: ductus ligation, not if reversed
  - Pulmonary stenosis: patch graft
  - VSD, ASD: refer, variable success, requires bypass
  - Persistent rt aortic arch: cut ligamentum arteriosum
- Medical:
  - Reversed PDA: rest, phlebotomies
  - Tetralogy of Fallot: palliative (rest, beta blockers), Sx not attempted
  - AV valve dysplasia: manage heart failure - 3Ds
  - Subaortic stenosis: Sx not attempted, Inderal®
- **CHF** (congestive heart failure) - **Rest & "3 Ds"**
  - **Rest** (exercise restriction)
  - **Diuretics** (furosemide [Lasix®])
  - **Vasodilation** (enalapril [Enacard®])
    - . Hydralazine + enalapril to reduce lt-to-rt shunting
    - . Use w/ caution in SAS (subaortic stenosis)
  - **Dietary sodium restriction**



- **Arrhythmias**
  - Supraventricular (atrial tachycardia, flutter, fibrillation)
    - . **Digoxin**, propranolol (beta blocker), diltiazem (Cardizem®)
  - Ventricular tachycardia: Lidocaine, Procainamide, Tocainide, Propranolol



Prognosis:
- PDA: excellent w/ surgery
- Reverse PDA: grave
- VSD & ASD, small: good; large: grave
- Pulmonic stenosis: fair to good
- Subaortic stenosis: poor to good
- AV dysplasia: good if mild
- Tetralogy of Fallot: grave - usually leads to sudden death
- Persistent rt. aortic arch: poor

CHD - Stenosis

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Pulmonic stenosis, PS

M8k 70; Mk 36; H-T/M 281; H2B 64; E-hb 390; I2M 150; IM 116; IM-WW 169; Cat 872; E 916; SAP 501t, 503t; C12T 817; C11T 647; F3IM 270; H-F 143, 364, 400; X-T 343; X-RP 126; Pys 186; Pa-T 183; Sx-G 124; SX-S-HB 298, 308; Sx-S 865, 901; Sx4B 662; Sx-WW 86, 92; NB 3.34

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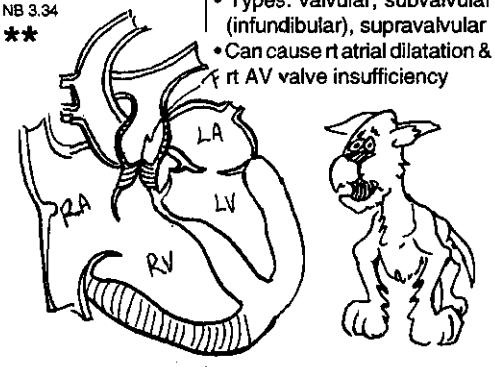
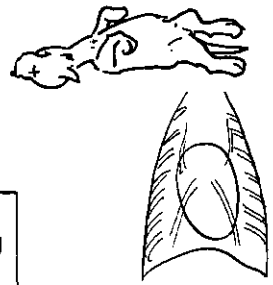


#2 CHD - Dog - RV hypertrophy
CS: Asymptomatic, Fainting, Tiring, Stunting
Dx: Hx, CS, Murmur, RHE
Tx: Sx: Patch graft

- **#2 CHD** (congenital heart defect) **in dog**
  - **-20% of CHD in dog**, 10% in cat
  - May be combined w/ tetralogy of Fallot
  - Rt. AV often also malformed
- Breeds: Eng. bulldog, Fox terriers, Chihuahua, Miniature schnauzers, Samoyed, Lab & Beagle
- Females: male - 3:1
- Caused by dysplasia of pulmonic valve
- Types: valvular, subvalvular (infundibular), supravalvular
- Can cause rt atrial dilatation & rt AV valve insufficiency

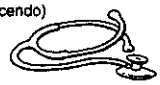
- **May be asymptomatic**
- Fainting (syncope)
- Tiring (exercise intolerance)
- Labored breathing
- Stunting

- **Sequelae:**
  - Right-sided congestive heart failure (CHF)
  - Sudden death



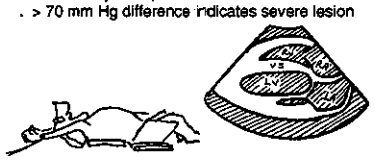
*Congenital Heart Defect

- Hx (breed, age), CS
- Physical exam: ± **jugular pulse**
- Auscultation:
  - **Systolic murmur** (PMI) at low left 3rd ICS
    - Ejection (crescendo decrescendo)
    - Split S2 may occur
    - ± 2° rt AV murmur

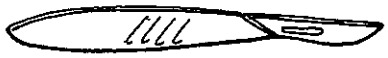


- **ECG:**
  - ± **RVE** (rt ventr. enlargement): Rt axis deviation, Deep S waves
  - P pulmonale (RAE)

- Radiograph:
  - **RVE: reverse "D"** in DV/VD view
  - RAE (right atrial enlargement)
  - ↓ Pulmonary vascularity
  - **"Pulmonary knob"** (1 o'clock): post stenotic pulmonary trunk (MPA) dilatation (DV/VD view)
- **Echocardiography** - difficult to evaluate P valve
  - Right ventricular hypertrophy
  - Rt atrial & pulmonary artery enlargement
  - Thickened valve
  - Attenuation of pulmonary outflow tract
- Angiocardiography:
  - Shows lesion & post stenotic dilatation
  - RVE evident
- Blood pressure:
  - Difference between pulmonary artery & right ventricular systolic pressures
    - > 70 mm Hg difference indicates severe lesion



- Only if evidence of 2° cardiac changes (RVE, etc.) &/or blood pressure difference > 40 mm Hg
- **Surgery best**
  - **"Patch graft"** procedure: if pressure gradient (across stenosis) > 40 mm Hg
  - Pulmonary valvulectomy, surgical or balloon valvuloplasty, or a combination
- Medical:
  - Exercise restriction
  - Manage rt heart failure if present
    - Salt restriction & diuretics



Prognosis:
- **Fair to good**: dogs w/ mild or moderate PS can live normal lives
- Severe: usually die w/in 3 yrs of Dx
- Good if right-sided CHF (congestive heart failure) has not developed prior to surgical correction
- Concurrent Rt AV insufficiency, CHF atrial fibrillation worsen prognosis

Subaortic stenosis, SAS, Aortic stenosis

M8k 70; Mk 36; H-T/M 284; H2B 63; E-hb 391; F3IM 269; H-Pic 71; I2M 152; IM 120; IM-WW 168; 5min 356; SAP 501t, 503t; Cat 694, 871; E 923; C12T 822; H-F 143, 369, 400; Sx-G 130; Sx4B 688; SX-S-HB 300; 312; Sx-S 870, 915; Sx-WW 88; X-T 311, 343; X-RP 126; Pa-T 183; NB 3.35

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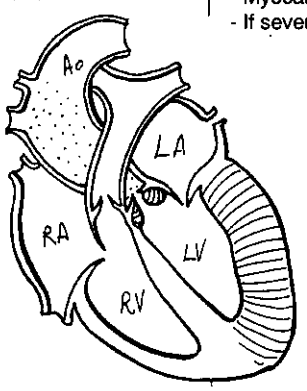
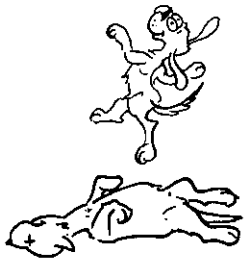


Subvalvular
CS: Asymptomatic, Sudden death
Dx: Hx, Systolic murmur, LVE
Tx: None

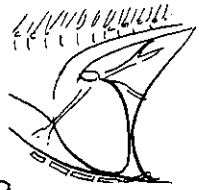
- Hereditary obstruction of left ventricular outflow
  - **Subvalvular**: most common
  - Develops during life, m/not be detected until 2 yrs of age
- Dogs #3 CHD (congenital heart defect) (20%), rare in cats (Siamese?)
- Breed: Boxer, Newfoundland, Golden retriever & G. shepherd, Rottweiler, Bull terrier, G. short haired pointer; also pigs
- Pathophysiology:
  - Obstruction: volume overload of lt ventricle (hypertrophy - LVH)
  - Myocardial ischemia
  - If severe, backward failure

- **Variable CS**
- **Asymptomatic**
- Left congestive heart failure
  - Weakness
  - Fainting (syncope), collapse
  - **Sudden death** - dysrhythmias induced by myocardial ischemia
- Rarely lung congestion (cough, dyspnea)

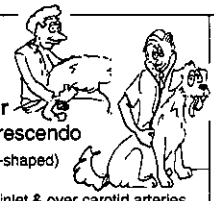


- Sequela:
  - Aortic bacterial endocarditis (trauma predispose)

DDx:
- Pulmonic stenosis
- Ventricular septal defect



- **Hx** (breed), CS
- PE: weak pulse
- Auscultation:
  - **Systolic murmur**
    - Crescendo-decrescendo ejection (diamond-shaped)
    - PMI - high lt. 4th ICS
    - ± Murmur at thoracic inlet & over carotid arteries

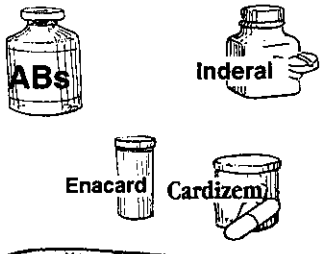


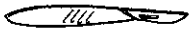
- Palpation:
  - ± Thrill: thoracic & carotid arteries
  - ± Weak femoral pulse (hypokinetic) "pulsus parvus"

- ECG:
  - ± **LVE** (lt. axis deviation, tall R wave)
  - ± Dysrhythmias (ventricular tachyarrhythmias)
  - Myocardial ischemia (S-T segment depression)

- Radiograph:
  - **Left ventricular enlargement (LVE)**
  - ± Left atrial enlargement (LAE)
  - **Enlargement of aorta** (loss of cranial waist - lat. view, widening of cranial mediastinum VD view)
  - Enlarged aortic arch
- Echocardiography (US):
  - LVE - lt wall thickening
  - Attenuation of aortic outflow tract
  - Abnormal aortic valve motion
- Angiocardiogram (cardiac catheterization)
  - LVE
  - Dilated aorta (post stenotic > 1.5 times)
  - Subvalvular narrowing
- Blood pressures: difference between left ventricular & aortic pressures:
  - 10-30 mm Hg: mild
  - 30-70 mm Hg: moderate
  - > 70 mm Hg: severe

- **No generally accepted Tx**
- **Mild** (aortic gradient < 50 mm Hg)
  - **None required**
- Propranolol (Inderal®) (Beta blocker) minimize O2 demand of lt. ventricle
- Vasodilator, ACE inhibitor e.g., Enalapril (Enacard®) to decrease afterload (resistance) and Na (H2O) retention
- Calcium channel blocker: diltiazem (Cardizem®) to ↓ afterload (resistance) & dilate coronary arteries
- Severe: consider surgery - refer
- Prophylactic ABs before procedures (e.g., dentistry)





- **Tx congestive heart failure: Rest + 3 Ds, ± Digoxin** (Diuretics, [vaso]Dilation, Diet, ± Digoxin)
- Arrhythmias
  - Ventricular tachycardia: Procainamide, Tocainide, Lidocaine, Propranolol

Prognosis:
- **Good** if mild
- Guarded to poor if left-sided congestive heart failure present

CHD - Heart Defects - Valves

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Ventricular septal defect, VSD, ** **Intraventricular septal defect** M8k 72; Mk 37; H-T/M 288; I2M 155; IM 121; IM-WW 170; F3IM 767; Cat 863; H-pic 91; H2B 66; E-hb 389; SAP 501t, 503t; E 910; C12T 827; H-F 141, 373, 396; Sx4B 691; Sx-G 128; Sx-S-hb 297, 310; Sx-S 861, 907; X-T 311, 343; X-RP Pa-T 182; NB 3.32	• **Opening between ventricles** • **Cats (#2 - 15% of CHD)** > dogs (7% of CHD) • Breeds: Eng. bulldogs, Beagle, Keeshond, Poodle, terriers, Golden retriever, Irish setter • Cause: unknown • Pathophysiology - Subaortic or high defect in the ventricular septum (75% in membranous part) - **Left-to-right shunt** usually . LVE & RVE (lt and rt ventricular enlargement) - Respiratory diz if large shunt **DDx:** • Aortic stenosis • ASD • Lt AV diz	• **Asymptomatic** • **Tiring** • **± Cyanosis** • Mild respiratory (cough, shortness of breath) - Respiratory failure - rare	• Hx (young, breed), CS • **Physical exam:** - **Precordial thrill** in right 3rd-4th ICS* • **Holosystolic** murmur: right side at costosternal border . **Harsh,** diamond-shaped to plateau murmur - ± Cats, murmur of mitral or tricuspid regurgitation • ECG: normal to RVE (rt axis deviation) • Radiology: **Usually normal or small defects** - Large defect: (RVE & LVE), Enlarged MPA, Hypervascularity of lung fields • Angiocardiography: - Shunting of contrast from left to right ventricle • Echocardiography (US): - Septal defect (can be hard to visualize)	• **Tx not required in most** - Occasional spontaneous closure in 18 months • Symptomatic - Support of pulmonary edema - diuretics • Surgery: requires heart-lung machine, rarely accomplished - Palliative pulmonary artery banding in mature animal • Treat for CHF **Prognosis:** • **Good: for small defects** • Varies with size of lesion & 2° cardiac changes
Left AV (mitral) valve dysplasia M8k 73; IM 122; IM-WW 172; H-T/M 293; E-hb 393; SAP 501t, 503t; E 928; H-F 144, 384, 398; SX-S-HB 299; Sx-S 869, 916 ** **Cat, Tiring, Tx HF**	• **Cat (#1)(15% of CHD): important malformation** • Dog (2% of CHD) • **Insufficiency** usually • Large breed: Great Dane, G. shepherd, Bull terrier, Eng. bulldog, Chihuahua • Male > female • Cause: may result from a combination of defects which cause the affected valve to leak during systole: - Abnormal chordae tendineae - Abnormal insertion of valve leaflets - Abnormal location of AV valve annulus • Pathophysiology: - Volume overload to left ventricle . Compensatory: dilation & hypertrophy . ± Blood backing up into lungs	• Similar to degenerative valvular diz (old animals) • **Tiring** (exercise intolerance) • Left congestive failure & respiratory distress ?? - Anorexia	• **Physical exam** • Auscultation: Systolic, regurgitant mitral murmur, PMI - low left 5th ICS • ECG: Atrial arrhythmias (atrial fibrillation) - P waves may be tall (P pulmonale) or wide (P mitrale) • Radiology: Left atrial enlargement • Echocardiology (US): visualize mitral valve	• **Manage cardiac heart failure: rest + 3 Ds** - Rest/ exercise restriction - Diuretics (furosemide [Lasix®]) - Dietary sodium restriction: h/d - Vasodilation: enalapril Lasix Enacard h/d • Atrial fibrillation - **Digoxin**, Propranolol (beta blocker), diltiazem (Cardizem®) . Combination of above Digoxin Prognosis: Depends on severity of lesion & 2° cardiac changes present • Poor: CHF

Atrial septal defect, ASD

M8k 71; Mk 37; H-T/M 275; I2M 156; IM 121; IM-WW 171; H2B 66; H-pic 91; Cat 863; F3IM 269; E-hb 389; 5min 378; SAP 501t, 503t; E 910; H-F 141, 378, 397; Pa-T 182; Sx4B 691; Sx-S-hb 292; Sx-S 859, 916; Sx-WW 92; Pa-T 182; NB 3.33 *

- **Opening between atria** (e.g., Patent foramen ovale), Cats (4%, dogs 1% of CHD); Samoyed, Boxer, Doberman; **Cause: ?;** Left-to-right shunt **usually** = right heart overload
- CS: **Usually asymptomatic** (small), Rarely right-sided CHF
- Dx: PE: generally normal, Auscultation: soft systolic (holosystolic), ECG, Rads, US
- DDx: Pulmonic stenosis, VSD
- Tx:: **Usually none needed**, surgery for large defects
- Px: **Good**: usually asymptomatic

Right AV (tricuspid) valve dysplasia

M8k 74; I2M 157; IM 122, F3IM 266; E-hb 396; 5min 380; H2B 65; SAP 501t, 503t; C12T 813; E 952; H-F 144, 384, 398; Sx-S 869, 916 *

- **Insufficiency**: leak during systole (abnormal chordae tendineae, insertion of valve leaflets & location of AV valve annulus, Great Dane, Weimaraner, Lab, G. Shepherd, Males > females; Pathophysiology: volume overload to right ventricle = right CHF
- CS: Initially asymptomatic, **Tiring**, ascites, dyspnea, weight loss
- Dx: Hx, CS, PE (**jugular vein distention/pulsation, systolic regurgitant**, ECG (± tall P wave), Rads & US: RVE, RAE; Cardiac catheterization
- DDx: Degenerative valve diz (old), Pericardial effusion, Dilated cardiomyopathy
- Tx: **Manage as signs of heart failure & arrhythmias** (Lasix®, exercise restriction, salt restriction)

Tetralogy of Fallot, TF

M8k 72; Mk 38; H-T/M 291; I2M 158; IM 123; F3IM 270; 5min 1096; H-pic 92; H2B 68; E-hb 392; Cat 873; SAP 501t; E 935; H-F 142, 380, 401; Sx-S-hb 299, 310; Sx-S 868; 908; X-T 311, 343; X-RP 126; Pa-T 183 *

- **Multiple cardiac defect: 1. VSD (high ventricular septal defect), 2. Pulmonic stenosis, 3. Overriding aorta, 4. 2° Rt Ventricle hypertrophy** **Rare** (dog: 3% of CHD, cat: 6%); **#1 cause of congenital cyanotic heart diz in dog & cat; Eng. bulldog, Keeshond, Pathophys:** Right-to-left shunt bypasses lungs = **Cyanosis**
- CS: Weakness, fainting, Tiring, stunted growth, dyspnea, ± **Cyanosis w/ exercise**; Sequelae: congestive heart failure rare
- Dx: Hx (breeds), CS, PE (systolic murmur), ↑ **PCV**, ECG, Rads (**RVE**, hypovascularity), US, Angiocardiography
- DDx: Pulmonic stenosis, ASD, VSD
- Tx: **Medical: only palliative (rest, beta blockers, phlebotomy; Surgery rarely attempted**
- Px: Varied **see if tolerate**

Vascular ring anomalies Persistent right aortic arch, PRAA SAP 641, 646; I2M 160; IM 124, 323; E-hb 393; H2B 68; 5min 936, 530; E 940; H-F 386, 404; H-pic 132; Sx-G 122; Sx4B 659; Sx-S-hb 301, 308; Sx-S 876, 900; S-B 509; X-T 127; Pa-T 184 *	• **Rare**, dogs: 5% of CHD, also in cats • **Congenital defect: abnormal** persistence of 1 of the aortic arches entraps the esophagus - **Persistent rt. aortic arch:** most common (normally left arch persists) - Less common vascular anomalies: double aortic arch, aberrant subclavian aa. m/ cause same problem . All have same signs & treatments • Genetic: G. Shepherd, Irish setters, Boston terriers • Causes stricture of esophageal (obstruction) & **megaesophagus** cranially Esophagus surrounded by: • Aortic arch to the right • Base of heart ventrally • Pulmonary trunk (artery) on the left • Ligamentum arteriosum dorsally	• **Regurgitation of solid food** - 1st noted when puppy weaned onto solid food . Ravenous appetite . Often thin, **stunted** • **Sequela:** - **Aspiration pneumonia** . **Coughing** **DDx:** • Stricture • Diverticulum • FB obstruction • Megaesophagus	• **Hx (young)**, CS • Physical exam: stunting • Radiography: **Megaesophagus** - **Esophagram** (barium swallow): ballooning of esophagus cranial to base of heart (contrast study) - Ventral displacement of trachea - Aspiration pneumonia in cranial & middle lung lobes	• **Sx: ligate & cut restricting arch** - **Ligamentum arteriosum** - Double ligate bec. 10% patent (open) - Frequent gruel feeding for 6 weeks . Head elevated **Prognosis:** • **Poor, Sx helps all** - 10% cured - 50% intermittent regurgitation - 40% continue severe signs

CHD - PDA & Reverse PDA

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Patent ductus arteriosus, PDA

M8k 68; Mk 35; H-T/M 276; I2M 147; IM 115; E-hb 388; 5min 914; H2B 67; F3IM 268; SAP 501t, 503t; Cat 685, 860; E 903; C12T 830; Dys 498; H-F 139, 360, 394; H-Pic 132; Sx-hb 300, 308; Sx4B 650; Sx-B 501; Sx-G 120; Sx-S 873; SxWW 84; X-T 339; X-RP 125; Pa-T 182; NB 3.30

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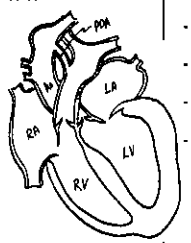


#1 CHD - Dog, Left to Right shunt
CS: Tiring, Stunting, Dyspnea
Dx: Hx, Machinery murmur, LVE, LVA - 3 Bumps
Tx: Sx: Ductus ligation

Facts/Cause

- **Failure of ductus arteriosus to close after birth**
  - Normally functionally closes w/in 2-3 days
  - Fetal structure that shunts blood away from lungs to more vital structure (brain) (connects pulmonary trunk to aorta)
- **#1 CHD of dogs** - 30% of CHD, rare in cats: 10%
- Females:male - 4:1
- Cause: **hereditary**
- Breeds: Eng. springer spaniels, Miniature poodle, Toy poodle, Shetland sheepdog, Maltese, Pomeranians, Keeshond, Bichon Frise, Yorkshire terriers, Collie, Chihuahua, Standard poodle, Cocker spaniel, G. shepherd
- Pathophysiology:
  - **Left-to-right shunt** (aorta to pulmonary trunk) during both systole & diastole
  - Volume overload of pulmonary circulation, left atrium & ventricle
  - Dilation of left ventricle
    . ± Lt (mitral) AV insufficiency
  - Can develop pulmonary hypertension
    . May result in a reverse PDA (see below)
  - Left dilation & failure

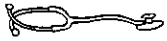
Presentation/CS

- Many asymptomatic when 1st diagnosed
- Left heart failure
  - **Tiring w/ exercise**
  - **Stunting**
  - **Respiratory signs**: cough, dyspnea or orthopnea

- Sequela:
  - Death from CHF if not treated

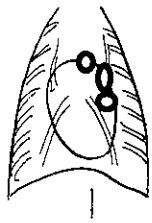
Diagnosis

- **Hx (young female, breed)**
- Physical exam: pink mucous membranes
- Palpation
  - Lt precordial thrill often present - Lt 3rd intercostal space (LI3)
  - ± **"Water hammer"** (bounding/hyperkinetic) arterial pulse (systolic > diastolic pressure)



- Auscultation:
  - **Continuous (machinery) murmur** pathognomonic - Left 3rd ICS. Radiates to right
  - 2nd systolic murmur if lt AV insufficiency (50%)
  - If CHF ± muffled sounds or pulmonary crackles
  - ± Split S2 if there is a right-to-left shunt

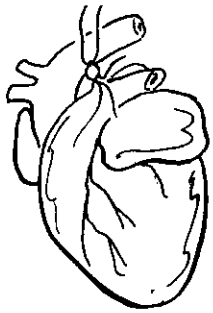
- **ECG:**
  - LVE most common (lt axis shift)
  - Tall R waves (leads II, aVF) (LVE)
  - ± Deep Q wave in lead II
  - Lt atrial enlargement (wide P wave?)
  - S-T segment changes (LVE)
- Dysrhythmias may develop - atrial fibrillation
- **Radiology:**
  - **Over vascularization** (hypervascularity) of lungs
  - ± Classic: all 3 bumps (1-3 o'clock DV)
    . **LVE, LAE** (3 o'clock)
    . ± **"Ductus bump"** of descending aorta (pathognomonic) (1 o'clock DV view)
    . **MPA knob** (pulmonary trunk, 2 o'clock DV view)
  - Pulmonary edema w/ left heart failure



- Echocardiology (US)
  - Dilated LA, LV & pulmonary trunk (MPA)
  - ± Identify PDA
- Doppler: identify shunt: Higher oxygen in pulmonary artery vs right ventricle
- Angiocardiography: shunting from aorta to pulmonary artery
- Blood pressures: RV & pulmonary artery pressures increased, but not equal to aortic pressure

Treatment

- **Ductus ligation** all dogs < 2 years old (2-4 mos old)
  - Neuter (hereditary)
  - 1.5% recanalize in 2 mo.; divide & suture
  - Contraindicated if reverse PDA (see below)
- If congestive heart failure
  - Furosemide (Lasix®)
  - Rest
  - Sodium restriction



Prognosis:

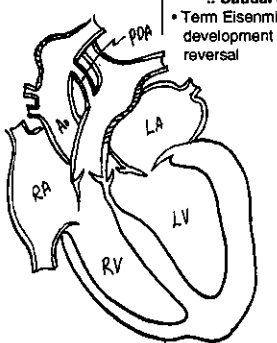
- **Excellent w/ surgery** (left to right shunt)
- Grave w/o Tx nearly always fatal (CHF) - reversed PDA
- Guarded to poor if atrial fibrillation or advanced CHF

Pulmonary hypertension & shunt reversal, Reverse PDA,

Rt to Lt shunt, Eisenmenger's physiology

Mk 35; IM 124; E-hb 388; H2B 67; Cat 685; E 966; X-T 308; Sx-S 860

**



Right-to-Left shunt
CS: Caudal cyanosis
Dx: Hx, CS, Rads, Continuous murmur stops
Tx: No Sx, Rest & Bleeding

Facts/Cause

- Left to right shunts of PDA reverses to **right to left** w/ compensatory hypertrophy of the right **ventricle** - Pulmonary hypertension
- Other congenital lesions assoc w/ hypertension
  - VSD
  - Endocardial cushion defect
  - Common AV canal
  - ASD
- Pathophysiology of PDA to reverse PDA
  - Excessive blood shunted through PDA into pulmonary vasculature
    . Results in pulmonary arteriolar injury, thickening & hypertrophy = ↑ resistance
    . **Pressure gradually rises in right side** stopping left to right shunt & finally reversing shunt (**right to left**)
    . Right to left shunt in PDA sends unoxygenated blood into the aorta distal to brachiocephalic trunk
    .. **Caudal cyanosis** as a result
- Term Eisenminger's physiology refers to development of severe hypertension & shunt reversal

Presentation/CS

- **Shortness of breath**
- **Tiring on exercise** (exercise intolerance)
- **Pelvic limb weakness or collapse**
- Fainting (syncope) esp w/ exercise or excitement
- Seizures
- **Differential cyanosis** (PDA)
  - **Caudally**, not cranially
  - Intrathoracic shunts - cyanosis throughout body
- ± Cough & hemoptysis (spitting blood)

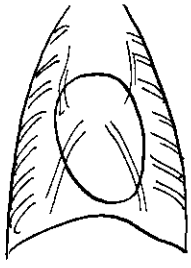
- Sequela:
  - Right congestive heart failure uncommon
    . 2° myocardial failure or Left AV insufficiency

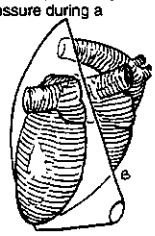
Diagnosis

- **Hx, CS**
- PE: **Cyanosis of caudal animal**
- Auscultation:
  - **No murmur, stops on reversal**
  - ± Split S2

- **Laboratory:** ↑ **PCV,** 2° Polycythemia (from hypoxemic blood), PCV often exceeds 65%
  - PaO2 low & PaCO2 high, esp. caudal veins
- Radiology:
  - RVE
  - Deceased peripheral lung vasculature (hypovasculature)
  - **"Ductus bump" of descending aorta**
  - **Pulmonary (artery) trunk knob sign** (VD or DV view)
- Angiocardiography: (nonselective angiogram)
  - Simultaneous opacification of pulmonary trunk & aorta
- ECG: RVE (right axis deviation)
- Echocardiogram (US)
  - RVE
  - ± **Anatomical defect**

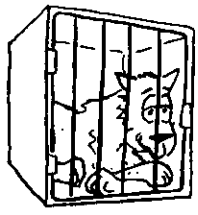
- Blood pressures:
  - Right-to-left shunt
    . Right ventricular pressures increased & pulmonary artery pressure exceeds aortic pressure during a portion of systole





Treatment

- **Enforced rest**
- **Limited exercise**
- **Avoid stress**
- **Phlebotomies** (bleed) to keep PCV between 62-68%
- Surgery contraindicated - "blow out" lungs
  - Open ductus arteriosus acts as a "pop-off" valve
  - If duct closed - "blow out" lung



Prognosis: **Grave**

Endocardial fibroelastosis

H-F 402; Cat 700; C11T 651; Sx-S 860

- Rare: Thickened endocardium, esp. in the left ventricle. Hereditary in Burmese cats, it is progressive to symptoms at 2 months of age.

Ectopic cordis (cervicalis or sternalis), situs inversus, ± Kartanger's syndrome

Rare: development of the heart outside the thoracic cavity, most are in the ventral aspect of the neck

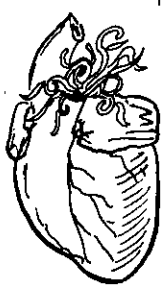
Heartworm Diz

Condition	Facts/Cause	Presentation/CS

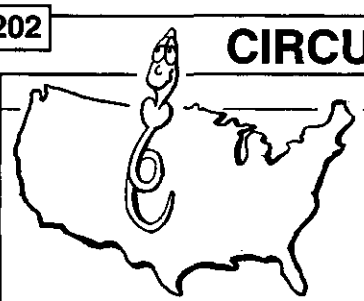
Heartworm diz, HWD, Dirofilariasis

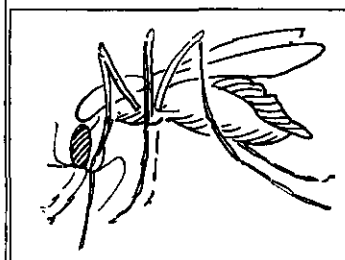
M8k 93, 63; Mk 73; H-T/M 225; C12T 879; C11T 658, 816; SAP 487; E-hb 421; I2M 162; IM 126; IM-WW 174; 5min 638; H3B 123; H2B 137; E 1046; H-F 519; Sx-S 880, 911; X-T 314, 346; X-RP 132; Pys-B 200, 224; NB 3.22

★★★ to ★★★★ (regional)



- **Obstructive pulmonary vascular disorder**
  - ± **Complicated by diz of heart, lung, liver & kidney**
- ***Dirofilaria immitis***: mosquito-born hematogenous filarial parasite
- Microfilaria (MF)
  - Dogs < 6 mos old have no microfilaria (MF)
  - MF positive = patent infection
  - MF negative = prepatent or occult (no microfilaria) infection
- **Mosquito**: intermediate host (diz vector)
- Infections:
  - Dogs & wild canines: definitive host (reservoir of infection)
  - Cats (relatively resistant), domestic ferrets & man
  - Outdoor dogs at greater risk
  - Endemic regions: SE Atlantic & Gulf coasts, Great lakes
    . 50% infection rate of dogs (tropical & subtropical)
  - Has spread throughout most of North America & Hawaii
    . 5% infection rate (found in every state including Alaska)
- Frequency of infection varies w/ bodies of water to support mosquito breeding





Pathophysiology:
- **Cardiopulmonary diz:**
  - Adult filarial worms cause pulmonary arteritis:
    . Damage arterial endothelium (caudal lobes)
  - Interstitial & alveolar lung diz
    . Pulmonary thromboemboli cause parenchymal lung diz
- **Right ventricle dilatation** (Cor pulmonale):
  - Obstruction of pulmonary arteries - hypertension
    . ↑ Right ventricular afterload
    . Large numbers of adult worms in right ventricle may ↓ ventricular capacity & stroke volume
    . Compensation is by ventricular dilatation & hypertrophy & ↑ heart rate finally results in ↓ cardiac output & systemic venous congestion
- Liver failure syndrome (vena cava syndrome)
  - Worms in rt heart & caudal vena cava, interfere w/ rt AV valve - systemic venous congestion
- Glomerular nephritis (protein losing nephropathy)
  - Deposition of immune complexes

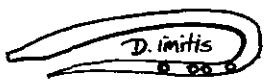
Life cycle of *Dirofilaria immitis*:
- Mosquito gets a blood meal from a dog w/ circulating microfilariae (L1)
- Larvae develop in mosquito & infective w/in 2.5 weeks (L3)
- L3 deposited by mosquito in canine through bite wound
- Migrate through tissues for 100 days during which they moult to L4 & then L5 stage larva. L5 larva enter venous circulation & reach the small pulmonary arteries in 3-4 months
- As numbers increase - fill rt ventricle, then rt atrium & finally vena cava
- **Microfilaria appear w/in blood ≥ 6 months** after infection

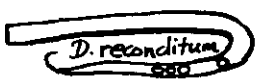
- **Many asymptomatic indefinitely** (lightly infected)
- **CS in 1 - 2 years** (cumulative infection)
- **Weight loss**
- **Anorexia**
- **Pulmonary signs**
  - **Coughing** (nonproductive)
  - **Dyspnea**
  - **Weakness** (exercise intolerance)
  - Hemoptysis (thromboembolism)
  - Fainting (syncope) (hypertension)
  - Congestive heart failure
    . Jugular pulse
    . Ascites (abdominal distension)
- **Sequelae:**
  - **Nephrotic syndrome** (occasionally): ascites, peripheral edema, variable azotemia
  - **Pulmonary eosinophilic granulomas**
  - **Allergic pneumonitis**
  - **Pulmonary thromboembolic diz**
  - Post caval syndrome
  - Chronic hepatic congestion
  - Aberrant worm
  - DIC

DDx:
- Pulmonary thrombosis
- Pulmonary neoplasia
- 1° chronic respiratory diz
- Microfilaremia (other filarial species)

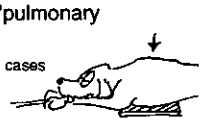
Diagnosis:

- **Routine yearly screening** for microfilaria (via Knott's, etc.) recommended
- Physical examination: normal to right-sided CHF, CS
- Auscultation:
  - ↑ Lung sounds on auscultation (crackles & wheezes)
  - Cardiac murmur < 10% of cases
    . Split second heart sound (S2)
    . Holosystolic murmur - tricuspid (rt AV) regurgitation
    . Unrelated murmurs due to mitral insufficiency or atrioventricular (AV) valve endocardiosis
- **Microfilaria detection** (occult infections : 20% no circulating MF [microfilaria])
  - Blood smear or wet mount; if negative do Knott's
  - Concentration test
    . **Knott's test** or modified Knott's ($0.01/test)
    . Millipore filter test (Difil test®) ($0.80/test)
    . If negative, do immunodiagnostic test
    . Poor correlation between # of microfilaria & adult heartworm burden
    . Differentiation of *D. immitis* from *Dipetalonema reconditum*

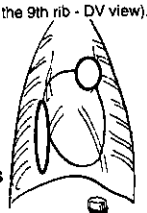




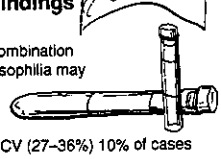
- **Immunodiagnosis/Serodiagnosis** - occult heartworm diz:
  - **Antigen (Ag)-ELISA**: detects circulating antigens of adult heartworms
    . Canine Assure CH®, DiroCheck® & UNI-TEC®; Snap® & PetChek®
    . Still have false negatives
- **Radiographic** signs present in 60-90% cases (determine severity of diz)
  - **Bulging of main pulmonary artery (MPA)** or "pulmonary knob" sign 65-70% of cases (DV view)
  - **Right ventricular enlargement** (RVE) 60-70% of cases
  - **Pulmonary arteries larger than veins**

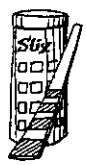


  - **Enlarged caudal lobar arteries** (normally < width of the 9th rib - DV view), cranial lobar arteries (normally < 4th rib - lateral view)
  - **Tortuous & blunted lobar pulmonary arteries** ("pruning" effect) (DV view)
  - ↑ Interstitial, alveolar pattern due to emboli, infarction infiltration, fibrosis, etc. (caudal or accessory lung lobes)
  - Hepatomegaly



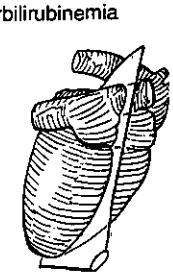
- **Clinical pathology: no pathognomonic findings**
  - Eosinophilia 85-95% of infected animals
  - Basophilia 50-70% of infected animals; Monocytosis. Combination of all 3 strongly suggestive, however, eosinophilia & basophilia may be present w/ Dipetalonema infections
  - Neutrophilia 20-75%, left shift
  - Platelets tend to be lower in infected animals
  - Anemia (normocytic, normochromic-mildly decreased PCV (27–36%) 10% of cases
  - ↑ Liver enzymes - SGPT (ALT) & SAP
    . SAP > 10X may indicate inability to tolerate adulticidal Tx
  - Azotemia
    . BUN & creatinine mildly ↑ in < 5% of cases
    . Nephrotic syndrome contraindication to Tx
  - Bromsulphalein (BSP) ↑ retention in < 20% of cases
  - ± Increase in Total protein





- **Urinalysis:**
  - Proteinuria (albuminuria) in 20-30% of cases due to glomerulonephritis or associated amyloidosis
  - Fixed specific gravity (1.007-1.017) if compensated renal insufficiency exists
  - Hemoglobinuria (post caval syndrome), hyperbilirubinemia

- **Electrocardiogram:**
  - **Often normal & of minimal value**
  - ± Right ventricular enlargement (RVE) - w/ right-sided CHF
    . Rt axis deviation > 103°
    . S waves in leads I, II & III
  - Premature complexes
  - ± Atrial fibrillation (severe pulmonary arterial diz or CHF)
- **Echocardiogram (US):**
  - Rt ventricular enlargement
  - ± Worms detected



***Dirofilaria immitis*, Mosquito, All USA**
CS: Asymptomatic, Wt loss, Dyspnea, Cough, Fainting
Sequelae: CHF, Renal, Thrombi, etc.
Dx: Yearly screening, Serology, ±Knott's; If CS: Rads, Chem, etc.
Tx: Tx cardiovascular diz
- **Adulticide: Caparsolate®, Imiticide?**
- **Microfilaria: Ivermectin**

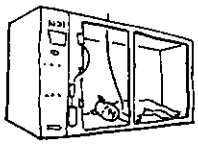
Prevention: Heartgard®, Interceptor®

Treatment - Heartworms

CIRCULATORY SYSTEM

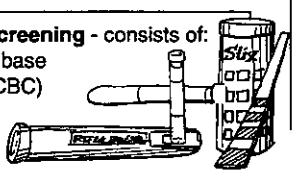
Treatment heartworm cardiovascular diz:

- Older dogs: may be nonprogressive
  - Aspirin alone m/b reasonable alternative
- Supportive therapy:
  - Severe heartworm diz - CHF, nephritis, etc.
- **Heartworm-induced CHF**
  - Rest
  - Furosemide (Lasix®): diuretic
  - Low sodium diet (< 12 mg/kg/day)
  - Aspirin (5-10 mg/kg/ SID)
  - **Note: Digitalis** reserved for unresponsive severe CHF cases (class IV) or cases with severe tachycardia
    - . Cardiac glycoside toxicity more frequent in heartworm-induced CHF
    - .. Adjust dosage for age, body condition (fat) & renal or hepatic function
  - ± Arteriodilators (enalapril or hydralazine) may be attempted, w/ close careful monitoring, to reduce severe pulmonary hypertension
- **Severe pulmonary diz** (thromboembolism or allergic pneumonitis)
  - Cage rest
  - Oxygen therapy



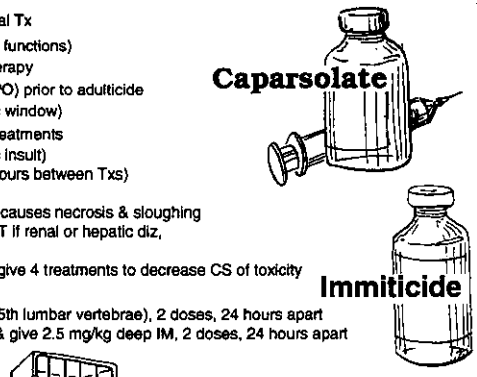
Pretreatment screening - consists of:

- Minimum data base
  - Hemogram (CBC)
  - BUN
  - SGPT (ALT)
  - Urinalysis
  - Radiographs - especially if cough or dyspnea
- Additional tests may include:
  - ECG
  - Transtracheal wash for cytology & culture if clinical or radiographic respiratory abnormalities present



Adulticidal therapy: prior to microfilaricidal Tx

- ± Aspirin (protects endothellum, inhibits platelet functions)
  - . Start 3-5 days prior to & 4-6 weeks following therapy
- ± Ivermectin: preventative dose (0.06 mg/kg PO) prior to adulticide to kill L3s & L4s that may moult to L5s (therapeutic window)
- **Thiacetarsamide (Caparsolate®)**: 4 treatments
  - Feed 1/2 hour prior to each Tx (minimize hepatic insult)
  - Slow IV bolus 2 x/day for 2 days (minimum of 8 hours between Txs)
    - . 75-85% kill generally
    - . Peripheral vein, never use jugular, perivascular causes necrosis & sloughing
    - . Monitor patients carefully: toxicity, BUN or SGPT if renal or hepatic diz, **urinalysis - bilirubinuria** (> +1) & proteinuria
    - . Can give 1 IV dose and then wait 2-4 weeks to give 4 treatments to decrease CS of toxicity
- Melarsomine (Immiticide®):
  - Mild to moderate cases: 2.5 mg/kg deep IM (3rd-5th lumbar vertebrae), 2 doses, 24 hours apart
  - Severe cases: 2.5 mg/kg deep IM, wait 1 month & give 2.5 mg/kg deep IM, 2 doses, 24 hours apart
  - Not recommended for post caval syndrome
  - ≥ 90% effective against adults & L5!
  - Greater risk of thromboembolism (faster kill)
  - Less nephrotoxic & hepatotoxic
- **Postadulticidal therapy:**
  - **Strict rest ≥ 4 weeks**
    - . Pulmonary thromboembolism 7 & 21 days (5 - 30 days) after Tx
  - Start microfilaricidal or preventative Tx in 4-6 weeks
- Surgical removal:
  - Pulmonary artery: benefit to risk ratio very low
  - Vena cava (post caval syndrome): alligator forceps into jugular vein
- NOTE: No Dichlorvos (Task®) & other organophosphates in canines > 6 months of age that may have adult heartworm infection because causes rapid kill with thromboembolism or aberrant migrations of adult worms - circulatory failure with hepatic congestion & centrilobular hemorrhage & necrosis



Contraindications - adulticide Tx:

- Renal failure - azotemia - BUN > 120 mg/dl w/out concentrated urine (specific gravity < 1.030) or nephrotic syndrome
- Hepatic failure with icterus
- Postcaval syndrome
- Pulmonary failure

Prognosis:

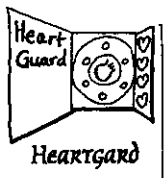
- **Excellent** if diagnosed & treated early - 100% with manageable complications
  - Reversible pulmonary arterial diz w/ normal function & life span
  - L4 can moult to L5 during 4-6 week postadulticide convalescence & re-establish patent infection (Ivermectin prior to adulticide can prevent this)

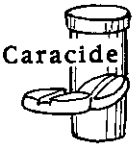
Microfilaricidal (L1) therapy:

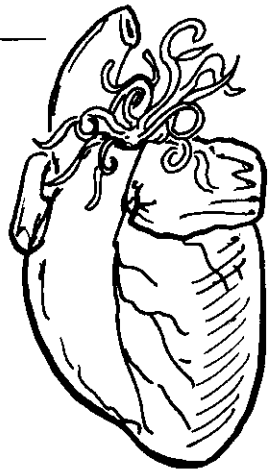
- **Usually 4-6 weeks following adulticidal therapy**
  - More severe hepatic & renal pathology in microcirculation seen with microfilaricidal therapy - hepatic granulomas & degeneration of glomeruli
- **Ivermectin (Ivomec®)**: Single oral dose 4 weeks post-adulticidal Tx
  - Most effective, but not FDA approved; fewest complications & easiest to use
  - Highly effective (> 98%) in killing microfilaria
  - Give in morning & monitor for excessive salivation, anorexia, vomiting, depression, etc., may be seen in approximately 5% of patients 1-2 days post Tx. Tx w/ fluids & prednisolone
  - Check for microfilaria in 3 weeks
    - . If positive repeat Ivermectin protocol & recheck in 3 weeks for MF
      - .. If positive repeat adulticidal Tx
    - . If negative start heartworm preventative
  - Safe for collies/shelties as prescribed (50 mg/kg PO)
- Dithiazanine iodide (Dizan®) FDA approved: variable effective or available
  - 7-10 days in food, purple dye to feces & vomitus
- Levamisole not FDA approved - SID for 1-2 weeks

Prevention:

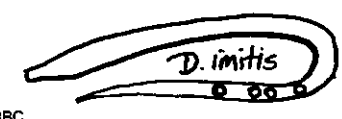
- **Ivermectin (Heartgard®): once a month** PO
  - OK if microfilaremic patient
  - Can start puppies between 6-8 weeks old w/o testing
  - Heartgard 30 Plus® contains pyrantel to control ascarids & hookworms
- **Milbemycin oxime (Interceptor®):**
  - Once a month PO
  - Some risk to microfilaremic patients
  - Hookworm & whip worm infections
- Diethylcarbamazine citrate/DEC (Caricide®, Difil®, Nemacide®) daily (liquid, tablet, chewable tablets)
  - Daily treatment - Effective prophylactic
    - . Protection voided if 2 or 3 days missed
  - Also prevents round worms (Toxocara)
  - Give from beginning to 2 months after mosquito season
  - In subtropical climates give year round
  - **DO NOT use in microfilaria-positive or untested animals.** Anaphylaxis can occur acutely (20 to 30 minutes) & likelihood & severity proportional to microfilariae/ml
  - Filaribits® (DEC) Plus® combination of DEC & oxibendazole for hook worms
  - Hepatotoxicity has been reported
- **Moxidectin**: effective once-a-month preventative

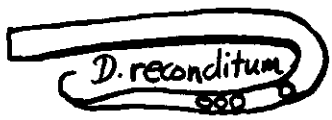




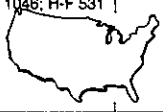
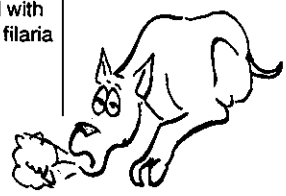
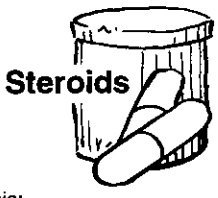
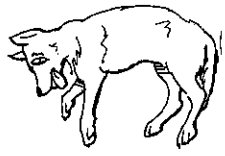
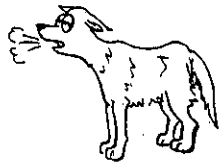
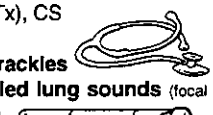
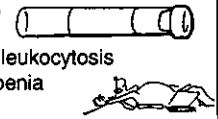
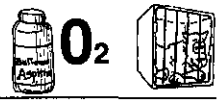


DDx	*Dirofilaria immitis*	*Dipetalonema reconditum*
Wet mounts		
Mobility	**Stationary - undulate**	**Mobile**
Shape	Straight body	Curved body
Length	324 (> 310) µm	277 (< 290) µm
Width	Similar to canine RBC	Smaller than canine RBC
Concentration tests		
Shape	**Tapered head**	**Blunt head**
	Straight body	Curved body
	Tapered tail	Button-hooked tail
Length	> 290 µm Knott's	< 275 µm Knott's
	> 240 µm Filter	< 240 µm Filter
Width	6.1-7.2 µm Filter	4.7–5.8 µm Filter
	> 6 µm Knott's	< 6 µm Knott's





Lung Diz - Heartworm

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Heartworm allergic pneumonitis, Pulmonary hypersensitivity, Pulmonary infiltrate w/ eosinophilia (PIE) H-T/M 240; SAP 491; I2M 171; IM 132; IM-WW 178; C12T 879, 267, C11T 658, 816; E 1046; H-F 531 ** to *** depending on region 	• **Complication in 10-15% of occult infection** • Immune response against circulating microfilaria - Antibody/WBC trap microfilaria in lungs - Hypersensitivity reaction • Appears to be associated with dead microfilariae & adult filaria by-products 	• **Progressively worsening cough** • Dyspnea & orthopnea - ± Cyanosis • Exercise intolerance • Weight loss & anorexia 	• Hx (occult heartworm), CS • Auscultation - Respiratory crackles • Radiographs - **Diffuse interstitial - alveolar infiltrates** • Laboratory - ± Eosinophilia, basophilia & hyperglobulinemia • Serologic heartworm test usually positive • Tracheal lavage cytology - eosinophilia • Response to Tx - improves in 2 days	• **Steroids: oral prednisone** for several days - Stop prednisolone Tx after 3-7 days & begin adulticide  Prognosis: • Fair to good
Heartworm, Pulmonary thrombo-embolism/ Parenchymal diz H-T/m 241; SAP 492; IM 132 ** 	• Common sequela of moderate to severe pulmonary arterial diz - **Most common 7-21 days after adulticide Tx** - Can occur prior to adulticide Tx • Dead & dying worms - Thrombosis & obstruction of pulmonary arteries • Caudal & accessory lobes most often 	• **Fever** • **Coughing** • ± Hemoptysis • **Tachycardia** • **Dyspnea**, tachypnea • Anorexia • ± Collapse, shock & death 	• Hx (adulticide Tx), CS • Auscultation - **Pulmonary crackles** - **Area of muffled lung sounds** (focal lung consolidation)  • Laboratory: - Regenerative leukocytosis - Thrombocytopenia  • Radiology: - Severe pulmonary arterial diz . **Pruning of pulmonary arteries** - Periarterial parenchymal diz . Patchy alveolar infiltrate w/ air bronchograms - often peripheral lung 	• **Strict cage rest** for 5-10 days • **Prednisolone** for 3-10 days (anti-inflammatory) **Steroids** • **Cough suppressants** (sedation) -Torbutrol® • **Aspirin** 2-4 weeks • **Bronchodilators**: aminophylline or theophylline (sustained release) • **IV fluids + steroids** if shock exists • **Oxygen therapy** (40%) (PaO2 < 70 mm Hg) • ± ABs (trimethoprim-sulfa, cephalosporins, enrofloxacin empirically [pneumonia]) Prognosis: • Guarded 

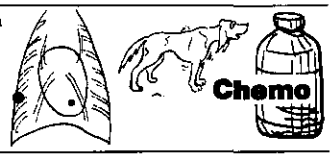
Heartworm

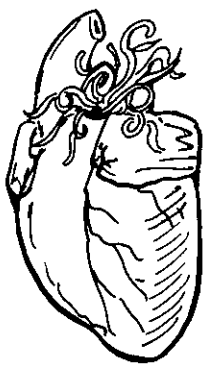
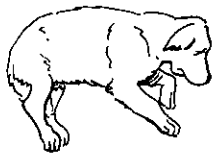
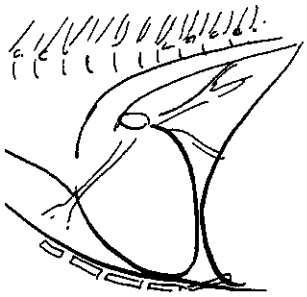
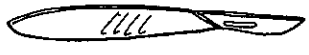
Eosinophilic granulomatosis

SAP 491; IM 133; H-F 531

*

- **Rare complication of occult heartworm diz**, some affected heartworm negative, Heartworm fragments nidus for eosinophilic granuloma development, ± tumor-like behavior, ± Eosinophilic infiltrates of trachea, liver, spleen, kidneys, intestines & lymph nodes
- CS: **Cough, Dyspnea**
- Dx: Hx (occult heartworm), CS; Lab: ± Eosinophilia & basophilia; Intrathoracic lymphadenopathy always; Rads: single or multiple **pulmonary nodules** (1/4-4"), mixed interstitial & alveolar (bronchograms) pattern ± mediastinal lymphadenopathy
- Tx: Combo chemo: **prednisone + azathioprine** (Imuran®) 7-10 days, then alternate days (indefinitely), ± Lung lobectomy
- Px: **Poor**: relapse is common



Heartworm - Severe pulmonary arterial diz SAP 492; IM 133; H-F 535 ** to *** (regional) 	• **Likely** in chronic heartworm, heavy worm load, & occult infections • 10% of heartworm-infected dogs in highly endemic regions 	• **Cough** • **Dyspnea** & orthopnea (± cyanosis) • **Tiring** (exercise intolerance) - Episodic weakness • Anorexia & weight loss • Fainting (syncope) • **Death** • Sequela: - Thromboembolism 	• Hx (HW diz), CS • Auscultation • Laboratory: - **Peripheral eosinophilia + basophilia** - Hyperglobulinemia - Decreased PaO2 - Thrombocytopenia • Radiography: - **↑ Pulmonary vascular pattern** . **Enlargement, tortuosity & blunting of pulmonary arteries** - Pulmonary parenchymal infiltrates . Can lead to hypoxemia 	• **Forceps extraction of adult worms from pulmonary arteries** - Jugular venostomy - Fluoroscope & long flexible alligator forceps . Manipulate through heart to pulmonary arteries . Multiple grasps at worms • Conservative - Cage rest for 2-3 weeks prior to, during, & 3-4 weeks following adulticide Txs - Aspirin 2 weeks before & 4 weeks after adulticide Tx . Use w/ caution if hemoptysis - Adulticide Tx - Low salt diet for overt right-sided CHF - ± ABs  Prognosis: • Surgery: highly effective in experienced hands • Conservative: Good - 70-80% survival rate w/ adulticide Tx (40-50% if no adulticide Tx)

Likely in chronic HW
CS: Cough, dyspnea, Tiring
Dx: Hx, Rads, Lab
Tx: Sx removal of worms

Heartworm — CIRCULATORY SYSTEM

Condition	Facts/cause	Presentation/CS	Diagnosis	Treatment
Right congestive heart failure I2M 172; IM 134; H-Pic 5 ★ to ★★ (regional)	• **Severe pulmonary arterial diz & subsequent pulmonary hypertension**	• **Right congestive heart failure** - Jugular distension &/or pulse - Ascites - Fainting (syncope) - Exercise intolerance	• Hx, CS • Arrhythmias • Radiology: DV - Right ventricular hypertrophy	• **Cage rest** - ± Aspirin • **Furosemide** (Lasix®) • **Sodium-restricted diet** • Digitalis not recommended since it doesn't prolong survival - Toxicity frequently - Causes pulmonary vasoconstriction • ± ABs • Vasodilators (enalapril) • Avoid steroids unless severe concurrent pulmonary parenchymal diz
Vena caval syndrome, Postcaval/acute hepatic/liver failure syndrome, Dirofilarial hemoglobinuria, Vena cava embolism H-T/M 242; H-F 534; SAP 492, I2M 172; IM 134; IM-WW 178; Sx-WW 97 ★ to ★★ (regional)	• **Acute, shock-like syndrome** • Cause: obstruction of venous inflow to heart - Massive retrograde worm migration from pulmonary artery through rt ventricle, rt AV valve, rt atrium in vena cava • **Severe rt AV (tricuspid) regurgitation**	• **Acute weakness, collapse** • Tachypnea, hyperpnea • Anorexia • Jugular distention &/or pulse • ± Coughing, hemoptysis • DIC • Sequelae: - Hepatic congestion - W/o Tx most die in 24-72 hours from: - Cardiogenic shock complicated by: . Metabolic acidosis . DIC . Anemia	• Hx (no heartworm related signs in most), CS • Physical exam: - Pale membranes - Weak pulse • Auscultation - Rt AV (tricuspid) insufficiency murmur . Loud & possibly split S2 - Cardiac gallop rhythm • Laboratory - Bilirubinuria, **hemoglobinuria** (RBC lysis) - Microfilaria - Azotemia: elevated BUN, creatinine - Increased liver enzymes - SGPT • **Radiology: Rt heart & pulmonary artery enlargement** • ECG: Rt ventricular enlargement • Echocardiogram - **Mass of worms in rt atrium & caudal vena cava** - Rt ventricular dilation	• **Surgical removal** initial Tx of choice - Jugular venotomy - Long forceps or endoscopic basket-retrieval device . Goal retrieve 35-50 worms - Supportive fluids - **Thiacetarsamide (Caparsolate®)** . Tx when patient has stabilized . Aspirin before & after Tx • Broad spectrum ABs Prognosis: • Fatal if not treated promptly • Guarded: Survival > 50% after successful surgery

Shock-like, Worms in vena cava
CS: Weakness, Jugular distention, Collapse
Dx: Hx, Echo, US, etc.
Tx: Sx, ABs

Heartworm - Renal diz H-T/M 246; H-F 537; IM 135; IM-WW 179 **	• **Immune complexes** - IgG, IgM & C3 w/ dirofilaria antigens - Deposited in the glomerular basement membrane • Basement membrane thickens - Protein losing glomerulopathy - Amyloidosis may develop with chronic antigenic stimulation - Prerenal azotemia with hypovolemia/ dehydration • Renal failure not common, but may be seen with glomerulosclerosis & chronic interstitial nephritis (end stage kidney diz) or 2° to CHF or postcaval syndrome • ± Toxic tubular nephrosis (renal insufficiency) 2° to thiacetarsamide Tx	• Mild prerenal azotemia • ± **Nephrotic syndrome** - Hypoalbuminemia - Peripheral edema • PU (polyurea)	• Hx, CS • Lab: - **Azotemia (BUN > 30 mg/dl)** - Isosthenuria - Proteinuria (+ hypoalbuminemia)	• **Renal insufficiency** - **Free choice water** - **Restrict protein & phosphorus** - Supplementation: water-soluble vitamins (Bs & C) & electrolytes (K+, Na+ HCO-3) - **Fluid &/or diuretic therapy** . Resolve prerenal azotemia prior to instituting adulticide therapy . Reduce mild to moderate azotemia (BUN 30-120 mg/dl) to a BUN of < 50 mg/dl prior to initiating adulticide therapy - **Anabolic steroids:** . Positive protein balance . Stimulation of erythropoiesis • Glomerulonephritis: - Glucocorticoids?, Aspirin, Thromboxane inhibitors • Amyloidosis: Dimethyl sulfoxide (DMSO) - AVOID Glucocorticoids • Nephrotic syndrome poor candidates for thiacetarsamide Tx Prognosis • Poor to guarded
Arsenical toxicity Mk 73; SAP 487; E-hb 402; IM 126; H2B 137; E 1046; H-F 537; NB 3.23 **	• **See Tox pg 735** • **Can occur during or w/in a week of adulticide Tx w/ Thiacetarsamide (Caparsolate®) for heartworm** - 2-24% develop hepatotoxicity &/or nephrotoxicity	• **Vomiting** - abort Tx if repeated or persistent • Lethargy or depression • Anorexia • Diarrhea • **Icterus** - abort Tx! • **Fever** - nonspecific inflammatory response • **Death**	• Hx (adulticide HW Tx) • Lab: - Azotemia - may continue therapy if BUN lowers to < 50 mg/dl with fluid therapy/diuresis - Elevated liver enzymes (common, not alarming unless CS) • Urinalysis - **Bilirubinuria** - prior to 2nd, 3rd or 4th Tx reason to abort Tx (precedes Icterus) - Tubular casts	• **Discontinue arsenical Tx if toxicity** - Rule of thumb: stop Tx if 2 toxicity signs coexist: depression, vomiting, anorexia, fever or diarrhea - Supportive - IV fluids to promote diuresis - Feed high-CHO & low fat diet for 4 weeks - ± ? BAL (Dimercaprol) if azotemia is present, but questionable value - Repeat thiacetarsamide series of 4 in 2-3 months if toxicity interrupts after 1st or 2nd Tx

Perivascular infiltration of thiacetarsamide
- Infiltrate w/ sterile saline & lidocaine
- DMSO topically TID for 3-5 days (Never use the jugular vein for treatment)

Heartworm

CIRCULATORY SYSTEM

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Heartworm Hepatic diz H-T/M 247; H-F 537; IM 135 ★ to ★★ (regional)	• Phlebitis/phlebosclerosis of hepatic veins resulting in fibrosis of veins • Chronic passive congestion w/ rt-sided heart failure or vena caval syndrome resulting in dilation of hepatic veins - Cirrhosis with centrilobular necrosis & fibrosis - Liver failure - Hepatotoxicity - thiacetarsamide - Microgranulomas - following microfilaricides	• **Asymptomatic** (just elevated enzymes) • Anorexia & depression • Ascites • Gastrointestinal signs • **Icterus** (contraindication for use of arsenicals) • Signs of severe pulmonary arterial diz - Dyspnea	• Hx (region), CS • Physical exam - Hepatic failure w/ icterus (contraindication for thiacetarsamide Tx) • Elevated serum liver enzymes (common, not alarming unless CS) - Elevated SGPT (ALT) & SAP . SAP > 10X inability to tolerate adulticidal Tx • ↑ up to 15% of BSP (sulfobromophthalein) retention (associated w/ thiacetarsamide toxicity) • Urinalyses: - **Bilirubinuria** - prior to 2nd, 3rd or 4th Tx cause for concern (precedes icterus)	• **Supportive** - Intravenous fluids & electrolytes • Diet: high carbohydrate, high quality protein & low fat **Prognosis:** • **Poor** if icterus & severe pulmonary arterial diz

Fibrosis of veins
CS: Asymptomatic, Ascites, Icterus
Dx: Hx, CS, SAP, Bilirubinuria
Tx: Supportive Diet

Heartworm - Disseminated intravascular coagulopathy, DIC ★ H-T/M 242; IM 135	• **Excessive intravascular clotting or parasite lysis of RBCs**, initiated & perpetuated by: intravascular hemolysis (vena caval syndrome), endothelial damage (adult worms), stagnant lung & hepatic blood flow; FDPs & consumption of coagulation components inhibits coagulation • **CS: subclinical DIC generally accompanies adulticidal Tx**, Petechiae & ecchymoses, blood loss - hemolysis or hemoptysis • Dx: Hx (HWD), CS, **thrombocytopenia** - monitor platelets, ↑ bleeding time & activated clotting times (> 120 seconds) & FDP (> 1:20 dilution), Hemoglobinuria • **Tx: Aspirin** BID, Low dose **heparin** SQ , transfusions for clotting factors, **Vincristine IV**, if severe thrombocytopenia
Aberrant * heartworm lesions	• Immature worms may remain in skin & SQ tissues, or migrate to CNS, systemic arteries (especially rear legs), lymph nodes, abdominal organs, intraocular • Inflammatory lesions may be due to: mechanical injury (intraocular), or immune-mediated response (eosinophilic or pyogranulomatous) to the adult worms • Surgical excision of granuloma from the anterior chamber of eye, spinal cord, skin or subcutis • Px: Guarded, depends on location of lesion
Spontaneous pneumothorax * H2B 216	• Bronchopleural fistula may develop with severe infections or aberrant heartworm migration • Tx: Rest + sedation, Aspirin, Bronchodilators, Cough suppressants, Corticosteroids, ± Antibiotics Surgical: Chest drains for pneumothorax, Thoracotomy to repair bronchopleural fistulas

Heparin

Vincristine

Feline heartworm disease

M8k 96; H-T/M 250; H3B 129; H2B 137; SAP 487; I2M 175; IM 126; IM-WW 179; 5min 637; H-F 551; Cat 495

★★ (regional)

- **Cats: less susceptible than dogs** (8-15% of incidence in dogs in the same area, 2% on necropsy in SE USA)
- 3-6 years (range 1-17 yrs)
- Males > females
- Resistance to infection:
  - Occult infections predominate in cats (> 80%)
  . Shorter life span of adult worms in cats (< 2.5 years) than in dogs (5-7 yrs)
- Pathogenesis:
  - Similar to canine infections, but:
  . Exaggerated pulmonary inflammatory response
  . Often severe pulmonary thromboembolism
  - 5-6 worms produce severe disease
- Average cat infection - 3 adult worms
- Life cycle (see dog)

- **Asymptomatic**
- **Sudden death** (without signs)
- Cardiopulmonary
  - **Cough** (50%)
  . ± hemoptysis (spitting blood)
  - Dyspnea (50%), thromboembolism
  - Ascites
- **GI signs**
  - **Episodic vomiting (50%) common in cats**
  - Anorexia & Weight loss
  - Diarrhea
- CNS signs (aberrant migration)
  - Seizures
  - Blindness
  - Depression
  - Lethargy
- **Sequelae:**
  - Pulmonary thromboembolism
  - Pneumonitis
  - CHF

- Hx (region), CS
- Auscultation: ± Gallop rhythm, Systolic murmur
  - Muffled heart sounds (consolidation or pleural fluid)
- Lab: nonregenerative anemia, eosinophilia (33%), hyperglobulinemia (inconsistent)
- Microfilarial tests < 20% of cats positive
- Serology
  - **Positive ELISA** (antigens) (Canine Assure CH® & DiroCheck®)
  . Less sensitive than in dog (false negatives)
- **Fecal examination** (flotation & Baermann)
  - R/O other parasites (respiratory & GI)
- **Radiography** always required in cats, useful screening test
  - Postpone in a dyspneic cat, stress may be fatal!
  - **Caudal lobar pulmonary artery enlargement** w/ or w/o tortuosity or pruning
  - **Right heart enlargement**
  - ± **Alveolar/interstitial densities**
  - Ascites
- Angiography - pulmonary vascular pattern
- **Echocardiology (US)**: especially useful in cats because Dx difficult
- Electrocardiography:
  - Often normal
  - Right atrial enlargement - tall P waves
  - Right ventricular enlargement 25-30% of cases
  . Mean electrical axis > +160
  . Deep S waves in V2 & V3: 0.7 mV
  . S waves in leads I, II, III, aVF: 0.5 mV
- Transtracheal aspirates - eosinophilia
- Postmortem: may be incidental finding

- **Self limiting in some**
- **Adulticide: weigh against high % of complications**
- **Asymptomatic: Tx not warranted**
- **Symptomatic**: consider Tx
  - **Tx severe lung involvement first!**
  . Steroids (discontinue before adulticide Tx)
  . Bronchodilators
  . Furosemide
  . Oxygen may be indicated
  - **Thiacetarsamide (Caparsolate®)** IV BID (8 hours minimum between Txs) for 2 days
  . Feed 1/2 hour before Tx
  - **Strict rest for 4 to 6 weeks** (thromboembolism 1-2 weeks after Tx (sudden deaths!)
  - ± Aspirin therapy 2 x a week for 4 weeks
  . Avoided in dyspnic cats (bronchoconstriction)
  - Microfilaricides: usually not required
  - **Complications of Tx** (< 40% of cases)
  . Thromboembolism (more than in dog)
  .. CS: Sudden death, fever, cough, dyspnea, hemoptysis (spitting blood), hypotension
  .. Tx: Prednisolone, IV fluids, Aminophylline, O2
  . Fatal respiratory distress syndrome (acute pulmonary edema)
  . Anorexia & profound depression, nausea & vomiting - discontinue Tx if severe - stabilize & adulticide in 2-4 weeks

Caparsolate

Prevention:
- Prophylactic medications - **not recommended** for routine use in cats

Prognosis:
- **Guarded**
  - **Good** in most if survive acute pulmonary diz

Less than dogs, Regional
CS: None, Cough, Vomiting, CNS
Dx: ELISA, Rads, Echo
Tx: Tx or not? Complications
Prevention not recommended

DDx:
- Feline asthma
- Eosinophilic pneumonitis
- Verminous pneumonia (Paragonimus, Capillaria or Aleurostrongylus)
- Cardiomyopathy
- GI diz (inflammatory bowel disease)

Valvular & Endocardial Diz

SAP 453; 5min 98; IM 107, 122; IM-WW 139; H2B 93; H-Pic 27; E-hb 348; Pys-B 180

★★★ to ★★★★ if lots of geriatric dogs

Valves of heart

- Left AV (mitral/bicuspid) valve
- Pulmonic (rt semilunar) valve
- Right AV (tricuspid) valve
- Aortic (lt semilunar) valve

Normal function

- One way opening for blood flow
  - Prevent retrograde flow (regurgitation)
- AV valves close at start of ventricular systole, 1st heart sound (S1 - "lub")
  - Prevent backflow of blood into atria during ventricular systole
- Semilunar valves close at start of ventricular diastole, 2nd heart sound (S2 - "dub")
  - Prevent backflow of blood into ventricles during ventricular diastole

Valve dysfunction

- **Stenosis**: narrowing w/ obstruction of flow
  - Usually congenital
- **Regurgitation** (insufficiency): incomplete closure of valve w/ backflow of blood (leakage)
  - Congenital or acquired

PMI (point of maximum intensity) for heart valve sounds

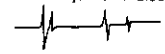
Rule of thumb:

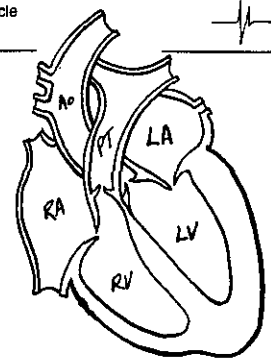
left $P^{A}M$ $3^{4}5$

- Pulmonic valve - low lt, 3rd ICS (intercostal space)
- Aortic valve - high lt, 4th ICS
- Rt. AV (mitral) valve - low lt, 5th ICS
- Left (tricuspid) AV valve - rt, low 5th ICS

Heart sounds (dogs & cats)

- S1 (lub) - closure of AV valves (start of systole)
- S2 (dub) - closure of semilunar (aortic & pulmonic) valves - start of ventricular diastole
- S3 - abnormal extra sound - usually from rapid filling of dilated ventricle associated w/ severe heart failure
- S4 - abnormal extra sound, usually from atrial ejection of blood into ventricle



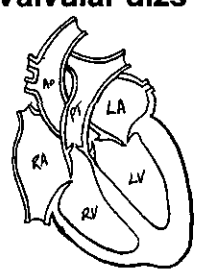


Murmurs: hallmark of valvular diz

- Facts
  - Caused by disturbance of blood flow over valve
  - Absence of a murmur virtually excludes valvular diz
- **Systolic murmur**
  - Semilunar (aortic, pulmonic) valve stenosis, or
  - AV valve insufficiency (regurgitation)
  - Tetralogy of Fallot
  - ASD (atrial septal defect)
  - Ventricular stenosis

- **Diastolic murmur**
  - Aortic valve regurgitation
  - AV valve stenosis (rare)
- **Continuous** (diastolic - systolic) murmur
  - Patent ductus arteriosus
- **Innocent or physiologic** (low grade, no other cardiac signs)
  - Anemia
  - Fever
  - Anxiety
  - Kittens & puppies < 6 months old

Valvular dizs

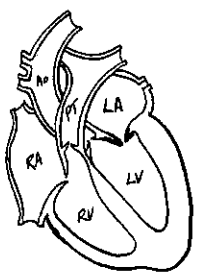


Diz	Facts	CS	Dx	Tx
• **Congenital**				
- PS (pulmonic stenosis)	#2 congenital	Fainting, tiring	Hx, Murmur, ECG, Rads	Sx (patch graft)
- AS (aortic stenosis)	Subvalvular	Asymptomatic, HF	Hx, Murmur, Rads	Controversial
- AV dysplasia	#1 cat	Tiring, HF	Hx, Murmur, Echo	Tx HF
• Acquired				
- Regurgitation				
. Endocardiosis (MI)	Lt AV, #1 CHF	Cough, tiring	Murmur, Rad, Echo	3 Ds for HF
. Ruptured chordae tendinae	Sequela: MI	CS of MI	Murmur, Echo	None
. Bacterial endocarditis	Systemic infection	Fever, vomiting, CHF	Murmur, Echo, + culture	ABs, 3 Ds
- Stenosis 2° to bacterial endocarditis	Rare, Rt AV	Tiring, cough	Murmur, Echo, Rads	No effective Tx

Mitral stenosis

H2B 102

*



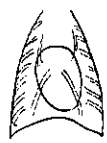
- **Rare**
- Narrowing of lt AV opening
- Causes
  - Congenital
  - Bacterial endocarditis
- Associated with lt atrial dilation, cardiac arrhythmias & lt atrial mural thrombi

- **Asymptomatic if mild**
- CS m/b related to underlying diz (bacterial endocarditis)
- Moderate to severe stenosis
  - **Tiring** (exercise intolerance)
  - **Cough**
  - Episodic weakness
  - Tachypnea, dyspnea

DDx:
- Mitral valve insufficiency
- Cardiomyopathy
- Subvalvular aortic stenosis
- Left atrial intraluminal or extraluminal masses
- Pulmonary hypertension causes
- 1° tricuspid valve incompetence

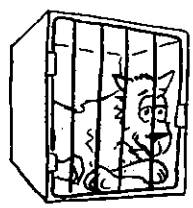
- Hx, CS
- Physical exam
- Auscultation - murmur
  - Early diastole
  - Diastolic rumbling murmur S3 & S4

- Radiology:
  - LA enlargement
  - Pulmonary venous distension
  - Pulmonary edema
  - Rt ventricular enlargement
  - Prominent main pulmonary arteries



- ECG:
  - ± Increased or prolonged (> 0.4 mV, > 0.05 sec)
  - Arrhythmias common
  - RVE changes
- Echocardiogram (US):
  - Left atrial enlargement

- **No effective Tx**
- Restrict exercise



Prognosis: Poor

Pulmonic insufficiency

H2B 104; E-hb 355

*

- **Rare, Generally not hemodynamically significant**; Cause: **2° to heartworm disease, PDA w/ pulmonary hypertension**, trauma to pulmonic valve leaflets, congenital malformation, tricuspid insufficiency, bacterial endocarditis; Pathophysiology: regurgitation of blood from pulmonary trunk to rt ventricle during ventricular diastole, Concurrent pulmonary hypertension or stenosis, Volume overload of rt heart, Rt sided heart failure
- CS: **Asymptomatic, generally not significant**, If concurrent pulmonary hypertension or stenosis (exercise intolerance, weight loss, ascites, jugular pulse)
- Dx: Hx, CS, Auscultation (Split heart sounds, Diastolic murmur: low in 4th ICS), Radiology: ± Enlarged rt ventricle, ± Pulmonary artery bulge at 1 o'clock, ± Enlarged caudal vena cava - ECG (Plt waves > 0.35 mV, > 0.05 sec, PR interval > 0.14 sec, R wave changes in leads, S wave changed, QRS > 0.06 sec, Arrhythmias uncommon), Echocardiogram (± Dilation of rt ventricle, pulmonary trunk & main pulmonary artery) Abnormalities of pulmonary valve
- DDx: Dirofilariasis, Bacterial endocarditis, Isolated diastolic murmurs, Aortic insufficiency, Tricuspid stenosis
- **Tx: None if asymptomatic** - usually, Diuretics - furosemide (Lasix®), Low sodium diet, ± Nitrates for pulmonary hypertension, Cardioglycoside usage is questionable

Chronic Left AV Valvular Diz

Condition	Facts/Cause	Presentation/CS

Endocardiosis,
Chronic AV valvular diz,
Left AV (Mitral) valve diz,
Mitral regurgitation,
Mitral insufficiency (MI),
Chronic "myxomatous transformation" valvular diz, Mucoid valvular degeneration;
Chronic mitral valvular fibrosis

M8k 62, 87; I2M 133; IM 107, 122; IM-WW 152; H3B 91; H2B 93, H-T/M 129; H-Pic 57; SAP 454; E-hb 348; C12T 837; E 944; Mk 46; C12T 784; H-F 144, 409; Sx-S 816; X-T 311; X-RP 127; NB 3.25

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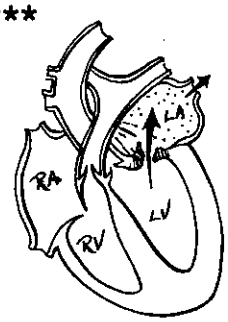
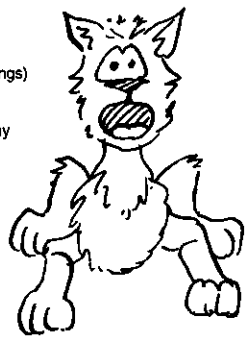
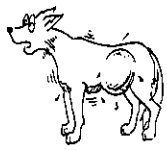


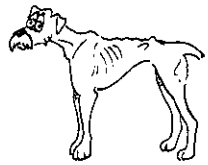
- **Chronic valvular diz**
- **Mitral insufficiency (MI) or regurgitation**
- **Unknown cause** of endocardiosis
  - Degeneration of subendocardium of valves
  - **Lt (mitral) AV valve most commonly**
    . Rt (tricuspid) AV valve (34%) & aortic valve (3%) sometimes
- **#1 cause of CHF (congestive heart failure) in dog**
- Signalment:
  - Middle-aged & older dogs, cats
  - Toy & small breeds (Poodle, Schnauzer, Cavalier King Charles, Cocker spaniels)
    . Large dogs: dilated cardiomyopathy more common than endocardiosis
- Pathology:
  - Progressive, gradual degeneration
  - **Thickened leaflets** (subendocardial)
  - **Nodular** distortion of edges
  - Thickened chordae tendineae ± rupture
  - Endocardium intact (glistens - DDx from endocarditis)
  - Dilated lt atrium (blood backs up)
  - Dilated lt ventricular (m/ proceed to hypertrophy if hypertension)
  - Endocardial sclerosis ("jet lesions") in lt atrium (regurgitation lesions)
  - ± Concommitant rt AV regurgitation & rt ventricle dilation
- Pathophysiology:
  - Lt heart overload
  - Insufficiency/regurgitation - progressive
    . Regurgitation from lt ventricle to lt atrium ± lungs
    . **Backward failure** (blood backing up into atria/lungs)
    . **Forward failure** (reduced cardiac output)
  - Asymptomatic for some time (compensation)
    . Initially: ↑ HR & contractility, eccentric hypertrophy of lt ventricle & dilation of lt atria
    . Chronic: lt ventricular dilation
  - Hypertension (afterload): ↑ blood backs up into lungs = congestion & edema
  - **Heart fails:** hypoxia

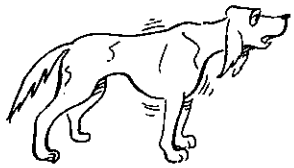


- Class 1: asymptomatic until progression
  - May live for years
- Class 2 (early signs)
- Class 3 & 4 (advanced signs)
- **Lt CHF (congestive heart failure)**
  - **Cough** (nocturnal or exercise related)
  - **Respiratory distress**
  - Tiring (exercise intolerance)
  - Restlessness
  - Tachypnea (fast breathing)
  - Poor appetite
  - Weight loss
  - Fainting (syncope)



- **Sequelae:**
  - Pulmonary edema
  - Ruptured chordae tendineae
  - Atrial endocardial splitting/rupture
  - Pulmonary hypertension



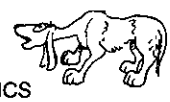


PMI
- **Lt AV (mitral) valve -** mid to **low lt 5-6th ICS**

DDx: Left AV valve diz
- Systolic murmur
  - **Left-sided CHF**
  - **Dilated cardiomyopathy**
  - **Congenital AV valve dysplasia**
  - **Bacterial endocarditis**
  - Acute rupture of chordae tendineae
  - Congenital heart disease - VSD & SAS
  - Anemia
- Respiratory signs
  - **Tracheal/bronchial collapse**
  - **Chronic obstructive pulmonary diz**
  - **Pneumonia**
  - Heartworm diz
  - Chronic bronchitis
  - Pulmonary fibrosis
  - Pulmonary edema

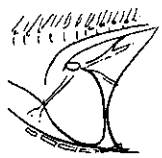
#1 CHF, Degenerative, ?, Lt AV
CS: LHF (Tiring, Dyspnea, Fainting)
Dx: Murmur, Rads, Echo
Tx: CHF Tx ("3 Ds") + Rest

Diagnosis:
- Hx (age, breeds)
- Physical exam:
  - ± Palpable thrill lt low 5th ICS
  - ± Pulse deficit (hypokinetic), rapid jerky pulse



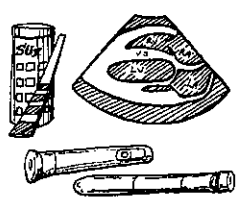
- Auscultation:
  - Soft **systolic murmur** progressing to holosystolic (plateau) murmur
  - **PMI left, low 5th ICS**
    . Severe, radiates to right
  - S3 or S4 usually indicates presence of CHF
  - Lung congestion & edema (crackles, wheezes)
  - ± Muffled heart sounds

- Radiology:
  - **LAE & then LVE** (atrial & ventricle enlargement)
    . Lat: elev. of trachea, separation of bronchi, DV: bowing of bronchi
    . ↑ Lung density
    . Dilated pulmonary veins - venous congestion progresses into pulmonary edema



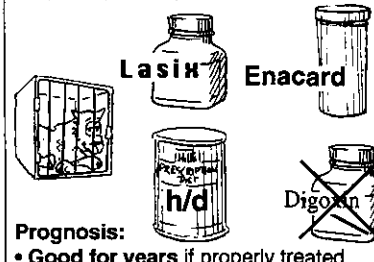
- ECG results: may be normal, doesn't R/O
  - LAE, wide P wave
  - **LVE** (large R in lead **II**, Wide QRS)
  - MEA (mean electrical axis) usually normal
  - S-T segment slurring or coving
  - **Arrhythmias** as diz progresses
    . Sinus arrhythmia, wandering pacemaker, sinus tachycardia; APCs (atrial premature contractions), atrial tachycardia/fibrillation
  - Occasionally ventricular arrhythmias, VPCs, ventricular tachycardia

- **Echocardiogram** (US)
  - ± Ruptured chordae tendineae
  - Look at valves & action



- Laboratory: for renal response to diz & complication caused by extracardiac dizs & drugs (diuretics)
  - ↑ BUN, creatinine & P
  - ↑ Liver enzymes (AST, ALT)

Treatment considerations:
- **Class 1 (asymptomatic):**
  - Low salt & high quality protein diet
  - Prophylactic digitalization NOT recommended
- **Class 2 (early signs):**
  - ↓ Sodium & caloric intake
    . Reduce exercise & excitement
  - ± Diuretics
- **Class 3 & 4 (advanced signs):**
  - **Rest + "3 Ds"**
    . **Diet**: restriction of sodium
    . **Diuretics** (mainstay of Tx)
    . (Vaso)dilators: (ACE inhibitors enalapril (Enacard®)
  - Complete restriction of exercise (rest)
  - Antitussive (cough suppressants)
  - ± O_2 therapy if pulmonary edema
- **Antiarrhythmic Tx as necessary**
- No digoxin as it is not a contractile problem early in diz. If supraventricular tachycardias (e.g. atrial fibrillation) develop then may need



Prognosis:
- **Good for years** if properly treated
- **Poor** for long term if CS, Sudden death may develop at anytime despite Tx, atrial fibrillations, biventricular failure

Tricuspid Insufficiency

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Left atrial rupture, Endocardial splitting of left atrial wall SAP 456; IM-WW 155; E-hb 395; E 952; 5min 379; H2B 456 *	• **Usually complication of chronic MI (mitral insufficiency)** • May occur in dogs w/ PDA or dilated cardiomyopathy or in cats w/ cardiomyopathy & aortic embolism • Middle-aged or older males • Toy & small breeds: Dachshund, Poodie, Yorkshire terrier, Cocker Spaniel) • Incomplete split of endocardium, usually of caudal lt atrial wall - May heal or rerupture (hemopericardium) • **Complete rupture**: bleeds into pericardial sac (tamponade)	• Similar to patients with MI • Cardiac tamponade • Fainting (syncope) **DDx:** • Chronic congestive heart failure • Rupture of chordae tendineae • Pericardial diz	• Hx, CS • Auscultation - Holosystolic murmur in caudal sternal region • Radiography - **Moderate to greatly enlarged heart silhouette**, globular in both views • ECG same as chronic lt AV valve diz - **LAE** (P mitrale) & LVE (R waves) - Atrial fibrillation of APCs (atrial premature contractions) • Echocardiogram - Pericardial effusions	• **None** • Pericardiocentesis, but hemorrhage is likely to occur, not done if complete tear is suspected **None** Prognosis: • **Grave**: TX usually unsuccessful due to rapid development of cardiac tamponade
Rupture of chordae tendineae H2B 94; IM 108; IM-WW 155; E 951; E-hb 395; SAP 456; H-F 410 *	• Chordae tendineae: fibrous collagen bands from papillary muscles to edges of AV valves • Not reported in cat • Rupture result in severe lt **(mitral) AV insufficiency** • Cause: unknown • Toy poodles most often • Acute, subacute or chronic **DDx:** • Volume overload of lt heart • Left atrial tear or rupture • Bronchopneumonia • Electrical shock • Heat prostration • Pulmonary distress syndrome • Pulmonary edema (toxic, infectious or CNS)	• **Acute form** (w/in 12-24 hours) - Severe congestive heart failure (CHF) - **Respiratory distress** (edema - lungs) - Cyanosis - Marked venous engorgement - Death (frothy blood-tinged fluid from mouth & nose) - Stand w/ forelimbs abducted & head & neck distended • **Subacute & chronic form indistinguishable from lt AV regurgitation see MI** (mitral insufficiency)	• Hx (MI) • Precordial thrill, jerky pulse • Jugular engorgement • Auscultation: - **Harsh holosystolic murmur** . Left caud. sternal border . Radiates & loud - ± Arrhythmias . Rapid HR - Loud respiratory sounds - ± Gallop rhythm (volume overload of lt atrium) • Radiographs (don't take if worsens respiration) - **Pulmonary alveolar edema** (mottled of peripheral lung fields) - ± Left atrial enlargement • Echocardiogram (US) - **"Flailing"** (eversion of mitral valve during systole) • ECG (in any position dog is comfortable) - Sinus rhythm (normal) or sinus tachycardia - ± P mitrale (wide P) or P pulmonale (tall P)	• **Tx usually unsuccessful** due to sudden pulmonary edema • Oxygen, diuretics, vasodilators, digitalis **Prognosis:** • **Poor**: most rapidly develop lt-sided CHF (pulmonary edema) refractory to Tx

Right AV (Tricuspid) valve insufficiency, TI

HB 100; I2M 133; IM 107; E-hb 396; SAP 453, Mk 47; E 952; 5min 382; H-F 409; H-Plc 66; Sx-S 879, 916; X-T 311, 346; X-RP 128; NB 3.27

**

• Dogs
• **Usually due to endocardiosis** (chronic valvular diz)
- Majority concurrently w/ **left AV valve** endocardiosis (100%?)
• Dachshund & Cocker Spaniel
• Pathophysiology:
- **Rt heart volume overload**
- Regurgitation into rt atrium
- **Backward failure** (↑ backflow to rt atrium - body)
- **Forward failure** (less blood to lungs)

Causes:
• **Chronic valvular diz** (endocardiosis) #1
• Dirofilaria
• Bacterial endocarditis
• Dilated cardiomyopathy
• Congenital cardiovascular anomalies
- Ebstein's anomaly
- Tricuspid valve dysplasia
- Common atrioventricular canal
• Elevated rt ventricular pressure
- Pulmonary hypertension
. Mitral valve insufficiency
. Pulmonary diz
. Lt to rt congenital shunt
- Rt ventricular outflow obstruction
. Congenital anomalies
. Pulmonary infarcts/thrombosis
- Intrinsic or extrinsic masses
• Rt atrial neoplasia

Endocardiosis
CS: Lt side failure usually
Dx: PE, ECG, Rads
Tx: 3 Ds + Rest, ± Digoxin

• Usually occurs w/ CMI (chronic mitral insufficiency)
- **CS of mitral insufficiency** (MI) (see pg 214)
• Mild cases asymptomatic
• **Right-sided failure**
- **Tiring** (exercise intolerance)
- **Jugular distention/pulse**
- **Abdominal distention** (progressive - ascites)
- Peripheral venous engorgement
- Ascites
- PU/PD
- Anorexia, weight loss
- ± Vomiting & diarrhea
- Pleural or pericardial effusions
- Edema - peripheral & dependent
• Cardiac cachexia

DDx:
• Chronic MI w/ radiation to rt thoracic wall
• Heartworm disease
• Concurrent 1° abdominal lesions
• Congenital defects: VSD of PS in young & middle aged
• Cardiomyopathy in larger breeds

• **See CMI**
• History
• CS: CMI (left AV insufficiency)
• Physical exam:
- **Signs of LHF (CMI)**
- ± RHF - dyspnea
. Hepatomegaly, splenomegaly
. Jugular distention/ pulse
. Ascites: abdominal "water wave" or ballottement" sign on palpation
• Auscultation:
- Holosystolic murmur
- **PMI: rt 4th ICS**
. May radiate to left wall
• ECG Findings: CMI +
- May be no evidence of chronic TI
- **P pulmonale** (tall P) (atrial enlargement)
- RVE: ± deep S waves
- Prolongation of P-R interval
- MEA usually normal
- Occasionally atrial fibrillation
• Radiology: CMI +
- **Moderate to massive RAE** (rt atrial enlargement)
. Dorsal displacement of trachea & cranial vena cava
. RVE (rt ventricle enlargement)(increased sternal contact [lat], backwards "D" [DV view])
- Difficult to distinguish from chronic MI w/ 2° cardiac changes
- **Hepatomegaly** & enlargement of abdominal organs w/ congestion
- Pleural & pericardial effusion
- **Ascites**
• Ascitic/pleural fluid - modified transudate
• SGPT (ALT) & SAP moderately increased

• **Congestive heart failure**
- **Rest + "3 Ds"**
. Rest (restrict exercise)
. Diet: low sodium
. Diuretic (Lasix)
. ± Dilators (Enacard®)
- Digitalis: may be helpful if weak Rt. ventricle (Echo)
• Abdominal paracentesis m/b necessary

Lasix
Enacard
h/d
Digoxin

Prognosis:
• **Guarded**

Bacterial Endocarditis

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Endocardial diz, Bacterial endocarditis BE, Infectious endocarditis, Vegetative endocarditis, "Great imitator"

M8k 86; I2M 140; IM-WW 156; H-T/M 140; SAP 460; H3B 97; H2B 106; 5min 550; F3IM 273; E-hb 396; E 954; H-F 150, 419; H-Pic 85; Cat 919; C11T 752; Sx-S 882; Pa-T 187; NB 3.25

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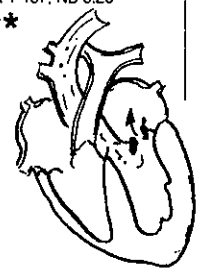
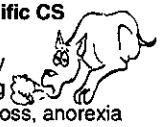


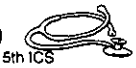
- **Infection of heart valves** or mural endocardium
  - **Life-threatening systemic infection**
- Middle aged & older dogs > cats, > 4 1/2 years
  - Cavalier King Charles spaniel, G. shepherd, **Boxer**
- **Routes of infection**
  - Wounds, local abscesses, pyoderma
  - Pyometra, prostatitis, pyelonephritis
  - Dental & other surgeries
  - IV catheters
- **Predisposing factors**
  - Immunosuppressive drugs
  - Injudicious use of ABs
  - Prior valvular diz (mitral insufficiency, aortic stenosis)
- **Pathophysiology:**
  - Bacteria from other infections passes in blood over valves
  - **Vegetation on valves**, layers of fibrin, blood cells, bacteria & necrotic tissue on endocardium of valves
  - **Lt AV & aortic** valves most commonly, then rt AV & pulmonic
  - **Insufficiency murmurs** (valves don't close & blood regurgitates backwards)
    . Large vegetations m/ cause stenosis
  - **Septic or nonseptic emboli:** seeding of other systems, lungs, kidneys & joints
  - Can progress to CHF

- **Nonspecific CS**
  - **Fever**
  - Lethargy
  - Vomiting
  - Weight loss, anorexia
- Sequela:
  - **Congestive heart failure** more common in aortic valve infections
    . **Cough**
    . **Tiring** (exercise intolerance)
    . **Labored breathing** (polypnea, dyspnea)
    . Jugular distention
    . SQ edema
    . Ascites
    . Fainting (syncope)
    . Sudden death

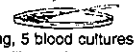


- **Sequelae to emboli (CS)**
  - Heart: myocardial infarction, pericarditis, myocarditis
  - Pyelonephritis
  - Pneumonia (adventitial sounds, ↓ bronchial tones, dyspnea & cough
  - Lameness, posterior paresis
  - Hematuria or pyuria
  - Retinal hemorrhage
  - Epistaxis
  - CNS signs

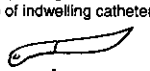
- **Hx** (dental Sx), **CS** (systemic signs of embolism)
- Physical exam:
  - **Water-hammer or bounding arterial pulse** (hyperkinetic)
  - **Check other organs systems** (retinal hemorrhages, epistaxis, cold extremities, lameness, CNS)
- Auscultation:
  - **Cardiac murmur (#1 finding)**
    . Lt (mitral) valve - systolic PMI - lt. low 5th ICS
    . Aortic valve - systolic (stenosis) diastolic (regurgitation) murmur (PMI - high 4th ICS)
    . Holodiastolic, decrescendo, musical murmurs
    . Intensity doesn't correlate to severity
  - ± Arrhythmia



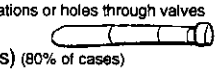
- Radiology:
  - Nonspecific - chamber enlargement & CHF signs
- **Echocardiogram (ultrasound)** (2 dimensional)
  - **±Thickening irregular valves, ragged or cystic appearance, ±"vegetations" (tags)**
- **Positive blood culture important,** 70% of cases - definitive



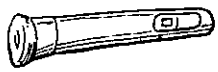
  - Collected at temp. elev., before peaking, 5 blood cultures taken, 10 min. apart, culture tip of indwelling catheter
  - Low counts - 100 colonies/ml
- Postmortem:



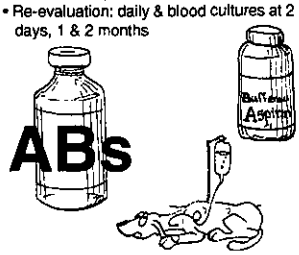
  - **Vegetations on valves, shaggy,** nodules, fibrous thickening, fenestrations or holes through valves



- Laboratory:
  - Leukocytosis (PMNs) (80% of cases)
  - Anemia (50-60%) Mild normocytic, normochromic
  - ± ↑ BUN (embolization)
- Urinalysis: ± Pyuria, hematuria & proteinuria
- Joint or CSF fluid: ± septic or nonseptic inflammation
- ECG: abnormal, but not specific (arrhythmias, LVE, deviation of S–T segments)



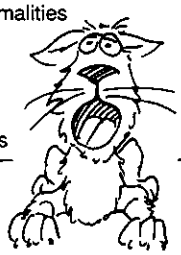
- **Long term antibiotics** immediately, minimum ≥ 6 weeks (3-6 months)
  - Vegetation m/ protect from ABs
  - Initially or if negative cultures & still suspected, broad spectrum: combination of high doses of penicillin, ampicillin or cephalothin + aminoglycosides (if renal function adequate)
    . Initially 1-2 weeks IV, continue for 4-6 weeks, except aminoglycosides (discontinue after 2-3 weeks or signs of renal toxicity)
  - Culture & sensitivity
- Aspirin (to prevent platelet adhesions)
- Supportive Tx: hydration, nutrition, nursing
- Treat concurrent infections aggressively
- **Congestive heart failure - "3 Ds" ± digoxin**
  - Diuretics Lasix® (Furosemide) for CHF
  - Dilators (vaso)
  - Diet - low salt
  - ± Digoxin to improve contractility if CHF due to weak ventricle (Echo)
  - Antiarrhythmics as needed
- Avoid corticosteroids (DDx from immune mediated diz)
- Re-evaluation: daily & blood cultures at 2 days, 1 & 2 months

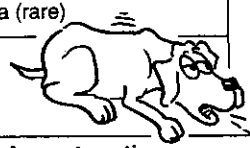


Systemic infection, Vegetation on valves, Lt AV & Aortic
CS: Fever, Vomiting, CHF (Cough, Tiring, Dyspnea, Edema)
Dx: Water-hammer pulse, Murmur, Echo, Blood culture
Tx: Long term ABs, Aspirin, "3 Ds" for CHF

Sequelae of infectious endocarditis

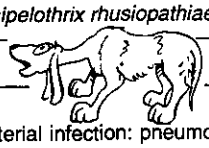
- Heart
  - Valvular regurgitation or stenosis
  - Coronary embolism: myocardial infarction, myocarditis, myocardial abscesses
  - Myocarditis
  - Pericarditis
  - Arrhythmias
  - Conduction abnormalities
- Renal
  - Infarction
  - Abscesses
  - Pyelonephritis
  - Glomerulonephritis
- Musculoskeletal
  - Septic arthritis
  - Immune-mediated polyarthritis
  - Septic osteomyelitis
  - Myositis
- CNS
  - Abscesses
  - Encephalitis/meningitis
- Vascular system
  - Vasculitis - thrombosis, petechiae & ischemia
- Eye - retinal hemorrhage
- Lungs
  - Pulmonary emboli (rare)
  - Pneumonia (rare)





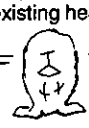
Bacteria involved:

- Streptococcus spp
- Staphylococcus ***spp***
- *E. coli*
- Corynebacterium spp
- *Aerobacter aerogenes*
- *Pseudomonas aeruginosa*
- *Erysipelothrix rhusiopathiae*



Prophylaxis:

- Ampicillin & gentamicin 1 hour before & 24 hours after surgery (e.g., dental)
  - In dogs & cats w/ pre-existing heart diz (subaortic stenosis)



Prognosis:

- **Grave to poor**
  - Survival from a few days to almost 2 years
  - Most die or euthanized w/in 6 months
  - Freq. results in sudden death, Chronic poor doers, may reoccur

DDx:

- Bacterial infection: pneumonia, pyometra, prostatitis, renal infections, abscesses, peritonitis, pancreatitis, septic polyarthritis, pyothorax
- Septicemia
- **Immune-mediated diz** (SLE, Rheumatoid arthritis, autoimmune anemia)
- Systemic infections (mycosis, rickettsial, FIP, infectious myocarditis)
- Drug reactions - fever (disophenol, halothane, ketamine, tetracycline [cats], AB hypersensitivity)

Aortic valvular insufficiency, Bacterial endocarditis of aortic valve

E-hb 354; H2B 103; 5min 382; SAP 460; Sx-S 882; X-T 346; NB 3.28

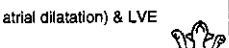
**

- **Regurgitation of blood from aorta back into left ventricle during diastole**
- **Cause: Bacterial endocarditis** usually, Congenital, Rupture of sinus Valsalva, Congenital heart diz, Trauma to aortic valve leaflet following cardiac catheterization, Repeated cardiac puncture
- Pathophysiology: Diastolic overload of lt ventricle, lt ventricular dilation
  - Left-sided failure common sequela

- **Asymptomatic**
- Cardiac decompensation (similar to MI)
  - Tiring (exercise intolerance)
  - Weakness, lethargy
  - Cough, dyspnea
- Bacterial endocarditis
  - **Fever**
  - Intermittent lameness

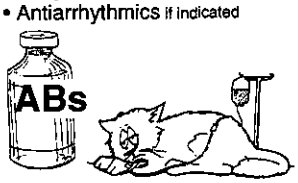
- Sequela:
  - Emboli (see bacterial endocarditis)
  - Lteft heart failure (LHF)

- Hx, CS
- PE: **Thready or water-hammer pulse** (rises & falls sharply)



- Auscultation:
  - Decrescendo **diastolic** murmur High lt 4th ICS
    . Blowing, high frequency sound of low intensity
  - Systolic murmur may also be present
- ECG :
  - ± P mitrale (wide P wave - atrial dilatation) & LVE
  - ± Ventricular arrhythmias
- Radiology: Nondiagnostic in uncomplicated cases
  - May see LVE & LAE (elevated trachea)
  - Occasionally aortic dilatation
- **Echocardiography (US)**
  - **Irregularities & thickening of valve**
  - **Valve prolapse into left ventricle during diastole**

- **Bacterial endocarditis Tx**
  - **ABs**, support
- **Heart failure Tx** if necessary
  - 3 "Ds" (Diet, Diuretics & Dilators)
  - ± Digoxin: if weak ventricle (Echo)
- Antiarrhythmics if indicated



Prognosis:

- Varies with severity; minimal regurgitation is fair, severe is grave: progressive diz

Bact. endocarditis, Diastolic regurgitation
CS: Tiring, Cough, Fever
Dx: Thready pulse, Diastolic murmur, Echo
Tx: Long term ABs, "3 Ds" for CHF

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Cardiomyopathy

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Cardiomyopathy Mk 51; M8k 89; I2M 102; IM-WW 158; 5min 416; H-T/M 145; SAP 464; H3B 103; H2B 109; H-Pic 98; E-hb 411; C11T 652, 749, 773, 799; E 995; H-F 146; Sx-S 882; X-T 314, 347; X-RP 129; Pa-T 193; NB 3.39 ***	• **1° myocardial diz of unknown or obscure cause** • **#1 cardiac diz of cats** • Examples - 1° (idiopathic) cardiomyopathy . **Dilated congestive cardiomyopathy (DCM)** .. Dog > cat ..**Systolic contractile problem** . **Hypertrophic cardiomyopathy (HCM)** .. Cats >> dog .. **Diastolic filling problem** . **Restrictive cardiomyopathy (RCM)** .. Cats .. Diastolic filling problem - 2° dilated cardiomyopathy . Toxins (e.g., doxorubicin) . Infections (e.g., canine parvovirus) . Inflammation (e.g., physical agents)	• **Sudden death** • **Left sided heart failure** - Cough, tachypnea, orthopnea, dyspnea - Fainting (syncope) - Tiring (exercise intolerance) • **Right sided heart failure** - Abdominal distention - Venous distention - SQ edema • **Nonspecific CS** - Lethargy, depression - Anorexia & weight loss • Collapse • **Sequelae:** - CHF (cong. heart failure) - Cardiac arrhythmias - Sudden death - Systemic embolism (cat)	• **Hx (species, breed), CS** • **PE** - Femoral pulse • **Auscultation** - Murmurs - Pulse deficit - Arrhythmias • **ECG** - Chamber enlargement - Arrhythmias • **Echocardiography** (US) (definitive) - HCM (Cat > dog) . Thick LV wall . Small chamber . ↑ Contractility, moderate to marked ↑ in fractional shortening - RCM (cat) . Normal LV wall . Normal chamber . Normal contractility - DCM . Thin wall . Large ventricle . Weak contractions: moderate to marked ↓ in fractional shortening • **Radiology:** - Cat: not definitive - Chamber enlargements • Angiography (differentiates forms)	• **Effective Tx requires accurate diagnosis** • **For all forms** - **Rest** (exercise restriction) for all - **Diuretics** (furosemide) for all forms - **Dietary sodium restriction** for all - ± Antiarrhythmics if indicated • **HCM & RCM** - **Diltiazem** to relax ventricles - **Enalapril** (Enacard®) to ↓ resistance (afterload) & Na retention (preload) - No digoxin: not a contractile problem • **DCM: digoxin** to ↑ contraction strength, slow rate if supraventricular tachycardia (tachyarrhythmia, & ↑ stroke volume & cardiac efficiency (CO) **Cat:** give all **taurine** supplementation **Prognosis:** • **Guarded at best**

3 Forms - DCM, HCM, RCM
Dog: Dilated #1
Cat: Hypertrophic #1
CS: Dyspnea, weakness
Dx: Hx, CS, PE, Rads, US
Tx: Correct Dx needed

Feline CM, Cardiomyopathies

M8k 8, 51; H-T/M 171; SAP 464; H3B 105; H2B 114; 5min 416; E-hb 414; Cat 712; I2M 117; IM 97; IM-WW 161; C11T 652; E 1014; H-F 435; Sx-S 882; Pa-T 194, 652; X-T 347; NB 3.40

***

• **1° myocardial diz of unknown or obscure cause**
• **#1 cardiac diz of cats**
• Forms
- 1° (idiopathic) cardiomyopathy
. **Dilated congestive CM**
.. Taurine deficiency
. **Hypertrophic CM (HCM)**
.. Most common form
. **Restrictive CM (RCM)**
- 2° dilated cardiomyopathy
. Toxins (e.g., doxorubicin)
. Infections
. Inflammation (e.g., physical agents)
. Idiopathic

• **Left-sided heart failure**
- Respiratory CS
- Fainting (syncope)
- Tiring (exercise intolerance)
• **Right-sided failure**
- Abdominal distention
- Venous distention
- SQ edema
• Nonspecific CS
- Lethargy, depression
- Anorexia & weight loss
• Collapse, sudden death
• Cough rare in cats w/ CHF

• **Sequelae:**
- Heart failure
- Cardiac arrhythmias
- **Systemic embolism**
. Hindlimb paralysis

• **Hx (diet), CS**
• **PE**: pulse, jugular pulse, apical beat
• **Auscultation**
• Radiology: not definitive for form because of overlap in findings
• ECG
• **Echocardiography - definitive**
• Angiography (differentiates forms): use if echo not available

• Effective Tx requires accurate diagnosis
• Cage rest, avoid excessive handling dyspnic cat
• **Lasix®** for all (pulmonary edema & pleural effusions)
• **Taurine** to all (in case it's DCM)
• ± **Vasodilator (enalapril)** to all (↓ water retention)
• ± **Aspirin** to all (↓ emboli)
• **Digoxin** for DCM, not for HCM or RCM, ↑ contractions (emptying) & stroke volume (CO)
• **Diltiazem** (Cardizem®) for HCM/RCM, not for DCM
. Relaxes stiff ventricle to allow better filling & ↑ stroke volume

Hypertrophic #1; Idiopathic
CS: CHF
Dx: Hx, CS, Rads, ECG, Echo
Tx: Lasix, Taurine, Enalapril, Aspirin

Differentiating Forms of Cardiomyopathy

	Hypertrophic CM	Restrictive CM	Dilated CM
Cause	?	?	? - **Taurine deficiency**
Pathophysiology	**Diastolic** dysfunction (Filling defect - pressure)	**Diastolic** dysfunction (Filling defect - pressure)	**Systolic** dysfunction (**Contractile** problem)
Radiology (not definitive)	**Valentine heart**	Enlarged heart	Enlarged heart
US (definitive)	**Thick LV wall** **Small chamber** **↑ Contractility**	Normal wall size Small chamber size Normal contractility	**Thin wall** **Large chambers** **↓ Contractions**
Treatment	**Diltiazem** **Lasix, taurine, enalapril**	**Diltiazem** **Lasix, taurine, enalapril**	**Digoxin** **Lasix, taurine, enalapril**

Canine Cardiomyopathy

Condition	Facts/Cause	Presentation/CS	Diagnosis

Canine dilated (congestive) cardiomyopathy, DCM,

Giant breed cardiomyopathy; Pump failure, Systolic failure

M8k 89; Mk 51; H-T/M 145; H3B 103; H2B 109; 5min 418; SAP 476, E-hb 411; I2M 102; IM 86; IM-WW 158; C12T 785, 799; C11T 773, 780; E 996; H-Pic 98, 4; H-F 146, 467; Sx-S 885; X-T 347, 314; X-RP 129; Pys-B 170; Pa-T 194

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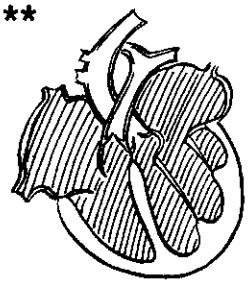
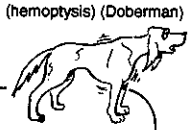


Facts/Cause

- **Cardiac pump failure due to reduced contractility**
- **Large breeds: most Boxers & Dobies**
  - Also: Great Dane, Irish Wolfhound, St. Bernard, G. Shepherd, Bull Mastiff, Newfoundland, Standard poodle
    - Occasionally in smaller breeds: Cocker spaniels, Miniature schnauzer, Bulldogs
  - 4-6 years old (relatively young)
  - Males:females - 4:1
- Atypical forms: Boxer & Doby (see box)
- Pathophysiology:
  - **Systolic dysfunction** ("pump failure")
    - Failure to generate normal **contractile** force & stroke volume
    - **Dilation of all 4 chambers of heart**
    - Lt (mitral) AV valvular regurgitation (Deformation due to dilation)
    - Arrhythmias common (further depress ventricular function)
    - Venous congestion (due to decreased output & hormonal & renal compensation)
    - CHF or sudden death

Presentation/CS

- **Sudden death** (boxer & doby)
- **Usually acute CS**
- Left-sided heart failure
  - **Labored breathing** (dyspnea)
    - Tachypnea, orthopnea (dyspnea unless standing)
  - **Cough** ("gagging")
  - **Fainting** (syncope)
  - **Tiring** (exercise intolerance)
- Right-sided heart failure
  - **Abdominal distention** (ascites)
  - **Jugular pulse**
  - SQ edema
- Chest wall heave
- Nonspecific CS
  - Lethargy, depression
  - Anorexia & weight loss
- Poor hair coat
- Collapse
- Sudden death
- ± Spitting blood (hemoptysis) (Doberman)



Diagnosis

- **Hx (breed), CS**
- Physical exam:
  - **Pale, muddy-colored mucosa**
  - **Prolonged capillary refill time**
  - **Weak, rapid, variable pulse** (hypokinetic) often w/ pulse deficits
  - Pronounced & variable apical beat
- Auscultation:
  - **Systolic AV (lt or rt) murmur** (low 5th ICS) low to moderate
  - **Rapid irregular HR** (tachycardia), S3 gallop rhythm, often sounds like tennis shoes in a clothes dryer
  - Pulse deficit - often < 70% of heart rate, Soft first sound (S1)
  - Inspiratory crackles, muffled heart sounds (edema)
- ECG: may be normal
  - LAE - P mitrale (wide P waves), atrial dilation
  - LVE (tall R waves in lead II, wide QRS, S-T segment slurring)
    - Severe pericardial or pleural effusions - small R waves
  - **Tachycardia: atrial fibrillation (f waves - no P waves)** or atrial or sinus tachycardia, ventricular tachycardia, VPCs

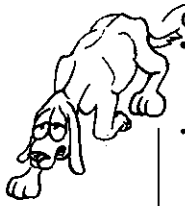
- **Radiology:**
  - **Huge, round heart** (elevated trachea, incr. sternal & diaphragmatic contact, rounding of borders)
  - **Pulmonary edema + pleural effusion:** perihilar or diffuse alveolar (air bronchograms) & interstitial pattern (incr. opacity)
    - Obscured heart silhouette, Pulmonary veins > arteries
  - ± Hepatosplenomegaly, ± Ascites (hazy abdomen)

- **Echocardiogram (US) - definitive**
  - **Thin-walled dilated lt atria & ventricle**
  - **Markedly decreased contractility**
  - Mitral insufficiency (MI)

- Laboratory - usually nonspecific
  - Prerenal azotemia (25% of cases) - ↓ renal perfusion
  - Elevated serum ALT (SGT)
  - Decreased serum protein (hypoproteinemia) (25% of cases)
  - Low taurine in some Amer. cocker spaniels
  - Pleural effusions & acidic fluid - modified transudates
  - ± Hypothyroidism

Contractile systolic dysfunction
Boxers, Dobies & Large breeds
CS: Acute - Resp., Congestion, Sudden death
Dx: Hx, CS, PE, ECG (A fib), Rads, US
Tx: 3 Ds + Digoxin, Rest, Antiarrhythmics

DDx:
- Lt AV &/or rt AV regurgitation
- Myocarditis
- Pericarditis
- Chronic valvular diz
- Heartworm diz
- Cardiac tumor
- Bacterial endocarditis

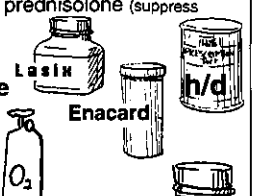


Causes cardiomyopathy:
- **1° cardiomyopathy: unknown** cause (idiopathic) - most cases
  - Hereditary? Hypothyroidism? Carnitine or Taurine deficiency? Virus damage?
- 2° cardiomyopathy
  - Toxins
    - Doxorubicin: Antineoplastic agent
    - Ethyl alcohol (esp. if given IV for ethylene glycol intoxication)
    - Others: cobalt, plant toxins (taxus, foxglove, black locust, buttercups, gossypol)
    - Anesthetic drugs
  - Carnitine-linked defect
  - Acute myocardial infarction (rare)
    - Septic, neoplastic or Thromboembolic dizs
  - Hypothyroidism
  - Pheochromocytoma
  - Diabetes mellitus
  - Muscular dystrophy (Springer spaniels)
  - Cardiac tumors
  - Traumatic myocarditis
  - Brain injury ("brain-heart" syndrome)
  - Infections
    - Canine parvovirus (rare now)
    - Bacterial
    - Lyme diz
    - *Trypanosoma cruzi, T. gondii, Neosporum caninum, Hepatozoon canis*
  - Fungi, rickettsiae & algae-like organisms (rare)

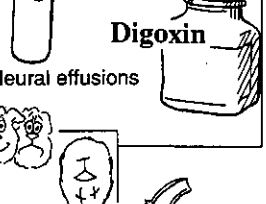
Atypical forms
- **Boxer cardiomyopathy**:
  - Older male Boxers (8.5 years old), familial?
  - More extensive histological changes to myocardium (diffuse, severe myofibril necrosis, degeneration & fibrosis ± mononuclear cell infiltration)
  - Left heart dilation is mild to moderate
  - **Severe ventricular arrhythmias**
  - CS - 3 categories
    - 1. Asymptomatic w/ arrhythmias
    - 2. Fainting & weakness w/o CHF
    - 3. CHF + arrhythmias
- **Doberman cardiomyopathy** H-F 799
  - Similar to others except:
    - **Higher prevalence for ventricular arrhythmias**

TREATMENT: 3 "Ds" + rest + digoxin + antiarrhythmics
- **3 "Ds" + rest**
  - **Exercise restriction**
  - **Diet: low sodium**
  - **Diuretics** (furosemide [Lasix®]) ↓ work load (volume)
  - ± (Vaso)dilators (enalapril [Enacard®]) to ↓ water retention

- ± Calcium channel blockers (diltiazem [Cardizem®]): ↓ heart rate & myocardial oxygen demand (debt)
- **Positive inotropes: strengthen contractions**
  - **Digoxin**, Digitoxin, Dobutamine (not in atrial fibrillation), Amrinone
    - NOTE: Dobermans sensitive to "digitalis" - use lower doses & monitor serum levels frequently until stabilized
- **Antiarrhythmic drugs** (digoxin, quinidine, procainamide, lidocaine, toxainide?, beta-blockers [propranolol], calcium channel blockers [diltiazem])
  - Boxer w/ refractory arrhythmias - prednisolone (suppress inflammation)
- ± Bronchodilators (aminophylline)
- ± Carnitine



Acute, critical cases - stabilize
- IV, IM furosemide (Lasix®)
- Nitroglycerin ointment
- Aminophylline IM
- Oxygen (40-50%)
- Cage rest
- ± Morphine
- Thoracocentesis if indicated by pleural effusions



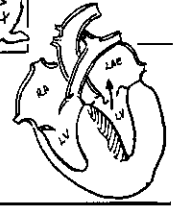
Intractable CHF - euthanasia

Prognosis:
- **Guarded for 6 months to 2 years**
- **Grave** for long term survival
  - Especially poor in Dobermans

Canine hypertrophic cardiomyopathy, HCM *

Mk 51; H-T/M 167; H2B 113; E-hb 413; IM 92; H-F 482; E 1002; Sx-S 885; Pa-T 194

- **More common in cat**, rare in dog, hypertrophy of ventricular septum, **Cause: ?**; Diastolic **filling dysfunction (not a contractile problem)** (stiff ventricle)
- CS: **Often none: usually sudden unexplained death**, coughing, dyspnea, weakness, collapse, fainting
- Dx: Hx, CS, weak femoral pulse, pallor; systolic murmur; ECG: **AV block**, ventricular hypertrophy; Rads: alveolar pattern; US: thick septum, LAE
- DDx: Mitral regurgitation, subaortic stenosis ↓ hypertensive renal diz, thyrotoxicosis, pheochromocytoma
- Tx: Lasix®, rest, **propranolol** (Inderal®), Diltiazem, ± Vasodilator
- Px: **Guarded**; sudden death



Feline Cardiomyopathies

Condition	Facts/Cause	Presentation/CS	Diagnosis

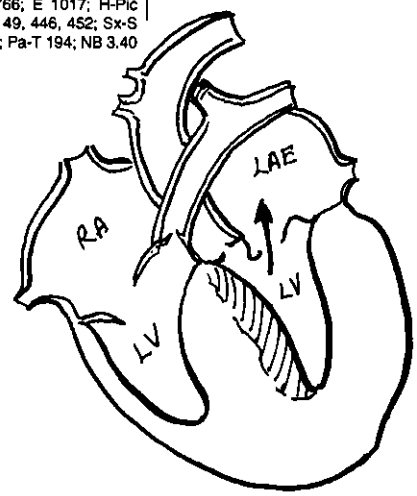
Feline hypertrophic cardiomyopathy, HCM, Idiopathic cardiomyopathy, CM

M8k 90; Mk 8, 51; I2M 117; IM 99; IM-WW 162; H-T/M 182; H3B 107; H2B 114; 5min 420; SAP 465; E-hb 415; Cat 889, 712; C12T 786, 854; C11T 766; E 1017; H-Pic 105, 5; H-F 149, 446, 452; Sx-S 883; X-T 347; Pa-T 194; NB 3.40

***

Facts/Cause

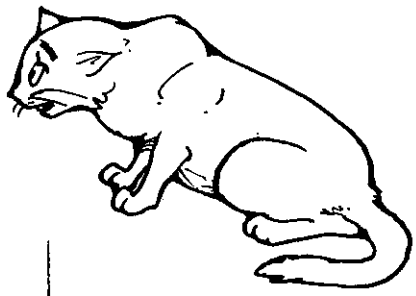
- **Hypertrophy of left ventricle**
- 6-9 years (6 mos -13 years), male
- Persians
- **Cause: unknown (idiopathic)**
  - Hyperthyroidism?
  - Congenital subaortic stenosis?



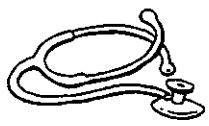
Presentation/CS

- Similar to DCM
- **CHF** (cong. heart failure)
  - Labored breathing (pulmonary edema or effusion)
  - Rapid respiratory rate (tachypnea) > 40/min
  - Sternal recumbency
  - Open mouth breathing
  - Cyanosis
  - Fainting (syncope)
- Lethargy, weakness, depression
- Anorexia, ± vomiting
- ± Jugular pulse
- Some asymptomatic

- Sequela:
  - **Aortic embolism**
    - . Hindlimb paralysis
    - . Relentless crying

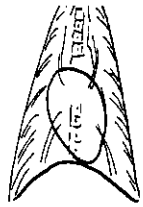


Diagnosis



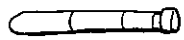
- **Hx, CS** (acute dyspnea + cyanosis)
- Physical exam
  - Subnormal temp (< 100° F)
  - Pale mucous membranes
  - **Weak pulse**, absent if emboli
- Auscultation:
  - **Systolic murmur**
    - . Lt (mitral) AV regurgitation or subaortic stenosis
  - Pulmonary crackles
  - **Gallop rhythm (atrial gallops, S4)**
  - **Tachycardia**
  - Harsh bronchovesicular sounds

- ECG: may be normal
  - LVE: Lt axis deviation, tall R waves in lead II
  - **Sinus tachycardia**, atrial fibrillation, deep S waves
  - P - mitrale (wide P) - RAE
- **Radiology**: can't DDx different forms
  - LAE - **"valentine heart"** (DV view)
    - . Elev. trachea, round heart silhouette (lat.)
  - Lt atrial bulge - 1-3 o'clock
  - Elongated heart
  - **Pulmonary edema** (mottled lung pattern)
  - **± Pleural effusion**



- Angiography - definitive
  - Small LV lumen, thick wall
  - Dilated atria, normal or enlarged aorta

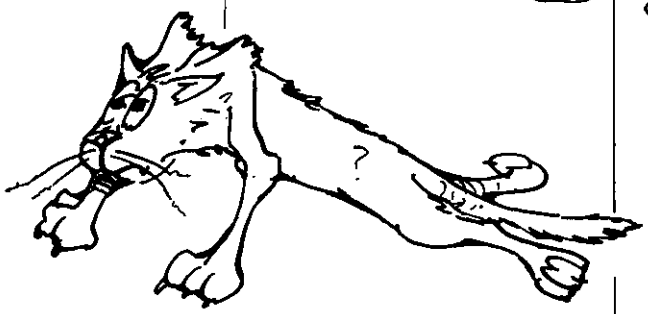
- **Echocardiogram (US):**
  - **Thickened lt ventricle free wall & septum**
  - **↓Ventricular volume**



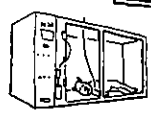
- Laboratory: variable
  - ± Azotemia
  - Test T4 levels to R/O hyperthyroidism
  - Urine analysis: protein

- Pathophysiology:
  - **Not a contractile dysfunction!**
  - **Diastolic filling dysfunction** (high pressure filling)
    - . Small LV chamber size
    - . Stiff, nondistensible ventricular wall (unrelaxed)
      - .. Possible outflow obstruction if septal wall thicker than LV wall (asymmetrical) - functional subaortic stenosis
    - . CO (cardiac output) compensation
      - .. ↑HR, contractile strength
    - . Lt (mitral) AV regurgitation
    - . Atrial dilation & hypertrophy leads to:
    - . **Pulmonary hypertension, edema & pleural effusion**
    - . Tachycardia
  - All leading to CHF
    - Thrombi may form in left atria

DDx:
- Hyperthyroidism
- Systemic hypertension
- Acromegaly
- Congenital aortic stenosis



Treatment:



- **Acutely symptomatic patient w/ CHF**
  - **Avoid stress** (± acetylpromazine [Acepromazine®] caution)
  - **Cage rest**/confinement
  - **Oxygen** (40-60%)
  - **Furosemide (Lasix®)** (resolve pulmonary edema & CHF)
  - **Thoracocentesis:** significant pleural effusion (21-23 g butterfly needle in each hemithorax)
  - Warm environment (prevent heat loss)
  - **Diltiazem (Cardizem®) relaxes heart & slows rate**
  - Fluids after edema controlled or effusion aspirated

- **Tx thromboembolism**

- **Long term therapy** (after acute CHF controlled): 3 Ds + rest
  - Diuretic: Furosemide (Lasix®) titrate to PO small dose 2-3/week
    - . Prevent recurrent pulmonary edema & pleural effusion
  - Diet: low sodium (Hill's h/d diet)

  - Dilator: enalapril (Enacard®) (ACE inhibitor) ↓water retention & a vasodilator

  - **Aspirin** (1 baby aspirin every 3 days)

  - **Diltiazem** (Cardizem®) (Ca channel blocker) or
  - **Propranolol** (Inderal®) (beta-adrenergic blocker) slows heart rate to 130-150 bpm

- **Digitalis not indicated** - may worsen condition
- Periodic thoracocentesis w/ refractory pleural effusions
- **Antiarrhythmics** as needed (propranolol)
- **Taurine**

Prognosis:
- **Guarded**: sudden death may occur
  - Many can live more than 2 years
- Poor: pleural effusion & atrial fibrillation

#1 feline CM, Diastolic filling problem
CS: CHF, Dyspnea, Embolism
Dx: CS, PE, "Valentine", Echo
Tx: Lasix®, Diltiazem; O_2, Aspirin, Enalapril; Not digoxin

Feline Cardiomyopathies

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Restrictive cardiomyopathy; RCM,

Intermediate cardiomyopathy, Intergrade cardiomyopathy

Mk 8; H-T/M 190; H3B 108; H2B 114; 5min 424; SAP 472; I2M 123; IM 103; IM-WW 158, 164; F3IM 286; C12T 843, 863; E-hb 416; E 1020; Cat 903, 720; H-Pic 111; H-F 450, 453; X-T 347; Pa-T 194; NB 3.40

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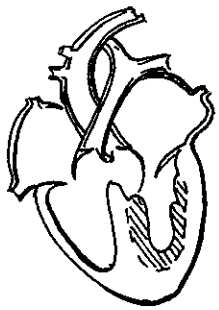
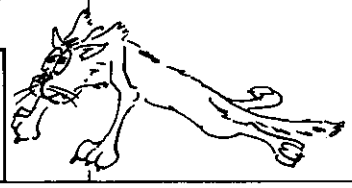


Rare, Diastolic filling dysfunction (stiff)
CS: Same as HDM, CDM - Milder
Dx: US
Tx: Same as HDM

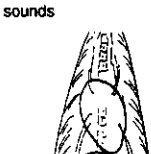
- Least common type of cardiomyopathy
- Reported in **cats**
  - 6 to 8 year old males
- Difficult to distinguish from HCM or DCM
- Cause: unknown
- Pathogenesis:
  - **Endocardial fibrosis/thickening** = ↑ LV stiffness
  - Excessive moderator bands bridging LV
  - **Diastolic dysfunction** (high filling pressure) = **Pulmonary edema**

- **Similar to but less severe than DCM or HCM**
- Acute onset
- Lethargy, Anorexia
- **Acute heart failure**
  - Acute dyspnea
  - Labored breathing (pulmonary edema or effusion)
  - Fast breathing (tachypnea) (> 40/min)
- Lethargy, weakness, depression
- ± Vomiting

- Sequela:
  - Aortic embolism
    . Hindlimb pain or paralysis



- Physical exam:
  - **Less severe signs than DCM or HCM**
  - Subnormal temp (< 100° F)
  - Pale mucous membranes
  - Weak femoral pulses
- Auscultation:
  - Lung sound often muffled
  - **50% murmurs** (systolic) - difficult to localize
  - **Gallop rhythm** (S3) hard to hear because of fast rhythm
  - Harsh bronchovesicular sounds



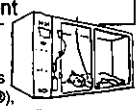
- Radiology:
  - Generalized cardiomegaly
  - **LA often enormous**
  - Nonselective angiography (after cat stabilized)
    . Dilated RV & RA, LA lumen very irregular w/ **filling defects** (large papillary muscles)

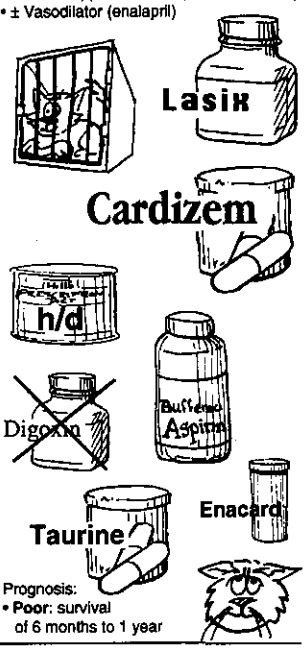
- **Echocardiogram - definitive**
  - Enlarged RV, RA & LA
  - LV slightly dilated - rigid w/ papillary muscle projecting into chamber
  - **Prominent moderator bands**

- ECG:
  - **LAE - P mitrale (wide P waves)**
  - LVE - tall R waves or wide QRSs
  - **LAE**, LVE, ventricular or supraventricular arrhythmias

- Supplementation w/ taurine doesn't reverse disorder

- **O2 cage therapy**
- **Enforced cage rest**
- **Diuretics** - high doses
- **Diltiazem** (Cardizem®), relaxes ventricle for better filling
- **Digoxin not indicated**
- Aspirin
- h/d Diet, sodium restriction
- Taurine supplementation (in case it is DCM)
- ± Vasodilator (enalapril)





Prognosis:
- **Poor**: survival of 6 months to 1 year

Feline dilated congestive cardiomyopathy, DCM,

Flabby heart

M8k 89; Mk 51, 8; I2M 125; IM-WW 161; H-T/M 188, 197; H3B 105; H2B 109; 5min 416, 1093; SAP 469, E-hb 414; Cat 883, 705, 151; NB 3.40; C10T 251; E 1013; H-Pic 98; H-F 437, 451; Sx-S 883; X-T 347, 314; Pa-T 194

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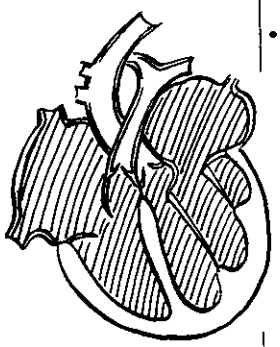
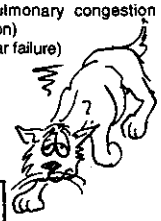
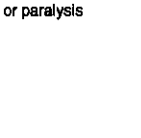


"Flabby" - Taurine, ↓Contractility
CS: CHF - Dyspnea
Dx: CS, PE, "Globular heart", US
Tx: Lasix, Taurine, Digoxin

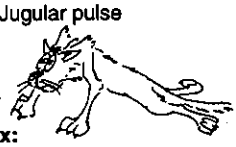
- **"Flabby heart"/pump failure in taurine deficient cats**
  - Taurine link discovered in 1987, most diets not defc now, but still occurs
- Cardiac pump failure w/ dilation of all chambers as a result of weakening & thinning
- Cats: Young to middle aged
  - Breeds: Siamese, Abyssinian, Burmese
  - Dogs readily synthesize taurine
  - Cats can't synthesize appreciable amounts of taurine due to low levels of the enzyme CSA decarboxylase
- Cause:
  - **Taurine deficiency in most (reversible)**
    . Single commercial diet, "off-brand" diet
    . Feeding only turkey, chicken, etc.
  - Idiopathic in some
- Pathophysiology:
  - **Poor contractility**
    . **Systolic dysfunction**
    . Dilation - weakening & thinning
  - Decreased CO (cardiac output)
  - Compensation - dilation, water & Na+ retention (renal, hormonal)
  - AV (mitral & tricuspid) regurgitation/insufficiency
  - Systemic & pulmonary congestion (edema & effusion)
  - CHF (biventricular failure)



- **Labored breathing** (pulmonary edema or effusion)
  - ↑ RR (tachypnea) (> 40/min)
- Lethargy, **weakness**, depression
- ± Vomiting
- Anorexia
- Jugular distention
- Some asymptomatic



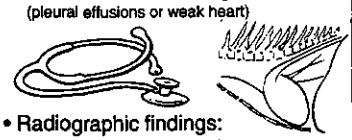
- Sequela:
  - **Aortic thromboembolism**
    . Paralysis of rear or front limbs
  - CHF
    . Jugular pulse



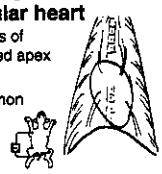
DDx:
- Congenital heart diz
- Diaphragmatic hernia
- Pneumothorax
- Pleural diz
- Thoracic neoplasia
- Pulmonary parenchymal diz (pneumonia, bronchitis, pulmonary infiltrate w/ eosinophilia)
- Musculoskeletal diz
- Neurological dizs

- Hx (Taurine defc), CS

- Physical exam:
  - Subnormal temp (< 100° F)
  - Pale mucous membranes
  - Weak femoral pulse, absent if embolus
  - Hyperreflective retinal areas
- Auscultation:
  - **50% Murmurs** (systolic, blowing, decrescendo)
    . AV (mitral &/or tricuspid murmur)
  - **Diastolic gallop rhythm** (S3) hard to hear due to fast HR
  - Harsh bronchovesicular sounds
  - Crackles (pulmonary edema)
  - ± Muffled heart & lung sounds (pleural effusions or weak heart)

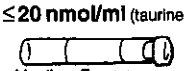


- Radiographic findings:
  - **Enlarged, globular heart**
    . Elevated trachea, loss of cardiac waist, rounded apex
  - Pleural effusion (pseudochylous) common
  - ± Ascites
  - ± Hepatomegaly

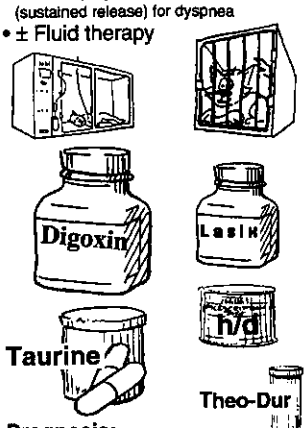


- ECG:
  - Variable rhythm: normal sinus rhythm, bradycardia, tachyarrhythmias or VPCs (?)
- **Echocardiography (US)** - **definitive**
  - **Dilated, thin ventricles**
  - **Poor contractility**

- Laboratory:
  - **Taurine level ≤ 20 nmol/ml** (taurine defc)
  - Prerenal azotemia
  - Measure T4 in cats older than 7 years



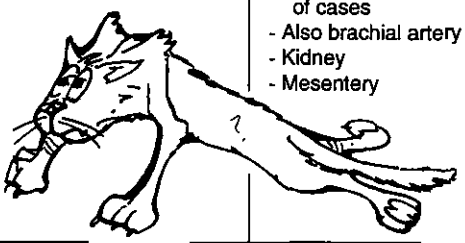
- O2 cage therapy (40-60%)
- Enforced cage rest
- **Diuretic (furosemide** [Lasix®])
- **Diet** - h/d diet - taurine
- **Digoxin**, dobutamine (positive contractility/inotrope)
- **Taurine** for all cardiomyopathies for 12 weeks
  - Health food stores carry capsules
- **B blockers not indicated (bradycardia)**
- Thoracocentesis if large pleural effusions
- Aminophylline or theophylline (sustained release) for dyspnea
- ± Fluid therapy



Prognosis:
- **Poor**: Long-term prognosis < 1 month generally
- Good if due to taurine deficiencies
- Thromboembolism - grave

Thromboembolism — CIRCULATORY SYSTEM

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Thrombo-embolism, TE, Saddle embolus, Aortic thrombo-embolism M8k 99; Mk 84; H2B 114; SAP 473; E-hb 417; I2M 128; IM 103; IM-WW 199; 5min 350; T-HB 45; Cat 920; C12T 857, 866; E 1026; H-Pic 133; H-F 454; Sx-WW 97; Pa-T 202, 195; NB 3.40 **	• Obstruction of vessel w/ emboli carried in blood • Causes: - **Feline cardiomyopathy** (all forms, hypertrophic most common) . Originates from aorta or lt atrium . Intracardiac thrombus formation in lt auricule between pectinate muscles . Focal endocardial inflammation - nidus for platelets & static blood flow (hypercoagulable state) - Bacterial endocarditis (dog) . Originate from valvular vegetations - Complication of heartworm diz & treatment • Embolize to various sites - **#1 - Terminal aorta** at bifurcation of iliac arteries . **"Saddle thrombus"** - 90% of cases - Also brachial artery - Kidney - Mesentery	• CHF if part of cardiomyopathy - Dyspnea - Weakness • Widely different CS depending on site of embolization • **Terminal aorta** - **Paralysis of hindlimbs** (lower motor neuron) . **Dragging hindlimbs** (can't flex or extend hocks) . **Intermittent lameness** (claudication = lameness) - **Relentless crying** • Brachial artery - Monoparesis of front limb • Renal: renal failure • Mesentery: colic (gut ischemia) - Death • Sequelae: - DIC (disseminated intravascular coagulopathy)	• **Hx (cardiomyopathy)** • **Physical signs** - **Saddle thrombus** . Pallor of affected paws . Paresthesia . Cyanotic nail beds . Absence of femoral pulse . Cold extremities • Auscultation: - Murmur or gallop rhythm: 50% • ECG: - Supraventricular arrhythmia - LAE, LVE • Radiographs: - Cardiomegaly (LAE, LVE) - Pulmonary edema & pleural effusions • Echocardiography (US) - Chamber enlargement - Intracardiac thrombi if present • Laboratory: - **Elevated skeletal muscle enzymes** - ±LDH, CPK & SGOT (widespread cellular damage) - Dehydrated - Coagulation profiles - DIC • Urinalysis (UA) - ± Hemorrhage (renal infarcts) • Angiography can locate site(s), but not needed & dangerous	• **Manage CHF** • **Analgesics for pain** - Butorphanol (Torbugesic®), buprenorphine (Buprinex®) • Antiplatelet aggregating drugs - **Aspirin** (PO every 3 days indefinitely) or dipyrimadole, sulfinpyrazone • Heparin to prolong clotting time 2-3 x • Acepromazine (collateral vasodilation) for up to 4 weeks • Treat underlying cause: cardio-myopathy or bacterial endocarditis - Digoxin, enalapril, salt restriction, Taurine supplementation - Propranolol contraindicated (peripheral resistance) - **Furosemide** as for HCM & DCM - ± Thoracocentesis - Refractory cases add diltiazem • ± Fluids when CHF controlled • Thrombolytic therapy: cost prohibitive - Streptokinase (human hospital??) - Tissue plasminogen activator (t-PA) (too $$$) - For cats w/ symptoms for less than 12 hours - Dissolves clot - **Danger of bleeding & hyperkalemia** • Surgical removal of clot - rarely done • **Euthanasia** **Prognosis:** • **Guarded:** Majority incur other thrombi - Motor function may return in 10-14 days, & survival of 4 years has been recorded • Grave: significant emboli to kidney, intestines or other organs



Sequela to CM, Saddle thrombus
CS: Hindlimb paralysis
Dx: Hx, CS, Muscle enzymes
Tx: Analgesic, Aspirin, CM Tx

DDx:
- Bacterial endocarditis
- Posterior paresis
  - Trauma
  - Intervertebral disc diz
  - Spinal lymphosarcoma
  - Fibrocartilaginous infarction
  - Myasthenia gravis
  - Diabetic neuropathy

CM - Atrial fibrillation

SAP 474
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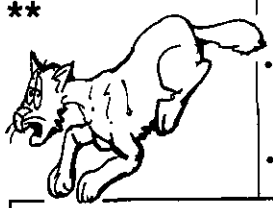


- Rapid, disorganized depolorization of atria + irregular AV conduction
- **More common w/ hypertrophic & restrictive forms of CM (cardiomyopathy)**
- Pathophysiology:
  - Disastrous to cats w/ **stiff ventricles**
    . Contributes to filling problem
- Paroxysmal (recurring)

- CS of HCM or RCM
  - **Labored breathing**
  - **Weakness**

- Hx, CS
- Auscultation
  - **Fast heart rate**
- ECG:
  - **"f waves"** (no P waves)
  - Normal QRS complexes
  - **Rapid irregular ventricular rate (> 320/min)**
  - Absolute irregularity of RR interval

- Initial Tx of
  - **Diltiazem (Cardizem®)**
    . Ca channel blocker

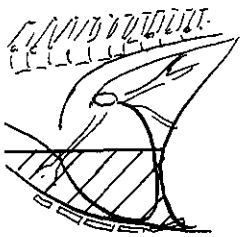
- Persistence:
  - **Digoxin + diltiazem** (Cardizem®)
    . Goal: ventricular rate < 200/min
- ± Thoracocentesis if pleural effusion develops

Prognosis: poor to guarded

Sequelae to Hypertrophic cardiomyopathy in cat
F waves - Tx: Enacard

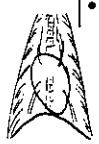
CM - Pleural effusion

SAP 475; X-RP 109; H2B 218; 5min 946
**

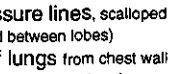


- **Escape of fluid into pleural cavity**
- Cause: ↑ Hydrostatic **pressure** in blood vessels & lymphatics draining pleural cavity
  . Biventricular CHF
  . End-stage CHF of lt-sided heart failure
  - Chylothorax not uncommon 2° to CHF, Cause unknown, may be associated w/ pleural effusion
- Pleura: serosa lining pulmonary cavities (2)
  - Visceral pleura covers lungs, supplied by pulmonary circulation
  - Parietal pleura: covers walls mediastinum & diaphragm of thoracic cavities, supplied by systemic circulation

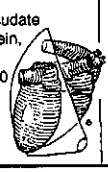
- Signs of cardiomyopathy
  - **Dyspnea** (restrictive breathing pattern - rapid & shallow)
  - Open mouth breathing
  - Orthopnea (difficult breathing unless upright)
  - Coughing
  - **Cyanosis** (bluish color)



- Hx, Clinical sign
- Physical exam:
  - ↓ Compressibility of cranial chest



- **Auscultation**
  - Muffled heart & ventral lung
  - Murmurs 50%
  - ↑ Bronchovesicular sounds in dor. lung
- **Radiology:**
  - Interlobar fissure lines, scalloped appearance (fluid between lobes)
  - Retraction of lungs from chest wall
  - **Blurring of cardiac shadow** (increased radiopacity)
  - Blunting of costodiaphragmatic angle (DV)
  - Widening of mediastinum (DV)
- **Thoracocentesis:**
  - Transudate to modified transudate
    . Transudate: < 1.5 g/dl protein, < 1000 cells/µl
    . Modified transudate: 1.5-3.0 g/dl, 1000-5000 cells/µl
- Ultrasound (US)



- **Thoracocentesis** for moderate to severe effusions
- **Furosemide** (Lasix®) maximize effect
  - Consider SQ injection by client QID
- **Enalapril** (Enacard®) ↓ water retention
- HCM & RCM - diltiazem (Cardizem®) improve diastole filling
- ± Digoxin - dilative CM
- Control atrial fibrillation if supervenes
- Sodium restricted diet (Hill's h/d)

Prognosis: guarded depending on response to treatment

CS: Dyspnea
Dx: Rads, Echo, Centesis
Tx: Lasix, Enalapril

Pericardial Disease

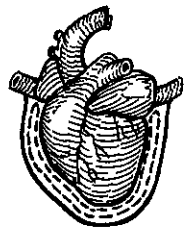
Pericardial diz **

Mk 52; H3B 113; H-T/M 259; SAP 481; IM 141; IM-WW 181; 5min 727; Cat 913; C12T 879, 267; C11T 658, 816; E-hb 418; E 1033; H-Pic 123; H-F 495, Sx-S 886; Sx4B 671; Sx-B 522; X-T 314; X-RP 131

- **Dog: asymptomatic or a cause of right-sided heart failure**
- **Cat: rare condition**
- Causes: acquired in dog usually
  - . #1 Pericardial effusions - dog
  - . Peritoneopericardial hernia
  - . Other acquired or congenital defects uncommon in dog
- Pericardial diz uncommon in cat

Types of pericardial diz
- Pericardial effusion
- Constrictive pericardial diz
- Pericardial mass lesion
- Congenital
  - Pericardial cysts
  - Peritoneopericardial hernia
  - Pericardial defects

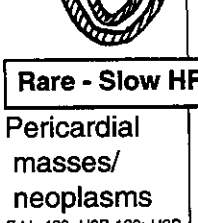
Pericardium: fibrosis sac around the heart
- Fibrous pericardium: layer attached to great vessels
- Serous pericardium: lines fibrous pericardium (parietal layer) & heart (visceral layer or epicardium)
- Pericardial cavity: potential space between layers of serous pericardium
- Protects heart & great vessels
- Contains a little fluid to lubricate heart's movement



Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Peritoneopericardial hernia, Peritoneopericardial diaphragmatic hernia, PPDH, Diaphragmatic peritoneopericardial hernia, DPPH, PDH ** H3B 114; HB 127; 5min 926; SAP 481; E-hb 418; E 1035; I2M 187; I2M 187; IM 146; IM-WW 183; F3IM 271; Cat 913; H-Pic 123; H-F 496; H-T/M 259; Sx-S 877, 913	• Abnormal development - **Communication of pericardial & peritoneal cavities** - Herniation of abdominal organs into pericardial sac - Most diagnosed 1st year or asymptomatic for several years • Rarely causes compressive tamponade or compromises cardiac function • Dogs & cat - Weimareiner • Cause: unknown	• ± **Asymptomatic for years** • **Respiratory** - Labored breathing (dyspnea) - Cough - Restrictive breathing pattern (rapid & shallow) (tachypnea) • **GI signs** - Vomiting - Diarrhea • Colic (liver or small bowel strangulation) • Weight loss • Exertional fatigue, listlessness • Sequelae: - Cardiac tamponade (rare) - Right heart failure - Umbilical or abdominal hernia	• Hx, CS • Physical exam (PE) - Unremarkable, or - Diminished or displaced cardiac sounds - ± Audible systolic murmur (cat) - ± Empty abdomen • **Radiology - confirm** - **Abdominal organs in pericardium** - Gas or fecal filled bowel w/in cardiac shadow - Contrast radiographs - Sternal deformities, no xyphoid process, splitting of last sternebrae • Fluoroscope: diminished heart movement • **Echocardiography (US)**	• **Asymptomatic: may not require Tx** • **Symptomatic** - **Surgery** Prognosis: • **Excellent w/ surgery** **DDx:** • Pericardial effusion • 1° cardiac diz • Traumatic diaphragmatic hernia • Pulmonary diz • GI dizs • Pleural dizs
Partial defects or absence of parietal pericardium Mk 52; SAP 481; H3B 113; H2B 127; IM 147; E 1035; Eo 1135 *			• Rare: incidental finding on necropsy • Clinically insignificant	
Pericardial cysts SAP 481; I2M 189; IM 146; H3B 114; E-hb 419; E 1035; H-F 497; H-T/M 260 *			• Cause: unknown (abnormal mesenchymal tissue development or incarceration of omental tissue from a PDH) • Clinically significant - ± Pericardial effusions • Dx: Echocardiography or pneumopericardiography • Tx: Surgically remove cyst + partial pericardiectomy • Prognosis: good w/ surgery	

Constrictive pericarditis

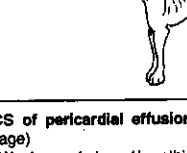
H3B 119; HB 128; E-hb 420; SAP 481; I2M 189; IM 147; IM-WW 183; 5min 927; H-Pic 124; H-F 511; Sx-G 116; Sx4B 676; Sx-B 528; Sx-WW 94 *

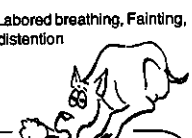


Rare - Slow HF, Sx

- **Pericardial fibrosis w/o effusions**
  - Less common than effusive pericarditis alone
- **Rare in dog, extremely rare in cat**
  - Large middle-aged dogs (G. shepherds)
- Pathophysiology:
  - Thickened visceral (epicardium) or parietal pericardium = Restriction of diastolic filling
  - **Cardiac compression/restriction**
  - ↓ ventricular compliance (**distensibility**) = ↓ filling & ↑ diastolic pressure = ↓ CO (cardiac output) & ↑ atrial & venous pressure
  - CHF (congestive heart failure)
- Effusive-restrictive pericarditis: combination of marked pericardial fibrosis & a small pericardial effusion
- Especially common w/ pericardial infections
- Causes see box:

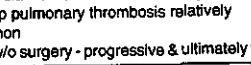
- **Similar to pericardial effusions**
- **Slow onset of HF** (heart failure)
  - Lethargy, fatigue, weakness
  - Labored breathing (dyspnea/tachypnea)
  - Cough
  - Jugular pulse
  - Abdominal enlargement (ascites)
  - Fainting (syncope) on exertion
  - Weight loss
- Fever if infectious





- Diagnosis can be difficult: Hx, CS
- Physical exam:
  - Diminished femoral pulse
  - Distended systemic (jugular) veins
  - Pulse paradoxes
- Auscultation:
  - **Diminished normal heart sounds**
  - **Pericardial friction rub rare**
- ECG:
  - Diminished QRS (75%)
  - P mitrale (wide P waves) (85%) (> 4.5 sec)
  - Atrial arrhythmias (fibrillation)
  - No electrical alternans
- Radiography:
  - Mild to moderate rounding of heart (65%)
  - Distended caudal vena cava (65%)
  - Pleural effusion (65%)
  - Left or right atrial enlargement (30%)
- **Echocardiography**
  - ± **Pericardial thickening**
  - ± **Abnormal septal motion**
  - ± **Effusions**
- Pericardiocentesis & fluid analysis

- **Surgery:**
  - **Subtotal pericardiectomy** (remove pericardium)
    - . CAUTION: Spare phrenic nerve
  - Epicardial stripping if marked epicardial fibrosis

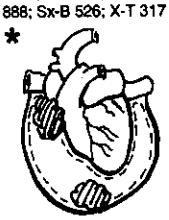


Prognosis
- **Good** w/o marked epicardial fibrosis (75% success rate)
  - Epicardial fibrosis recurs commonly
  - Postop pulmonary thrombosis relatively common
- Grave w/o surgery - progressive & ultimately fatal

Causes:
- **Idiopathic** (most common)
- Infections
  - Bacterial (Actinomycosis)
  - Fungal (Coccidioidomycosis)
- Metallic pericardial foreign bodies
- Neoplasia
  - Heart base tumor
  - Mesothelioma
- Recurrent idiopathic, hemorrhagic pericarditis

Pericardial masses/ neoplasms

E-hb 420; H3B 120; H2B 122, 134; SAP 481; IM 141, 879; C12T 873; E 1036; H-F 153, 515; Sx-S 888; Sx-B 526; X-T 317 *

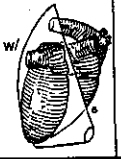


- **Space occupying lesions w/in pericardial sac**
  - Arise from pericardium, myocardium or heart base/great vessels
  - CS & Dx when associated pericardial effusion (hemorrhagic)
- Pathophysiology: (see pericardial effusions)

- **CS of pericardial effusion** (see next page)
  - Weakness, Labored breathing, Fainting, Abdominal distention

Pericardial masses:
- Dog (rare)
  - Hemangiosarcoma (rt atrial origin)
  - Heart base tumor: chemodectoma, thyroid carcinoma
  - Mesothelioma (pericardial serosa)
  - Rare tumors (lymphosarcoma, fibrosarcoma, metastatic tumors, myxosarcoma)
  - Granuloma: Actinomycosis, Coccidiomycosis
  - Abscess
  - Pericardial cyst
- Cat (rare)
  - Lymphosarcoma
  - Mesothelioma
  - Heart base tumor: chemodectoma
  - Metastatic tumors hemangiosarcoma, mammary & pulmonary carcinomas
  - Other neoplastic masses (very rare)

- **Hx, CS, PE, Auscultation - as for pericardial effusions**
- Radiographs:
  - ± Enlargement or distortion of heart shadow
  - Hemangiosarcoma - protrusion of right or cranial border
- Echocardiography (US): most specific (2-D localizes mass if pericardial effusion)
- Pneumopericardiography: if US not available
  - Outlines mass lesion 75% of the time
- Pericardiocentesis:
  - Often fails to distinguish idiopathic hemorrhagic from neoplastic effusions
    - . Neoplastic cells look like reactive mesothelial cells
- Laboratory:
  - Anemia or nucleated RBCs w/ hemangiosarcoma



- **Hemangiosarcoma** - dog
  - Repeated centesis
  - Sx considered for small tumors (poor Px)
- **Heart base tumor**
  - Repeated centesis if surgery refused
  - Resection if accessible
  - Palliative parietal pericardiectomy
- Resection of mass
  - Thoracotomy, pericardiectomy or pericardiectomy
- Chemotherapy: experience limited

Prognosis:
- **Poor**

Pericardial Effusions

Condition	Facts/Cause	Presentation/CS	Diagnosis

Pericardial effusion & tamponade

M8k 91; SAP 481; H3B 115; H2B 128; 5min 924; E-hb 419; I2M 181; IM 141; IM-WW 181; Cat 914; C12T 774, 875; C11T 725; H-Pic 123; E 1036; Sx-S 886, 912; Sx-B 523; Sx-WW 92; Sx4B 671; H-T/M 261; H-F 71, 152, 498; X-T 347, 316

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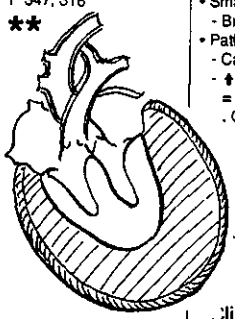


Most common pericardial diz - 90%

End result of all pericardial dizs

Cardiac tamponade: fluid in pericardial cavity interfering w/ rt heart function (at or above rt-side diastolic pressure)

- Uncommon in dog
- Rare in cat
- Clinical significance (cardiac tamponade)
  . Either exudative or hemorrhagic

Large breed male dogs > 6 years of age

- G. Shepherd - hemangiosarcoma & idiopathic hemorrhagic effusion

Small breeds: Dachshund: ruptured rt atria

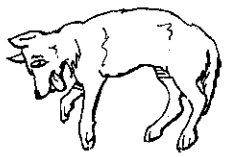
- Brachycephalic: aortic body tumor (chemodectoma)

Pathophysiology:

- Cardiac compression (effusion/tamponade)
- ↑ Pressure within pericardium
  = **↓Diastolic distensibility** (compliance)
  . Can't fill maximally
  = ↓ Cardiac output & ↑ venous pressure
  = Rt & lt side forward heart failure (CO)
  = **Right-sided congestive heart failure**
  = Impaired perfusion of vital organs
  = Cardiogenic shock
- Cardiac systolic dysfunction (rare in pericardial diz)
  . Atrial tear due to lt AV regurgitation
  . Hemangiosarcoma
  . Heart based tumor maybe

Clinical signs depends on volume of fluid formed or how rapidly it forms

- Slower the rate of formation, greater the accumulation



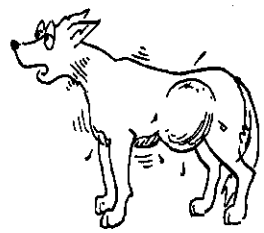
Variable

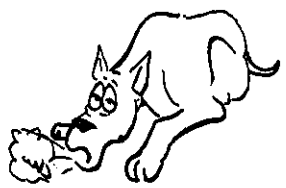
Acute failure & sudden death (rapid accumulation) or

Slow RHF (Rt heart failure)

- Lethargy, fatigue, weakness
- Labored respiration/tachypnea
- Cough
- Jugular pulse/distension
- Abdominal distention (ascites)
- Fainting (syncope) on exertion

Fever if infectious





Hx, CS (labored breathing)

Physical exam:

- **Weak, variable femoral pulse**
- **Distended jugular veins**
- ↑ heart rate
- **Pulse paradoxes** (exaggerated ↑ & ↓ in arterial pressure w/ expiration & inspiration)
- Shock: pallor, slow capillary refill

Auscultation

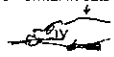
- **Diminished**, but otherwise normal heart sounds
- ± Fast RR (tachypnea), Pericardial friction rub **rare**, ± Arrhythmias

ECG (electrocardiography):

- **Diminished QRS voltages** < 1 mV in all leads (50-60%) dogs, normal in cats
- Nonspecific S-T segment deviation
- **Electrical alternans** (alteration of size of QRS complexes)
- Taller/shorter (50% of dogs) caused by heart swinging in pericardial sac
- ± Arrhythmias (sinus tachycardia)

Radiography:

- **Spherical, large heart** silhouette (tamponade) in dog, m/ be normal in cats
  . Shape more important than size
- Distended caudal vena cava
- Pleural effusion - may have to do thoracocentesis to visualize heart
- Hepatomegaly - ascites



Pneumopericardiography (negative contrast)

Nonselective angiography

Echocardiography (US) - most sensitive technique to detect & evaluate effusions & masses

- **Echo-free space (anechoic or markedly hypoechoic) surrounding all 4 chambers of heart**

Pericardiocentesis & fluid analysis - definitive

- Indicated in all cases of tamponade
- Purulent, serosanguinous, chylous or transudative

Pneumopericardiography if US not available

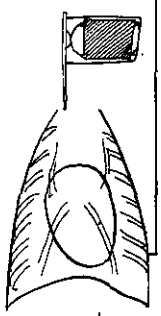
- After fluid removed, replace (1/2-3/4ths) w/ CO_2 or room air
- Radiograph for intrapericardial mass lesions

DDx: Pericardial effusions

- Other causes of RHF (rt heart failure)
  - Dilated cardiomyopathy
  - Valvular diz
  - Cor pulmonale/pulmonary hypertension
    . Chronic heartworm diz
    . Pulmonary thromboembolism
  - Congenital heart diz
    . Tricuspid dysplasia
    . Pulmonic stenosis
    . Atrial or ventricular septal defect
    . Endocardial fibroelastosis
- Other causes of abdominal enlargement
  - Pregnancy
  - Tumors
  - Abdominal effusions
    . Blood: trauma, tumor
    . Transudate: hypoproteinemia, lymphangiectasia
  - Organomegaly: liver, bladder, spleen
  - Gastric distention
  - Obesity
  - Abdominal weakness (age, hyperadrenocorticism
- Diminished heart sounds
  - Barrel chest conformation
  - Obesity
  - Pleural effusions
  - Pneumothorax
  - Thoracic masses
  - Diaphragmatic hernia

Types of pericardial effusions & causes

- Transudate (hydropericardium) - rarely compromises cardiac function
  - Biventricular or right-sided CHF
  - Hypoalbuminemia
  - PPDH (pericardioperitoneal diaphragmatic hernia
- Exudate (pericarditis):
  - Infection - bacterial, fungal
  - Sterile serosanguinous
  - Idiopathic, uremia, other inflammatory dizs
- Hemorrhage (hemopericardium):
  - Neoplasia
  - Trauma - external iatrogenic
  - Cardiac rupture, esp. lt atrial with MI (mitral insufficiency)
  - Idiopathic



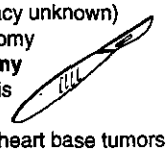
Causes of clinical significance

(cardiac tamponade)

- **Dog**
  - **Idiopathic pericarditis**
  - **Cardiac or extracardiac neoplasms w/ in pericardium**
    . **Hemangiosarcoma**
    . **Heart based tumor**
    . **Mesothelioma**
  - Ruptured left atrium (lt AV regurgitation)
  - Infectious
- **Cat:**
  - **Feline infectious peritonitis**
  - **Bacterial infection**
  - **Neoplasia**

Treatment:

- **Pericardiocentesis** TOC (Tx of choice)
  - Temporary or emergency measure
  - Idiopathic hemorrhagic pericarditis (50% respond)
- **Idiopathic**
  - Pericardiocentesis
  - Broad spectrum antibiotics
  - Steroids if culture negative (efficacy unknown)
  - Refractory - subtotal pericardiectomy
- **Surgery: subtotal pericardiectomy**
  - Idiopathic hemorrhagic pericarditis
  - Constrictive pericarditis
- **Resection**: pericardial masses or heart base tumors
- Tx underlying causes - CHF, infection
- Euthanasia considered for hemangiosarcoma
- Chemotherapy for neoplasia (few cases reported)

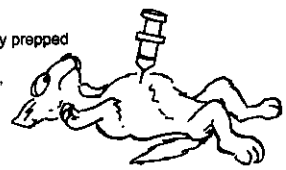


Prognosis:

- **Fair to good**: idiopathic & pericardial cysts w/ Tx
- **Poor to guarded**: infective pericarditis & resectable heart based tumors
- **Grave**: hemangiosarcoma or nonresectable heart based tumors
- Idiopathic: in 50% effusions recur

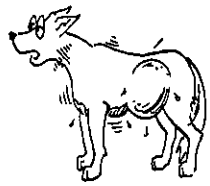
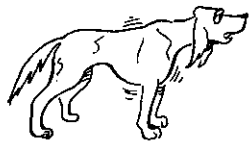
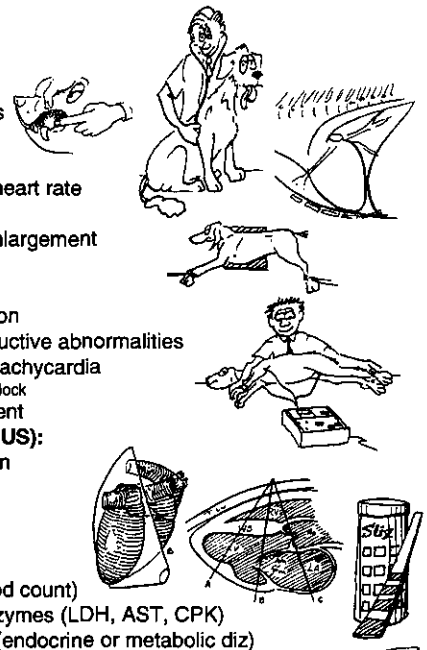
Pericardiocentesis: Sx-B 524, H-F 506

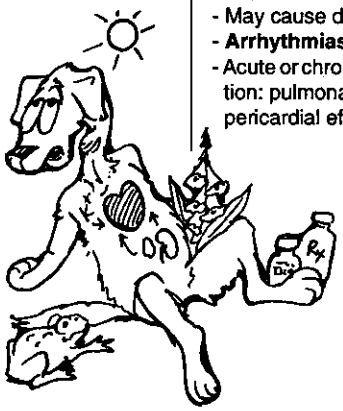
- **14-16 g, 5-6" over-the needle** radiopaque catheter
- Left lateral recumbency w/ ECG machine hooked up
- Right or left 4-5th ICS at costochondral junction, surgically prepped
- Insert needle & slowly advance toward heart
- When fluid is obtained, advance catheter over the needle, & remove needle
- Remove all pericardial fluid
- Submit samples for analysis
- Complications rare - ventricular arrhythmias if epicardium contacted - withdraw needle slightly



90% of pericardial cases
CS: Sudden death, Slow RHF (jugular pulse)
Dx: Weak pulse, Quiet, ↓QRS, Spherical heart, Echo
Tx: Pericardiocentesis

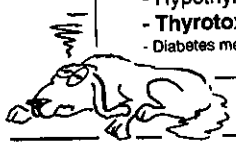
Heart Disorders - Systemic Diz

Condition	Facts/Cause	Presentation/CS	Diagnosis
Systemic diz - 2° myocardial dizs, 2° myocarditis Mk 50; H-T/M 295; H3B 109; H2B 118; IM 93, 103; H-Pic 115; Cat 883, 908; SAP 464, 475, 110; E-hb 413; C12T 842; E 1011; H-F 459; Pa-T 193, 195 **	• **Inflammation of myocardium** • **Myocardial diz 2° to** - **Systemic, predisposing diz** . **Hyperthyroidism (cats)** - Cardiovascular abnormality - Forms of cardiomyopathy - Trauma - Ischemic injury - Toxicity • Initially m/b an incidental finding - May become important & possibly lead to death • Dogs & cats • Pathophysiology: - 1° diz effect on myocardium: Necrosis, Ischemic injury, Degeneration - May cause dilative cardiomyopathy - **Arrhythmias** w/ 2° cardiac failure - Acute or chronic pulmonary congestion: pulmonary effusions & edema, pericardial effusions	• **CS of 1° diz** usually overshadows cardiac CS • **Infectious - fever** • 2° myocardial involvement - **Weakness** - **Labored breathing** - **Unexpected heart failure** - **Fainting (syncope)** - **Sudden death**   • **Sequela:** - **CHF (cong. heart failure)**	• **Difficult to Dx, biopsy only specific test, but rarely done** • **1° diz - identify** • **Hx (1° diz)** • **CS** • **Physical exam:** - Mucous membranes - Femoral pulse • **Auscultation:** - Murmurs, irregular heart rate • **Radiology:** - Cardiac chamber enlargement - Lung involvement • **ECG:** - ST segment alteration - Arrhythmias & conductive abnormalities . VPCs, ventricular tachycardia . Atrial arrhythmias & AV block - Chamber enlargement • **Echocardiography (US):** - ↓ Myocardial function - Heart anatomy - Valvular vegetation - Effusions • **Laboratory:** - CBC (complete blood count) - ↑ Serum muscle enzymes (LDH, AST, CPK) - Serum chemistries (endocrine or metabolic diz) - Thyroid tests (T_3 & T_4) • Blood cultures if fever • Serological testing for infectious causes in selective cases (toxoplasmosis, neosporosis, Lyme diz, Rocky Mt spotted fever, etc.) • Biopsy: specific test, but rarely done 



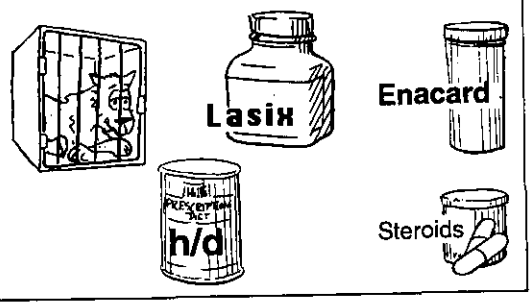
Types of 2° myocardial dizs

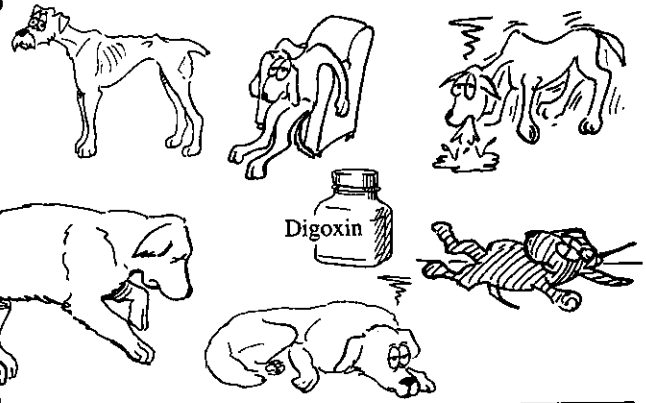
- **Infectious**
  - Bacterial: acute, focal myocarditis due to pyogenic bacteria from septicemia or other suppurative foci
    . Lyme diz
  - Viral: (rare now)
    . Canine parvovirus
    . Canine distemper virus, Herpesvirus
  - Fungus & algae (rare) - immune compromised patients
    . Aspergillus
    . Cryptococcus
    . Prototheca
  - Rickettsiae: Rocky Mt spotted fever (rare)
  - Algae-like organisms (rare)
  - Protozoa:
    . *Trypanosoma cruzi*
    . *Toxoplasma gondii*
    . *Neosporum caninum*
    . *Hepatozoon canis*
- Immune-mediated dizs
  - Lupus erythematosus
  - 2° to bacterial infection (immune-mediated)
- Physical:
  - Trauma (contusions) - "HBCs"
  - Heat stroke
    . Environmental
    . Malignant hyperthermia
  - Neurological trauma of cerebrum
- Metabolic/endocrinology
  - **Hyperkalemia**
    . Hypoadrenocorticism
  - **Hypokalemia**
  - Other electrolyte imbalances
  - Hypothyroidism
  - **Thyrotoxicosis** (hyperthyroidism)
  - Diabetes mellitus
  - Uremia
  - **Hyperadrenocorticism**
  - Pheochromocytoma
  - Hypercalcemia
  - Hypocalcemia
  - Hyperglycemia
- Neoplasia:
  - Chemodectoma (heart base tumor)
  - Hemangiosarcoma
- Amyloidosis
- Ischemia/infarction - microscopic intraventricular myocardial infarction (MIMI)
  - Gastric dilatation/volvulus
  - Trauma
  - Vegetative endocarditis
  - Atherosclerosis
- Nutritional:
  - Vitamin E or selenium defc
  - Taurine in cats with DCM
  - Carnitine defc
  - Thiamine defc
  - Anemia
- Chemical/toxic
  - **Digitalis**
  - Doxorubicin
  - Oleander, foxglove, lily of the valley
  - Halothane (anesthetics)
  - Chocolate toxicity
  - Sodium fluoroacetate
  - Carbon monoxide
  - Toad toxicity
- Genetic
  - Hypertrophic cardiomyopathy
  - Dilated cardiomyopathy (DCM)
  - Duchenne-type cardiomyopathy, canine X-linked muscular dystrophy



Treatment:

- **Treat 1° diz**
- **Treat cardiomyopathy**
  - **Supportive care**
  - **Manage arrhythmias**
  - **Tx cardiac failure: Rest + "3 Ds" (diuretics, diet/low salt & dilators)**
  - Steroids for refractory arrhythmias (traumatic or postviral myocarditis)





Secondary Myocarditis

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Neurogenic cardiomyopathy, Brain-heart syndrome H-T/M 339; SAP 465t *	• **CNS (central nervous system) diz associated w/ myocardial lesions**, all species, except cat • Cause: **Trauma to brain or spinal cord #1** - CNS neoplasia - Infection - Encephalomalacia - Ruptured intervertebral disc • Pathophysiology: - Lesions of endocardium & subendocardium . Degeneration, necrosis & mineralization-scars which result in arrhythmias . Cause of lesions: ? ↑ sympathetic tone & release of catecholamines?	• **CS of CNS diz usually** • **Arrhythmic signs** (weakness, fainting, depression, pallor, dyspnea) • Sequela of arrhythmias - Heart failure - Sudden death	• Hx (CNS trauma); CS • ECG - Atrial & ventricular arrhythmias - S-T segment depression - Prolonged Q-T interval - T wave abnormalities • Necropsy: often when diagnosis made **CNS trauma - Heart lesions - Cause ?** **CS: CNS, Arrhythmias** **Dx: Hx, CS, ECG, Necropsy** **Tx: CNS Tx**	• Treat CNS disease • Appropriate antiarrhythmic Tx **Antiarrhythmics** Prognosis: **Guarded**, depends on severity of CNS signs
Feline hyperthyroidism, Thyrotoxic myocardial diz, 2° hypertrophic cardiomyopathy Mk 284; C11T 756, 334; H-T/M 295; SAP 221; E-hb 552, 389; E 1023; IM 552; H-F 734, 255, 459, 565; Cat 723, 909 ** = ***	• **See Endo pg 672** • Excessive T3 & T4 in blood • **Multisystemic disorder** **- #1 endocrine diz** of cats **- Cardiac involvement fortunately uncommon** Pathophysiology - heart • T4/T3 direct effects on heart (↑ HR, & contractility) • ↑ sympathetic ANS: ↑ heart activity • Indirect effects: ↑ demand on heart (↑ metabolism)	• Common CS: **weight loss,** unkept hair coat, **excellent appetite & active, frantic, anxious, aggressive** (70%) • Other systems: CNS, GI, Renal, Respiratory: PU/PD, Vomiting, Diarrhea • **Cardiovascular** complications **- Hypertension** **- Hypertrophic cardiomyopathy (HCM)** **- Congestive heart failure** (15% of hypothyroid cats) (15%) **. Weakness, dyspnea, lethargy** **Multisystems, #1 Endo diz - Cat** **CS: Thin, Frantic** **Dx: Large thyroid, TSH, Rads, Echo, ECG** **Tx: Sx - Excision**	• Hx, CS • **Thyroid enlargement (90%)** • Thyroid function tests • Thyroid stimulating hormone (TSH) response test • Cardiac involvement - Physical exam: weak pulse - Muffled heart & lungs (effusions) - Tachycardia, systolic murmur - Echocardiology **. Lt ventricular hypertrophy** (70%) **. Thick ventricular septum** (40%) **. Lt atrial dilation** (70%) **. Ventricular dilation** (45%) . Myocardial hypercontractility (20%) - Radiology: **Cardiomegaly** (50%) **. Pulmonary edema/pleural effusion (10%)** - ECG (electrocardiography): **. Sinus tachycardia** (70%) Large R waves (30%), APCs /Atrial fibrillation (10%), VPCs (2%), Conduction defects (10%)	Minimally or uncomplicated cases • **Surgical thyroidectomy** • Radioactive iodine • Methimazole [Tapazole®]: chronic antithyroid Dx • **Arrhythmias:** Propranolol (Inderal®) ß blocker for sinus tachycardia, supraventricular or ventricular arrhythmias • Hypertrophic cardiomyopathy **- Diuretic** (furosemide [Lasix®]) **- Diltiazem (Cardizem®), digoxin or Propranolol** (Inderal®) carefully **Prognosis:** • Uncomplicated cases: Good • After correction of hyperthyroid state - Good: hypertrophic cardiomyopathy may be reversible

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Myocardial ischemia & infarction, MI HB 118; E-hb 414; IM 86; 5min 847; C11T 791; Pys 462; Pa-T 195 *	• Ischemic heart diz accounts for 1/3 of all deaths in **humans** in USA - 50% from acute myocardial infarction due to atherosclerosis (coronary artery diz) - Coronary artery diz of dogs & cats doesn't cause morbidity & death on scale w/ humans . Therefore little clinical evaluation **- Myocardial infarction (MI) extremely rare in dogs & cats**, but can happen due to emboli **- Microscopic intraventricular myocardial infarction (MIMI) not uncommon in older dogs, clinical significance remains unknown** **MI: Common in humans** **Rare in dogs & cats**	• **Weakness** • **Tiring** **Causes of ischemia &/or infarction:** • Left ventricular hypertrophy (cat) • Coronary artery obstruction - Coronary thromboembolism (cat) - Atherosclerosis (dog) - 1° coronary amyloidosis - Coronary thrombosis (renal diz) - Coronary vasculitis & thrombosis • Idiopathic hypertrophic cardiomyopathy (dog) • Endocardiosis (chronic valvular diz) • Gastric dilatation/volvulus • Arterial hypertension • Hypothyroidism • Congenital heart diz - Severe aortic & pulmonic stenosis - Advanced uncorrected patent ductus arteriosus • Physical diz - Heat stroke - Direct trauma (penetrating or blunt) - Neurological stress - Electrical shock - Hypothermia - Hypersensitivity reactions	• Difficult to Dx • Hx (1° CS) • ECG of ischemia/infarction **- S-T segment slurring** **- MIMI: notches or shoulders on down slope of "R" waves** - Arrhythmias, Cardiac chamber enlargement - PVCs & ventricular tachycardia - gastric dilatation • Echo: Lt ventricular wall motion abnormality (MI) - Ventricular dysfunction - Endocardial hyperechogenicity (chronic fibrosis) • Necropsy: myocardial necrosis assoc. w/ cardiovascular diz, **MIMI common in older dogs**	• **Evidence of efficacy of Tx for diz lacking** • **Tx primary disorder** (often none for MIMI) • General care - Hospitalization & cage rest - ß adrenergic blockers to lower heart rate & blood pressure - Nitroglycerin - Avoid digoxin if clear cut evidence of ischemia or infarction - Heat stroke: reduce body temperature, steroids & mannitol for cerebral edema • Tx concurrent cardiomyopathy Prognosis: • Good for MIMI • Guarded for MI
Atherosclerosis SAP 498; IM 86; E-hb 414; 5min 374; Pa-T 200; Pys 418 *	• **Extremely common in humans** • **Little clinical significance in dogs & cats** • Characterized by loss of elasticity, luminal narrowing, proliferative & degenerative lesions; fatty degenerative changes • Pathophysiology: Small & microscopic areas of myocardial fibrosis (myocardial infarction, MI) - May contribute to other cardiac disorders **Common in humans** **Rare in dogs & cats**	• CS of complicated cardiac disorders - Respiratory distress **Causes:** • Endocardiosis (chronic valvular diz) • Congenital subaortic stenosis • Diabetes mellitus • Hypertrophic cardiomyopathy (cat) • Canine hypothyroidism	• Diagnosis difficult • Hx (diz causes) • Hypercholesterolemia (suspect) • ECG - ischemia, Ventricular arrhythmias - Severe S-T segment elevation • Presumptive because coronary angiogram & myocardial enzyme analysis rarely done in animals	• Tx underlying diz • Presumptive myocardial infarction - Oxygen - Nitroglycerine ointment • Beta blockers (propranolol [Inderal®]) protect by decreasing O2 demand • Diltiazem (Cardizem®) vasodilator & decrease HR Prognosis: unknown

Vit. E - Selenium deficiency diz, Nutritional myodegeneration, NMD Mk 538, H2B 1282t, 911

*

• **Rare** - Young dogs, Common regionally in **ox & horse**, semisynthetic diet, Se & Vit. E are antioxidants, protect from free radicals, defc destabilizes lysosomes - autodigestion of muscles
• CS: Stilted gait, Weakness, ± Retinal degeneration; **Sequela: Cardiomyopathy**
• Dx: Hx (noncommercial diet - puppy), EMG (fibrillation, myotonic discharges), Muscle biopsy (necrosis w/ calcification), ± Elevation of muscle enzymes
• DDx: Infectious myopathy, "Swimming-puppy" syndrome, Breed specific congenital myopathies
• Tx: Vit. E 400 IU PO SID if early
• Prognosis: Good if treated early, Guarded if cardiac myopathy develops

DDx:
• Emboli of bacterial endocarditis

Hyperkalemia

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Hyperkalemia

Mk 1365; H-T/M 313; SAP 432, 845, 418, 802, 512, 519t; H2B 75, 87, 532, 571; E-hb 153; IM 620; H-F 71, 573

***

- **Excessive serum potassium (K+)**
- Pathophysiology
  - **Bradycardia** (conduction disturbance) - ↓**CO**
  - Difficulty repolarizing myocardial cells after action potential (depolarization - P to QRS)

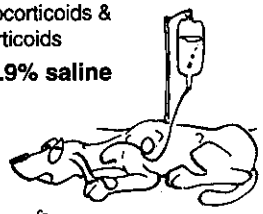
- **Depression**
- **Neuromuscular weakness**

- Hx, CS
- Physical exam
  - ± Weak femoral pulse
- Auscultation
  - **Bradycardia**
- Chem:
  - ↑**K+** (hyperkalemia)
- **ECG:** correlates w/ severity of hyperkalemia
  - **Spiked T wave**
  - ↓ or absent P waves as K+ rises
  - Prolonged PR interval
  - **Wide & flat QRS complex**
  - **Bradycardia**
  - Sinoventricular rhythm & atrial stand still (absence of P waves)

- CS of hypoadrenocorticism, renal failure, etc.

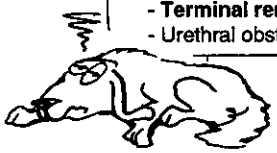
- **Potentially fatal**
- **Fluid dilution**
  - **0.9% saline,** 40-90 ml/kg/h IV
- "Drive" K out of blood & into cells
  - **Regular insulin + dextrose**
  - **Sodium bicarbonate** (alkali)
- **Diuresis:** fluid or diuretics to promote urine elimination
- **Calcium gluconate** IV to effect if life threatening situation
- If hyperadrenocorticism cause: mineralocorticoids & glucocorticoids

0.9% saline

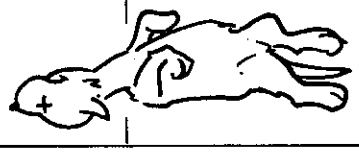


Cause: Hyperkalemia

- ↑Intake
  - **Potassium supplementation PO, IV**
  - Potassium-sparing diuretics
  - ACE inhibitors
  - High dose potassium penicillin G
- ↓**Renal clearance**
  - **Oliguric acute renal failure**
  - **Terminal renal failure**
  - Urethral obstruction (FUS - cats)
  - Uroabdomen
  - **Hypoadrenocorticism**
  - Heat prostration
  - Burns
- Translocation from cells to serum
  - Metabolic acidosis
    - Diabetic ketoacidosis
  - Tissue damage



- **Sequelae**
  - **Fatal rhythm disturbances**



Prognosis: varies w/ cause & severity

- Good to excellent w/ Tx if moderate to mild
- Grave to poor if severe w/ or w/o Tx

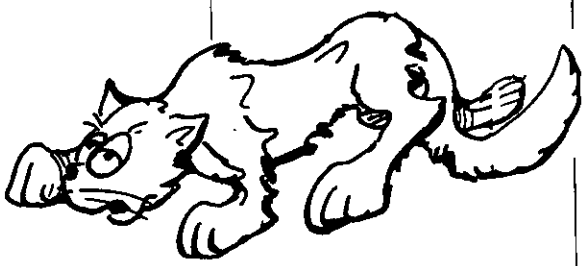
K+, Bradycardia
CS: Depression, Weakness
Dx: Spiked T waves
Tx: Saline fluids, Insulin + Dextrose

Hypokalemia

IM 621, 49, 64; SAP 465t; H2B 390, 909, 76; H-F 574

**

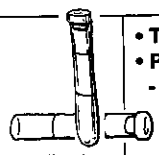
- **Also see Neuromuscular pg 593**
- **Potassium defc < 4 mEq/L - dogs, < 3.6 mEq/L - cat**
- **Cats more susceptible than dogs**
  - Prolonged anorexia in cats can lead to hypokalemia
  - Chronic renal failure at higher risk
- Causes (see box)
  - ↑Sequestration in cells
  - Loss in GI & urine
  - Iatrogenic
  - Low intake uncommon
  - Pseudohypokalemia uncommon & depends on method used to measure serum K
- Pathophysiology:
  - Effects resting membrane potential
    - **Less sensitive to stimuli**
    - Neuromuscular function of skeletal, cardiac & GI smooth muscle
  - Abnormal cardiac conduction
  - Lower motor neuron paralysis



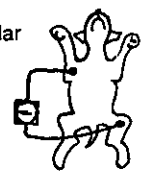
- **Muscle weakness**
  - Cervical ventroflexion in cats
  - Plantigrade stance - cats
- Depression
- Ileus
- Paralysis (flaccid)

- Sequelae
  - **Predisposes to arrhythmias**

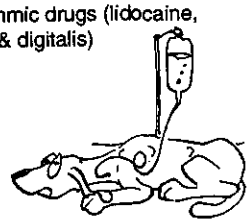
- Laboratory
  - **Hypokalemia**
    - **Dog: < 4 m/Eq/L**
    - **Cat: < 3.6 mEq/L**



- ECG
  - Depressed T wave amplitude
  - Depressed S-T segment
  - Prominent U wave
  - Prolonged Q-T interval
  - Arrhythmias
    - Supraventricular
    - Ventricular



- **Tx if CS & low K+**
- **Potassium supplementation**
  - **Per os (PO) whenever possible**
    - **To avoid life threatening hyperkalemia**
      - Potassium gluconate elixir (Kaon Elixer®)
      - Potassium gluconate (Tumil-K®)
  - **Parenteral K+ if vomiting or anorexia**
    - Potassium chloride
    - Added to fluids
      - Initially w/ normal renal function
      - 20 mEq/L/day if fluid rate is 40 ml/kg day or 0.5 mEq/kg/day
      - Don't exceed 0.5 mEq/kg/hr of K+
    - Monitor w/ serum values (BID), ECG
- Cardiac arrhythmias:
  - Hypokalemia reduces efficacy of antiarrhythmic drugs (lidocaine, quinidine & digitalis)



DDx - Hypokalemia

Common causes
- Gastrointestinal
  - Vomiting
  - Diarrhea
  - Gastric dilation/volvulus
- Renal insufficiency
- Diabetic ketoacidosis
- 2° hyperaldosteronism
  - Liver insufficiency
  - Congestive heart failure
  - Nephrotic syndrome
- Iatrogenic
  - Fluid Tx
  - Insulin Tx
  - Bicarbonate Tx
  - Loop (Lasix®) or thiazide diuretics
  - Enemas

Uncommon causes
- Low dietary intake
- 1° hyperaldosteronism
- Hyperthyroidism
- Hypomagnesemia
- Neuromuscular/CNS diz
- Pseudohypokalemia
  - Hyperlipidemia
  - Hyperproteinemia
  - Hyperglycemia
  - Azotemia

Prognosis:
- **Good:** CS resolve in 1-5 days following correction
- Chronic oral supplementation may be needed to prevent recurrence

Cat > dog, Difficult muscle contraction
CS: Weakness, Paralysis
Dx: Short T wave, Arrhythmias
Tx: K+ PO

Calcium

CIRCULATORY SYSTEM

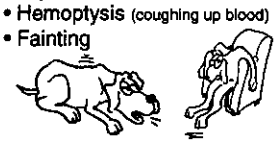
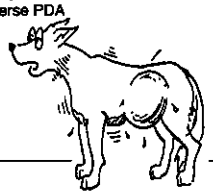
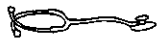
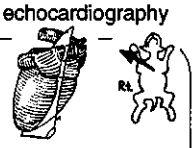
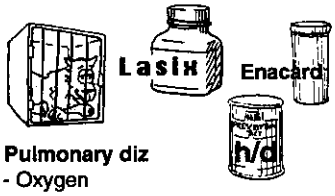
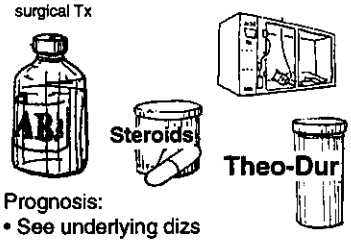
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Hypocalcemia H-T/M 313; IM 626, 541; E-hb 277; SAP 234, 72; H2B 1384, 518, 1277; C11T 301; H-F 577 **	• **See Endo pg 681** • **Low serum Ca^{++}** < 6.5 mg/dl • Clinically significant hypocalcemia uncommon in dog & cat • Cardiac abnormalities • Common causes: **- Puerperal tetany/eclampsia #1** **- Hypoparathyroidism**	• Asymptomatic to severe neuromuscular dysfunction • Tremors, twitches, tetany - Ataxia, Seizures • Behavior changes - Restlessness, aggression, panting, facial rubbing • ± **Bradycardias**	• Hx, CS • PE: weak femoral pulse • Muffled heart sounds - Tachyarrhythmias • **Laboratory:** **- Serum calcium < 6.5 mg/dl** if normal serum albumin/protein • **ECG** **- Prolonged Q-T interval** - VPCs (ventricular premature contractions)	• **Eliminate cause** • Crisis - Supportive Tx, pending diagnosis **- Calcium gluconate slow IV** **.. Toxicity signs: bradycardia** & shortening of Q-T interval .. Ca gluconate may be given SQ - Oral calcium - Vitamin D supplementation • **Maintenance:** SQ injection of Ca • **Chronic maintenance: Oral Vit D + calcium** Prognosis: Good to excellent, guarded if severe
Hypercalcemia **	• **See Endo pg 676** • **Uncommon in dog & rare in cat** • **Repeated high serum calcium** • Lymphosarcoma/malignancy #1 cause • Other causes: Hypoadrenocorticism, Renal failure, 1° Hyperparathyroidism, Young age, Laboratory error	• **PU/PD** • CNS depression, seizures • GI: anorexia, vomiting, constipation • **Muscular weakness** • Fine muscle fasciculations • Sequelae: - Cardiac arrhythmias (rare)	• **Hypercalcemia** - Dog > 12.0 mg/dl - Cat: > 11.0 mg/dl **- > 18.0 mg/dl** life-threatening • R/O causes - fortunately short list • 1st rule out young age & error due to hemolysis or lipemia • ECG: - Prolonged P-R interval - Shortening of Q-T interval - Cardiac arrhythmias (ventricular fibrillation)	• **0.9% sodium chloride** . Furosemide (Lasix®) requires high dosages • **Lymphosarcoma: Chemo Tx** **Prognosis: Guarded** • **Lymphosarcoma - Guarded to good; Chemo Tx**

Neuromuscular excitability
CS: Tremors, Tetany, Panting
Dx: Hx, CS, PE, < 6.5 mg/dl, ECG
Tx: Calcium, Eliminate cause

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Chronic renal failure, CRF **hypertension** **Uremic heart diz** Mk 835; H2B 572, 119, 86; H-T/M 321; SAP 804; IM 487; Cat 725 ***	• **Progressive, irreversible** damage over months to years - loss of renal tissue • **Hypertension:** pathogenesis not determined **- > 75%** of nephrons destroyed - progresses to end-stage failure - Permanently disabling - Distinguish from acute, which is reversible • Dogs >>> cats • Older animals usually • **Retention of by-products of protein metabolism & resulting toxic condition** - Generally associated w/ **renal failure** - Not uncommon in geriatric animals • Pathophysiology - cardiovascular - Metabolic acidosis & uremic toxicity, anemia & fluid overload . Enhances myocardial irritability . Leads to arrhythmias . Reduction in contractility - **Systemic hypertension** (chronic renal failure) - ↑ K^+, ± Ca^{++} serum level (ECG) terminally - Pericarditis common complication	• **PU/PD** (polyuria/polydipsia), nocturia • **GI: Vomiting,** ± Diarrhea, **Oral ulcerations** • **Nonspecific: Anorexia, Lethargy,** Weight loss, **Dehydration** • **Cardiovascular** **- Anemia,** bleeding tendencies **- Hypotension** **- Weakness** & tiring (CHF) • Bone pain, bone pliability • Fast breathing (anemia) • Respiratory distress (dyspnea, tachypnea) from uremic pneumonitis & metabolic acidosis • **Terminal stages** - **CNS:** depression, convulsions, coma to death	• Hx (familial, toxins, drugs, infections), CS (PU/PD) • Physical exam (PE) - Pale mucous membranes, **Oral ulcers** - Retinal changes (hypotension) - Palpation: small, firm, "lumpy bumpy" - SQ edema or ascites (hypoproteinemia) • ↑ **BUN, creatinine,** ± ↑ phosphorus • **Anemia** (nonregenerative), proteinuria, acidosis • **UA: Specific gravity fixed** **- 1.008-1.012, isosthenuric** • **Radiology:** small, irregular kidney • Ultrasound (US) • Renal biopsy • ECG: Nonspecific abnormalities - Conduction defects or arrhythmias • **Hypotension** (systemic BP)(> 50%) - Dog: > 180 (systolic) & > 95 (diastolic) mmHg - Cat: > 200 mmHg (systolic), > 145 mmHg (diastolic) • **Cardiac arrhythmias** (uremia, hypoxia [anemia], acidosis)	• **No cure, palliative** • Avoid stress • **Fluid therapy** - Check renal failure in cardiac patients before fluids & diuretics - Rehydrate carefully w/ low-sodium fluids (half strength saline & dextrose) - Reduce dose or avoid cardiac drugs eliminated by kidney . Monitor kidney function & electrolytes frequently if using ACE inhibitors (enalapril) or digoxin . Digitoxin can be substituted for digoxin . Hydralazine & nitroglycerine can be substituted for ACE inhibitors • **Diet k/d:** restrict proteins & phosphorus, gradually restrict sodium (hypertension) • **Phosphate binders: aluminium** hydroxide (Amphojel®), aluminum carbonate (Basaljel®), calcium carbonate (Camalox®) • Anemia: androgens, transfusion • **Hypertension:** maintain systolic pressure at 120-160 mmHg & diastolic at 60-100 mmHg - Propranolol (Inderal®) (ß blocker) - Enalapril (Enacard®), ACE inhibitor: stops angiotensinogen conversion, vasodilator - Prazosin (Minipress®): vasodilator • **Tx vomiting:** Cimetidine (Tagamet®) or ranitidine (Zantac®) • Multiple vit (B & C) • **Euthanasia** considered if above doesn't work **Prognosis: Poor** to guarded, resolution of uremia may improve ECG abnormalities or may not

Hypertension, Toxic - Renal failure
CS: PU/PD, Anemia, Weakness
Dx: BUN, Creatine, Arrhythmias
Tx: Fluid, Diet, Inderal, Enacard

Hypertension

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Pulmonary hypertension, Cor pulmonale Mk 49; SAP 496, 448t; H2B 155; IM 126, 124; IM-WW 184, 200; Cat 925; E 1023; C9T 313; H-Pic 147; H-T/M 413; H-F 578 ** to *** (HW area)	• **High pulmonary arterial blood pressure (BP)** • Requires cardiac catheterization - Identification impeded by technique of determination & wide variation if normal values • **Cor pulmonale:** right heart enlargement due to pulmonary "hypertension" • Pathophysiology: - Pulmonary vascular diz or vasoconstriction . **Heartworm:** embolic dead heartworms . Pulmonary diz . Alveolar hypoxia (cat asthma) - ↑ Pulmonary blood flow damages vessels, raising vessel resistance . Large left-to-right shunts (PDA, septal defects) - Obstruction of vessels - ± Left heart failure results in backup into lungs • **Right ventricle dilates or hypertrophies** to pump against higher pressure	• **Tiring** (exercise intolerance) • Episodic weakness • **Labored breathing** (tachypnea & dyspnea) • Hemoptysis (coughing up blood) • Fainting  • Sequela: - CHF (congestive heart failure) - Polycythemia - Reverse PDA 	• **Often missed** • Hx, CS • Physical exam - Fast HR  - Cyanosis • Auscultation: - Murmurs (loud or split 2nd heart sound, tricuspid regurgitation) - Abnormal lung sounds (crackles) • Radiology: - Right heart enlargement (sternal contact, reverse "D") - Dilated pulmonary arteries - ↑ Lung opacity (interstitial pattern), fibrosis, thromboembolism • ECG & echocardiology - **Rt ventricle hypertrophy or dilation, deep S waves** - ± Rt atrial dilation, tall P waves • Pressure measurement - Systolic pressure > **30 mmHg** - **Heart catheterization** or Doppler echocardiography 	• **Treat underlying dizs** • Heartworm: Thiacetarsamide or melorsamine? • **Right heart failure:** 3 "Ds" + rest - Cage rest - Diet: low sodium **3 "Ds"** - Diuretics: Lasix® - ± Vasodilator drugs, less effective on pulmonary arteries, best if left to right shunt (VSD or PDA) - Phlebotomy (rarely needed or documented)  • **Pulmonary diz** - Oxygen - Bronchodilators (theophylline [Theo-Dur]) - Steroids (Glucocorticoids) - Antibiotics • Pulmonary embolism - thrombolytic or surgical Tx  Prognosis: • See underlying dizs

↑ Pulmonary BP - Right heart enlargement
CS: Tiring, Dyspnea, CHF
Dx: Hx, CS, Murmur, Rads, ECG
Tx: Tx cause

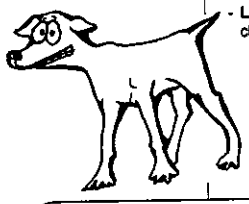
Causes - pulmonary hypertension

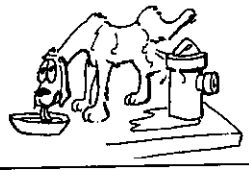
- **Complication of any heart diz**
  - **Heartworm diz**
  - **Congenital heart defects**
    . Large left to right shunts (PDA, ASD, VSD)
  - Aortic valvular regurgitation
  - Severe or chronic left-sided heart failure
- **Pulmonary diz**
  - Pulmonary embolism
  - Chronic pulmonary fibrosis
  - Chronic bronchial diz
  - Pulmonary parenchymal diz/alveolar hypoxemia
  - Reactive pulmonary vasoconstriction
  - Idiopathic (1° pulmonary hypertension)

Hypertension - systemic

SAP 496; E-hb 49; H2B 155; I2M 193; IM 126, 30, 49; IM-WW 200; 5min 706; E 1023; C11T 310; H-Pic 134; H-F 578; Pys 410, 424, 473; Pys-B 190
**

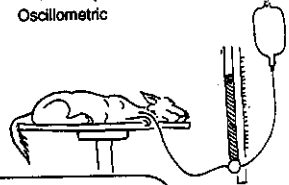
- **High arterial blood pressure (BP)**
- Identification impeded by technique of determination & wide variation if normal values
- Causes of systemic hypertension:
  - Primary or "essential": idiopathic cause
    . Rare in dogs & not reported in cats
  - **Secondary:** common in dogs & cats
    . Vasoconstriction
    . Vascular stiffness
    . Na^+ & H_2O retention
  - **Renal diz** (cause & effect of hypertension)
    . 50-90% have hypotension
- Pathogenesis:
  - **Lesions in small arteries & arterioles**
  - Effects brain, heart, kidney & eye
  - **Left ventricular hypertrophy,** mechanism not clear





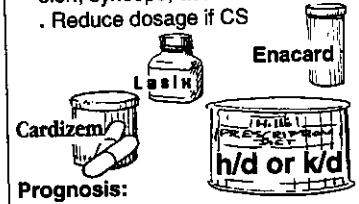
- **Renal problems**
  - PU/PD
  - ↓ Appetite
  - Weight loss
- **CNS deficits** (vascular hemorrhage)
  - Hemiparesis, seizures
  - Cerebrovascular injury
- **Acute blindness**
  - Retinal hemorrhage & detachment
  - Hyphema (blood shot)
- **Epistaxis**

- **Often missed**
- Hx (chronic renal diz), CS
- Eye exam
  - Retinal arteriolar tortuosity
  - Preretinal & retinal hemorrhages
  - Retinal edema & detachment
  - Vitreal & anterior chamber hemorrhages
- Auscultation:
  - Systolic & diastolic murmur in cat (mitral regurgitation) & atrial (S4) gallop (ventricular stiffness) - cat
- Radiology, echo & ECG
  - **Lt ventricular hypertrophy: tall R waves**
- Proteinuria, azotemia (BUN)
- Pressure measurements
  - **Dog: > 160 mm Hg systolic & > 95 mm Hg diastolic**
  - **Cat: > 170 mmHg systolic; > 100 mmHg diastolic**
  - Direct cannulation of artery
  - Indirect (inflatable cuffs): Doppler, Oscillometric



- **Treat underlying dizs:** hyperthyroidism, Renal diz, Cushing's
- **Dietary: sodium restriction** (< 40 mg/kg/day) Hill's h/d or k/d diet, poorly accepted by animal, gradual introduction
- Drugs - empirical try for 2-4 weeks
  - **Diuretics** (furosemide [Lasix®])
  - **Propranolol** [Inderal®])
    . ß blocker: ↓ renin release & central sympathetic outflow
    . NOTE: caution if bronchoconstriction
  - Prazosin (Minipress®) alpha 1 blocker, vasodilation & potential hypotension
  - Direct arterial dilators (hydralazine), but reflex sympathetic stimulation so use w/ diuretic & propranolol
  - **Ca channel blockers** (diltiazem [Cardizem®]) vasodilation
  - **Angiotensin-converting enzyme (ACE)** inhibitors (enalapril) = dilation & Na^+ & H_2O elimination

- **Emergency Tx**
  - **Na nitroprusside** (Nipride®) IV extremely hypotensive, cyanide toxicity, careful in hepatic or renal dizs
- Monitor Tx:
  - Hypotension: weakness, depression, syncope, acute renal failure
    . Reduce dosage if CS

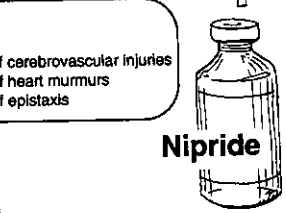


Causes - hypertension

1° "essential" (rare in domestic animals)
- Idiopathic - high sodium diet?

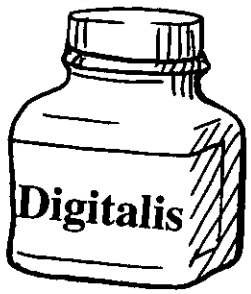
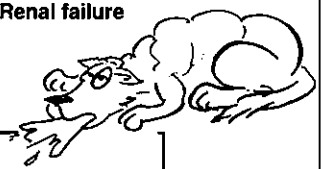
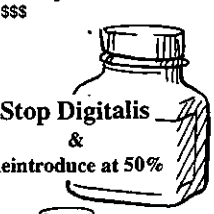
- Secondary:
  - **Renal Diz** (dogs & cats):
    . Particularly glomerular diz
    . Tumors - renin producing (RAAS)
  - Renal arterial diz
    . Arteriosclerosis
    . Thromboembolism
  - **Endocrine**
    . **Cushing's/Hyperadrenocorticism** (dog)
    . **Hyperthyroidism** (Cats)
    . Hypothyroidism (Dogs)
    . Hyperparathyroidism (hypercalcemia)
    . Pheochromocytoma: catecholamines
    . Acromegaly - ↑ Na+ & H_2O retention?
  - Anemia: ↑ heart rate & contractility
  - Old age
  - **CNS disorders:** pain, anxiety or stress

DDx:
- Eye diz
- Other causes of cerebrovascular injuries
- Other causes of heart murmurs
- Other causes of epistaxis



↑ BP, 2° Diz
CS: CNS, Blind, PU/PD
Dx: Fundic exam, BP (indirect)
Tx: Low Na diet, Rx (Diuretics, Cardizem, ACE inhib, Propranolol)

Prognosis:
- **Depends on cause**
- Expect gradual response to Tx: days to weeks

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Digitalis intoxication SAP 438; E-hb 379; IM 56; H2B 75, 78; H-F 192; Pys-F 156; Tox-WW 162, 391 ** 	• **Intoxication** - **Narrow margin of safety** - **Arrhythmias** (↑ incidence of spontaneous or ectopic activity) - Myocardial toxicity greater concern than GI toxicity - **Cats & dobies:** easily intoxicated • **Forms of digitalis: digoxin** (metabolized by kidney), **digitoxin** (metabolized by liver) • **Predisposing factors** to intoxication - Hypokalemia (anorexia, diuretics) - Hypercalcemia - Quinidine: ↑ serum concentrations of digoxin . Doesn't affect digitoxin - Verapamil, amiodarone, spironolactone, aspirin & triamtene, captopril, diltiazem & m/b cimetidine - Propranolol, diltiazem & parasympathomimetics exacerbate vagal effects of digitalis - Hyperthyroidism & hypothyroidism - Hepatic dysfunction - **Renal failure** 	• Gastrointestinal CS - **Anorexia** - Borborygmus (rumbling gut sounds) - **Vomiting** (nausea) - Diarrhea • Cardiac CS **(arrhythmias)** - Weakness - Short, shallow breathing - Fainting • CNS - Depression, **lethargy** - Restlessness 	• **Hx (digitalis), CS** • **Auscultation** - **Slow heart rate** (bradycardia) - **Arrhythmias** • **ECG: arrhythmias** - Sinus bradycardia - Sinus arrest - AV blocks (Mobitz I/2° AV block) - Ventricular bigeminy or tachycardia - Junctional & supraventricular arrhythmias - Slow ventricular response to atrial fibrillation	• **Stop digoxin** if toxicity suspected • Supportive care until resolution of CS • **Reinstitute digitalis** at reduced level (50% usually) • **Lidocaine or phenytoin** (Dilantin®) for ventricular arrhythmias (aggressive Tx) • Quinidine contraindicated • Antidigoxin & antidigitoxin antibodies cost prohibitive $$$  Prognosis: • **Fair to good** for supraventricular arrhythmia; • Guarded: ventricular arrhythmia

Digoxin (Lanoxin®, Cardoxin®), digitoxin
- Improve contractibility (+ inotropes)
  - Causes ↑ in intracellular calcium
- Supraventricular antiarrhythmic actions
  - Parasympathomimetic slowing of AV node
- Indications:
  - Myocardial failure (dilative cardiomyopathy)
  - Most supraventricular arrhythmias
  - Use in chronic valvular diz controversial
- Contraindicated :
  - Sinus node dysfunction (except tachycardia-bradycardia syndrome)
  - 2nd & 3rd° AV node block
  - Pericardial diz
  - HCM (hypertrophic cardiomyopathy)
  - Aortic stenosis
  - Severe ventricular arrhythmias

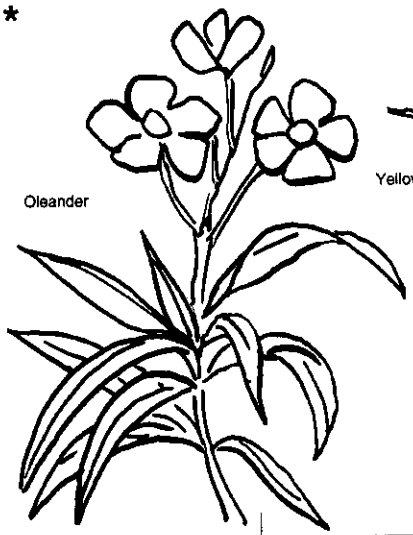
Toxic, Cat & Doby
CS: Vomiting, Weakness, CNS
Dx: Hx, CS, Slow HR, Arrhythmias
Tx: Stop Tx, Phenytoin for arrhythmias

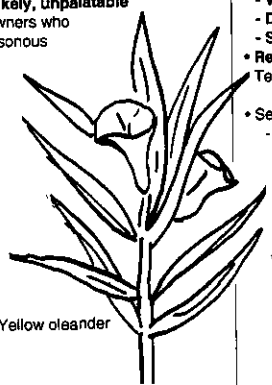
Cardiac glycosides: Oleander, Foxglove toxicity

JAVMA 205(3) p417, 1994; Mk 50: 208; H-T/M 331; H2B 1342; SAP 465t; IM 86; IM-WW 186; C11T 180; Tox-WW 392

*

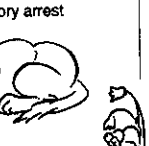
- Action similar to digitalis toxicity
- Pathophysiology: atrioventricular block & asystole
- Digitalis-like toxin
- **Poisoning unlikely, unpalatable**
  - Concern to owners who know it is poisonous


Oleander

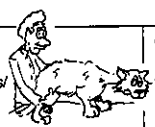

Yellow oleander

Sources
- Glycoside containing plants
  - . Oleander (*Nerium oleander*) [Apocynaceae])
  - .. #1 - Ornamental shrub
  - . Milkweeds (Asclepias spp)
  - . Lily-of-the valley (*Convallaria majalis*)
  - . Laurel or azalea (Rhododendron sp)
  - . Dogbane (Apocynum)
  - . Yellow oleander
  - . Foxglove (*Digitalis purpura*)
- Taxine alkaloids
  - . Japanese yew (*Taxus cuspidata*)
  - . European yew (*Taxus baccata*)

- **Found dead**
- Depression, dizziness, weakness
- Mydriasis (dilated eye), blurred vision
- **GI:** abdominal pain, nausea
  - **Vomiting**
  - **Diarrhea**
  - **Salivation**
- **Respiratory distress**
  Terminal convulsions, coma
- Sequelae:
  - Cardiac & respiratory arrest



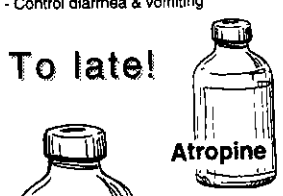
- Hx (exposure)
- Clinical signs (CS)
- Plant parts in vomitus/ stomach contents
- Pulse: slow to fast, weak to strong
- ECG: Cardiac arrhythmias (**bradycardia**, tachycardia, missed beats, blocks, fibrillation)



Lily of the Valley

Foxglove

- **Treatment rarely possible, absorbed rapidly**
- Induce vomiting in a conscious pet (apomorphine (dog); xylazine (cat))
- ± Gastric lavage (stop absorption)
- Activated charcoal PO followed by cathartic (sodium sulfate)
- Monitor ECG
  - Ventricular arrhythmias: lidocaine, phenytoin, propranolol
  - Potassium solution IV
  - Severe bradycardia - atropine
  - ± Antidigitalis antibody fragments (FAB) if severe
  - ± Isopeteranol or sodium channel blockers (quinidine) for heart block
- Symptomatic & supportive care
  - Control diarrhea & vomiting


To late!

Prognosis: **Poor**

Rare, Digitalis-like toxin, Unpalatable
CS: Dead, GI (vomiting, salivation), Dyspnea, Coma
Dx: Hx, CS, ECG
Tx: Too late usually

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Carbon monoxide H3B 1300; 5min 415; Cat 243; H-T/M 330; Tox 374; Tox-WW 171, 172, 22 *	• Running older cars, leaky indoor barbecue, propane gas heaters in unventilated areas • Putting animal in the trunk • **CO competes w/ O2** for binding to hemoglobin - Affinity 250x Oxygen - Forms carboxyhemoglobin (blocks O2 pickup) - Tissue hypoxia: Myocardial hypoxia - hemorrhage & necrosis	• **Cardiac hypoxia** **- Sudden death** • **Brain hypoxia** - Convulsion - Disorientation - Coma • Listless & weak • Twitching	• Hx (exposure to fumes) • CS • Physical exam: **hot, bright red gums** • Laboratory - **Cherry red blood** - Carboxyhemoglobin levels • ECG: - **S-T segment changes** (slurring - hypoxia) - Conduction abnormalities - Arrhythmias	• No heroics, air out area, move into fresh air • CPR if necessary • Encourage movement • **100% oxygen (hyperbaric chamber)** • **Treat any arrhythmias** • Supportive: electrolyte & acid-base balance

Competes w/ O_2 & wins
CS: Sudden death, CNS
Dx: Hx, CS, Cherry red blood, S-T slurring
Tx: O_2, Antiarrhythmics, Support

Prognosis:
• Good if treated early

Toad (Bufo) toxicity H-T/M 330; SAP 465t; E-hb 165 * to **	• **Rare** most of USA, uncommon in Florida • All toads irritating to mouth • Colorado river toad (*Bufo alvarius*), marine toad (*B. marinus*) **- Toxic glands in skin** **- Digitalis-like toxin**	• Mouth irritation w/ **hypersalivation** • **± Emesis & diarrhea** • **Cardiac irregularities** - Cyanosis - Depression - Weakness, collapse - Pulmonary edema - Convulsions, seizures • Death in 30 minutes	• **Hx (playing w/ toad)** • CS • Auscultation/ECG - Cardiac irregularities leading to **ventricular fibrillation** • Monitor w/ ECG • Necropsy - Toad parts in stomach	• **Propranolol (Inderal®)** immediately IV - Repeat dose in 20 min if needed • Intubate & flush mouth w/ water • ± Atropine for salivation • Pentobarbital anesthesia for seizures

Digitalis-like toxin
CS: Vomition, Diarrhea, Weakness
Dx: Hx, CS, ECG
Tx: Flush mouth, Propranolol

DDx:
• Cardiac glycoside plants (oleander)
• Iatrogenic digoxin
• Snakebite
• Carbon monoxide
• 2° cardiac diz
- Gastric torsion, anemia, shock, pancreatitis

Atropine

Inderal

Prognosis: **Guarded**, depending on severity of signs & duration

Doxorubicin (Adriamycin) cardiomyopathy, Epirubicin H-T/M 333; H3B 110; H2B 119; IM-WW 186; C11T 783; E-hb 227; C11T 392, 412, 783; SAP 189t, 476, 485t, 465t; IM 86 *	• Dogs, cats resistant • **Useful anticancer chemotherapy** (anthracycline antibiotic) - Used for lymphoproliferative disorders, soft tissue sarcomas, carcinomas including cardiac & pericardial neoplasms • Greater risk - Breeds at risk for cardiomyopathy . Pre-existing cardiac abnormalities (murmurs, arrhythmias) • Bone marrow toxicity • Cardiac toxicity relatively frequent & potentially life threatening **- Arrhythmias** - Progressive cardiac degeneration **- Dilated cardiomyopathy** (DCM) (dogs)	• **Dilative cardiomyopathy signs** - Tiring - Dyspnea & cough - Distended abdomen • Anorexia, weight loss • Cold extremities • Anemia • GI toxicities • Urticaria • Alopecia • Sudden death	• **Hx (treatment)**, CS • **ECG:** - Arrhythmias (ventricular, supraventricular & conductive abnormalities) - Atrial/ventricular enlargement - S-T segment & T wave changes - ↓ QRS voltage • Radiology - Cardiomegaly, pulmonary edema & pleural effusions • Echocardiology - ↓ Contractility - ↑ Lt ventricular end-systolic internal dimensions & ↓ Fractional shortening	• **Refractory to treatment** **None** Prevention: • Monitor doxorubicin Tx w/ ECG - If arrhythmias develop, stop treatment

Adriamycin

Anticancer drug
CS: Dilated cardiomyopathy
Dx: Hx, CS, ECG, Rads, Echo
Tx: Refractory

Halothane
HB 118
• Hyperthermia leading to myocardial damage

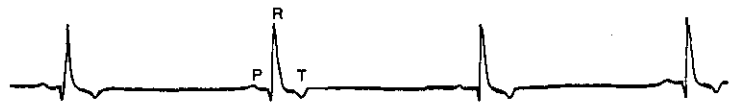
Prognosis:
• **Poor**

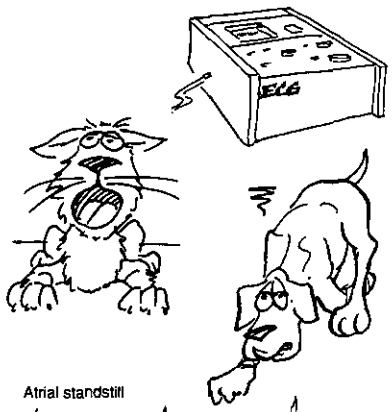
Cardiac arrhythmias, Dysrhythmias, Ectopia

M8k 63; Mk 42; H-T/M 59, 371; SAP 421; I2M 69; IM 59; IM-WW 187; H3B 77, 63; H2B 71; H-hb 28; H-F 73, 269; H-Plc 154; Cat 925; Pys 142, 152

Dysrhythmia: abnormality in:
- Heart rate (HR)
- Regularity (rhythm)

• Cause: abnormality in:
- Origin of electrical impulse
- Cardiac impulse conduction
- Ectopic irritant foci discharge becoming a pacemaker



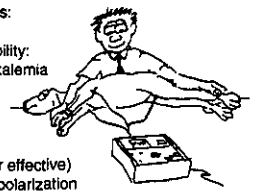


• **Supraventricular arrhythmias:**
- Sinus bradycardia/tachycardia
- Sick sinus syndrome/sinus arrest
- Atrial premature complexes (APCs)
- AV blocks

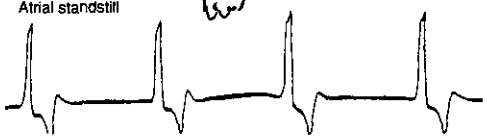
• **Ventricular arrhythmias:**
- Ventricular premature contractions (VPCs)
- Ventricular tachycardia
- Ventricular fibrillation

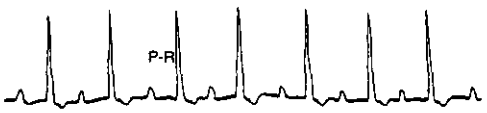
• **Pathogenesis:**
- Altered automaticity - SA node, His Purkinje conduction fibers, etc.
- Altered refractory period - shortened or prolonged
- Conduction abnormalities - ischemia, infarct, necrosis, fibrosis, etc.

• Mechanisms of arrhythmogenesis:
- Reentry (unidirectional block)
- Increased or decreased excitability:
  . Electrolyte imbalance - hyperkalemia
  . Acidosis - acidemia
  . Ischemia/hypoxia
- Changes in:
  . Membrane resting potential
  . Refractory period (absolute or effective)
  . Duration of each phase of depolarization
  . Repolarization
- Arrhythmogenic agents
  . Digitalis



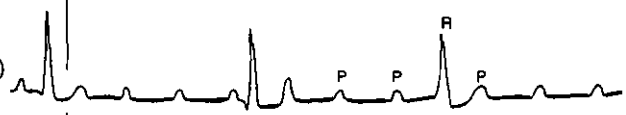
Atrial standstill

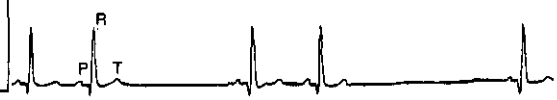




Classification of arrhythmias:

• Frequency:	Bigeminy
	Trigeminy
	Paroxysmal (≥ 3-5 recurring)
	Continuous
• Origin:	Supraventricular
	Ventricular
• Rate:	Bradycardia (slow rate)
	Tachycardia (fast rate or irregular)
	Conduction abnormalities



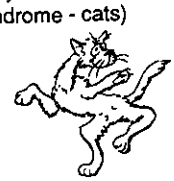


Causes of arrhythmias:

Primary (cardiogenic):

• **Hereditary** (rare in cats):
- Sinoatrial (SA) node defects
  . Sick sinus, sinus block (SA arrest)
- Atrioventricular (AV) node block
- Bundle of His
- Ventricular pre-excitation syndrome (Wolf Parkinson White syndrome - cats)

• **Acquired (cardiogenic):**
- Conduction system diz
- Trauma or surgery
- Valvular diz
- Atrial diz
- Myocarditis
- Cardiomyopathy (hypertrophic or dilated)
- Ischemia
- Neoplasia
- Pericardial effusion/tamponade



Secondary (noncardiogenic):

• **Dysautonomias** (autonomic nervous system)
- Vagal tone increase (parasympathetic)
  . Respiratory disorders (primarily dogs)
  . Gastrointestinal diz
- Sympathetic tone: tachycardia
  . Excitement, exercise, pain, fever
- Organic brain diz: parasympathetic/sympathetic

• **Metabolic disturbances:**
- Ischemia/hypoxia: hypotension or hypoperfusion/ anemia or respiratory diz
- Acidosis - respiratory & metabolic
- Electrolyte imbalances - K^+, Ca^{++}
- Hypo- or hyperadrenocorticism
- Hypo- or hyperthyroidism
- Diabetes mellitus (cats)

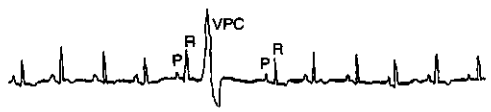
• **Respiratory causes:**
- Respiratory arrest
- Pneumonia
- Pulmonary edema, thrombosis
- Brachiocephalic airway diz

• **GI causes:**
- **Acute gastric dilatation**
- Pancreatitis, peritonitis
- Intestinal obstruction/volvulus

• **Hemolymphatic causes:**
- Severe anemia
- Hemangiosarcoma
- Lymphosarcoma (myocardial)

• **Urogenital causes:**
- Renal failure
- Obstruction
- Pyometra/acute prostatitis

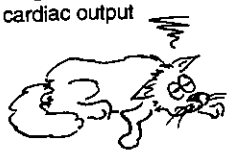
• **Iatrogenic causes:**
- Medications
  . **Digitalis, antiarrhythmics**
  . Anesthetics, sedatives
  . Sympathomimetics, Parasympathomimetics
  . Electrolyte supplementation
  . Cancer chemotherapeutics
- Mechanical:
  . Pacemakers
  . Cardiac catheterization



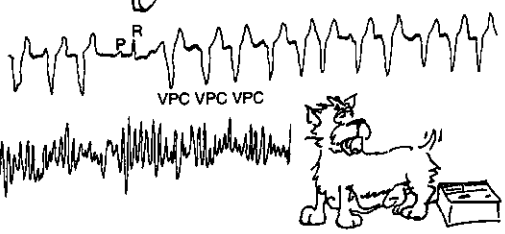
Presentation/CS

• **Benign & clinically insignificant**

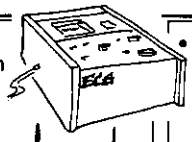
• Clinical signs of poor cardiac output
- Episodic weakness
- Fainting (syncope)
- Depression
- Pallor
- Dyspnea



• Sequelae:
- Malignant arrhythmias
- Heart failure
- Sudden death

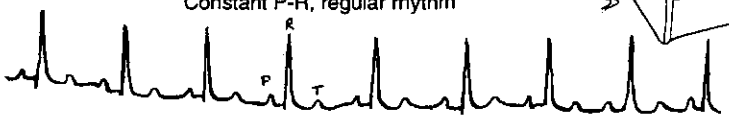


Rhythms - Summary

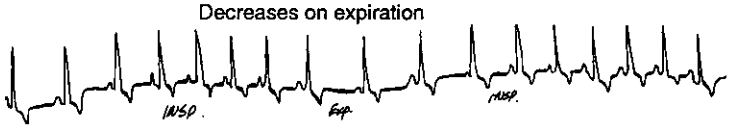


Normal rhythms

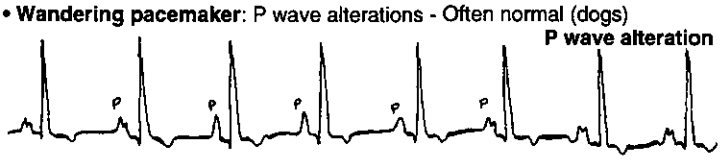
- **Normal sinus rhythm** Dog: 60-180 bpm; Cat: 120-200 bpm
  Constant P-R, regular rhythm



- **Normal sinus arrhythmia:** Alters w/ respiration - Increases on inspiration, Decreases on expiration



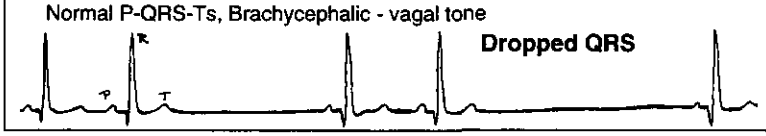
- **Wandering pacemaker:** P wave alterations - Often normal (dogs)



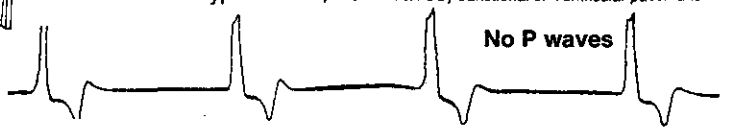
Bradyarrhythmias (too slow)

- **Sinus bradycardia:** HR: Dog: < 70 bpm, Cat: < 90; Normal, regular P-QRS-T

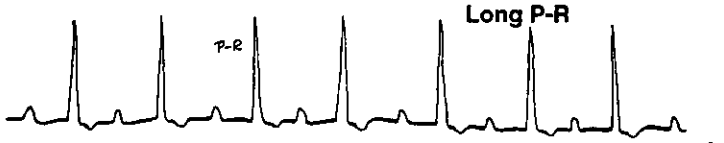
- **Sinoatrial block (arrest):** Pause of 2 or more R-R intervals, Clinically insignificant
  Normal P-QRS-Ts, Brachycephalic - vagal tone



- **Atrial standstill** (hyperkalemia): HR: Dog < 60 bpm; Cat < 90 bpm
  Hyperkalemia, No P waves, Junctional or Ventricular pacemaker

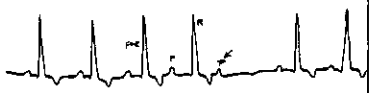


- **1st degree atrioventricular block:** Long P-R interval, delayed conduction of impulse through AV-node to ventricle - Dog > 0.14 sec, Cat > 0.05 sec

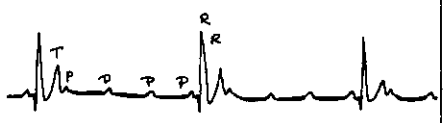


- **2nd degree Atrioventricular blocks**

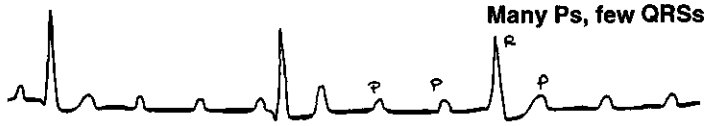
Mobitz I:
P-R prolongs until a QRS dropped



Mobitz II:
Dropped QRSs
(bigeminy or trigeminy)
P-R intervals are constant

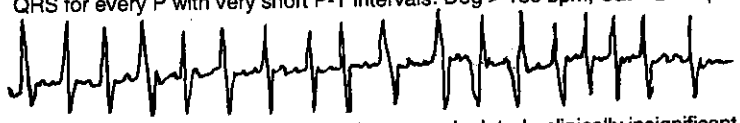


- **Complete (3rd degree) AV block:** Many Ps, few QRSs (ventricular escape)
  No association between Ps & QRSs

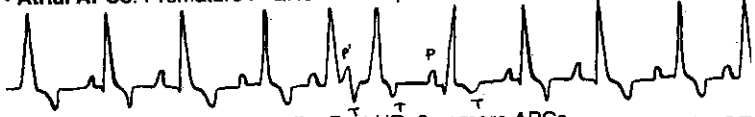


Tachyarrhythmias (too fast or irregular)

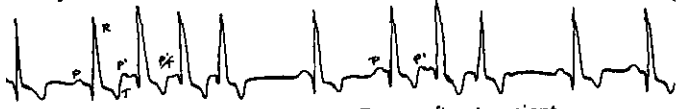
- **Sinus tachycardia:** Normal ECG, except fast rate, Normal physiologic response
  QRS for every P with very short P-T intervals: Dog > 180 bpm; Cat > 240 bpm



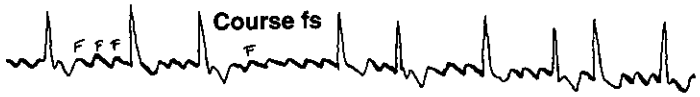
- **Atrial APCs:** Premature P-QRS-Ts w/ a pause, Isolated - clinically insignificant



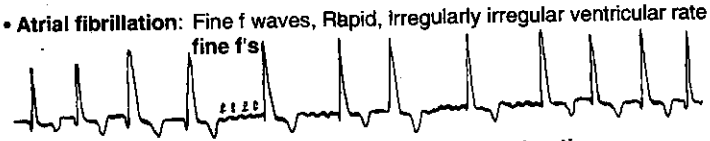
- **Paroxysmal atrial tachycardia:** Fast HR, 3 or more APCs ≥3 APCs (P-QRS)



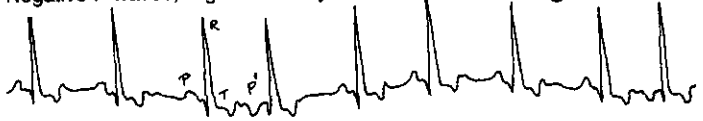
- **Atrial flutter:** NO Ps, course f waves, Rare - often transient



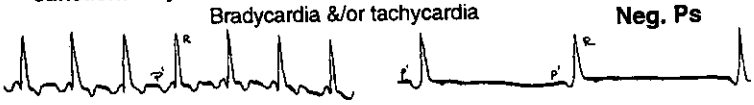
- **Atrial fibrillation:** Fine f waves, Rapid, irregularly irregular ventricular rate



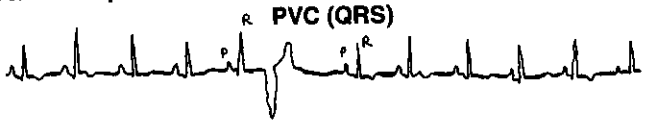
- **Junctional (AV node - His Purkinje) premature contractions:**
  Negative P waves, Digitalis toxicity



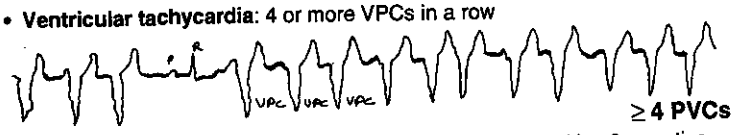
- **Junctional rhythm:** fast or slow/JPCs Negative Ps, Spontaneously reverts
  Bradycardia &/or tachycardia



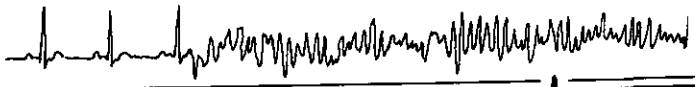
- **Ventricular premature contractions:** QRSs wide & bizarre



- **Ventricular tachycardia:** 4 or more VPCs in a row



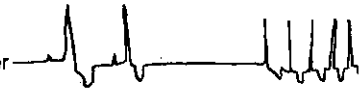
- **Ventricular fibrillations:** Continuous, chaotic, bizarre positive & negative oscillations, Medical emergency - CPR



Conduction disorders

- **Intraventricular conduction blocks:** QRSs prolonged, MIMI (microscopic intraventricular myocardial infarct)

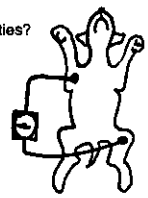
- **Pre-excitation syndromes:** QRSs widened w/ notched Rs (Delta waves), Re-entrant impulses
- **Sick sinus syndrome:** Bradycardia pattern, Female miniature schnauzer - Weakness, syncope



Diagnosis of arrhythmias

IM 60; Pys 152

- History (Hx)
  - **Digitalis toxicity common cause of arrhythmias**
- **CS of arrhythmias: episodic weakness, fainting, CHF**
- Physical exam:
  - Other signs of cardiac diz? or other dizs or abnormalities?
  - ± Pulse deficits
- Auscultation:
  - Heart sounds of varying intensity?
  - Splitting of heart sounds (VPCs)?
- **ECG (electrocardiogram):**
  - HR (too fast, too slow, normal?)
  - Rhythm (regular or irregular?)
  - P waves (normal or abnormal?)
    - . F waves?
  - QRS complexes (normal [sinus origin] or wide [ventricular origin])
    - . Premature QRS not proceeded by a P wave (atrial)
  - P-R interval (normal, short or prolonged)
  - No consistent relationship between P waves & QRS complexes (2° & 3° or complete AV block)
  - Long pauses before an abnormal complex (escape beats)?
- Further diagnostics needed?
- Decide if antiarrhythmic Tx indicated
- Monitor patient

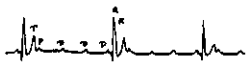


Treatment of arrhythmias H-T/M 371

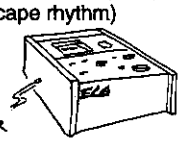
- Some require no Tx; others require aggressive Tx
- Bradycardias - rest
- **All arrhythmias:**
  - Oxygen therapy
  - Correction of acid-base & electrolyte imbalances & fluid disorders
  - Stop drug if causes arrhythmia (Digitalis)
- Pacemaker therapy:
  - Indication: symptomatic bradyarrhythmias:
    - . Sinoatrial dysfunction (arrest & standstill)
    - . AV block (2nd [Mobitz type 2] & 3rd degree blocks)
  - Methods: pulse generator & electrode:
    - . Epicardial (thoracotomy)
    - . Transvenous or endocardial (fluoroscopy)

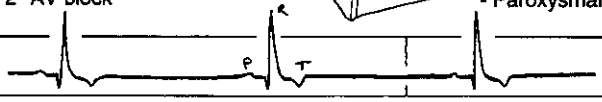
DDx - HR & rhythm disturbances

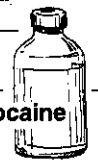
IM 60



- **Slow, regular rhythms**
  - Sinus bradycardia
  - Complete AV block (ventricular escape rhythm)
  - Atrial standstill (ventricular escape rhythm)
- **Slow, irregular rhythms**
  - Sinus block/arrest
  - Sick sinus syndrome
  - 2° AV block
- **Fast regular rhythm**
  - Sustained ventricular tachycardia
  - Atrial tachycardia
  - Sinus tachycardia
- **Fast irregular rhythms**
  - APCs (atrial premature contractions)
  - Paroxysmal atrial tachycardia
  - Atrial flutter or fibrillation
  - VPCs (ventricular premature contractions)
  - Paroxysmal ventricular tachycardia







Lidocaine

Antiarrhythmic Drugs

Drugs	Mechanism	Uses
Group 1 drugs		
• **Lidocaine**	↓ **Na conduction**	**Ventricular arrhythmias (DOC)**
• Quinidine (Quinidex®)	"	" Not given w/ digitalis
• **Phenytoin (Dilantin®)**	"	**Digitalis toxicity**
Group 2 Drugs	**Beta blockers**	↓ sympathetic tone
• **Propranolol (Inderal®)**	"	**Supraven. & ventricular arrhythmias**
. Atenolol (Tenormin®)	"	"
Group 3 Drugs: Bretylium, amiodarone	Expensive, not used much in vet med.	
Group 4 Drugs	Ca+ channel blockers	Supraventricular tachyarrhythmias (atrial fibrillation)
• Diltiazem (Cardizem®)	"	Not given w/ beta blockers ??
Miscellaneous antiarrhythmics:		
• **Digitalis glycosides**	Negative chronotrope	Atrial fibrillation & cardiac diz
• Anticholinergics	↑ HR (parasympathetic)	Bradycardia
- **Propantheline** (Pro-Banthine®)	"	"
- **Glycopyrrolate (Robinul®)**	"	"

Inderal

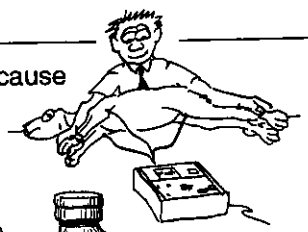
Cardizem

Digoxin

Pro-Banthine

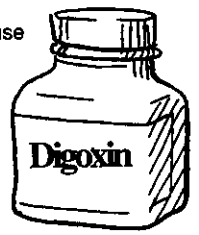
Robinul

Arrhythmias	Facts	ECG	Treatment: Stop digitalis if cause
• **Normal rhythms**			
- Sinus rhythm	Normal	Dog 60-180 bpm, cat: 120-240 bpm	Normal
- Sinus arrhythmia	Dog, normal respiration	HR increased w/ inspiration	Normal
- Wandering pacemaker	Pacemaker shift	P wave alteration	
• **Bradycardia**			
- Sinus bradycardia	Normal or pathological	Dog < 70 bpm, Cat < 90 bpm	None or glycopyrrolate (Robinul®)
- Sinus arrest	Usually insignificant	R-R interval pause	None
- Sick sinus syndrome	Female min. schnauzer	Bradycardia	Pacemaker
- Atrial standstill	Hyperkalemia? breed?	No P waves	IV NaCl
- AV blocks			
. 1st degree AV block	Asymptomatic	Prolonged P-R interval	None
. 2nd degree			
.. Mobitz 1		P-R lengthens to QRS drop	Propantheline (Pro-Banthine®)
.. Mobitz 2		Bigeminy/trigeminy - QRS drops	Pacemaker
. 3rd degree	Complete block	Many Ps few QRSs	Pacemaker
- Junctional rhythm	AV junctional impulses	Negative P waves	Propentheline, Stop digitalis
- Branch blocks		Wide QRSs	
. RBBB			None
. LBBB or AFB	Course fs		Tx underlying cause
• **Tachycardia**			
- Sinus tachycardia	Exercise - normal	Dog: >160 bpm, Cat: > 240	None
- Atrial tachycardia	Cardiac diz	≥ 4 APCs in succession	Digitalis
- Atrial flutter	Very rare		Digoxin
- Atrial fibrillation	Enlarged atria	Fine "f" waves/ no "P" waves	Digoxin
		Irregular irregular HR	
- Junctional tachycardia		Negative P waves	Digoxin
- Ventricular preexcitment WPW syndrome	Accessory pathways	Delta waves	Propranolol (not digoxin)
- Ventricular tachycardia	Life threatening	> 3 PVCs in a row	Lidocaine
- Ventricular fibrillation	Precedes cardiac arrest	Chaotic, bizarre oscillations	Cardiopulmonary resuscitation
- Cardiac arrest			CPR



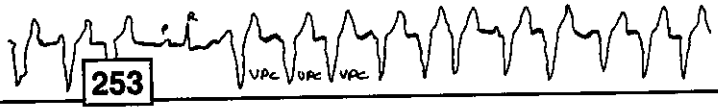
Robinul

Pro-Banthine



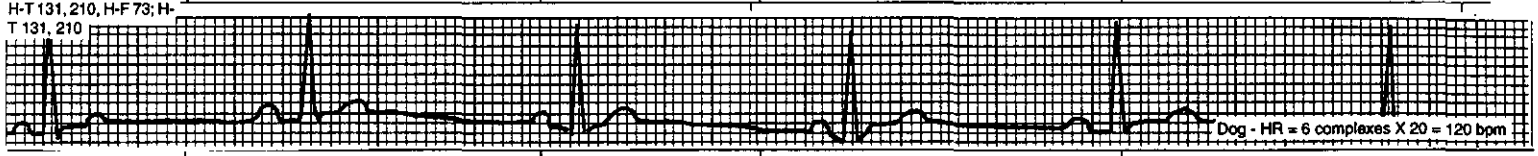
Digoxin

Lidocaine



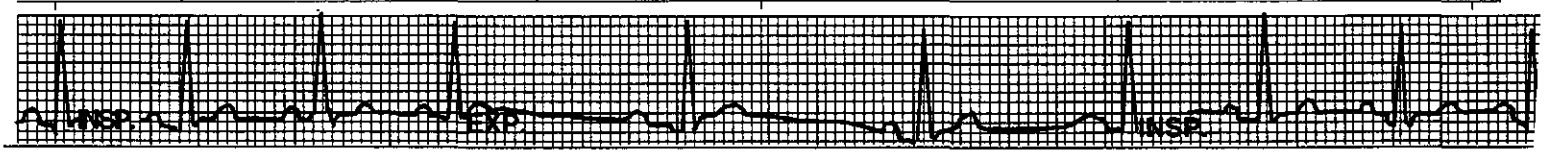
Rhythm - Normal - Bradycardia

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Normal sinus ** rhythm** M8k 78; Mk 42; H3B 66; H-T/M 61, 377; SAP 422, E-hb 398; E 962; Cat 928; H-T 131, 210, H-F 73; H-T 131, 210	• Normal resting rhythm in dogs & cats	• **Normal rhythm**	• Regular rhythm w/ less than 10% variation in R-R interval • Normal P wave for each QRS • P-R interval is constant • **HR: dog: 60-180 bpm** **- Cat: 120-200 bpm**	• **None required**



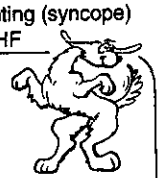
Normal sinus arrhythmia **Respiratory sinus arrhythmia** M8k 78; Mk 42; IM-WW 188; H3B 66; H-T/M 64, 377; Cat 928; 5min 301; SAP 422; T 133; E 978; H-T 133; H-hb 29; H-F 73; NB 3.14; Pys 383 ********	• **Normal rhythm variation in dogs** - Especially brachycephalic breeds (increased by upper airway obstruction) - Inspiration decreases vagal tone - Abnormal in cat - Atropine eliminates (vagal in nature) • Pathological conditions w/ sinus arrhythmia - Pronounced in dogs & cats w/ respiratory dz - Sinus arrhythmia associated w/ sinus bradycardia may suggest digitalis toxicity • **Wandering pacemaker** - Variation of sinus arrhythmia	• **Normal variation of normal sinus rhythm**	• **HR increased on inspiration** • **HR decreased on expiration** • All criteria like sinus rhythm, except: - Irregularity of R-R interval > ± 10% • Normal P-QRS-T complexes, with a wandering pacemaker (morphological changes in P wave)	• **Normal rhythm in dog** • **No Tx required**

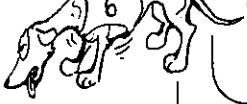
Normal dog arrhythmia related to breathing

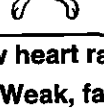


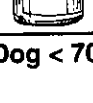
Sinus wandering pacemaker Mk 42; E-hb 404; E 978; H-T 138, 212 *******	• **Variation of sinus arrhythmia** - Irregular, multiform, supraventricular rhythm w/ changing P wave morphology • Pacemaker shifts w/in SA node or to AV node • **Frequently a normal finding in dogs**	• Asymptomatic - **Normal finding**	• Normal P-QRS-T complexes • **P waves: change in configuration** **- Differ in height, may become negative** • Normal heart rate	• No Tx required
Sinus bradycardia M8k 78; Mk 43; H-T/M 64, 379; SAP 423; H3B 67; H2B 73; I2M 77; IM 66; IM-WW 188; E 978; 5min 302; Cat 928; H-T 133, 213; H-F 74, 295; Sx-WW 95; NB 3.14; Pys 471 ******	• **Regular sinus rhythm w/ a slow heart rate** - Normal in **athletic dogs**	• **Asymptomatic** • **Weakness** & lethargy • Fainting (syncope) • ± CHF	• **Normal P-QRS-T complexes & regular rhythm** • Heart rate: - **< 70 in dogs** (< 60 in giant breeds) - **≤ 90 bpm resting cat** (< 120 bpm in nonresting) • Atropine response test, then ECG in 15-30 min	• **None if normal physiological rhythm** • **Treat underlying problem** • If increased HR on atropine test consider anticholinergics: - **Glycopyrrolate** (Robinul®): IV SQ or IM - Propanteline (Pro Banthine®) PO - Isoproterenol (Isuprel®) • Artificial pacemaker if poor clinical response • Congestive heart failure - Diuretics - Vasodilators Prognosis: • Guarded to good

Causes:
- ↑ **vagal tone** - may be normal variation
- **Normal in athletic dogs**
- Cardiomyopathy
- Respiratory arrest
- Sick sinus syndrome
- Hypothermia
- Hypothyroidism
- Toxemia
- Hypo- or hyperkalemia, hypocalcemia
- Increased intracranial pressure
- CNS lesions
- Drugs: digoxin, beta blockers, Ca channel blockers, morphine derivatives, xylazine, anesthesia
- Dysautonomia

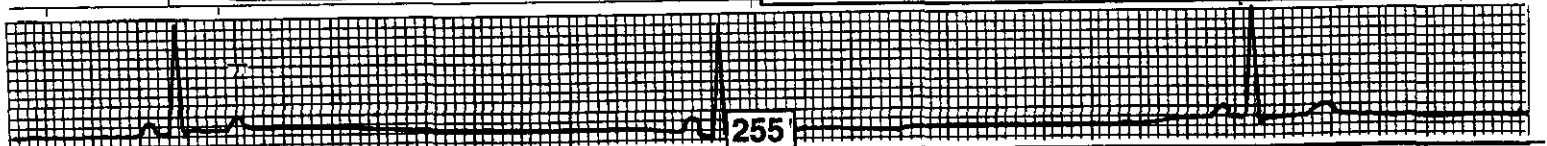








Slow heart rate: Dog < 70 bpm; Cat < 90 bpm
CS: Weak, faint
Dx: HR, Normal P-QRS-T, Atropine response test
Tx: None, Glycopyrrolate



Arrhythmia - Bradycardia

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Sinus arrest; Sinoatrial block, Prolonged sinus pause M8k 78; Mk 43; E-hb 404; IM-WW 188, 192; Cat 928; 5min 300; SAP 423; H2B 74; E 980; H-Pic 154; H-T 164, 230; H-F 61, 175; NB 3.15 **	• **1° disorder of SA node** - Lack of, or poor propagation of impulse - Often junctional or ventricular escape beats • **No clinical significance** usually • Cause: - ↑ **vagal tone** (brachycephalic dogs, ocular pressure, irritation of vagus nerve) - Atrial pathology (fibrosis, cardiomyopathy, tumor, drug toxicity [digitalis, propranolol, quinidine, xylazine & acepromazine]) - Sick sinus syndrome (miniature schnauzer) • **Brachycephalic breeds** - Extreme accentuation of sinus arrhythmia, markedly slowed during expiration	• **Asymptomatic:** usually clinically insignificant • Fainting (syncope) • Generalize weakness (wobbling, stumbling) • CHF (congestive heart failure)	• HR (heart rate) variable - Often bradycardia or slow sinus rhythm • Rhythms: regularly irregular or irregular w/ pauses • Normal P-QRS-T complexes • **Pauses of 2 or more R-R intervals** - May be terminated by an escape beat	• **Asymptomatic - none required** • Symptomatic - fainting: same as sinus bradycardia - Glycopyrrolate (Robinul®) - Propantheline (Pro Banthine®) • Unresponsive, consider pacemaker **DDx:** • Marked sinus arrhythmia • Sinus bradycardia • Nonconducted (APCs)
Sick sinus syndrome Mk 43; H-T/M 71, 394; SAP 434; H3B 70; H2B 74, I2M 78; IM 66; 5min 299; E-hb 404; E 984; H-T 184; H-F 79, 296; Sx-WW 95; Pys 153, 471 **	• **SA node unable to generate an impulse** • **Female miniature schnauzer** - Other breeds reported: Pug, Boxer, Dachshund, Cocker spaniel, Doberman - Middle aged or older (geriatric) - Extremely rare in cat	• **Episodic weakness, ataxia** • **Fainting** (syncope) • ± **Confusion** • Stokes-Adam's seizures • Sequela: CHF	• **Hx (breed)**, CS • ECG - one or more of following rhythms - Sinus bradycardia - Sinoatrial block (pauses) - Sinus arrest - **Alternating brady & tachycardia** • Some may have normal resting ECG (24 hour ambulatory ECG) • Refer for further testing	• **Pacemaker** TOC (Tx of choice) • If pacemaker not feasible - Glycopyrrolate - Propantheline (Pro Banthine®) **Prognosis:** • **Poor** for long term survival • Extension of life possible w/ pacemaker or drugs

Normal in brachycephalic - ECG pauses

**** Miniature schnauzer, ECG: Slow/fast, pauses**
CS: Faint, weak, confused
Tx: Pacemaker

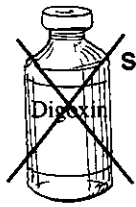
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Sinoatrial standstill, **Persistent atrial standstill** H-T/M 66; H-T 166, 182, 240; SAP 432; H3B 71; H2B 74; I2M 78; IM 67; IM-WW 193; 5min 286; Cat 935; E 981; H-Pic 154; H-T 166, 182, 240; H-F 61, 296; NB 3.15; Sx-WW 96 **	• **Bradycardia** • **Impulse not generated in SA node** & poorly or not conducted through atrial tissue - **Junctional or ventricular escape rhythm controls heart** • **Cause:** - **Hyperkalemia** . Hypoadrenocorticism . Acute renal failure . Urinary obstruction . Diabetes ketoacidosis - Dilated cardiomyopathy (cat) - **Digitalis toxicity** - Muscular dystrophy (Springer spaniels) • Dog; extremely rare in cat • Breed: English springer spaniels, Shih tzu, Old Eng. sheepdog (correlated w/ muscular dystrophy [silent atrium]) • **Life threatening if associated w/ hyperkalemia**	• **Weakness** • **Hypovolemic shock** • **CHF** • **Sudden death**	• **Hx (breed)**, CS • ECG: - **Bradycardia:** < 60 bpm - dog < 90 bpm - cat - Rhythm regular or irregular - **No P waves in any lead** - QRS complexes normal or bizarre - S-T segment elevation or depression - Tall T waves due to shortened repolarization • Cardiac enlargement • Normal electrolytes w/ persistent atrial standstill • Laboratory - Check potassium level	• **If hyperkalemia suspected** - Emergency Tx ("push" K^+ into cells) . **0.9% saline**, 40-90 ml/kg/hr until hyperkalemia & hypovolemia corrected; plus: .. **2 mEq/kg sodium bicarbonate** slowly IV (beware of paradoxical cerebral acidosis); or .. **0.5 U/kg of regular insulin** slowly IV • If life threatening condition - **Calcium gluconate** (1 ml of 10% solution/ 10 kg slowly IV [temporarily counteracts cardiotoxic effect of hyperkalemia]) • If hyperadrenocorticism is the cause: - Mineralocorticoid & glucocorticoid replacement • Stop digitalis if cause • Silent atrium - Isoproterenol may be tried - Permanent cardiac pacemaker in Eng. springer spaniels (rarely done) **0.9% NaCl** Prognosis: • Hyperkalemia: good if corrected • Silent atrium - Grave: progressive myocardial failure usually develops

**** No Atrial pacemaker, Ventricle takes over**
CS: Weak, Fainting, Shock, Death
Dx: No P waves in any lead, Bradycardia
Tx: Emergency for hyperkalemia - NaCl

AV Blocks - Bradyarrhythmias

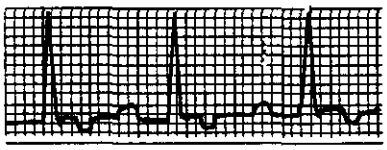
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Incomplete (1st & 2nd degree) AV heart block M8k 78; Mk 43; H-T/M 67, 382, 393; T 74, 169, 231; SAP 433; Cat 936; E-hb 404; I2M 79; IM 67; IM-WW 193; H3B 72; H2B 75; E 981; H-T 74, 169, 231; H-F 61, 295; H-Pic 154; NB 3.20; Sx-WW 96 **	• **Partial block of impulse in AV node or AV junction** • Rare in cat • Types: - 1st degree AV block - Mobitz type 1 (2nd°) AV block . More advanced degree of block • **Digitalis #1 cause**	• **Type 1 usually none** • Type 2 - **Weakness** - **Fainting (syncope)** - Congestive heart failure • Cats - ± Asymptomatic, may tolerate 2nd & 3rd degree blocks	• Heart rate variable • **1st degree block** - Regular rhythm unless other arrhythmias - **Prolonged, constant P-R interval** . **Dog: > 0.14 sec** . **Cat: > 0.08 sec** - Normal P wave & QRS complexes - 1:1 ratio • **2nd degree block** - Normal P waves & QRS complexes - **Mobitz type 1 (Wenckebach) AV block** . **P-R interval gradually prolonged before QRS dropped** . Rhythm: regularly irregular - **Mobitz type 2** . **P-R interval not prolonged** . QRS absent after repeated P wave stimulation .. **Bigeminy**: 2 P waves to 1 QRS complex (2:1) .. **Trigeminy**: 3:1 pattern • **Atropine challenge test**: determine degree of vagal influence - Organic heart diz . Block unchanged or worsens - If corrects Tx w/ anticholinergic	• **1st ± Mobitz type 1 (2nd): Tx not required** - Stop digitalis or other "causing" drugs • **Some Mobitz 1 & Mobitz 2**: Tx depends on CS (weakness, syncope) - Short term: . Glycopyrrolate (Robinul®) . Propantheline (Pro Banthine®) . Dobutamine (Dobutrex®) . Isoproterenol (Isuprel®) - **Permanent pacemaker (TOC)** **Stop digitalis** Prognosis: • 1° = good • 2° = guarded • 3° = poor to fair

Causes:
- Normal aging phenomena (type 1)
- Increased vagal tone
  - Brachiocephalic breeds
  - Respiratory diz
  - GI diz
  - Neurological diz
- **Digitalis toxicity (#1 cause)**
- Sedatives (xylazine, acetylpromazine)
- Antiarrhythmic drugs (propranolol, quinidine, procainamide &)
- AV nodal diz
- Heartworm
- Bacterial endocarditis
- Cardiomyopathy
- Myocarditis
- Hypertrophic cardiomyopathy
- Idiopathic fibrosis
- Hereditary stenosis of His bundle
- Neoplastic metastasis
- Profound electrolyte disorders
- Infection (Lyme diz)

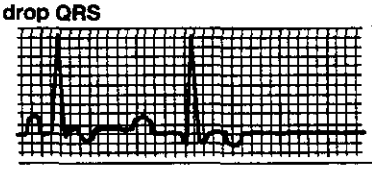


Prolonged P-R interval, Digitalis
CS: None, Weak, Fainting
Dx: Long P-R, Dropped QRS, Atropine
Tx: None to atropine to pacemaker

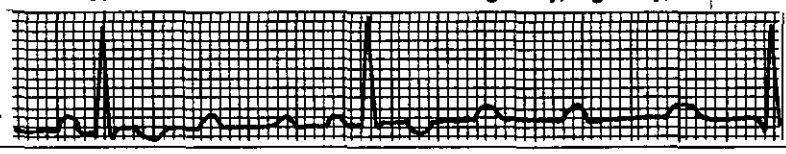
Type I - Prolonged P-R interval



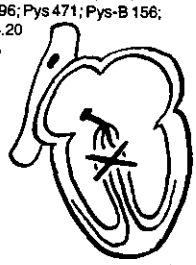
Mobitz type I - progressive P-R & then drop QRS



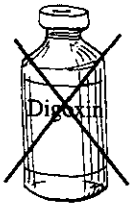
Mobitz type II - absence of QRS after P waves - bigeminy, trigeminy, etc.



Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Complete (3rd degree) AV Block, Atrioventricular block, "Stoke-Adam's" syndrome M8k 78; Mk 43; H-T/M 68, 382, 394; SAP 433; E-hb 404; H3B 72; H2B 75; I2M 79; IM 67; IM-WW 193; Cat 936; 5mln 290; E 981; H-T 74, 175, 235; H-F 63, 295; H-Pic 154; Sx-S 882, 913; Sx-WW 96; Pys 471; Pys-B 156; NB 3.20 **	• **Impulse completely blocked** (AV junction or His bundle) • **Escape rhythm**: heart rate taken over by accessory pacemaker tissue (junction or ventricle) - **Junctional escape: 40-60 bpm** - **Ventricular escape: 20-40 bpm**	• Junctional escape - Asymptomatic • Ventricular escape - Weakness - Fainting (syncope) - Congestive heart failure	• Hx, CS • Normal P waves with a normal atrial rate of 70-80 beats/min • QRS complexes - slower rate: escape beats - bradycardia - Dog < 52 bpm - Cat < 64 bpm • **No association of P wave & QRS complexes** (many Ps & few QRSs) • QRS looks aberrant (wide & bizarre) - Called ectopic beats (originate from accessory pacemaker tissue) • Atropine challenge test (see above)	• **Permanent cardiac pacemaker** (long term) for symptomatic animals • Stop digitalis therapy if the cause • Short term Tx - **Glycopyrrolate (Robinul®)** - Isoproterenol (Isuprel®) - Dobutamine (Dobutrex®) - Corticosteroids **Prognosis: Poor**

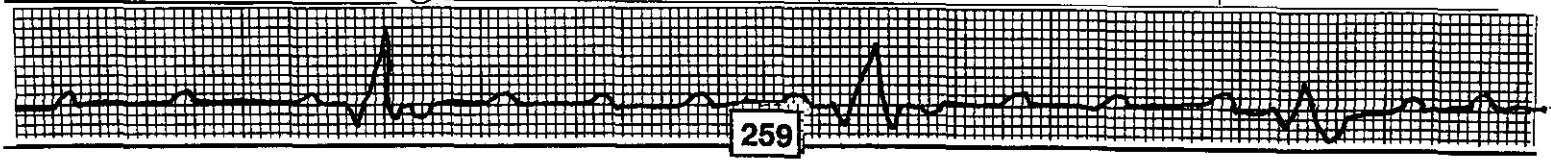


Causes:
- Digitalis toxicity
- Cardiomyopathy
- AV node disease
- See cause of type 1 & 2 blocks
- AV conduction dizs (infarction, inflammation, neoplasia)
- Congenital disorders (AS, VSD, AV block)

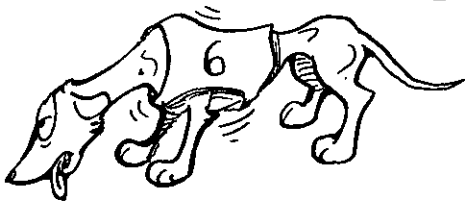


DDx:
- Advanced 2° AV block
- Atrial standstill
- Ventricular tachycardia

Ventricular escape rhythm
CS: None, Weakness, Fainting, CHF
Dx: Hx, P & QRS don't match
Tx: Atropine, Pacemaker



Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Sinus tachycardia Mk 44; H-T/M 64, 380; C12T 807; SAP 426; E-hb 400; I2M 76; IM 64; IM-WW 188; H3B 74; H2B 77; C12T 807; H-T 133, 213; H-F 74, 298; 5min 303; Cat 929; Pys 154; NB 3.14 ★★★★	• **High rate rhythm from SA node w/ consistent 1:1 AV conduction** • **Usually normal physiologic response to exercise**	• **Usually no symptoms** (asymptomatic) • Shortness of breath • Weakness	• Heart rate - **rapidly regular** **- Dog > 160-180** **- Puppies > 220** **- Cat > 240** • All other ECG features normal • Ocular pressure will decrease heart rate (vagal maneuver)	• **No Tx required** if normal physiological response • Treat underlying cause • Antiarrhythmic drugs seldom required • Propranolol (Inderal®) to hyperthyroid cats w/ intractable tachycardia (unresponsive to antithyroid drugs) • Congestive heart failure - Digoxin - Diuretics (furosemide [Lasix®]) - Vasodilation - Exercise restriction - Dietary sodium restriction



Causes - sinus tachycardia
- **Normal** sympathetic tone from:
  - **Exercise or excitement**
  - Stress (fright, anxiety, heat)
- **Fever** (pyrexia)
- Anemia
- Shock
- Congestive heart failure (CHF)
- **Hyperthyroidism**
- Pheochromocytoma
- Drugs (atropine, sympathomimetic agents, ketamine, diazepam, light anesthesia)
- Electrical shock

DDx:
- Paroxysmal tachycardia
- Atrial flutter
- Ventricular tachycardia

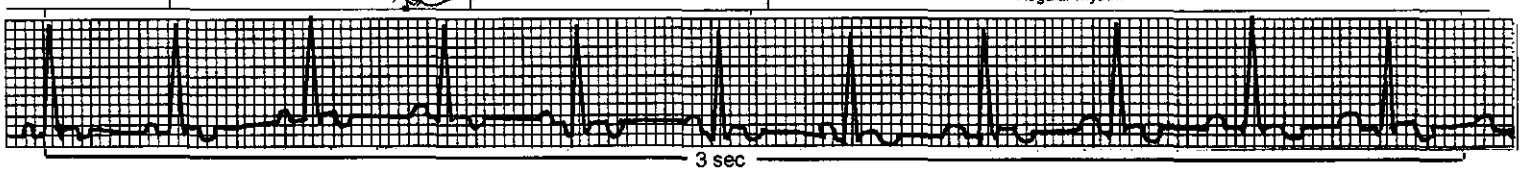
Fast HR - Normal or Pathological
CS: Asymptomatic
Dx: Dog > 160 bpm; Cat > 240 bpm
Tx: None usually

Prognosis: excellent

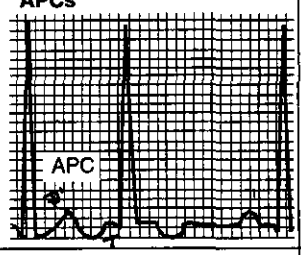
Faster rate

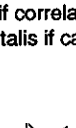
50 mm/sec proper speed

Dog - HR = 11 complexes (3 sec) X 20 = 220 bpm
Regular rhythm



Atrial premature contractions/ complexes/ depolarizations **APCs/ APDs** **Supraventricular premature contractions** Mk 44; IM-WW 188; H-T/M 64, 380; T 140, 215; SAP 426; H2B 77; H-T 140, 215; H-F 76; 5min 285; NB 3.16 ★★★	• **Impulses originate from an atrial focus other than SA node** - Isolated, pairs, runs (3 in succession) or paroxysmal supraventricular tachycardia (4 or more in a row) or sustained supraventricular tachycardia	• **No symptoms for isolated APCs**	• **ECG:** - **APCs** (premature P-QRS-T complexes followed by **pause**) - **Irregular rhythm** - Abnormal P **(P')** followed by normal QRS complex - P wave may be hidden in T wave of proceeding beat - P-R intervals constant	• **No Tx required** - Infrequent APCs m/b normal • Digitalis if correlated w/ CHF • Stop digitalis if cause Prognosis: • **Good**, m/b normal



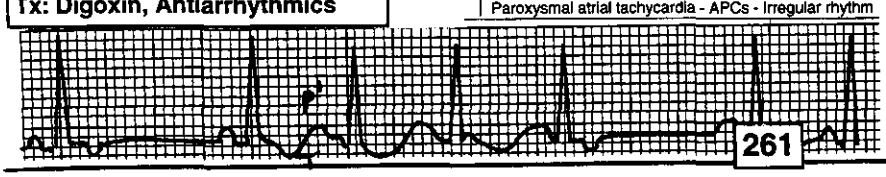


Atrial tachycardia, **Paroxysmal atrial tachycardia, Sustained supraventricular tachycardia** M8k 79; Mk 44; H-T/M 65, 383; T 142, 217; C12T 807; SAP 427; E-hb 400; H3B 76; H2B 77; I2M 76; IM-WW 189; 5min 288; E 969; C12T 807; H-T 142, 217; H-F 77, 298; H-Pic 155; Pys 154, 170; NB 3.16 ★★	• **≥ 4 APCs in succession** - Paroxysmal (recurring) - Sustained	• **Episodic weakness** • **Hypotension** • **Heart failure** - Fainting (syncope) - Precipitation or worsening of CHF - Sudden death	• **Heart rate > 140-180 in dogs, > 240 bpm in cats** • Rhythm usually regular • **4 or more APCs in succession**	• **Sustained tachycardia - requires immediate Tx** • **Vagal maneuver** (ocular pressure or carotid sinus pressure) m/ terminate re-entrant atrial tachycardia • **Digitalis** if CHF - If ineffective . Diltiazem or propranolol • Atrial tachycardia w/o CHF - **Propranolol** (Inderal®) or diltiazem (Cardizem®) • Refractory atrial tachycardia - IM quinidine gluconate to convert • **Discontinue if digitalis** the cause **Prognosis: guarded**

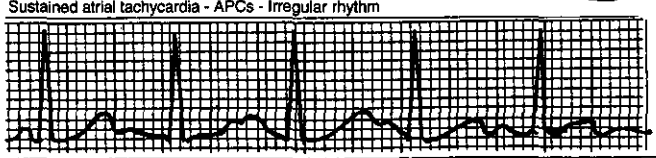
Causes of APCs & atrial tachycardia
- Often indicate underlying cardiac diz
  - Atrial enlargement (AV insufficiency)
  - Congenital defects (PDA, AV dysplasia)
  - Chronic valvular fibrosis
  - Myocardial diz
  - Conduction system diz
  - Cardiomyopathy
  - Congenital defects (PDA, AV valve insufficiency)
  - Cor pulmonale
- Electrolyte disturbances
- Systemic diz
- Hypoxia
- Anemia
- Drug toxicity
  - **Digitalis**
  - Dopamine
  - Dobutamine
  - General anesthesia
- Hypokalemia
- Toxemia
- Increased sympathetic tone
- **Hyperthyroidism** (cat)

4 APCs w/ QRS complexes
CS: Weakness, Hypotension, HF
Dx: ECG, ↑ HR
Tx: Digoxin, Antiarrhythmics

Paroxysmal atrial tachycardia - APCs - Irregular rhythm



Sustained atrial tachycardia - APCs - Irregular rhythm



Atrial Flutter - Fibrillation

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Atrial flutter & **Atrial fibrillation,** Accelerated atrioventricular rhythm M8k 79; Mk 45; SAP 452; H3B 82, 76; H2B 79; I2M 76, 78; IM 21; IM-WW 189; 5min 299; E-hb 400; E 972; T 144; H-T 144-6, 220; H-F 77, 300; H-Pic 155; Pys-B 154; NB 3.17 **	• **"Flutter" rare, ("saw-toothed f") waves** usually over 400/min followed by irregular or regular ventricular response; unstable, degenerating into fibrillation or back to normal rhythm • **Fibrillation:** rapid, disorganized depolarization of atria + **irregular AV conduction** - Variable & irregular ventricular response • Pathophysiology: - Reduced cardiac output due to: . High ventricular rate . ↓ stroke volume • Mechanism - unknown - Circus movement of electrical impulses in a ring of tissue between the 2 vena cavae, or - Rapid discharge of ectopic atrial foci • Large breeds w/ large atria may have fibrillation w/o diz • Small breeds usually have an underlying diz resulting in enlarged atria	• **Congestive heart failure** (HF) - **Weakness** - **Fainting** (syncope)	• **CS** • **Absolute irregularity of R-R intervals** • Fibrillation: No P waves (**fine f waves**), flutter: sawtoothed waves • Normal QRS-T complexes usually • **Rapid & irregular ventricular rate** • **HR > 160 bpm - dog** - Atrial rate 600-700 bpm	• **Digoxin** (slow rate - negative chronotrope) • Diuretics if in congestive heart failure • **Propranolol** (Inderal®) added if HR remains ≥160 bpm after using digoxin, stabilize CHF first • Diltiazem (Cardizem®) helps some to convert to sinus rhythm • Quinidine gluconate added to propranolol: if recent onset of fibrillation, withdraw after conversion Digoxin Cardizem Inderal Px: **Guarded in small animals**

Causes - atrial fibrillation
- **Cardiomyopathy w/ dilated atria**
- **Advanced chronic valvular diz** (toy breeds)
- Congenital heart diz
- Severe ischemia or shock
  - Gastric dilatation/volvulus
  - Cardiac arrest
- Atrial tumor (hemangiosarcoma)
- Electrolyte disturbances (hyperkalemia)
- Heartworm diz
- Slow atrial fibrillations (< 100 bpm)
  - **Drug toxicity (digitalis)**
  - Concurrent AV block
  - Low sympathetic tone (giant breeds)

**** Rapid atrial rate**
CS: CHF (weakness, syncope, dyspnea)
Dx: f waves, No P waves, Fast, Irregular HR
Tx: Digoxin, Propranolol

Fine "f" waves

Flutter - Sawtooth waves

Junctional rhythm

H3B 79; H-T 148; H-F 80; H-T/M 66, 385, Cat 934; SAP 428; NB 3.16, 3.19

**

Digitalis

- **Impulses generated in AV junctional tissue**
  - Spread backwards (retrograde) through atrium (negative P waves [P']) & forward (antegrade) to ventricles

- **Reverts spontaneously** usually
- ± Syncope
- ± Weakness

Cause:
- Digitalis toxicity
- Sick sinus syndrome
- Myocarditis

- Rhythm usually regular
- HR can be junctional (40-60 bpm) or have a junctional tachycardia (60-100 bpm)
- **±Negative P' waves** before, during or after **normal QRS complex**
- P'-R & R-P' interval constant
- Ocular or carotid sinus pressure can temporarily slow tachycardia if due to digitalis toxicity

- No Tx required as rhythm usually reverts **spontaneously**
- Stop digitalis if cause
- Syncope & weakness
  - Dobutamine or isoproterenol to accelerate SA node
- Digitalis if concurrent CHF (congestive heart failure)

Dobutamine

Stop Digoxin if cause, use if CHF

JPCs (Junctional premature [escape] contractions)
- Usually due to digitalis toxicity
- CS: **Asymptomatic if single**
- **Dx: Negative (-) P wave**, Irregular R-R intervals, **Normal QRS complexes**, Premature P-QRS-T followed by a pause
- **Tx: Discontinue digitalis treatment**

P' JPC

DDx:
- Atrial standstill
- Slow atrial tachycardia

Prognosis: ???

Junctional rhythm - Negative P waves, slow rhythm

P'

Junctional tachycardia - HR 60-100 bpm - Negative P waves

Ventricular pre-excitation

H3B 83; H-T/M 67, 71; H-T 180; Cat 936; SAP 434; E 972; C12T 807

**

- Ventricular pre-excitation
  - Impulses from SA node spread to ventricles via anomalous conduction pathways as well as AV node
- Cause: unknown
  - Congenital in dogs & cats w/ or w/o other congenital defects (atrial septal defect, valvular dysplasia, hypertrophic cardiomyopathy)

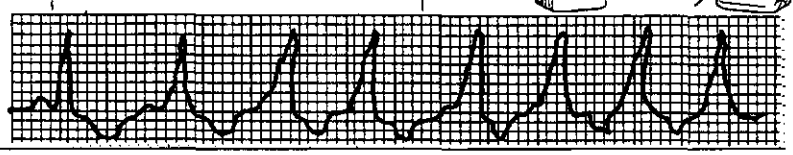
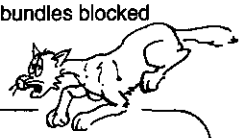
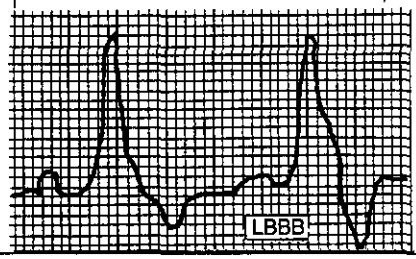
- **Asymptomatic, incidental finding**

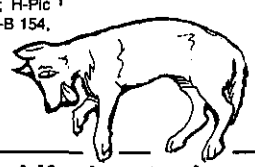
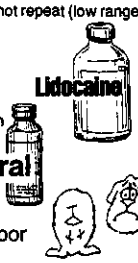
- Cardiac rate & rhythm normal
- P waves normal
- **QRS complexes - widened w/ notching of R wave** (delta wave)
- P-R interval short

None required

Delta wave

Miscellaneous Arrhythmias

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Wolf-Parkinson-White (WRW) syndrome IM-WW 193; Cat 746; 5min 308; H-T/M 68, H-T 179, 236; H-F 67; SAP 434; H2B 87; NB 3.21 * 	• **Cats** • WPW syndrome - Ventricular pre-excitement . Impulse uses accessory pathways to bypass AV node . Activate portions of ventricle . Paroxysmal (recurring) supraventricular tachycardia • Lown-Ganong-Levine (LGL) syndrome: similar to WPW • Cause: - Congenital: rare - Acquired - Feline hypertrophic cardiomyopathy - Canine chronic valvular diz	• Episodic weakness, syncope • Tachycardia-induced CHF **DDx:** • AV junctional tachycardia • Atrial tachycardia • Ventricular tachycardia • Shortened P-R interval - Fever - Hyperthyroidism - Anemia	• **HR rapid, often greater than 300 bpm** • P waves unrecognizable • **QRS complexes: normal, wide or bizarre** - **± Delta wave** • **Tachycardia** • P-R interval: short • Episodes of supraventricular tachycardia - P & delta wave disappear 	• **Conversion of tachycardia** - Vagal maneuver (eye or carotid sinus pressure) - Propranolol, Cardizem®, adenosine • **Avoid digitalis** (accelerates accessory pathway conduction) **Inderal** Digoxin
Bundle branch block (Right or Left), Intraventricular conduction blocks IM-WW 194; H-T/M 68; H-F 64; E 984; H2B 86; 5min 296, 298; Cat 938; NB 3.21 *** 	• LBBB (left bundle branch block) - Associated w/ severe dilation of left ventricle - Fascicular block (1 of 2 division of left bundle branch) - Cats: associated w/ hypertrophic cardiomyopathy & hyperthyroidism - Anterior fascicular block (AFB): positive QRS in leads I and avR) • RBBB (right bundle branch block)	• Asymptomatic (if subtotal block) • RBBB: may be incidental finding w/o clinical significance (normal CO) • **LBBB indicates significant myocardial diz** • **Complete (3rd °) AV block if** all bundles blocked  • **Causes** - Occasionally in normal dog (RBBB) - Cardiomyopathy (AFB cats & LBBB dogs) - Congenital defects - Tumor or trauma - Myocarditis - Canine chronic valvular fibrosis - Heartworm & other pulmonary dizs - Hyperkalemia	• **QRS prolonged** (> 0.08 sec in dog, > 0.06 sec in cat) • Right bundle branch block: Deep S wave (QRS complexes) - Differentiate from right ventricular enlargement w/ radiographs • Left branch block: tall wide QRSs w/ slurred ST segment  LBBB	• None if isolated bundle blocks • **Pacemaker if complete AV block** • Periodic ECG monitoring

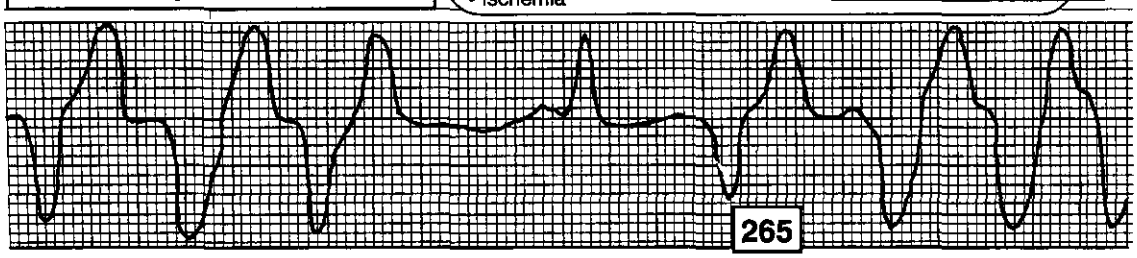
Ventricular premature contractions/ apolarization **VPCs, Ventricular tachycardia** M8k 80; Mk 44; H-T/M 69, 386; T 156, 226; C12T 799; SAP 429; H3B 80; H2B 85; 5min 305, 307; E-hb 400; I2M 73, 77; IM 21, 66; IM-WW 191; E 974; H-T 154, 224; H-F 81, 301; H-Plc 155; Pys 471; Pys-B 154, NB 3.18 **  **> 3 VPCs, Life threatening** **CS: Fainting, Seizure, Death** **Dx: VPCs & Bizarre QRSs** **Tx: Dog - Lidocaine, Quinidine** **Cat - Propranolol**	• **VCPs = ectopic impulse originating in ventricles** • Breeds: Doberman, Boxer • **Tachycardia = > 3 VPCs in a row** - Life threatening - **Ventricular fibrillation can easily follow** • **Paroxysmal or sustained**	• Asymptomatic esp. if isolated VCPs if no underlying 1° cardiac diz • **Fainting** (syncope) • **Shock** • **Sudden death** • Sequelae: - Hypotension - Myocardia ischemia - CHF (congestive heart failure)	• Hx (cause), CS • Premature QRS-T complexes - **wide & bizarre,** VPCs usually coupled to normal beats, Ventricular bigeminy: 1 to 1 pairing of VPC w/ normal beat. Usually full compensatory pause following VPC • ± P waves, not fixed relationship w/ QRS • Tachy: **4 or more VPCs in a row** - **Wide, bizarre QRS complexes** 	• **None if isolated VPCs** • **Withdraw digitalis** if the cause - Phenytoin for digitalis toxicity • **Antiarrhythmic required in most** - Exceptions: Complete heart block, Slow ventricular rhythms, Severe acid-base or electrolyte disturbances • **Dogs: Lidocaine** slow IV drip (initial TOC) - ± Repeat several times at 10 min intervals, Maximum total dose 8 mg/kg. Toxicity: seizures & vomiting (Valium® IV) - Once controlled w/ lidocaine . IM or PO procainamide, quinidine or tocainide . Slowly reduce lidocaine infusion over 24-48 hrs . Tx acidosis & hypokalemia - **Quinidine gluconate (Quinadex®)** or procainamide IM if lidocaine not indicated or impractical - Other antiarrhythmic drugs: tocainide, propranolol - If arrhythmias worsen . Consider antiarrhythmic drug toxicity (procainamide or quinidine toxicity) . Tx: withdraw drug, give bicarbonate, isoproterenol or dopamine - Once well controlled consider slow discontinuation of drugs over 2-3 weeks (monitor w/ ECG) - **Refractory cases - refer** to a cardiologist • **Cats: Propranolol (Inderal®)** in a slow IV drip infusion - Lidocaine IV slowly, do not repeat (low range of safety in cats • **Supportive care** - Oxygen - IV fluids - Potassium supplementation if needed  Lidocaine Inderal **Prognosis:** grave to poor

Cause of VPCs & Ventricular Tachycardia

- Cardiac diz: Congenital heart diz, Endocarditis, Myocarditis, Cardiomyopathy, Myocardial infarction
- Chest trauma, 12-24 hrs post HBC
- Pericarditis, pericardial effusion, tamponade
- Electrolyte disturbances
  - Altered serum potassium
  - Altered serum calcium
  - Altered blood pH
- Autonomic changes
- Hypoxia
- Systemic disturbances: Pyometra, Pancreatitis, Fever, Excitement, Uremia
- Hypoxia: Gastric or intestinal volvulus
- Ischemia
- Drug toxicity: **Digitalis**, Anesthesia, Antiarrhythmic drugs, Atropine (IV), Sympathomimetic drugs, Aminophylline IV
- Mechanical: Cardiac catheterization, Pericardiocentesis, thoracocentesis, Opened heart surgery

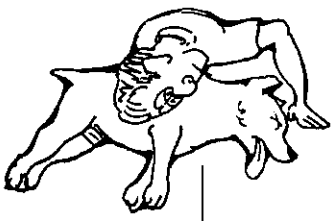
DDx:

- Sinus tachycardia
- Atrial tachycardia
- Atrial fibrillation w/ conduction disturbance (branch block)

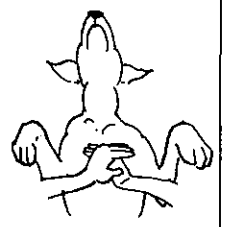


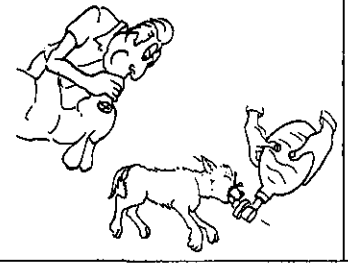
Ventricular Fibrillation

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Ventricular fibrillation IM-WW 192; H-T 228; H-F 82, 304; C12T 171; SAP 431; H3B 83; H2B 90; 5min 304; E-hb 402; H-Pic 156; Pys-B 155; NB 3.18 **	• **Chaotic, asynchronous impulse originating in the ventricles** • #1 arrhythmia associated w/ cardiac arrest • **No effective cardiac output**	• **Precedes cardiac arrest** - Slowing of heart rate - Slowing of respiratory rate - Gasping or irregular respiration - **Unconsciousness** • **Sequela:** - **Cardiac arrest**	• History, Clinical signs • Physical exam - **Weak or absence of palpable pulse** - Dishwasher gray or cyanotic mucous membranes • Auscultation - **Bradycardia or absence of heartbeat** • ECG (electrocardiogram) - No P waves - No recognizable QRS complexes - **Continuous, chaotic & bizarre positive & negative oscillations** . Oscillation coarse (large) or fine (small)	• **EMERGENCY SITUATION** • **Cardiopulmonary resuscitation** (CPR) immediately **Steps** to follow: - A = airway (intubate, etc.) - B = breathing: 10-12 breaths/minute - C = intrathoracic cardiac massage in animals >15 kg; external chest compression if < 15 kg ("thump" version) - Defibrillation equipment if available - D = Drugs/Electrocardioconversion - Intracardiac lidocaine occasionally successful Prognosis: • **Very grave**

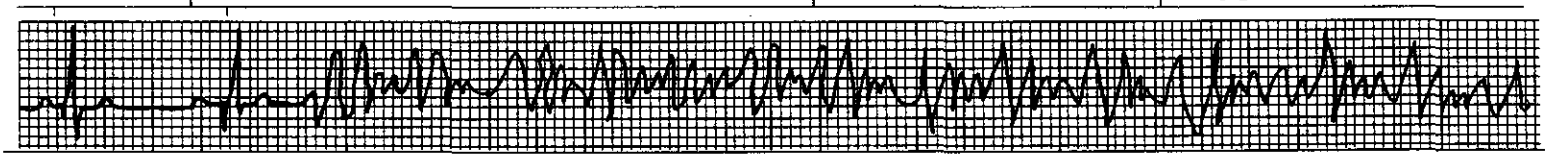


Cause:
- Myocardial ischemia
- Electrolyte imbalance
- Hypoxia
- Increased automaticity
- ANS imbalance
- Slow conduction
- Drug toxicity
- Unstable ventricular arrhythmias

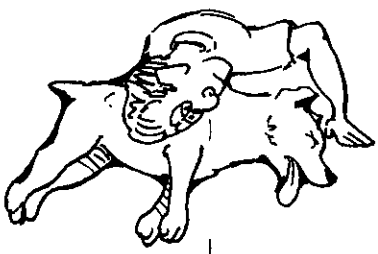


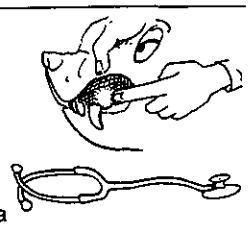


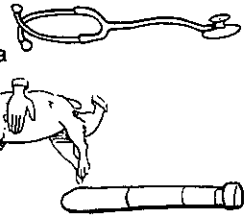
Chaotic ventricular impulses
CS: Precedes cardiac arrest
Dx: No pulse or heart beat, ECG - bizarre
Tx: Emergency - CPR



Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Cardiopulmonary arrest, **CPA,** **Ventricular asystole** I2M 93; IM-WW 195; 5min 26, 306; H-T/M 71, 72, 391, 425; H3B 85; H2B 88; SAP 432; C12T 171; H-T 228; H-hb 64; H-F 83, 341; IM 78 **	• **Sudden cessation of effective heart action, circulation & functional ventilation** • Absence of any ventricular **complexes** • No impulses generated in atrial, junctional or ventricular pacemakers	• **CS of impending arrest** - Slowing of heart rate - Slowing of respiratory rate - Gasping or irregular respiration - Deteriorating consciousness • **CS of cardiac arrest** - Loss of consciousness - Dilated pupils - Agonal gasping - Loss of muscular tone - Cessation of bleeding from surgical site or wounds • Sequela: Irreversible brain damage if not restored w/in 3-4 min	• **Usually based on CS & PE** • **Physical exam** - **No palpable peripheral pulse** - **Cyanotic mucous membranes** • **Auscultation: No heartbeat or bradycardia** • **ECG** - **Signs of impending arrest** . Progressive T wave enlargement (hypoxia) . S-T segment changes . Cardiac arrhythmias .. **Ventricular asystole** or severe bradycardia .. **Ventricular fibrillation** .. **Ventricular flutter** - No ventricular rhythm or cardiac rate - P waves present if complete AV block - NO QRS complexes - **Bizarre oscillations** • Laboratory: Check serum electrolytes & blood gases • Electromechanical dissociation: P-QRS-T & no cardiac output • Pulseless idioventricular rhythm: spontaneous ectopic ventricular depolarization w/ bizarre QRS complexes	• Treatment: see following pages

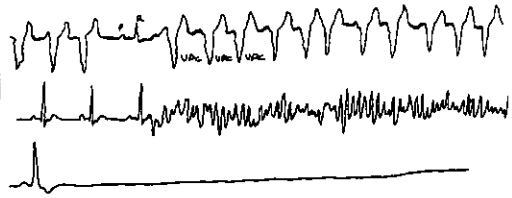


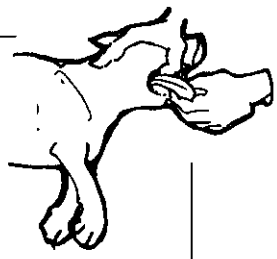




No heart activity
CS: Unconsciousness, Dilated pupils, Loss of tone
Dx: No pulse or heart beat, ECG
Tx: Emergency CPR

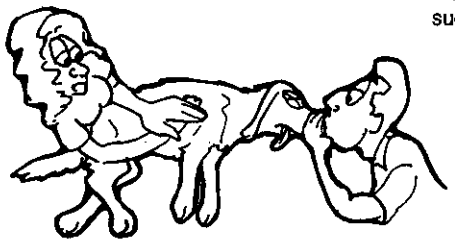
DDx:
- ECG artifact (ECG not on proper lead or connected improperly)

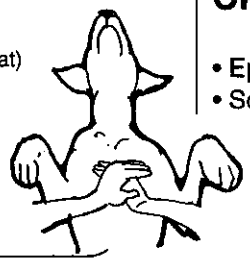




Causes of CPA

- Hypoxia
  - Respiratory failure
    - . Anesthesia
    - . Severe pulmonary diz
    - . Severe CNS diz
    - . Airway obstruction
    - . Suffocation
  - Anemia
  - Circulatory failure
  - Iatrogenic inadequate ventilation
- Hypotension
- Myocardial diz
- Anesthetics
- CNS trauma
- Toxemia
- Arrhythmias
  - **Ventricular fibrillation (#1 in dog)**
  - **Ventricular asystole**
  - Severe SA node
  - Sinus rest
  - Complete (3rd degree) AV block
  - Electromechanical dissociation (EMD) (#1 cat)
- Electrical shock
- Electrolyte abnormalities
  - Severe hyperkalemia
- Acid-base abnormalities
- Advanced shock
- Trauma

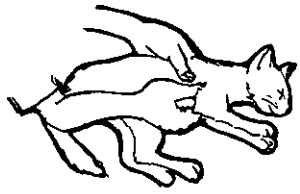




EMERGENCY Cardiopulmonary resuscitation (CPR)

Steps to follow:

- **A** = airway (intubate, etc.)
- **B** = breathing: 10-12 breaths/minute
- **C** = intrathoracic cardiac massage in animals >15 kg; external chest compression if < 15 kg ("thump" version)
- Defibrillation equipment if available
- **D** = Drugs/Electrocardioconversion
- Intracardiac lidocaine occasionally successful

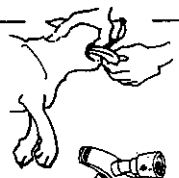


CPR - Drug dosages

• Epinephrine:	0.2 mg/kg IV
• Sodium bicarbonate	0.5-1.0 mEq/kg initial dose up to 8 mEq/kg

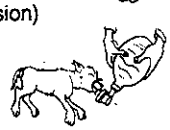
TREATMENT - CPA:

- **EMERGENCY SITUATION**



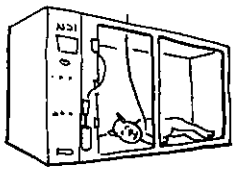
- **Cardiopulmonary resuscitating (CPR) immediately !!**
- **A = airway** (intubate endotracheal)
  - Tracheostomy if necessary

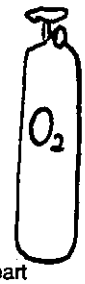
- **B = breathing: 25-30 breaths/minute - CPR**
  - 100% O2 insufflation best
    - . AMBU bag, anesthetic machine, oxygen line, mouth to tube (approximate normal chest expansion)
    - . Simultaneously w/ chest massage (1 per 5 compressions)



- **C = circulation - cardiac massage**
  - **External chest compression** (80-120/min)
    - . Right lateral recumbency
    - . Compression over 5th rib using heels of hand below & above chest
    - . One hand compression (thumb on 1 side & fingers on other) for small dogs & cats
    - . Simultaneous compression & ventilation (O2)
    - . Good for small & medium dogs & cats, inadequate for dogs over 20 lb
    - . Effective massage = detectable femoral or arterial pulse & improved color (membranes)

- **Open chest** (thoracotomy) & pericardial sac massage
  - . Large (45#/20kg) or barrel-chested dogs
  - . W/in 5 min if no pulse
- **Defibrillation** for ventricular fibrillation





- **D = Drugs** - best given by central vein
  - **Oxygen (100%)**
  - **High-dose epinephrine** IV to restart heart
  - **IV fluids** if needed
  - **Sodium bicarbonate** if acidosis is proven or suspected
- **E = electrical activity - ECG** as soon as possible & proceed on its findings
  - No activity - give epinephrine
  - Chaotic: defibrillate
  - Normal: administer fluids
  - Ventricular asystole or severe bradycardia
    - . Atropine IV or glycopyrrolate
    - . Calcium gluconate 10%/Electroconversion
    - . Epinephrine may be repeated at 5 min intervals
  - Ventricular fibrillation
    - . Precordial thump from 8-12" above chest
    - . DC counter shock up to 2 times
    - . Epinephrine can be repeated at high doses

  - . If transient sinus rhythm reverts to fibrillation
    - .. Lidocaine IV
  - Ventricular flutter
    - . Pulse present
      - .. Precordial thump: check ECG
      - .. Lidocaine IV
      - ... When convert adjust Tx to ECG
    - . Pulse absent
      - .. Institute CPR
      - .. Precordial thump: check ECG
      - .. DC counter shock
      - .. Lidocaine IV
      - .. Continue CPR, repeat drugs as needed
  - Electromechanical dissociation
    - . Normal or abnormal P-QRS-T, but no cardiac output
    - . Rule out severe hypovolemia & pericardial tamponade
      - .. Dexamethasone
      - .. Calcium (anecdotal reports)
      - .. Repeat epinephrine at 5 min intervals
      - .. Sodium bicarbonate every 10-15 min
  - Pulseless idioventricular rhythm
    - . Continue all steps of CPR (associated w/ severe hypoperfusion
  - If sinus bradycardia w/ AV block
    - . Atropine sulfate IV, or
    - . Isoproterenol IV drip

- **F = follow-up**
  - **Monitor patient & ECG** (deterioration & recurrence not uncommon)

Prognosis: Grave???

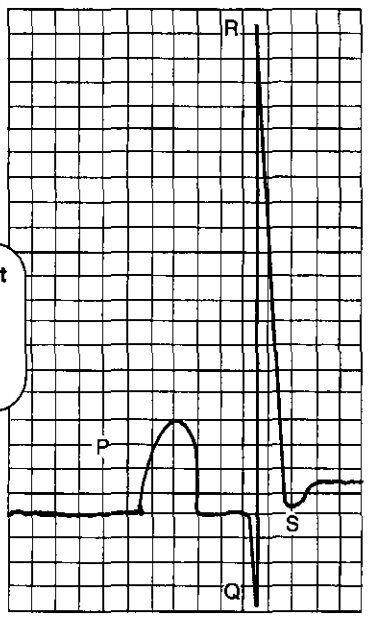
ECG heart enlargement patterns

SAP 419; T 23; NB 3.10

Right atrial enlargement

ECG pattern

- Tall P waves (lead II)
  - Dog > 0.4 mV (> 4 boxes)
  - Cat > 0.2 mV (> 2 boxes)



- **DDx: rt. atrial enlargement**
  - Tricuspid insufficiency
  - Chronic respiratory diz
  - Interatrial septal defect
  - Pulmonary stenosis

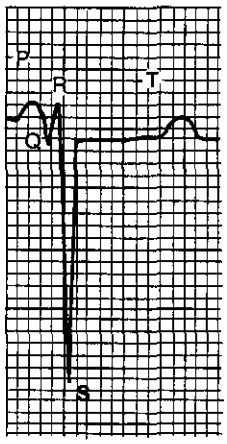
Right ventricular enlargement

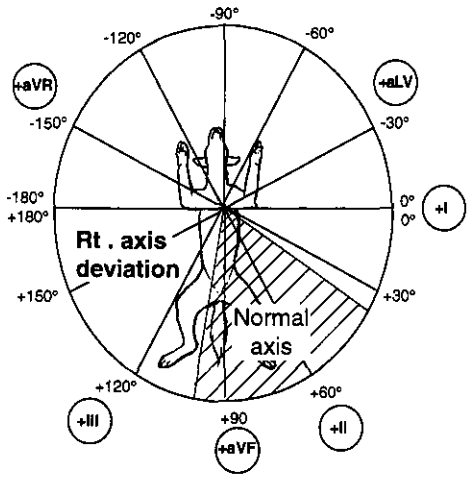
ECG pattern

- Right axis deviation
  - Dog > + 100°
  - Cat > + 160°
- **Deep S wave in leads I, II, III & aVF**
- Deep Q waves

DDx - Rt. ventricular enlargement

- Pulmonic stenosis
- Tetralogy of Fallot
- Rt. AV insufficiency
- Severe heartworm diz
- Pulmonary hypertension



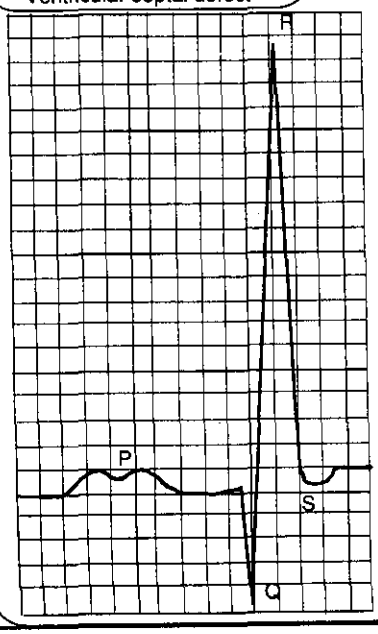


Left atrial enlargement

- **ECG pattern**
  - **Wide notched P waves** (notch not abnormal unless also wide)
    - . Dog: > 0.04 sec (> 2 boxes)

DDx - Left atrial enlargement

- Mitral insufficiency
- Cardiomyopathies
- Patent ductus arteriosus
- Subaortic stenosis
- Ventricular septal defect

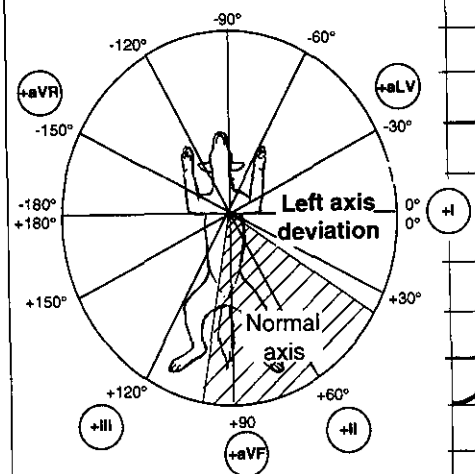


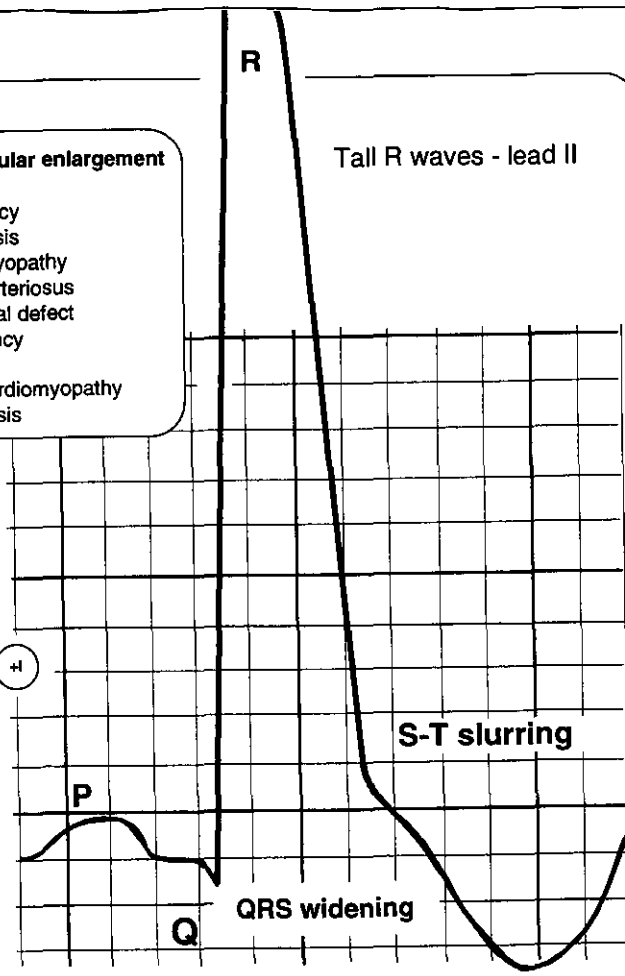
Left ventricular enlargement

- ECG pattern
  - **Wide QRS**
    - . Dog > 0.06 sec
    - . Cat 0.04 sec
  - **Tall R waves** (lead II)
  - Left axis deviation
    - . Dog <+ 40°
    - . Cat < 0°
  - ST slurring or coving

DDx - Left ventricular enlargement

- Dilation
  - Mitral insufficiency
  - Subaortic stenosis
  - Dilated cardiomyopathy
  - Patent ductus arteriosus
  - Ventricular septal defect
  - Aortic insufficiency
- **Hypertrophy**
  - Hypertrophic cardiomyopathy
  - Subaortic stenosis

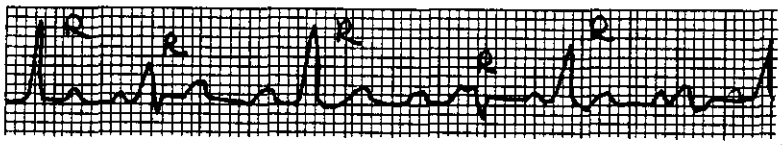




Electrical alterans (alternating configuration of ECG complexes (taller:shorter QRS complexes)

M8k 92; SAP 417; H-T 188, 243

DDx - **Electrical alterans**
- Large pericardial perfusions
- Supraventricular tachycardia
- Alternating bundle branch block
- Tachypnea (e.g., pleural effusions)

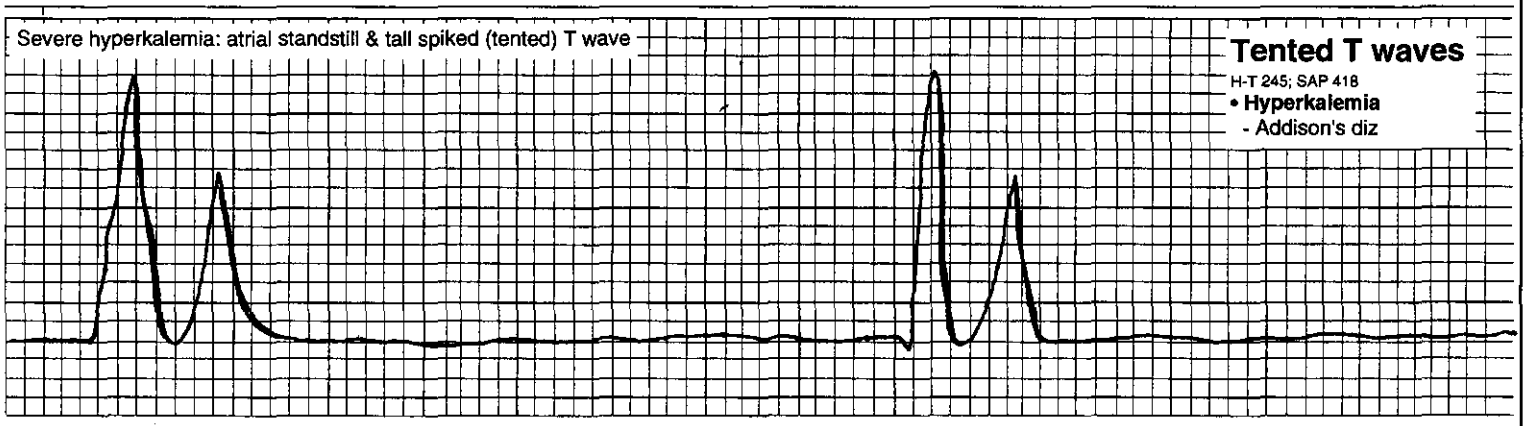


Large T waves

H-T 92, 120; H-F 69; SAP 418

DDx: Large T waves
- Normal variation
- Myocardial hypoxia
- Ventricular enlargement
- Hypothermia
- **Hyperkalemia**
  - Addison's diz
- **Urinary obstruction**
- Intraventricular conduction abnormalities
- Metabolic diz
- Respiratory diz
- Cardiac drug toxicities

Severe hyperkalemia: atrial standstill & tall spiked (tented) T wave



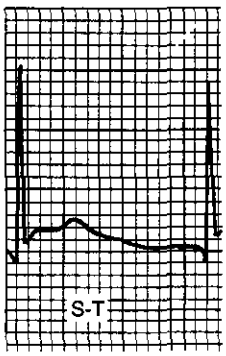
Tented T waves

H-T 245; SAP 418
- **Hyperkalemia**
  - Addison's diz

Elevation of S-T segment

H-T 84, 118, SAP 417

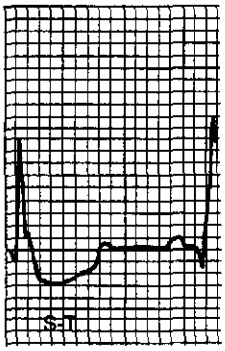
DDx - S-T elevation
- Variation of normal
- **Myocardial ischemia, hypoxia**
- Myocardial infarction
- Hyperkalemia
- Cardiac trauma
- 2° changes
  - Ventricular hypertrophy
  - VPCs
  - Conduction disturbances
- Digitalis toxicity
- Artifact



S-T segment depression

H-T 84, 118; SAP 417; NB 3.11

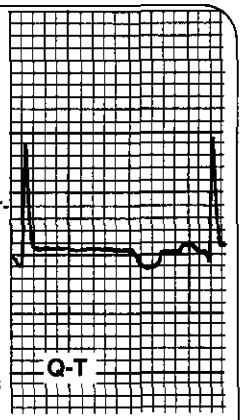
DDx - S-T depression
- Variation of normal
- **Myocardial hypoxia**
- Hypokalemia
- Digitalis toxicity
- Pericardial effusion
- Digitalis toxicity
- 2° changes
  - Ventricular hypertrophy
  - VPCs
  - Conduction disturbances
- Artifact



Prolonged Q-T interval

H-T 88; SAP 418

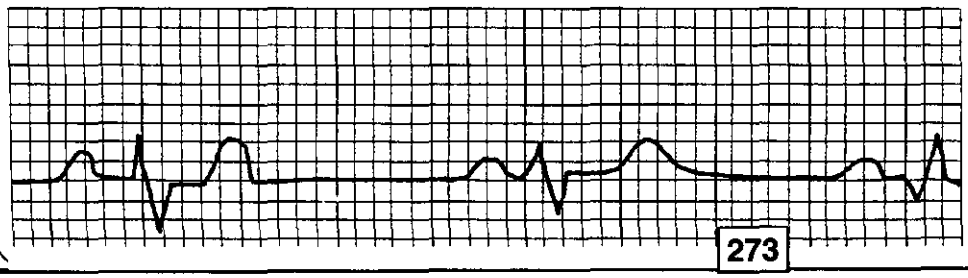
DDx: Prolonged Q-T interval
- Normal (strenuous exercise)
- Hypocalcemia
- Hypokalemia
- Hypothermia
- Quinidine toxicity
- Intraventricular conduction disturbances
- 2° to prolonged QRS
- Ethylene glycol toxicity
- CNS problems
- Bradycardia



Short R waves

SAP 417; H-T 82

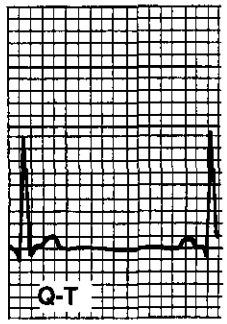
DDx: Short R waves
- **Normal variation** (large deep chested dogs)
- **Pleural effusions**
- **Pericardial effusions**
- **Hypothyroidism**
- Pulmonary edema
- Obesity
- Pneumothorax
- Hypoalbuminemia
- Severe myocardial damage
- Loss of cardiac muscle mass



Shortened Q-T interval

SAP 418

DDx: Shortened Q-T Interval
- Hypercalcemia
- Hyperkalemia
- Digitalis toxicity



Anemia

M8k 8, 1203; E-hb 732, 217, 58, 220; SAP 147; H2B 715; I2M 1160; IM 895; IM-WW 507; 5min 341, 198; Cat 702; E-hb 684; E 1876; Pa-T 287; Lap 30

★★★★

- **↓ O_2-carrying capacity of blood**
  - **↓ RBCs &/or hemoglobin content or PCV**
- Pathophysiologic causes:
  1. **Blood loss**
  2. **Hemolysis** (increased RBC destruction)
  3. **Inadequate RBC production** (bone marrow)
- **Regenerative** or responsive **anemias**
  - **↑ Reticulocytes (new RBCs) in circulation**
- **Nonregenerative** - inadequate reticulocytes, bone marrow is problem

- **MCV** (mean corpuscular volume): reflects the size of RBCs

$$\text{MCV (fl)} = \frac{\text{PCV X 10}}{\text{RBC count (millions/µl)}}$$

- **↑ MCV** indicates regenerative anemia (immature RBCs larger than mature RBCs)
- **↓ MCV** (microcytosis) indicates iron defc.

Clinical Signs
- **Asymptomatic**
- **Lethargy**
- **Weakness**
- **Anorexia**
- ↑ HR (tachycardia)
- Dyspnea, ↑ RR (tachypnea)
- **Reduced exercise tolerance**
- Depression
- Poor grooming in cats
- Pale mucous membranes
- ± Icterus
- ± Fever
- ± Lymphadenopathy (lymphoma)
- Collapse if severe

DDx - Anemia (large type indicates common causes, small type less common)

- **Blood loss**
  - **Acute hemorrhage**
  - **Chronic blood loss**
  - **Internal hemorrhage**
    - **Trauma**
    - Tumors (hemangiosarcoma)
  - **Occult blood loss**
    - **Intestinal parasites**
    - **Ectoparasites (lice, ticks)**
    - **Gastric ulcers**
    - Tumors
  - **Platelet abnormalities**
  - Factor deficiencies
  - Immune-mediated thrombocytopenia
  - DIC (disseminated intravascular coagulation)
  - Warfarin poisoning
  - Hemophilia A or other congenital factor defc
- **Hemolysis**
  - **Intravascular**
    - **RBC parasites**
    - Acetaminophen/onion toxicity
    - Splenic torsion
    - Vena caval syndrome
  - Extravascular hemolysis
    - **Autoimmune hemolytic anemia**
    - Red cell parasites (Hemobartonella, Babesia, Cytauxzoonosis)
    - Heinz body hemolytic anemia
    - Drugs (propylthiouracil, gold salts)
    - Modified live virus vaccines
    - Heartworm
    - Pyruvate kinase deficiency
    - Phosphofructokinase deficiency
    - Leptospirosis
    - Fragmentation hemolysis
    - Snake venom
    - Zinc toxicity
- **Nonregenerative anemia**
  - **Myelophthisic anemia**
    - **Lymphosarcoma**
    - **Myeloproliferative leukemia**
    - **Lymphoproliferative leukemia**
  - **FeLV anemia #1 cause in cats**
- **Drugs**
  - Acetominophen
  - Antineoplastic drugs
  - Antiarrhythmics
  - Anticonvulsants
  - Antiinflammatories (nonsteroidal)
  - Benzene
  - Benzocaine
  - Chloramphenicol
  - Cimetidine
  - Gold salts
  - Griseofulvin
  - Levamisole
  - Methimazole
  - Methionine
  - Methylene blue
  - Metronidazole
  - Penicillin & cephalosporins
  - Phenothiazines
  - Propylthiouracil
  - Sulfa derivatives
  - Thiacetarsamide
  - Trimethoprim-sulfa
  - Vitamin K
  - Zinc
- Hormones, chemicals
  - **Estrogen** (endogenous or exogenous)
  - **Lead poisoning**
- **Deficiency syndromes**
  - **Iron deficiencies**
  - **Hypothyroidism**
  - Folate or B12 deficiencies (rare)
- **Renal failure**
- **Chronic inflammatory diz**
- **Canine ehrlichiosis**
- **Idiopathic RBC aplasia**
- Radiation toxicosis
- Idiopathic aplastic anemia
- Hypoadrenocorticism
- Osteopetrosis

Diagnosis - Anemia:
- **History**
  - Deworming?
  - Diet (young > old - iron deficiency)
  - Drugs or recent vaccination?
  - Geography (ehrlichiosis, heartworm, Babesiosis)?
  - Immune-mediated anemia (last Coggins' test)
  - Travel history (Babesiosis)?
  - Past illness (chronic anemia)?
  - Immune status?
  - Blood loss or dark tarry stool?
  - Ticks?
  - Shot for mismating?
- **PE** (physical exam)
  - Pale mucous membranes (differentiate from heart - hypoperfusion problems w/ PCV)
  - Petechiation or ecchymoses - thrombocytopenia
  - **Icterus**: suggests acute hemolysis, hepatic or biliary diz
  - **± Heart murmur**
  - Respiratory or GI dizs, concurrent
  - Lymphadenopathy (lymphoma, FeLV, FIV, ehrlichiosis granulomatous infection)
  - ± Splenomegaly/hepatomegaly
  - ± Oral ulcers/uremic breath - renal failure
  - ± Feminization - hyperestrogenism
- **Blood smear**: usually sufficient for regeneration
  - **Reticulocyte count** if PCV < 30% in dog & < 20% in cat
    - Normal dog = 0-1% (0-60,000/µl); Cat = 0-0.4% (0-40,000/µl)
    - **Regenerative if > 1%**, may take 3 days to show up
  - RBC morphology: size (anisocytosis), shape (poikilocytosis), color (polychromasia), nucleated RBCs, basophilic stippling, parasites or Heinz bodies
  - Regenerative anemia: reticulocytosis, polychromasia, anisocytosis & elev. WBC count
    - **Spherocytes: immune mediated hemolysis**
  - **Heinz bodies** or brown blood: oxidant toxicosis or drugs (acetaminophen/onion)
  - **Agglutination** suggests immune-mediated anemia
- **CBC** (complete blood count)
  - **PCV reduced** (normal canine - 40-55%, feline - 30-45%)
    - Not reduced for 24 hours w/ acute hemorrhage)
  - ± **Pink plasma** (IV hemolysis)
  - MCV: increased (macrocytosis) - reticulocytosis, decreased (microcytosis) - iron deficiency
  - **WBCs**: ↑ PMNs (neutrophilia)
  - ↑ Globulin (hyperglobinemia) &/or fibrin (hyperfibrinogenemia) suggestive of chronic infection
  - Hypoproteinemia: indicates blood-loss anemia or underlying diz causing blood loss (granulomatous bowel diz or intestinal lymphosarcoma)
- **Bone marrow analysis**: to adequately characterize anemia as regenerative or nonregenerative
- **Coombs' test**: positive indicates immune-mediated anemia (autoimmune hemolytic anemia, drug-induced hemolytic anemia, neonatal isoerythrolysis)
- **FeLV test for all anemic cats**
- **Urine analysis**
  - Occult blood: hemoglobinuria (from IV hemolysis) or myoglobinuria (myopathy)
- **Fecal occult blood**: if chronic loss suspected, indicates GI loss of blood (gastric ulcers or SCC [squamous cell carcinoma])
- **Biochemical profile for concurrent diz** - hypothyroidism, renal failure, liver diz, chronic diz)
- Serum iron & total iron-binding capacity (TIBC)
  - Low serum iron & high TIBC - iron defc
  - Low serum iron & norm. TIBC - chronic anemia
- Radiographs & ultrasound for neoplasia & bleeding lesions & pennies (zinc)

TREATMENT:
- 1st collect all blood samples
- Stabilize patient
- Determine if regenerative or nonregenerative
  - Regenerative (blood loss or hemolysis) requires more aggressive Tx than nonregenerative
- Treat underlying cause

Prognosis
- Regenerative better than nonregenerative
- Good for acute or chronic blood loss if cause removed

Congenital Hemolytic Anemias

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Pyruvate kinase (PK) deficiency * M8k 17; Mk 20; 5min 1006; IM-WW 509; E-hb 688; SAP 150; H2B 718t, 791; Pa-T 289; Lab 39	• **Glycolytic enzyme deficiency**, needed to form ATP & maintain RBCs viability • **Basenjis, Beagles**, West Highland White terriers • Autosomal recessive trait - Chronic severe hemolysis - Shortened life span due to myelofibrosis & osteosclerosis • **3-6 months of age** first diagnosed	• **Death after 1-3 years**	• Hx (age) • PCV 15-30% when 1st diagnosed - Progressively declines over next 1-3 years to death - Intense **reticulocytes** (15-70%) • Echinocytosis (sharp projection from RBCs) • Splenomegaly • Terminal myelofibrosis & osteosclerosis • Definitive: special assay	• **None** • Don't breed carriers Prognosis: • **Grave**: die in 1-4 years
Phospho-fructose (PFK) deficiency M8k 18; Mk 20; E-hb 736; SAP 150; H2B 718t; 5min 940; Pa-T 289 *	• Less severe than PK deficiency • Autosomal recessive inheritance • **English Springer spaniels**	• **Hyperventilation**	• Hx (spaniel) • Chronic hemolytic anemia • Normal or mildly ↓ PCV, but reticulocytes (7-23%) • Splenomegaly • Definitive: special RBC assay	• **Avoid overexertion** Prognosis: good
Feline porphyria E-hb 688; IM-WW 509; Cat711; Lab39; SAP150 *	• **Rare** • Autosomal dominate trait - affect heme synthesis • Mechanism of hemolysis unknown	• **Brown to pink teeth & bones** • **Photosensitization** • Pink urine	• Hx, CS Pigments fluoresce • Anemia variable	• **None** • **Avoid exposure to sunlight** • Don't breed carrier animals Prognosis: ???
Stomatocytosis IM-WW 509; SAP 150; HB 718t; Lab 39 *	• **Hereditary - autosomal recessive trait** • **Alaskan Malamutes** associated w/ chondro-dysplasia • Defects: to cell membrane or of ion transport leading to increased water content & large cells	• **Dwarfism, chondrodysplasia**	• Hx (**Malamute**) • Mild hemolytic anemia & slight reticulocytosis (2%) • RBC numbers reduced, but PCV normal due to enlarged RBCs • Morphology - RBCs appear to have mouthlike area of central pallor	• None, do not breed Prognosis: good

Blood loss anemia, Hemorrhage

M8k 13; Mk 26; E-hb 684; SAP 149; H2B 722; I2M 1164, 1171; IM 899; IM-WW 508; 5min 200, 256; Cat 703; Pa-T 289; Lab 31, 40

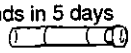
***

• **Large volumes must be lost to effect PVC or RBC numbers**
- **Internal or external bleeding**
• **Acute: 2-3 days for regeneration**
- Initially PVC & RBC normal
- Anemia shows as fluid shifts into vascular space
. Appears nonregenerative for 2-3 days then reticulocytes in blood
- Hypovolemic shock if severe
• Chronic blood loss:
- ↓ Iron stores, resulting in ↓ RBC production
- Regenerative until iron stores are depleted

• **Blood** if external
• Occult in internal bleeding
• Acute:
- Signs of anemia: lethargy, weakness, anorexia, tiring
- Massive loss = **hypovolemic shock**
- Tachycardia
- Tachypnea
- Cold extremities
- Cardiovascular collapse
- Renal damage
- **Bleeding**

• Chronic:
- Signs or anemia
- Gradual onset
- Source of bleeding obvious (fleas) or obscure (internal bleeding)
• **No icterus**

• Hx (trauma), CS
- Check bleeding: wound, multiple sites
- Coagulation disorders
- Capillary refill time
• Bone marrow responds in 5 days

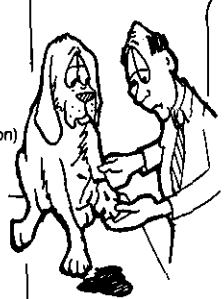


• **CBC:**
- Acutely PCV & TP normal (declines in 24 hours due to mobilization of extracellular fluid to maintain volume)
- **Reticulocytes** in 2-4 days as bone marrow responds
- ↓ Plasma proteins
- Coagulation tests if clotting problem suspected
• Chemistry:
- For other organ function
- Total protein
• Radiographs:
- Blood in cavities or source of bleeding

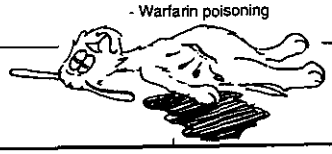
• Other tests:
- Fecal flotation, fecal occult blood, urinalysis, cytologic of body cavity fluids

• **Stop hemorrhage**
- External - suture or pressure bandages
- Internal
• **Monitor for shock**
• **Tx hypovolemic shock**
- Balanced electrolyte soln to replace estimated blood loss
• PCV < 15-20% consider whole blood transfusions

• **Blood loss**
- **Acute hemorrhage**
. **Trauma (laceration)/surgery**
. **Splenic rupture**
- **Chronic blood loss**
- **Internal hemorrhage**
. **Trauma**
. **Tumors (hemangiosarcoma)**
- **Occult blood loss**
. **Intestinal parasites (hookworms)**
. **Ectoparasites (lice, ticks)**
. **Gastric ulcers**
. **Tumors**
- Coagulation disorders
. Factor deficiencies
. DIC (disseminated intravascular coagulation)
. Thrombocytopenia/platelets
- Warfarin poisoning



DDx:
• Regenerative anemias
- Immune-mediated hemolytic anemia (dog)
- Hemobartonellosis & Heinz body anemia
• Nonregenerative anemias



2-3 days for regeneration
CS: Blood, Anemia, No icterus
Dx: Hx, CS, PE, CBC
Tx: Stop hemorrhage, Shock

Prognosis
• **Good**: if bleeding stopped

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Hemolytic anemia

M8k 14; Mk 21, 428; E-hb 685, 217, 58, 220; SAP 147; H2B 715; I2M 1164; IM 895; IM-WW 509, 552, 344; Cat 706; F3IM 471; Pa-T 289; Lab 31, 40

Facts/Cause

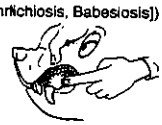
- **↓ O_2-carrying capacity of blood due to hemolysis**
  - **↓ RBCs &/or hemoglobin content or PCV**
- **Hemolysis (excessive RBC destruction)**
  - Extravascular: RBCs destroyed by mononuclear phagocytic cells in spleen, liver & bone marrow
  - Intravascular: RBCs lysed by antibody, complement, drugs, toxins or fibrin strands
- **Regenerative anemias**
- **Dogs: IMHA #1**
- **Cats: drug & hemobartonellosis** most common causes

Presentation/CS

- **Asymptomatic**
- **Pallor**
- **± Icterus** (50% of cases)
- **Lethargy, weakness**
- **Anorexia**
- ↑ HR (tachycardia)
- Dyspnea, ↑ RR (tachypnea)
- **Reduced exercise tolerance**
- Depression
- ± Fever

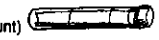
Diagnosis

- Hx (Drugs, Geography [ehrlichiosis, Babesiosis])
- PE (physical exam)
  - **Pale mucous membranes**
  - **± Icterus**
  - ± Splenomegaly/hepatomegaly



- Blood smear: usually sufficient for regeneration
  - **Reticulocyte count:** Normal dog = 0-1% (0-60,000/µl); Cat = 0-0.4% (0-40,000/µl)
    . Regenerative if >1%, may take 3 days to show up
  - RBC morphology: size (anisocytosis), shape (poikilocytosis), color (polychromasia), nucleated RBCs, basophilic stippling
  - **Spherocytes** - immune mediated hemolysis
  - Heinz bodies or brown blood: oxidant toxicosis or drugs
  - RBC parasites

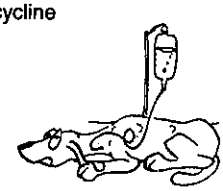
- **Agglutination test** (drop of blood on slide at room temperature & at 4° C: suggests immune-mediated anemia)
- CBC (complete blood count)



  - PCV reduced (normal canine - 40-55%, feline - 30-45%)
  - ± Pink plasma (IV hemolysis)
- **Coombs' test:** positive indicates immune-mediated anemia (autoimmune hemolytic anemia, drug-induced hemolytic anemia, neonatal isoerythrolysis) not needed if autoagglutination
- FeLV test for all anemic cats???
- Urine analysis: occult blood: hemoglobinuria (from IV hemolysis) or myoglobinuria (myopathy)

Treatment

- **Dog: if cause not found:**
  - Tx for IHA (immune hemolytic anemia) while wait for test results
    . Remove from drugs
    . **Steroids** prolonged/life time Tx
    . ± Cyclophosphamide (Cytoxan®)
    . ± Azathioprine (Imuran®)
- Cat: look for drug or Hemobartonella cause
- If cause found treat
  - Drug, infection, gastric pennies
    . Remove cause
    . Supportive Tx
  - Hemobartonellosis, ehrlichiosis: tetracycline or doxycycline



Prognosis:
- Regenerative better than non-regenerative

Cause - Hemolytic anemia

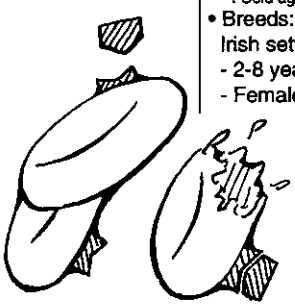
- Intravascular
  - RBC parasites
  - Acetaminophen/onion toxicity
  - Splenic torsion
  - Vena caval syndrome
  - Drugs
- Extravascular hemolysis
  - **IMHA #1 in dog**
  - Red cell parasites (Hemobartonella, babesia)
  - Pyruvate kinase deficiency
  - Heinz body hemolytic anemia
  - Drugs (propylthiouracil, gold salts)
  - Modified live virus vaccines
  - Fragmentation hemolysis
  - Ehrlichiosis
  - Leptospirosis

Drugs - hemolysis

- **Acetominophen**
- Antiarrhythmics
- Anticonvulsants
- Benzocaine
- Gold salts
- Methimazole
- Methionine
- Methylene blue
- Metronidazole
- Penicillin & cephalosporins
- **Phenothiazines**
- Propylthiouracil
- Sulfa derivatives
- Trimethoprim-sulfa
- **Vitamin K**
- Zinc

Immune-mediated hemolytic anemia, IMHA, Autoimmune hemolytic anemia

M8k 14; Mk 21, 248; E-hb 685; SAP 171; H2B 720; I2M 1166; IM 901; IM-WW 509; 5min 344; Cat 708; Pa-T 298; Lab 34



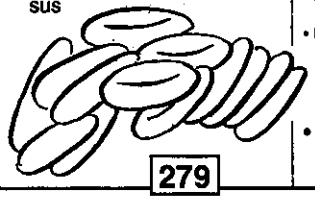
- **#1 cause of hemolytic anemia - dog**
  - Rare in cat - 1/2-3/4 associated w/ FeLV, other causes: Hemobartonellosis & lymphoma
- **Anti-RBC antibodies attach to antigens on RBCs**
  - Antibody-coated RBC destroyed by:
    . Extravascular phagocytosis in spleen & liver, or
    . Intravascular hemolysis: induced compliment activation
- Type 2 hypersensitivity - 1° or 2°
- **Cause: most idiopathic - primary**
  - Secondary: antibodies initiated by:
    . Viral, bacterial or protozoal infections
    . Propylthiouracil in cats
    . Lymphoproliferative disorders
    . Autoimmune hemolytic anemia uncommon
    . Neonatal isoerythrolysis (antibodies in colostrum): rare in dogs, common in horses
    . Cold agglutinating antibodies (IgM) rare
- Breeds: Poodles, Old Eng. sheepdog, Irish setters, Cocker spaniels
  - 2-8 years old (middle aged)
  - Females 3-4 x males

DDx:
- Other regenerative anemias

#1 Hemolytic anemia - Dog
CS: Depression, Tiring, ± Icterus
Dx: Pallor, Spherocytes, Autoagglutination
Tx: Prolonged steroids

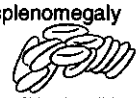
- Vague:
  - Sensitivity to cold
  - Anorexia, listlessness
  - Weakness
  - **Depression**
  - ± GI (pica, vomiting, diarrhea)
- Acute:
  - **Exercise intolerance** (tiring)
  - Hyperpnea (fast breathing)
  - Fever
  - **± Icterus** (intravascular hemolysis)

- Complications:
  - DIC
  - Sepsis
  - Acute thromboembolism
  - Renal failure
  - Persistent hemolysis
- Concurrent diz
  - Immune-mediated thrombocytopenia
  - Systemic lupus erythematosus

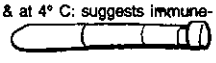


- Hx, CS
- Physical exam

  - **Pale mucous membranes**
  - Tachycardia (fast heart rate)
  - ± Systolic heart murmur
  - ± Hepatomegaly or splenomegaly (extravascular hemolysis)
  - ± Lymphadenopathy
  - **± Jaundice**

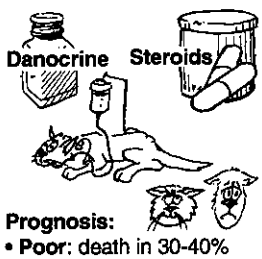


- **Agglutination test** (drop of blood on slide at room temperature & at 4° C: suggests immune-mediated anemia)



- CBC
  - **Severe anemia - regenerative**
  - **Marked reticulocytosis** (polychromasia), nucleated RBCs
  - **Spherocytes - definitive** (small globular RBCs w/o central pallor, result of phagocyte taking a bite out of RBC)
  - Extreme variation in RBC size
  - **PMN leukocytosis w/ left shift & monocytosis**
  - ± Immune-mediated thrombocytopenia
  - Plasma fibrinogen level usually elevated
  - Nonregenerative form exists, reticulocytopenia
    . Bone marrow aspirate to characterize
- **Positive Coombs' test** (direct antiglobulin): indicates immune-mediated anemia (autoimmune hemolytic anemia, drug-induced hemolytic anemia, neonatal isoerythrolysis) not required if spherocytes or agglutination
  - 10% have negative Coombs' test
- Chemistry: usually unrewarding
  ± Increased bilirubin
- Urinalysis:
  - Rarely hemoglobinuria
  - Bilirubinuria
  - Proteinuria if immune glomerular damage
  - Cylinduria (casts) - tubular damage
- **Response to steroid Tx**

- If 2° - treat 1° cause
  - Remove from drugs
- **Steroids** (dexamethasone IV; then prednisolone for maintenance 3-6 months)
  - Prolonged/life time Tx
  - Consider cimetidine to prevent ulcers
- Danazol (Danocrine®) to prevent phagocytosis of RBCs
- Other immunosuppressive drugs if steroid alone ineffective
  - ± Cyclophosphamide (Cytoxan®)
    . Not if platelets < 30,000/µl
  - Azathioprine (Imuran®)
- Heparin
- Blood transfusion only if life threatening
- ± Splenectomy (beneficial?)
- Monitor PVC, total solids & autoagglutination bid-qid, reticulocyte count, spherocytes for 72 hours
  - Periodic hemogram - 1-2 wks then monthly to detect recurrences (common)
  - Wean off steroids slowly & monitor
    . 2/3 require lifelong Tx



Prognosis:
- **Poor:** death in 30-40% despite Tx
- Cats worse than dogs

Hemolytic Anemia

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Hemobartonellosis, Feline infectious anemia; FIA M8K 27; Mk 28; 72; E-hb 686; SAP 151; F3IM 439; H2B 717; IM 900; IM-WW 511; 5min 648; Cat 419, 543, 706; F-IM 49, 477; Pa-T 295	• ***Hemobartonella felis***, *Eperythrozoon felis* (Europe & Austr.), *H. canis* - **Rickettsia** • A type of immune-mediated anemia • Blood sucking arthropod vectors (tick, fleas) or from queen to kittens • Carrier cats likely reservoirs • Dogs: rare in splenectomized or immunosuppressed dogs • Pathophysiology: parasitized RBCs removed by phagocytes: extravascular hemolysis - Intravascular hemolysis rare	• **Lethargy, weakness, anorexia** • Weight loss • Depression • ± Icterus	• Hx, CS • Stained blood films (Wright's) - 3 days in a row - **Organism in RBCs** . Cat: coccoid or ring shapes . Dog: linear chains . Unlikely to find if receiving tetracycline • ± Coomb's test positive in cats • ↑ Total bilirubin • Urinalysis: bilirubinuria • Splenomegaly • CBC: regenerative anemia	• **Oral tetracycline** for 2-3 weeks • Steroids for immune-mediated hemolytic component • ± Transfusion if severe **Prognosis????**

Cat >> Dog, Rickettsia
CS: Lethargy, Weakness, Anorexia
Dx: Organism in RBCs
Tx: Tetracycline

DDx:
- Cytauxzoonosis
- Other cause of regenerative anemia
- FeLV, ehrlichiosis, myeloproliferative dizs

Ehrlichiosis

E-hb 689, 181, 284; SAP 154; H2B 1219, 740, 758; Pa-T 303

*?

- Rickettsial diz, *Ehrlichia canis*, Transmitted by ticks (brown dog tick)
- CS: Depression, lethargy, anorexia, weight loss, fever, lymphadenopathy, bleeding tendencies, edema of limbs & scrotum, CNS, eye, joint, kidney & liver CS
- Dx: Hx, CS, CBC: thrombocytopenia & mild to moderate anemia, ± Leuc; Hyperglobinemia as a polyclonal gammopathy; Bone marrow: acute - normal cellular to hypercellular; late: hypocellular w/ fat replacement
- Tx: Tetracycline, Doxycycline, Chloramphenicol, Imidocarb dipropionate; Supportive: Fluids, transfusions; Tick control

Blood transfusions

M8k 19; E-hb 739; 5min 398; SAP 149

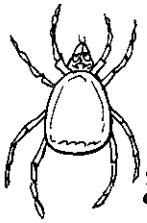
- Generally given when PCV < 10-15 %
- Increased heart rate & respiratory rates & low PCV clear indications

- **Canine transfusions**
  - A unit of blood - 500 ml (50-60 ml of citrate anticoagulant soln). Can store for 21 days
  - Quantity to transfuses - 1 unit for most dogs; target 5-10 ml/lb
  - Ideal donor: negative for RBC antigens CEA-1, CEA-2 & CEA-7, free of blood born infections, > 50 lb, bled less than once a month, well nourished & supplemented w/ iron
  - No problem w/ first transfusion because no naturally occurring antibodies to RBC antigens
- **Feline transfusions**
  - A unit of blood: 40 ml of blood + 10 ml of acid-citrate-dextrose or citrate-phosphate-dextrose-adenine anticoagulant
  - Quantity transfused - 1 unit to adult (5-10 ml/lb). Kittens & adults less than 4 lb given proportionally less
  - Site: vein or into femoral marrow space
- Donor cat: FeLV negative
- 1st transfusion considered safe
- Cats have group A >> B & AB: Transfusion reaction recorded, hemolytic transfusion reactions not reported

Babesiosis

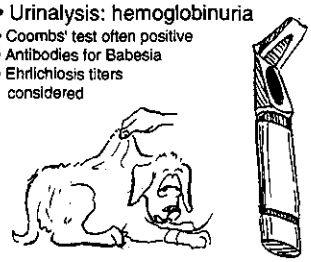
M8k 23; Mk 69, 71; E-hb 687; SAP 151; 5min 385; H2B 717, 1232t; IM 900; IM-WW 511; Pa-T 292

- **Protozoal diz**
  - ***Babesia canis*** *& B. gibsoni*
- **Brown dog tick:** ***Rhipicephalus sanguineus***
- Chronic carriers once infected
- Common in kennels - Greyhounds
- **SW USA**
- Not reported in cats in USA
- Pathophysiology:
  - Parasitized RBCs phagocytized by macrophages - extravascular hemolysis
  - Intravascular hemolysis also possible
- May occur concurrently w/ other infections - **ehrlichiosis**

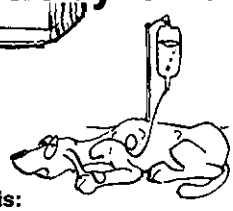


- Acute, subacute & chronic
- **Fever**
- Anorexia, depression
- **Icterus**
- Collapse
- Subacute or chronic
  - Fever 102-107° F
- Malaise & anorexia
- Hemoglobinuria, dark yellow-colored urine
- Death

- CS: fever, anemia, jaundice & hemoglobinuria
- Tick infested area
- **Organisms** in Giemsa stained RBCs of thin blood smear
  - Tear drop or ring-shaped organism in RBC, sometimes in pairs
- CBC
  - Mild to moderate anemias
    . Regenerative
  - PMN leukocytosis
- Hyperbilirubinemia
- Dehydration, acidosis
- Urinalysis: hemoglobinuria
- Coombs' test often positive
- Antibodies for Babesia
- Ehrlichiosis titers considered



- Goal: control until dog's immunity controls diz
  - **Tetracycline**
- Fluids
- Babesial drugs: not approved in USA
  - **Bernil®** (diminazene aceturate)
  - Imidocarb HCl (Imizole®) (protozoacide)
  - Pentamidine isethionate (Lomadine®)



Protozoa, Tick
CS: Lethargy, Anorexia, Icterus
Dx: Organism in RBCs
Tx: Tetracycline

Prognosis:
- Recovery if Tx'd early

Cytauxzoonosis

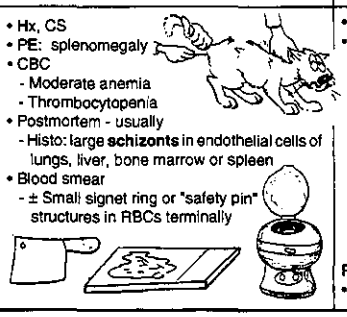
M8k 26; Mk 72; E-hb 687; SAP 151; H2B 719, 1232t; Cat 710; IM 900; F3IM 494; Pa-T 296

*

- **Fatal protozoal diz of cats**
- *Cytauxzoon felis*
- Tick-born - *Dermacentor variabilis*
- Wooded areas of **Southern U.S.**
- Bobcat natural intermediate host

- Anorexia
- Dehydration
- Lethargy
- Gradual **fever**
- Progresses rapidly
- **Icterus**
- **Death w/in days to week**

- Hx, CS
- PE: splenomegaly
- CBC
  - Moderate anemia
  - Thrombocytopenia
- Postmortem - usually
  - Histo: large **schizonts** in endothelial cells of lungs, liver, bone marrow or spleen
- Blood smear
  - ± Small signet ring or "safety pin" structures in RBCs terminally



- **Not been successful**
- Paraquone, buparvaquone, thiacetarsamide

Prognosis
- **Grave:** all reported cases fatal

Hemolytic Anemia

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Oxidative injury to RBCs, Hemolysis & methemoglobinemia

E-hb 687; F3IM 869; Cat 707; SAP 152; H2B 719

- **Oxidation of RBCs causing hemoglobin denaturation, or**
  - **Methemoglobinemia (reversible)**
  - **Heinz body formation (irreversible)**

Causes: hemolysis

- Methylene-blue (cats)
- Spontaneous Heinz bodies in cats (unknown cause)
- Onion poisoning (dogs)
- Acetaminophen toxicity (Tylenol®)(cats & dogs)
- Phenacetin toxicity
- Phenazopyridine
- Propylene glycol
- Vitamin K3
- DL-methionine
- Topical benzocaine (Cetamine®) (larynx spray)

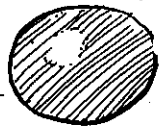
Heinz body anemia

M8k 1208; E-hb 687; SAP 151; H2B 719; IM 898; F3IM 469; 5min 342; Cat 707

**?

- **Erythrocyte-refractile (ER) bodies**
- **Oxidation agent causing precipitation of hemoglobin**
- Irreversible: altered cell shape & flexibility
  - Hemolysis: IV or extravascular phagocytosis
- **Cats predisposed**
  - Heinz bodies found in normal cats & those w/ a variety of illnesses that don't cause clinically significant hemolysis
- Causes: see above

- Acute CS
  - **Lethargy, weakness, anorexia**
  - **Depression**
  - Fever
  - ± Icterus
  - Facial edema w/ acetaminophen toxicity



DDx:

- Other regenerative anemias
- Cats: concurrent diz w/ Heinz bodies (chronic renal failure, lymphoma)
- Normal small Heinz bodies in cats

Hemoglobin precipitates
CS: Cats: m/be normal, Lethargy
Dx: Hx, CS, CBC, Heinz bodies
Tx: Stop drugs, Support

- Hx (exposure), CS
- Physical exam: splenomegaly

- CBC
  - Hemoglobinemia
  - Moderate to severe anemia
    - Regenerative - reticulocytes
  - PMN leukocytosis & ↑ protein
- **Heinz bodies**: Romanowsky-stained blood smear
  - Cat: single, large pale area in RBCs
  - Dog: small & multiple - more difficult to appreciate
  - Methylene blue stained smear = dark blue spots
  - Differentiate from normal RBC refractile bodies (smaller, infrequent)
- Chemistries
  - ± ↑ Total bilirubin

- Urinalysis (UA)
  - Hemoglobinuria (rare)
  - Bilirubinuria

- **Stop any drug or toxin**
- Simple supportive care
  - ± Blood transfusions only if life threatening
- Emetics if recent ingestion of toxin
- For Tylenol® toxicity
  - Acetylcysteine (Mucomyst®)

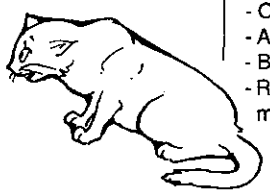
Prognosis: ????

Methemoglobinemia

E-hb 687; SAP 152; H2B 719; 5min 248

**

- **Oxidation of iron in hemoglobin = methemoglobinemia**
  - Ferrous iron oxidized to ferric iron
  - **Unable to bind O_2**, relative hypoxia
  - Methemoglobinemia (reversible)
- Heinz bodies & methemoglobinemia can occur together
  - Methemoglobinemia occurs first
- Causes similar to Heinz body formation
  - Methylene-blue (cats)
  - Spontaneous Heinz bodies in cats (unknown cause)
  - Onion poisoning (dogs)
  - Acetaminophen toxicity (cats & dogs)
  - Benzocaine topicals
  - Rare enzyme defc (NADH-methemoglobin reductase): dog



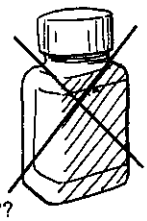
- **General anemic CS**: lethargy, weakness, anorexia
- Respiratory distress & recumbency w/ 50-70% methemoglobin
- Weakness
- Ataxia
- Death if > 70% methemoglobin

- Hx (exposure), CS
- Physical exam
  - **Glue-gray gums** if methemoglobinemia > 30%

- CBC
  - **Chocolate brown** color to blood even after exposure to air
    - Normal blood turns from dark to bright red on exposure to air
  - Not anemic unless concurrent Heinz body hemolysis
- Spectrophotometry - quantitative

Chocolate blood

- **Similar to Heinz body anemia**
  - Stop any drug or toxin
  - Simple supportive care
    - ± Blood transfusions
  - Emetics if recent ingestion of toxin
  - For Tylenol® toxicity
    - Acetylcysteine (Mucomyst®)
- Severe methemoglobinemia
  - Methylene blue once, IV (not repeatedly or get Heinz bodies)



Prognosis: ???

Snake venom toxicity

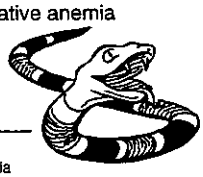
SAP 152

*

- **Causes hemolysis**
- Coral snakes can cause spherocytes

- Painful swelling at bite
- CNS signs
- Coagulation abnormalities

- Hx (snake bite), CS
- CBC: regenerative anemia



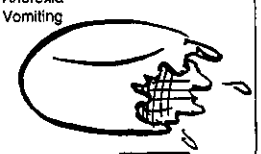
- Specific venom antidote
- Anti-inflammatories
- Antibiotics

Zinc toxicity

E-hb 161; SAP 152; H2B 719, 1282t

- IV hemolysis in dogs
- Source
  - Galvanized wire
  - Kennel cage nuts
  - Pennies > 1983

- Anorexia
- Vomiting



- Hx (zinc exposure)
- Regenerative anemia
- Radiograph - metallic foreign bodies
- Coombs' negative

- Remove source by surgery or endoscopy
- Calcium EDTA

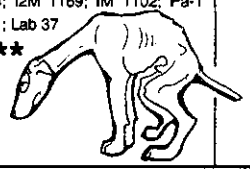
Nonregenerative anemia

M8k 9; I2M 1168; IM-WW 512; 5min 196; Pa-T 300; SAP 153

- **Causes: Direct toxicity of RBC precursors in bone marrow**
  - **2° suppression of erythropoiesis**
- **Often PMNs & platelets also affected**
  - Pancytopenia: ↓ RBCs, WBCs & platelets
- Aplastic anemia: bone marrow failure leading to peripheral pancytopenia
- Myelophthisis: reduction of cell formation in bone marrow

DDx: Nonregenerative anemia

- Myelophthisic anemia (neoplastic bone marrow infiltration)
  - Lymphosarcoma
  - Myeloproliferative leukemia
  - Lymphoproliferative leukemia
- FeLV anemia #1 cause in cats
- Hormones, drugs or chemicals
  - Cytotoxic antineoplastic drugs
  - Chloramphenicol
  - Estrogen (endogenous or exogenous)
  - Benzene
  - Phenylbutazone
- Deficiency syndromes
  - Iron deficiencies
  - Hypothyroidism
  - Folate or B12 defc from chronic intestinal diz (rare)
- Renal failure
- Chronic diz
- Canine ehrlichiosis
- Idiopathic RBC aplasia
  - Immune-mediated destruction of RBCs

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Secondary anemia of chronic inflammation, Anemia of inflammatory diz M8k 13; E-hb 688; SAP 155; H2B 724; I2M 1169; IM 1102; Pa-T 301; Lab 37 *** 	• **#1 cause of nonregenerative anemia in dog & man** • Pathogenesis not understood: abnormal iron kinetics, ↓ RBC life span, ↓ response to erythropoietin • Mild to moderate nonregenerative anemia • Apparent bone hyporesponsiveness	• **CS of chronic diz take precedence** • Anemia - Lethargy - Weakness 	• Hx (chronic diz), CS • **PVC: only mildly ↓** - 25-35% - Anemia: normocytic/normochromic **nonregenerative** - Inflammatory leukogram - Liver failure: "Burr cells" (RBCs) • ↓ Serum iron • Low total iron binding capacity • ↑ Tissue iron stores • Bone marrow - ↑ Stores of iron - Hypocellular bone marrow w/ normal to ↑ myeloid-to-erythroid ratio • Chemistries for 1° diz	• **Treat 1° diz & anemia resolves** • **Treat renal failure:** fluids, k/d diet, sodium restriction, Vit B & C, cimetidine • No proof that anabolic steroids are beneficial for anemia • Iron doesn't reverse this form of anemia • Blood transfusion not needed until PCV < 15% - dog; < 12% - cat Prognosis • Renal failure: poor • Liver failure: grave

Chronic diz, Mechanism ?
Tx: Tx 1° diz

DDx: Anemia of chronic diz

- Chronic inflammatory or infectious process
  - **Chronic renal diz**
  - **Chronic liver failure**
- **Neoplasia**
- Necrosis
- Disturbance of iron metabolism

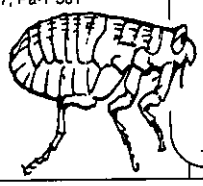
Cancer: anemia most common CBC abnormality of cancer

- Immunohemolytic anemia: associated w/ lymphoproliferative malignancies (lymphoid leukemia)
- Hemorrhagic anemias: invasion of tumors
- Aplastic anemias: excessive production of estrogen by testicular tumors

Nutritional anemia; Iron deficiency anemia; Microcytic, hypochromic anemia

M8k 12; E-hb 685; I2M 1171; 5min 346; Cat 705; SAP 154; H2B 727; Pa-T 301

*?



- **Indication of chronic blood loss**
  - Progresses from regenerative to nonregenerative as iron stores are depleted. Deficient hemoglobin synthesis
- Not recognized in adult cat
- Reported in kittens at weaning
- Pathophysiology:
  - Low iron = deficient hemoglobin synthesis = hypochromasia & microcytic cells

- Causes: iron defc anemia
  - **Chronic blood loss**
    - **Severe flea** infestation
    - Hookworms
    - Bleeding GI neoplasms
    - External hemorrhage
    - Coagulopathies
    - Overused blood donor
  - Dietary defc seldom cause, even in neonates

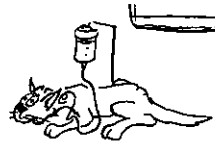
- **General signs of anemia; gradual**
  - Lethargy, weakness, anorexia, tiring
- ±Evidence of external loss (fleas, melena)

- **Hx**, CS
- **CBC: Anemia**: starts as regenerative, progresses to nonregenerative
  - PCV varies widely, falsely high because RBCs don't pack well; MCV often low
  - ± Reticulocytes, as high as 500,000/µl
  - ± Hypoproteinemia
  - Hypochromia (increased central pallor)
  - ± Poikilocytosis, leptocytosis & fragmentation
  - **Microcytic anemia**
  - **Thrombocytosis** 50% of dog cases
- Low serum iron levels dog: < 80 µg/dl, Cat: < 60 µg/dl
- ± ↑ Total iron binding capacity (measure of transferrin)
- Bone marrow biopsy in dog:
  - No stainable iron (Prussian blue stain)
  - Hypercellularity w/ marked erythroid proliferation

DDx:

- Other nonregenerative anemias
- Other cause of microcytic, hypochromic anemias
  - Copper defc, Vit B6 defc, lead intoxication

- **Correct chronic blood loss**
- **Iron supplementation** for 30-60 days
  - Ferrous sulfate
- ± Transfusion in young w/ hookworms
- Wean neonate onto solid food



Prognosis
??????

Indicates chronic blood loss

Cobalamine (Vit. B12) deficiency, Inherited nonregenerative anemia

Mk 1351; SAP 154; IM 297; HB 1281t; 5min 238,459; Lab 39

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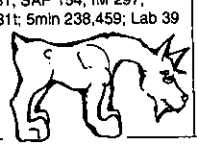

- **Rare**, young dogs; Causes: Congenital: **Malabsorption of B12 in Giant Schnauzers;** Acquired (small intestinal diz [ileum], exocrine pancreatic insufficiency, bacterial overgrowth in dogs), **Macrocytic anemias in cats**; Pathophysiology: B12 required for DNA synthesis & nuclear maturation = large nucleated RBCs (megablasts)
- CS: Weight loss/cachexia; ↓ appetite, lethargy, failure to thrive at 3 months old
- Dx: Hx (age, breed), CS; CBC: Chronic normocytic, normochromic nonregenerative anemia - **Giant Schnauzers; Macrocytic anemia in cats**, occasional erythroid dysplasia (megablasts) in peripheral blood or bone marrow, anicytosis, poikilocytosis, macrocytes; macrocytic anemia (cat), eutropenia & hypersegmented PMNs; Serum cobalamine levels
- Tx: **Cobalamine supplementation**; Cyanocobalamine or hydroxocobalamin
- Px: **Excellent** w/ Tx

Folate/folic acid deficiency

Mk 1352; SAP 154; H2B 1281t; IM 297

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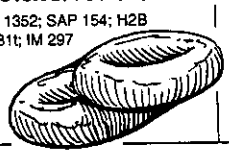
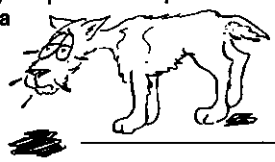
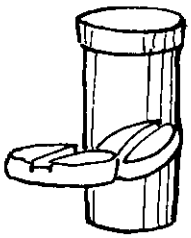
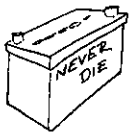
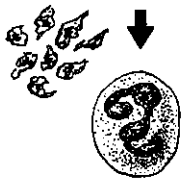
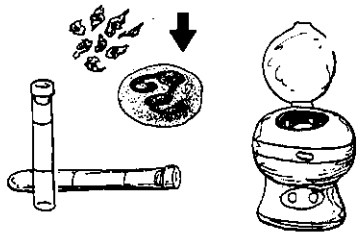
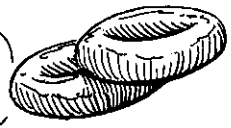
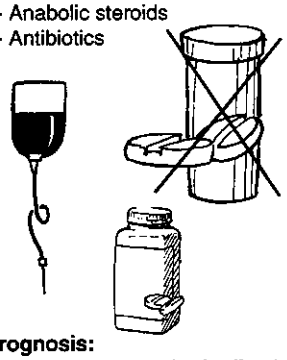
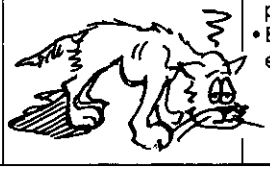
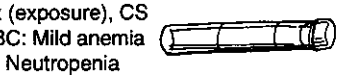
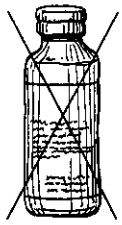
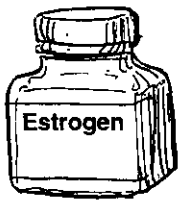
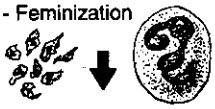
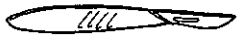
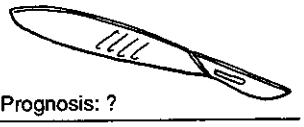
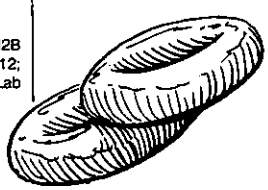
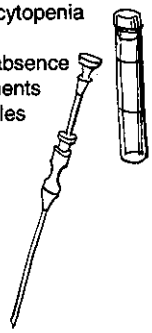


- Causes: Neoplasia, Intestinal malabsorption (jejunum), Liver diz, Severe anorexia or starvation, Drugs (may impair absorption or production): Anticonvulsants (phenobarbital, primidone), Sulfonamides (sulfasalazine, trimethoprim-sulfa), Antineoplastic agents (methotrexate); Pathophysiology: Hypoplasia of bone marrow, Glossitis
- CS of inciting problem, Glossitis
- Hx (drug exposure of concurrent diz); CBC: Macrocytic anemia (cat); Serum folate levels may be measured to confirm
- Treat cause, **Oral folate supplementation** (Folic acid [Folvite®])
- Prognosis: ???

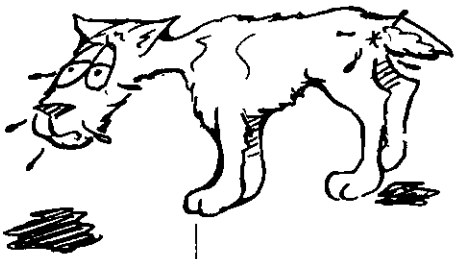
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Drug & toxin induced anemia M8k 18; E-hb 690; SAP 155; H2B 725; IM-WW 572 ****?**	• **Drugs associated w/ reduced erythropoiesis & aplastic anemia**  **Hormones, drugs or chemicals - anemia** • Cytotoxic antineoplastic drugs • Chloramphenicol • Estrogen (endogenous or exogenous) • Benzene • Phenylbutazone • Trimethoprim-sulfa • Neclofenamic acid • Thiacearsamide • Quinidine • **Lead poisoning** • Levamisole-induced immunohemolysis  	• **Signs related to thrombocytopenia & neutropenia take precedence over chronic anemia** • Sequela: - Overwhelming sepsis  **DDx:** • **Other causes of pancytopenia & aplastic anemia**	• Hx (drug), CS • CBC: - Initially anemia, thrombocytopenia w/ leukocytosis (PMNs) - Later: **pancytopenia**  	• **Stop drug or toxin** - Recovery begins in 1 month • Supportive care - Blood transfusions - Anabolic steroids - Antibiotics  **Prognosis:** • Depends on severity & offending toxin • Pancytopenia: poor to grave
Chloramphenicol toxicity E-hb 690; SAP 155; H2B 725 ***?** 	• **Reversible bone marrow suppression may occur** - Not bone marrow aplasia as in humans • **Cats** especially susceptible - If use, limit to smallest dose & shortest duration possible (when would you ever do this?? & why??) • Do not use in dogs or cats w/ nonregenerative anemias	• CNS depression • GI signs • Anorexia (vomiting, diarrhea) • Weight loss 	• Hx (exposure), CS • CBC: Mild anemia - ± Neutropenia • Thrombocytopenia & neutropenia precede anemia • Bone marrow: vacuolation of hematopoietic precursors  	• **Stop drug - reverses toxicity**  Prognosis: ????

Hyperestrogenism SAP 155; H2B 725; 5min 694, 570; IM-WW 512 	• **See Tox 733** • Testicular Sertoli cell or ovarian granulosa cell produce estrogen • Exogenous: - Diethylstilbestrol - Estradiol cyclopentylpropionate - Treatment of mismating, infertility, urinary incontinence & perianal adenomas - Depends on dose & age of animal (worse in older dogs)	• **CS of thrombocytopenia & neutropenia more pronounced than mild anemia** • **Exercise intolerance** • Sertoli cell tumor - Alopecia - Feminization 	• Hx (drug exposure), CS • PE: Cryptorchidism, feminization • CBC: Moderate to severe anemia - **Thrombocytopenia:** w/in 2-3 weeks - **Leukopenia** w/in 4 weeks • Bone marrow: early ↓ megakaryocytes, granulocytic hyperplasia - Late: generalized hypoplasia/aplasia • Surgical removal of tumor + recovery from anemia 	• Surgical removal of tumor • Supportive care - Blood transfusion if life threatening thrombocytopenia - Anabolic steroids; unknown efficacy  Prognosis: ?
Myeloaplasia, Aplastic anemia, Idiopathic erythroid hypoplasia/aplasia, Hypoproliferative anemia, Bone marrow failure M8k 12; E-hb 689; SAP 153; H2B 726; I2M 1169, 1189; IM-WW 512; F3IM 499; Cat 713; Pa-T 302; Lab 36, 40, 80 ***?**	• Severe marrow depopulation leading to blood cytopenias - Pure RBC aplasia: ↓/absence of RBC precursors in bone marrow & nonregenerative anemia - Aplastic anemia: ↓ of all stem cell lines in bone marrow & peripheral cytopenias  **Causes - aplastic anemia** • Idiopathic • FeLV • Estrogen toxicity • Phenylbutazone toxicity • Chemotherapy • Canine ehrlichiosis • Lymphoproliferative disorders Pure RBC aplasia • Idiopathic (usually) • Autoimmune process	• Lethargy • Weakness • Anorexia • Fever & infections • Bleeding disorders	• CBC - Cytopenias: nonregenerative anemia, neutropenia, thrombocytopenia • Marrow aspiration: - Severely reduced or absence of hematopoietic elements - Hypocellular fat particles 	• No specific Tx • Symptomatic & supportive until body can take over/recover • **Broad spectrum ABs** • Transfusion • ± Steroids for thrombocytopenic hemorrhage • Anabolic steroids - wishful thinking! Prognosis • Repopulation possible
Mechanical fragmentation of RBCs, Pathic hemolytic diz, Microangiopathic hemolytic diz E-hb 688; I2M 1171; SAP 152 	• Mechanical fragmentation of RBCs • Cause: - Postcaval syndrome associated w/ heartworm (Dirofilariasis), Hemolysis if large numbers of worms obstruct blood flow, causing turbulence & mechanical disruption of RBCs - Splenic torsion - DIC: fibrin from damaged vessels mechanically disrupts RBCs		• CS: usually subclinical • Dx: Hemoglobinemia, schizocytosis (RBC fragments), ± hemoglobinuria, hemoglobinemia, hemoglobinuria; Circulating microfilaria, Serologic detection of circulating antigens (occult heartworm test?) • Tx: Treat cause 	

Coagulation Disorders

Condition	Facts/Cause	Presentation/CS	Diagnosis
Disorders of hemostasis, Coagulation disorders M8k 40; Mk 55; I2M 1192; IM-WW 299; E-hb 713; SAP 164; IM 926; cat 704, 739; Pa-T 312 ****?**	• **Spontaneous or excessive bleeding** • **Group of bleeding diathesis** • Uncommon in dog • Rare in cat, but abnormalities in hemostasis screens w/o bleeding frequent in liver diz	• **Spontaneous hemorrhage** • Excessive bleeding after surgery or trauma • Sequelae: - Thrombosis & thromboembolism . ± Organ failure	• 1st differentiate blood loss from single location from systemic bleeding diathesis (Hx, PE & quick assessment tests) • **Hx of spontaneous bleeding or excessive bleeding after surgery or trauma** - Bleeding from tooth eruption, dewclaw removal or tail docking? - 1st bleeding episode? Littermates w/ similar CS? - ↑ Prenatal death in litter? (Internal bleeding) - Recent modified live vaccine? Drugs (aspirin, sulfas)? - Outside animal - access to rodenticides? - Hepatic diz: risk of coagulation disorders? • Physical exam (PE): for specific sites - local or systemic • **Radiographs**: chest & abdomen for fluid lines - Intra-alveolar pattern in intrapulmonary hemorrhage - Contrast radiographs, ultrasound for erosions, infiltrations or mass lesions • **Quick assessment tests (QATs), cage side tests** - **Blood slide for platelets** (Diff-Quick®) . Normal oil immersion microscope: >12-15 platelets/field in dog or 10-15/field in cat . If < 2 or 3/field suspect thrombocytopenia - **Activated clotting/coagulation time (ACT)** tests intrinsic clotting system . Prolongation in **intrinsic & common** coagulation factor defc (normal time to form clot in dog: 60-120 sec, cat 60-70 sec.) . Prolongation in hemophilia, Warfarin poisoning, DIC & ± vWF . 2 ml of whole blood into diatomaceous earth (gray topped tube) - **FDP** (fibrin degradation products) test (Thrombco Wellco test) . Increased w/ DIC (commonly) & occasionally in warfarin toxicity - **Bleeding time tests**: wound & measure time until bleeding stops . Buccal mucosa bleeding time (BMBT): 2 incisions in mucosa of upper lip; normal 2-3 minutes .. Prolonged: **platelet dysfunction** (aspirin Tx & vWD) .. Normal in coagulation factor deficiencies & some DIC

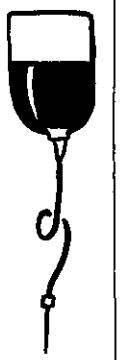
	Thrombocytopenia	Clotting factor deficiencies
Petechiae	Common	Rare
Hematoma	Rare	Common
Bleeding	Mucous membranes Multiple sites	Into muscles, joints & body cavities
Venipuncture	Immediate bleeding	Delayed bleeding



Platelets, Warfarin
CS: Spontaneous or excessive bleeding
Dx: Cage side, Bleeding, APTT, PT tests
Tx: Proper Dx & Tx

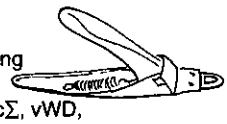
DDx - Bleeding disorders
- **Thrombocytopenia #1 in dog**
- Vit K deficiency
  - **Anticoagulant rodenticides**
  - Decreased absorption
    . Posthepatic biliary obstruction
    . Infiltrative bowel diz
  - Premature neonates or delivered by C-section
    . Heparin - inhibits coagulation
- Congenital clotting factor deficiencies
  - Hemophilia
  - Von Willebrand's diz (vWD)
- **DIC**
- **Liver diz**
- Cat: retrovirus-induced bone marrow disorder

Treatment:
- **Proper treatment depends on accurate diagnosis**
- **Aggressive Tx because potentially life threatening**
- **Nursing care**: feed soft food; avoid neck leads, IM injections & exercise
  - Venipuncture w/ smallest needle possible (25 g), apply pressure for 5 minutes + pressure bandage
  - Never collect urine by cystocentesis
- Do not give platelet inhibiting drugs (sulfa & NSAIDs)
- **Wound management**: suture or pressure bandage
  - Tissue adhesion (Vetbond) to focal areas of bleeding
- **Transfusions** for severe inherited coagulation factor defc, vWD, & acquired disorders not responsive to correction of underlying diz
  - Fresh whole blood: active coagulation factors & RBCs
  - Plasma products (fresh plasma, fresh frozen plasma, plasma concentrates) reduces immunologic transfusion reactions
- Drug therapy:
  - **Vitamin K SQ**
    . Initiating pending test results, only helps K deficiency states, not for DIC, vWF, inherited factor defc & nonobstructive liver diz
    . Anticoagulants rodenticides (Warfarin) - reverses in 24-48 hours
- Hormonal Tx for vWD associated w/ endocrine disorders
  - Hypothyroidism (L-thyroxine supplementation)
  - Desmopressin acetate (DDAVP®): for vWD, a vasopressin analog
- Heparin Tx - DIC causing vessel thrombosis or embolism



Normal hemostasis
- Vessel injury - exposes subendothelial collagen
  - Primary platelet plug: adhesion of platelets mediated by von Willibrand's factor (short lived)
  - Secondary plug due to intrinsic & extrinsic hemostatic pathways forming fibrin
  - Excessive clotting prevented by fibrinolytic pathway, antithrombin (AT) III

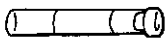
(Dx continued)
. Toenail bleeding time (TBT)
.. Guillotine toenail clipper to bleeding
.. Normal TBT 5-6 min
.. Prolonged coagulation factor defcΣ, vWD, platelet dysfunction & DIC



- **CBC:Platelets: < 100,000/µl = thrombocytopenia**
  . Bone marrow aspirate for all thrombocytopenic dogs & cats
  - Spontaneous bleeding < 30,000/µl
- Definitive tests: coagulation screening assays: *in vitro* fibrin clot formation
  - **APTT** (activated partial thromboplastin time) for intrinsic & common coagulation pathways
  - **PT/OSPT** (prothrombin time): for extrinsic & common pathways
  - Fibrinogen concentration (plasma)
  - Thrombin clotting time (TCT): deficiencies & dysfunction of fibrinogen
- Specialized veterinary coagulation laboratory
  - For unusual coagulopathy; or specific clotting factor deficiency
  - Specific vWF assays
    . vWF antigen (vWF:Ag) most common
- **DIC**: definitive Dx can't be based on 1 test
  . FDP (fibrinogen degradation products) or fibrin split products (FSP)
  . Falling platelet count
  . Low plasma fibrinogen & antithrombin 3
  . Prolongation of all coagulation screening assays
  . Schistocytes on stained peripheral blood

Cage side test

Gray (diatomaceous earth)	ACT test
Thrombco Wellco test	FDPs
Simplate-II®	ACT

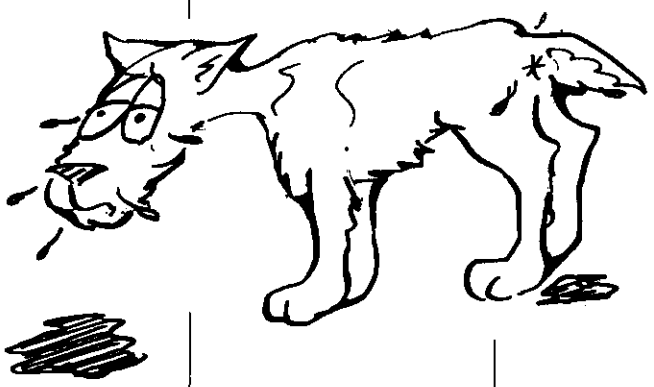


Lab tubes for hemostasis

Purple (EDTA blood)	Platelet count
Blue (citrated blood)	OSPT, APTT, Fibrinogen, AT III
Special blue (thrombin)	FDPs

Thrombocytopenia

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Thrombocytopenia M8k 43; Mk 56; SAP 160; E-hb 720; H2B 760; I2M 1197; IM 931; IM-WW 523; 5min 278, 1100; Cat 703, 748; Pa-T 311 ****?**	• ↓ **Platelets** • Types of thrombocytopenia - ↑ Platelet destruction (#1 in dog) - ↑ Consumption - Sequestration - ↓ Production (#1 in cats, retrovirus - bone marrow disorders) • Immune-mediated #1 in dogs	• **Petechiae or ecchymotic hemorrhages** (mucous membranes or skin) • Epistaxis, melena, hematuria, hyphema • **Prolonged bleeding** from wounds/injection sites • CS or inciting condition (infection, neoplasia or splenomegaly) - Sepsis: fever, poor perfusion	• Hx (assume drug related until proven otherwise) • Physical exam: for site of hemorrhage, hepatosplenomegaly, infection or neoplasia • **Cage side test - blood smear** (Diff-Quick®) - Normal platelet numbers: oil immersion microscope: >12-15 platelets/field in dog or 10-15/field in cat - **If < 2 or 3/field suspect thrombocytopenia** • CBC: - **Thrombocytopenia: < 100,000/µl** . Clinical bleeding at < 20,000/µl . Stop any drug & reevaluate in 2-6 days • ± Spherocytic hemolytic anemia if concurrent IHA (Evans syndrome) - ± Combs test • **Bone marrow aspiration & core biopsy**: check megakaryocyte numbers - Hyperplasia of megakaryocytes: peripheral destruction/consumption/sequestration of platelets - Infiltrative or dysplastic bone marrow • **Cats: FeLV & FIV tests** • **Clotting profile**: PT, APTT usually normal unless DIC • ± von Willebrand factor assay • Assays for canine ehrlichiosis, Rocky mountain spotted fever, cyclic thrombocytopenia, Hemobartonellosis • Urine & blood cultures if sepsis suspected • R/O DIC w/ hemostatic screen • Antiplatelet antibody tests are unreliable - R/O other clause • Radiographs: splenomegaly 1° or 2° • Positive response to steroids for IMT • Tetracycline & steroids if ehrlichiosis or IMT suspected until serology returns	• **Treat cause** **- Immune mediated - steroids** **- Ehrlichiosis - tetracyclines** • **Supportive** - Fresh transfusions (w/in 8 hours of collection) if both RBCs & platelets low - If only low platelets - platelet rich plasma



↓ Platelets < 100,000/µl
CS: Hemorrhages
Dx: Blood smear, CBC, Marrow, FeLV, PT & APTT, Steroids
Tx: Support & Tx cause

DDx - Thrombocytopenia

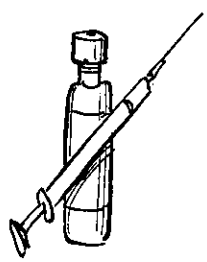
- **↓ Platelet production**
  - Immune-mediated megakaryocytic hypoplasia
  - Idiopathic bone marrow aplasia
  - Drug-induced megakaryocytic hypoplasia (estrogen, butazolidine) antineoplastic (cisplatin, cyclophosphamide, chlorambucil, doxorubicin, hydroxyurea)
  - Myelophthisic thrombocytopenia
  - Cystic thrombocytopenia
  - Congenital thrombocytopenia cyclic hematopoiesis - gray collie
  - Infectious agents (canine distemper, parvovirus, FeLV & *Ehrlichiosis canis*)
- **↑ Platelet destruction/consumption**
  - **Immune-mediated thrombocytopenia (IMT)**
  - **Live viral vaccine - distemper**
  - **Drugs**
    - . Acetaminophen
    - . Antineoplastic drugs
    - . Antiarrhythmics
    - . Anticonvulsants
    - . Antiinflammatories (nonsteroidal)
    - . Benzene
    - . Benzocaine
    - . Chloramphenicol
    - . Cimetidine
    - . Gold salts
    - . Griseofulvin
    - . Levamisole
    - . Methimazole
    - . Methionine
    - . Methylene blue
    - . Metronidazole
    - . Penicillin & cephalosporins
    - . Phenothiazines
    - . Propylthiouracil
    - . Sulfa derivatives
    - . Thiacearsamide
    - . Trimethoprim-sulfa
    - . Vitamin K
    - . Zinc
  - Microangiopathy
  - DIC
  - Hemolytic uremic syndrome
  - Hemorrhage
  - Vasculitis
  - Endotoxemia/ sepsis
  - *Ehrlichia canis, E. plarys, E. equi*
  - Acute hepatic necrosis
  - Neoplasia (immune mediated, microangiopathy)
  - Bleeding
- **Sequestration**
  - Splenomegaly (sequestration)
  - Splenic torsion
  - Hepatomegaly (rare)

Selected causes of thrombocytopenia

- **Infectious see Systemic**
  - *Ehrlichia canis, E. plarys, E. equi*
  - ↑ Platelet activation & consumption
  - Dx: Hx (tick), positive serology, bone marrow: megakaryocytic hyperplasia in acute phase

Infectious cyclic thrombocytopenia
SAP 125; H2B 1220; E-hb 190; E 380

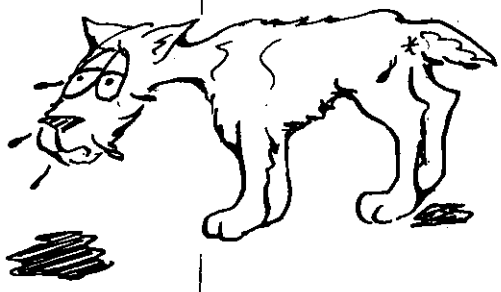
- *Ehrlichia platys*, Gulf coast, low morbidity & mortality
- CS: asymptomatic, incidental finding
- Dx: Thrombocytopenia at 1-2 week intervals in asymptomatic dogs, IFA testing or organism in platelets (Giemsa-stained blood smear)
- Tx: Tetracycline or doxycycline. Px: excellent w/ Tx

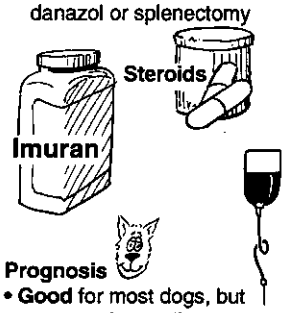


- **Live viral vaccine**
  - Canine distemper vaccine: 1 week post-vaccine
    - . Transient - up to 3 weeks
    - . Rarely significant unless surgery during low platelets
- **Hemorrhage**: can consume platelets
  - Bleeding alone or in association w/ bacterial or viral infections
  - Endotoxemia from gram negative bacteria cause endothelial damage & platelet activation
  - Dx: Hx, PE, Cytology, histopath, culture
  - Tx: Transfusion if severe
- **Splenomegaly**: causes sequestration of platelets in spleen
  - Dx: enlarged spleen w/o evidence of other causes of thrombocytopenia
  - Little clinical significance if benign enlargement

Thrombocytopenia

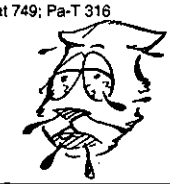
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Immune-mediated thrombocytopenia M8k 43; Mk 56; SAP 160; E-hb 720; I2M 1199; IM 933; IM-WW 523; 5min 1100	• **↓ Platelets** • **#1 cause of spontaneous bleeding in dogs** • #1 cause of thrombocytopenia - Middle age females - Breeds: Old Eng. sheepdog, toy breeds • Extremely rare in cat	• **Petechiae or ecchymotic hemorrhages** (mucous membranes or skin) • **Superficial bleeding** • Epistaxis, melena, hematuria, hyphema • Prolonged bleeding from wounds/injection sites • Asymptomatic or collapse depending on degree of bleeding • ± Vomiting	• **Diagnose by ruling out other causes** • Hx (rule out drugs 1st) • Physical exam: for site of hemorrhage, splenomegaly • **CBC** - **Thrombocytopenia: < 100,000/µl** **. Clinical bleeding at < 20,000/µl** - ± Anemia depending on degree of bleeding & concurrent IHA - ± Leukocytosis w/ left shift - ± IHA (immune-mediated hemolytic anemia) + IMT = Evan's syndrome - Coombs' positive anemia w/ spherocytes • Bone marrow aspiration & core biopsy: check megakaryocyte numbers - Hyperplasia of megakaryocytes usually - R/O infiltrative or dysplastic bone marrow • **Bleeding time - prolonged** • Clotting profile all normal: PT, APTT, ACT, FDPs & fibrinogen • Radiographs: splenomegaly • Urine & blood cultures if sepsis suspected • R/O DIC w/ hemostatic screen • R/O ehrlichiosis (assay), drugs, infections, clotting abnormalities before diagnosis • Antiplatelet antibody tests are unreliable • **Positive response to steroid** in 48-96 hours	• **Lifelong Tx required** • Remission: adjust until platelets normalize - **Immunosuppressive dosage of steroids (prednisolone)** - Single dose of cyclophosphamide to induce remission • Maintenance: **steroid + azathioprine (Imuran®)** - ± Danzol: androgenic steroid? • Fresh transfusions (w/in 8 hours of collection) if both RBCs & platelets low - If only low platelets - platelet rich plasma • Tetracycline & steroids if ehrlichiosis or IMT suspected until serology returns • Refractory IMT - Vinca- loaded platelets, danazol or splenectomy **Prognosis** • **Good** for most dogs, but requires lifelong Tx

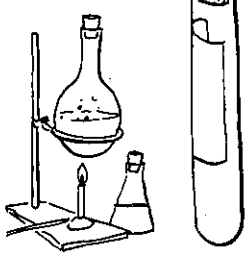




#1 Spontaneous bleeding
CS: Bleeding
Dx: R/O other causes
Tx: Lifetime steroids

Inherited clotting factor deficiencies; Hemophilia M8k 40; Mk 54; E-hb 716; SAP 164; H2B 769; I2M 1201; IM 936; IM-WW 526, 522; F3IM 488; 5min 212; Cat 749; Pa-T 316 *	• **Deficiencies in specific coagulation factors** - Mutation in genes • A secondary hemostatic deficiency (less common than rodenticide poisoning) • Rare in purebred dog, extremely rare in cats • **Hemophilia**: common severe coagulation deficiently - X linked traits - inherited . Males inheriting 1 abnormal gene from mom express trait . Females w/ 1 gene are asymptomatic carriers . Hemophilia A: mutation of factor 8 . Hemophilia B: deficiency of factor 9 . Hemophilia A > B . German shepherd - hemophilia A - Autosomal; traits: female & males equally . Deficiencies in factors 9, 10, 7, 2 & fibrinogen . Factor 12 deficiency common in cats, but doesn't cause bleeding	• **Asymptomatic** • **Spontaneous hemorrhage** - Bleeding from tooth eruption, dewclaw removal or tail docking • Prolonged bleeding after surgery or trauma • Deep bleeding into cavities, joints & muscles • **SQ hematoma formation (lumps)** • Lameness due to bleeding into joints • No petechiae or ecchymoses • Fading puppy syndrome • Prolonged umbilical cord bleeding DDx: • Thrombocytopenias (more common than coagulation disorders)	• Physical exam (PE): for specific sites • **BT (bleeding time) tests** (cuticle bleeding time > 6 min) • **Platelets normal** • **APTT** (activated partial thromboplastin time) for intrinsic & common coagulation pathways • PT (prothrombin time): for extrinsic & common pathways • Fibrinogen concentration plasma fibrinogen • Thrombin clotting time (TCT): deficiencies & dysfunction of fibrinogen	• **Periodic blood transfusions** - Fresh whole blood: active coagulation factors & RBCs - Plasma products (fresh plasma, fresh frozen plasma, plasma concentrates) reduces immunologic transfusion reactions • Confine bleeding patient (avoid trauma) • **Nursing care**: limit activity, feed soft food, avoid neck leads & IM injections - Peripheral veins for blood sampling & catheters • Do not give platelet inhibiting drugs (sulfa & NSAIDs) • Wound management: suture or pressure bandage - Tissue adhesion (Vetbond) to focal areas of bleeding Prognosis: ????
Von Willebrand's diz, vWD, Hereditary thrombocytopathies, Inherited platelet dysfunction M8k 45; Mk 54; E-hb 716; SAP 164; H2B 769; I2M 1200; IM 934; IM-WW 525; F3IM 494; 5min 1158; Pa-T 317 *	• Most common hereditary bleeding disorder in dogs • Deficiency or dysfunction of **von Willebrand's factor** (vWF, FVIII:AG): plasma glycoprotein **- Required for normal platelet adhesion** • Autosomal: male & females • Apparent acquired forms • Breeds: Doby, Scottish terrier, Shetland sheepdog, Golden retriever, Pembroke Welsh corgi, Standard Poodle, Chesapeake Bay retrievers; recently documented in cats • Associated w/ hypothyroidism	• **Prolonged bleeding after surgery or trauma** • Rarely spontaneous hemorrhage from oral & nasal mucosa or GI or genitourinary tracts - Stillbirths/neonatal deaths - Prolonged estrus, postpartum bleeding **DDx:** • Thrombocytopenias (more common than coagulation disorders)	• **Suggestive: bleeding & normal platelet count** • Physical exam (PE): for specific sites • **BT (bleeding time) tests** (cuticle bleeding time > 6 min) • **Platelets normal** • Homeostasis screen usually normal (ATPP, PT) • **Specific vWF assays** - vWF antigen (vWF:Ag) most common • Test for hypothyroidism in all vWD	• **Desmopressin acetate** (DDAVP®) causes massive release of vWF & results in shortening of BT w/in 30 min. of administration • Cryoprecipitate, fresh frozen plasma or whole fresh blood increases circulating vWF • Hypothyroidism (L-thyroxine supplementation) shortens BT • Do not breed Prognosis: ????





Anemia

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
DIC, Disseminated intravascular coagulation, Mixed (combined) hemostatic defects, Consumptive coagulopathy, **Defibrination syndrome, Fibrinolytic abnormalities** M8k 43; Mk 24; E-hb 715; SAP 165; H2B 773; I2M 1203; IM 937; IM-WW 527; 5min 526; Cat 751 **	• **Not a 1° diz, but a common pathway in a variety of disorders - Complex syndrome** • **Coagulation cascade - dynamic** - Fibrin deposition due to small vessel damage - Activates coagulation & fibrinolytic systems simultaneously - Depletion of platelets (thrombocytopenia) & clotting factors - Shearing of RBCs (hemolytic anemia) - Microvascular thrombosis or bleeding tendencies • Uncommon in dog, rare in cats **DIC - causes** • **Vascular/endothelial damage** - Electrocution - Heat stroke - Heartworms - Vascular stasis • Release of tissue coagulants - **Neoplasia** . **Hemangiosarcoma (HSA)** . Prostatic & mammary carcinomas - **Burns or crush wounds** - **Pancreatitis** - Liver diz - Trauma - **Bacterial infections/sepsis** • **Hemolytic anemia** • Platelet activation - FIP in cats (rare)	• Variable - dep. on 1° diz • **Acute (fulminate) DIC** - Paradoxical bleeding from body orifices & into body cavities . **Petechial or ecchymotic hemorrhages** (depletion of clotting factors) . Life threatening hemorrhage rare . Trauma or Sx m/ induce uncontrollable hemorrhage . Bleeding from venipuncture sites - **Thrombosis & ischemic organ failure** . **Kidney failure** . **DIC lungs** (bleeding & thrombi) . **CNS - microvascular thrombosis** .. Delirium, convulsions, coma - **Thrombosis of major veins** . Catheters & needle • Chronic (silent), compensated DIC - Few or no CS . M/ become fulminant DIC due to stress, concurrent diz DIC = "Death Is Coming!"	• **Definitive Dx can't be based on one test** • Strongly suggestive findings - **Hemolytic anemia** . **Schistocytes** (RBC fragments), spherocytes . Hemoglobinemia (hemolysis) - **Thrombocytopenia <100,000/ml platelets - suspect DIC** - **Hypofibrinogenemia**, low fibrinogen & antithrombin 3 - ↑ **FDP** (fibrin degradation products) ≥ 1:20 diagnostic - **Prolonged PT &/or APTT time** - Prolonged bleeding times - Prolonged activated clotting time (ACT) dog: 60-120, cat 60-70 sec.) - Neutrophilia w/ left shift • Chemistries: - Hyperbilirubinemia - Azotemia & hyperphosphatemia - Elevated liver enzymes • Urinalysis: - Hemoglobinuria - Bilirubinemia • Radiographs: chest & abdomen for fluid lines **DDx:** •Thrombocytopenias (more common than coagulation disorders)	• **Remove cause,** rarely possible - Sx or chemo for HSA - ABs for sepsis - Immunosuppression for autoimmune hemolytic anemia - Others as electrocution, heat stroke or pancreatitis can't be eliminated fast enough • **No consensus on Tx** • **Supportive Tx** to combat shock & maintain tissue **perfusion** - IV fluids - Blood transfusion - Antiplatelet Tx: aspirin - Heparin Tx may be tried (releases inhibition on clotting factors & platelet function if sufficient AT III) **Prognosis:** • **Grave**: high mortality even w/ treatment • Depends on underlying diz

Result of many dizs- platelets & factors consumed - Grave

Vitamin K deficiency, Anticoagulants (Warfarin, coumarins) AVMA 205(3)p416, 1994; M8k 2142; Mk 1720; E-hb 714; SAP 164; H2B ; I2M 1202; IM 936; IM-WW 527; 5min 1044; E1953; Cat 221;; E1953; Pa-T316; NB20.9	• **Most common form of acquired coagulopathy - #1 clotting factor deficiency** • Source: - **Rodenticides #1 (warfarin** [D-Con®, Coumafene®], pindone [Pival®], isovaleryl indanedione [PMP®, Valone®], brodifacoum [Talon®], diphacinone [Ramik®], chlorophecinone [Rozol®], bromadiolone [Maki®]) - Obstructive cholestasis - Infiltrative bowel diz (↓ absorption of Vit. K - Liver diz • **Mechanism of action:** - **Competitive inhibition of Vit. K** - Vit. K needed for production of clotting factors (II, VII, IX & X) - Thrombin formation depressed - Rapidly absorbed from GI - Potentiated by Vit. K defc. diet	• **Acute collapse** • **Hemorrhagic diathesis** (predisposition to abnormal homeostasis) • **Hematoma** • Ecchymoses (small hemorrhagic spot > petechiae) in mucous membranes • **Epistaxis** • Periarticular swelling • Hematuria • No fever • Spontaneous hemorrhage • Excessive bleeding after surgery or trauma Vit K_1	• Hx (exposure) • Hemorrhages • **Prolonged PT & APTT** • **No other abnormalities of clotting profile** (norm. platelet count, plasma fibrinogen, usually) • **Anemia** • Hypoproteinemia • Chem. analysis for dicoumerol - feed, blood & liver (absence doesn't rule out) **DDx** • DIC (thrombocytopenia) (pg 142) • Mycotoxicosis • Septicemia (fever)(pg 35) • Liver failure (pg 84)	• **Acute: emetic w/in hours** • **Remove source** • **Vitamin K1** (Aqua-Mephyton®, Veta-K1®) SQ (IM not recommended because of anaphylaxis) - Oral Vit. K1 for 1 week if warfarin or 1st generation hydroxycoumarin, 3 weeks if indanedione or 2nd generation • Fresh plasma or whole blood transfusion • Keep quiet immediately post exposure **Prognosis:** • Good if early Dx & prompt Vit. K1
	#1 coagulopathy; Rodenticides, Inhibition of Vit. K **CS: Dyspnea, Bleeding** **Dx: Hx, CS, Response to vit K1, Lab** **Tx: Emetic, Vitamin K1± Transfusion • Px: Good**			
Liver diz & hemostatic dysfunction E-hb 716; H2B 774; Cat 751; Pa-T 316 **?	• **Generalized liver diz** - **Major clotting factor producer** - **Platelet dysfunction & DIC**	• **Bleeding** disorders uncommon except in fulminating hepatic failure (aflatoxicosis) • **Other signs or liver diz** - **Icterus, vomiting, diarrhea, encephalopathy,**	• Hx (**liver diz**) • APTT time • ↑ FDP (fibrin degradation products) in 50% of dogs w/ hepatic neoplasia	• Treat underlying liver diz • Supplement Vit K1 at moderate doses Prognosis:???
Thrombocytosis, High platelet count, Thrombocythemia E-hb 772; SAP 161; H2B 766, 762; 5min 280; Pa-T 311 *?	• **Elevated platelet count** • **Physiological** thrombocytosis: platelets released from spleen due to epinephrine during heavy exercise (clinically insignificant) • **Reactive or regenerative thrombocytosis**: causes: - Acute blood loss, iron deficiency anemia, trauma, surgery, inflammation, splenectomy, hyperadrenocorticism, neoplasia (mast cell tumors, hemangiosarcoma, osteosarcoma, some carcinomas, lymphoma, lymphocytic leukemia) Vincristine; Chronic infections (rheumatoid arthritis, cirrhosis, granulomatosis, brucellosis, chronic pneumonitis) • CS: **Asymptomatic** (physiologic); Myeloproliferative disorders (bleeding complications, thromboembolic event) • Dx: Platelet count: dog: > 600,000/µl, Cat: > 800,000/µl, mild to moderate megakaryocytic bone marrow hyperplasia w/o circulating megakaryocytes; ± pseudohyperkalemia from leakage from clotted platelets • Tx: depends on inciting cause; Myeloproliferative: Alkylating agent (melphelan) to reduce numbers, Hydroxyurea, IV radioactive phosphorus. Low dose aspirin to prevent platelet aggregation			

Leukocytes

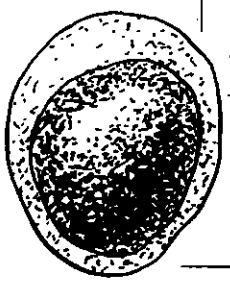
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

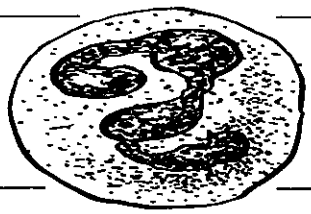
Leukocytes

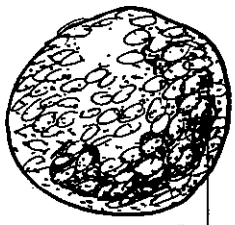
M8k 48, 1206; Mk 59; I2M 1173; IM-WW 515, 520; Cat 721; Pa-T 304; Lab 43; RP-CBC 28

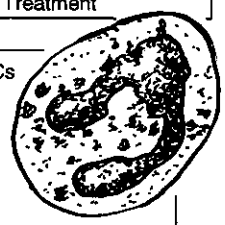
****

- **Leukocytes: white blood cells, WBCs**
  - **Granulocytes**: neutrophils (PMNs), eosinophils & basophils
    - . Produced in bone marrow from a common progenitor cell - myeloblast
    - . Circulate in blood for only a few hours
  - **Lymphocytes**: produced in lymphopoietic tissues (lymph nodes & spleen), but also bone marrow
    - . May recirculate in blood
  - **Monocytes**: produced in bone marrow

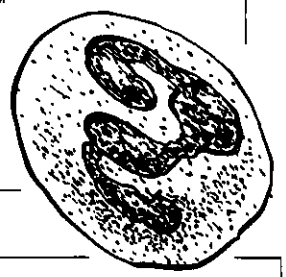




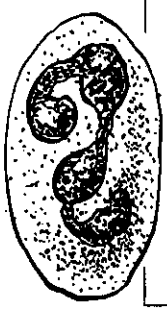




- Increase in various types of WBCs
  - **"-philia" or "-cytosis"**
    - . Lymphocytosis
    - . Neutrophilia
    - . Lymphocytosis
    - . Monocytosis
    - . Eosinophilia
    - . Basophilia
- Decrease in various types of WBCs
  - **"-penia" or "cytopenia"**
    - . Leukopenia
    - . Neutropenia
    - . Lymphopenia
    - . Monocytopenia
    - . Eosinopenia
    - . Basopenia



Leukopenia: ↓ Circulating WBCs
- Almost always due to neutropenia because of predominance of neutrophils

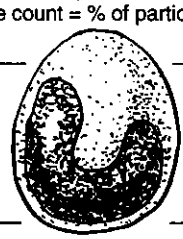


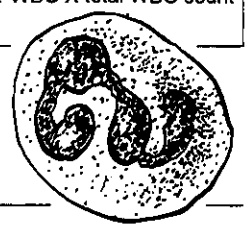
Leukocytosis: ↑ Total circulating WBCs
- Most often a result of absolute increase in neutrophils (neutrophilia)

Physiologic leukocytosis: due to exercise or excitement (↑ epinephrine). Causes: centralization in vessel of marginating pool of WBCs. Additionally splenic contraction releases WBC & RBC into circulation

Stress/glucocorticoid leukogram: cause leukocytosis (neutrophilia, lymphopenia & eosinopenia)

Differential WBC Count - blood smear
Identify & classify first 100 WBC
Absolute count = % of particular WBC X total WBC count





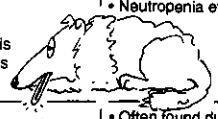
Cyclic neutropenia, Cyclic hematopoiesis

M8k 54; Mk 64; E-hb 725; 5min 493; Lab 71

*

- Inherited in **gray collies** & other dogs
- Periodic fluctuations in PMNs & monocytes, platelets & RBCs (12 day cycles)
- Due to intrinsic bone marrow stem cell defect
- Carriers - discovered only by test mating

- **Severe, recurrent infections**
- Lethargy
- Pyrexia
- Anorexia, Arthritis, Keratitis
- Respiratory & GI infections



- Hx (**gray collies**)
- Neutropenia every 12 days

- **Unrewarding** (ABs & supportive care during neutropenic cycles)

- Px: **Grave:** most die w/in 6 months following chronic recurrent infections

Pelger-Huet anomaly, Chediak-Pelger-Huet syndrome

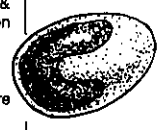
M8k 54; Mk 64; E-hb 691, 725; SAP 156; H2B 736; IM 913; 5min 917; Cat 733, Lab 70 *

- Inheritable in dogs & cats
- Considered benign
- **Granulocytic maturation defect**
  - PMN nuclei mature, but don't divide
  - Dog: normal WBC function & no immunosuppression (no predisposition to infection or inflammation)
  - Cat: chondrodysplasia if homozygous

- **Asymptomatic**

DDx:
- Inflammation w/ left shift

- Often found during pre-operative screening
- PMNs in blood w/ condensed, coarse & patchy chromatin lacking segmentation (**hyposegmentation**)
  - Nucleus resembles **bands**, metamyelocytes & myelocytes
  - Looks like left shift, but not because mature PMNs



- **No treatment necessary**

Feline Chediak-Higashi syndrome

M8k 53, 45; Mk 63; E-hb 725; SAP 156; HB 832; IM 978, 913; F3IM 496; Cat 734; 5min 434; Lab 71

- **Rare** inheritable disorder
- **Blue-smoke Persians w/ yellow eyes**
- Pathogenesis: abnormal & enlarged lysosomal granule in granulocytes & monocytes
  - Platelet dysfunction
  - Melanin in skin abnormal
- Lethal, autosomal recessive condition

- ± Photophobic
- ± Cataract formation
- Bleeding tendencies after surgery & venipuncture
- **↑ Susceptibility to infections**

- Hx (Persian: pale coat, light eyes), CS
- ↑ bleeding time
- Romanowsky stains
  - **PMNs: large eosinophilic granules** (pink to magenta)
    - . Stain positive w/ peroxidase & Sudan black B
- Enlarged melanin granules in hairs

- **Symptomatic**

Prognosis: ??

Mucopolysaccharidosis; Feline storage dizs,

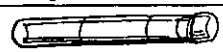
Hurler's syndrome, Maroteaux-Lamy syndrome SAP 157; H2B 736, 883; E-hb 301, 737; 5min 830, Cat 734; Lab 71

- **Inheritable lysosomal storage dIz**
  - Deficiency of enzymes required for mucopolysaccharides
- Siamese cats, Dachshunds, Plott hounds & Springer spaniels
- Pathophysiology: Abnormal catabolism of mucopolysaccharides, leading to accumulation in tissues

- **Skeletal & facial deformities**
  - Small head, broad, flat face, pectus excavarum (concavity of sternum)
  - Joint crepitation & pain
- CNS - diffuse abnormalities, thoracolumbar column deformities
- Corneal opacification

DDx: Toxic PMNs

- HX, CS
- CBC



  - Blood smear: toluidine blue stain
    - . Coarse, reddish granules in PMNs, eosinophils & basophils
    - . Lymphocytes: ± granules or vacuolation
- Radiographs: skeletal abnormalities
- Enzymatic analysis of WBCs

- **No treatment**
- Spinal decompressive surgery
- Euthanasia if progressive
- Experimentally: bone marrow transplantation
- Do not breed

Prognosis:
- **Poor**, euthanasia if progressive

Birman cat neutrophilic anomaly; Abnormal granulation syndrome in Birman cats

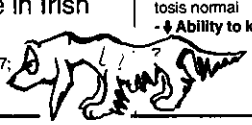
E-hb 742; SAP 157; H2B 737; Cat 734

*

- Genetic anomaly in highly inbred Birman cats, **no clinical dIz**
- Fine, pinkish-purple granules in cytoplasm of PMNs; these lysosomal granules have antiaffinity for eosin dye, but have normal morphology & PMN function
- DDx: from Toxic granulation & mucopolysaccharidosis

Granulocytopathy syndrome in Irish setters

HB 737; SAP 157; Lab 71



- Congenital (autosomal recessive trait)
- PMNs morphologically normal & phagocytosis normal
  - **↓ Ability to kill phagocytized bacteria**

- **Recurrent bacterial infections** starting in puppyhood (dermatitis, gingivitis, osteomyelitis, omphalophlebitis
- Lymphadenopathy w/ extreme leukocytosis

- ↑ PMNs + left shift (↑ nonsegmented PMNs) - 50,000-100,000 WBC/µl w/ left shift to bands, metamyelocytes & myelocytes
- Nonregenerative anemia in chronic cases
- Hypergammaglobulinemia
- Difficult to confirm because PMNs morphologically normal

- **Continuous ABs may be necessary**

Prognosis:
- **Poor/grave:** most die at a few months old

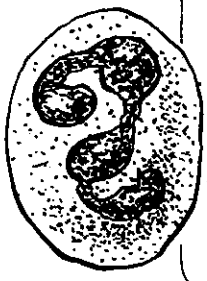
Neutrophils, PMNs ****

M8k 49; Mk 59; E-hb 691; SAP 157; H2B 739; I2M 1179; IM917; E1897; 5min 238; Cat 727; Pa-T 304

- **Polymorphic nucleus w/ pale granules**
  - Band PMNs: immature - indented nucleus (band)
- Peripheral PMNs: marginating pool (adhere to endothelium) & circulating pool (cells counted in a CBC)
- Function: phagocytosis, killing bacteria, lysis of phagocytosed bacteria & dead tissue

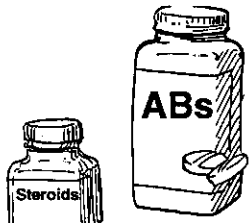
- **Left shift: ↑ bands**
  - Regenerative left shift: requires simultaneous neutrophilia
  - Degenerative left shift w/o neutrophilia, especially if neutropenia or if more nonsegmented PMNs than mature
- **Toxic PMNs**: ± response to injury: basophilia, vacuolation, Dohle bodies (small blue inclusions [endoplasmic reticulum]), giant PMNs

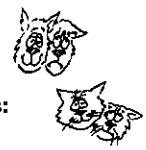
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Neutropenia Mk 59; E-hb 695; SAP 157; H2B 740; IM 915 ***	• **↓ Circulating PMNs** - Dog: < 3000 PMNs/µl - Cat: < 2500 PMNs/µl • Dog > cat • Parvovirus in dogs & cats • Lymphopenia almost always due to neutropenia	• **Often vague & nonspecific** - Fever - Anorexia - Lethargy - Mild GI CS • Bacterial infection - Skin & mucous membranes - Pneumonia, urinary tract • Parvovirus - Diarrhea & vomiting	• **Hx (drugs, acute or chronic infections)** • **CBC** - **Neutropenia** - Look for bone marrow disorders . Nonregenerative anemia, nucleated RBCs, abnormal WBCs (blasts, bands), thrombocytopenia • Bone marrow aspirate - Granulocytic hyperplasia: increased PMN consumption • Core bone marrow biopsy - Hypoplasia, aplasia or myelofibrosis • Serology/virology (FeLV, FIV, Ehrlichiosis, parvovirus) • Immunosuppressive dose test for steroid responsive neutropenia	• **None if no fever or CS of illness** • Remove drugs if they are the cause - Resolves • Sepsis: - Take culture (blood & urine) - **Start ABs** . Initial: IV gentamicin + cephalosporin . Modify according to culture • Immunosuppressive doses of prednisolone if immune-mediated



DDx - Neutropenia

- Infectious neutropenia
  - **Overwhelming bacterial infection**
    . Gram negative septicemia or endotoxemia
  - Mycosis (disseminated histoplasmosis)
  - Protozoal infections (Toxoplasmosis)
  - Viruses (FeLV, FIV, feline panleukopenia, canine **parvovirus**, canine hepatitis)
  - *Ehrlichia canis*
- Toxic/drug neutropenia
  - Drugs: estrogens, chloramphenicol, sulfonamides, tetracyclines, cancer chemotherapeutics agents (cyclophosphamides, chlorambucil, busulfan, melphalan, cisplatin, cytosine arabinoside, methotrexate, vincristine, doxorubicin, hydroxyurea), cephalosporins
- Vaccination (panleukemia - cat, parvo - dog)
- Endotoxins (gram negative sepsis) transient
- Immune-mediated
- Bone marrow necrosis or aplasia
- Myelofibrosis & osteopetrosis
- Myelophthisis (space occupying lesion in bone marrow)
  - Neoplastic & myelodysplastic diz
    . Leukemias (granulocytic, lymphocytic, myelomonocytic), lymphoma, myelodysplastic syndromes)
- Cyclic neutropenia or cyclic hematopoiesis of gray collie, cyclophosphamide Tx, FeLV)
- Anaphylaxis (+thrombocytopenia)
- Irradiation





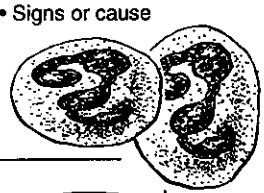
Prognosis:
- **Guarded**

Neutrophilia

M8k 49; Mk 59; E-hb 694; SAP 157; H2B 739; I2M 1182; IM917; IM-WW 515; E 1905; RP-CBC 29; 5min 252; Cat 726; Lab 65
****

- **↑ Circulating PMNs**
  - Dog >11,500 PMNs/µl
  - Cat: >12,500 in cats
- Results in leukocytosis

- Signs or cause



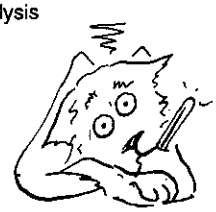
- **CBC:Neutrophilia > 11,500/µl**
- If toxic changes or persistent neutrophilia - look for septic foci
  - Physical exam (abscess)
  - Abdominal & thoracic radiographs (pneumonia, pleural or abdominal effusion)
  - Ultrasound - abdomen (pancreatic or hepatic abscesses)
  - CBC, UA, serology, bacterial & fungal cultures

- **Treat inciting cause**
- **Empirical broad spectrum ABs** if can't identify cause

Prognosis:
- **Guarded**: degenerative left shift ± toxic changes or maturation abnormalities
- **Good**: if return of PMN count to normal + resolution of left shifts, toxic changes, disturbed cellular maturation

DDx/causes - Neutrophilia

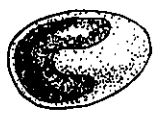
- **Physiology neutrophilia** (epinephrine)
  - Stress, Fear, Strenuous muscular exertion
- **Corticosteroid induced**
  - Steroid Tx
  - Cushing's diz
- Drugs: epinephrine & estrogen (early)
- **Inflammatory neutrophilia**
  - **Infectious**
    . **Bacteria**
    . Rickettsia
    . Viruses (canine distemper, feline rhinotracheitis)
    . Fungi
    . Severe abscessation (pyometra)
    . Parasites: Toxoplasma, Hepatozoonosis
  - Blood loss: hemorrhage or hemolysis
  - Noninfectious
    . **Tissue necrosis**
    .. Necrotizing pancreatitis
    .. Muscle necrosis
    .. Liver necrosis
    .. Neoplasia
    . **Neoplasia**/malignancies
    . Thrombosis
    . Burns
    . Immune-mediated reaction (systemic lupus, AIHA, polymyositis, polyserositis)
    . Granulocytopathy syndrome (congenital) Irish setters
    . Paraneoplastic syndrome (fibrosarcoma, renal tubular carcinoma)
- Neutrophilic leukemia

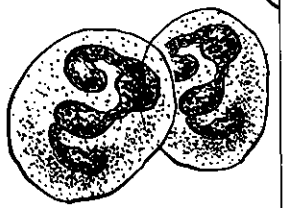


Physiology neutrophilia (pseudoneutrophilia): epinephrine released - stress, fear or exertion (venipuncture)
- Demargination of WBC (WBC move away from walls of vessels)
- Rapid rise in PMNs & lymphocytes, no left shift. Cell count returns to normal in 20 minutes

Corticosteroid induced: releases cells from marginating pool & bone marrow storage pools
- Dx: Hx, concurrent lymphopenia, eosinopenia, monocytosis w/o left shift, PMN hypersegmentation due to prolonged life

Inflammatory/infectious neutrophilia
- Magnitude reflects intensity of diz process
- Degree of left shift suggests severity of the diz

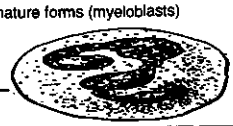




Marked neutrophilia: > 100,000/µl
- Localized purulent infection: pyometra, peritonitis, pyothorax, severe abscesses
- Certain systemic diz: autoimmune hemolytic anemia, endocarditis, mycoses
- *Hepatozoon caninis*
- Some neoplasms: renal tubular carcinoma, fibrosarcoma

Neutrophilia + left shift (hallmark of purulent infection). Significant left shift (> 1,000 bands/µl)
- Severe exudative processes - pyoderma, pleuritis, peritonitis, pyometra & abscess formation
- Shift decreases w/ bone marrow hyperplasia
- Decreasing left shift w/ persistent neutrophilia indicates chronic suppurative process
- Right shift: hypersegmented PMNs associated w/ convalescence

Leukomoid reaction: WBC > 50,000 /µl + left shift including myelocytes & more immature forms (myeloblasts)
- Resembles leukemia, chronic granulocytic leukemia (CGL)
- Benign: more common than CGL, shows orderly cell maturation
- Difficult to differentiate leukomoid reaction from CGL, frequent multiple leukograms

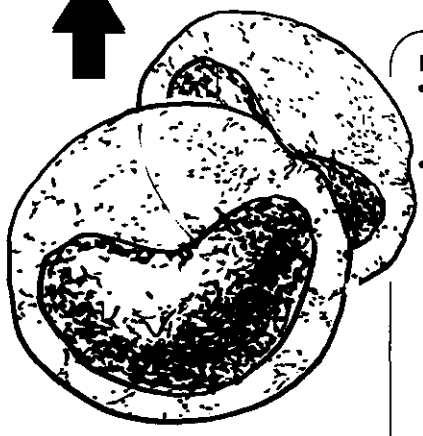


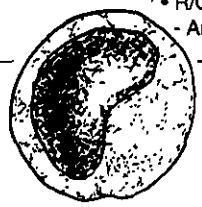
Monocytes

M8k 51; Mk 59; E-hb 700; SAP 158; H2B 744, I2M 1180, 1184; IM 914; IM-WW 516; E 1914; 5min 250; Cat 732; Pa-T 306; Lab 63, 68

- Become **macrophages, Kupffer's cells, etc.** when enter tissues
- Slightly larger than PMNs, foamy cytoplasm
- Function: defence against infectious agents, phagocytes, remodeling,immunologic (present antigen to lymphocytes)

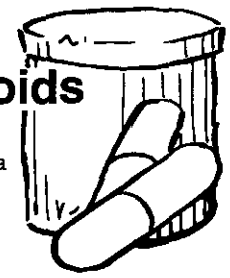
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Monocytosis Mk 59; E-hb 700; SAP 158; H2B 744, IM 919; E 915	• ↑ **Circulating monocytes** - Dog: >1,350 /µl - Cat: > 850 /µl	• **Acute or chronic diz** (traditionally described primarily w/ chronic diz)	• **Look for septic cause** • Hx (steroid induced have concurrent lymphopenia, eosinopenia & neutrophilia), PE • Cytology & histopathology • R/O immune-mediated - Arthrocentesis or other immune tests	• Treat 1° diz

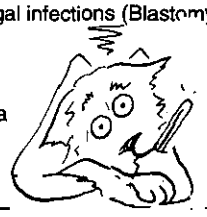


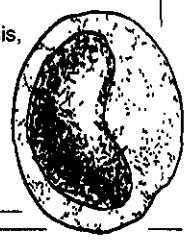


DDx - Monocytosis

- **Corticosteroid-induced**
  - Steroid therapy
  - Hyperadrenocorticism
- Antigenic stimulation
  - **Acute or chronic inflammatory dizs** (pyometra, abscesses, peritonitis, pyothorax, osteomyelitis, prostatitis (dog), Nocardia, Actinomyces, Ehrlichia (dog), Hemobartonella
  - Immune-mediated dizs (hemolytic anemia, dermatitis, polyarthritis)
  - Trauma/crushing injuries - tissue necrosis, foreign body reactions
  - Internal hemorrhage (tissue or cavities)
  - Pyogranulomatous infection
  - Neoplasia (tumor necrosis, lymphoma, myelodysplastic disorders, leukemias)
  - Chronic granulomatous infections - mycobacterial, Brucella sp. & fungal infections (Blastomycosis, Histoplasmosis, Cryptococcosis, Coccidioidomycosis [dog])
  - Heartworms
- Cyclic hematopoiesis
- Monocytic leukemia, myelomonocytic leukemia, myelogenous leukemia
- Recovering neutropenia





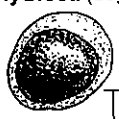


Monocytopenia: infrequently documented & clinically insignificant

Lymphocytes

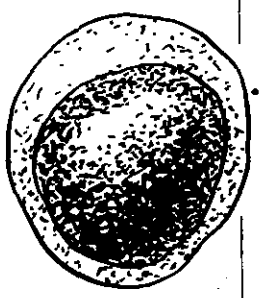
M8k 51; Mk 59; SAP 159; H2B 743; E-hb 701; I2M 1181, 1185; IM 914; IM-WW 516; 5min 242; Cat 732; E 1915; Lab 62-67

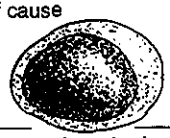
- **Lymphocytes: 2nd most common WBC in healthy blood** (dog & cat)
- Small cells w/ round nucleus

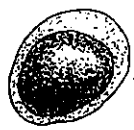


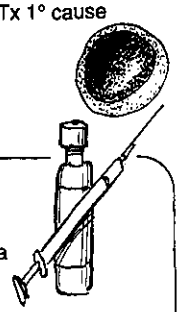
- Function: host defence & immune system component
  - Retain ability to mitose & recirculate
  - T-lymphocyte (T-killer cells) - cell mediated immunity
  - B-lymphocytes (plasma cells - antibodies) - humoral immunity

Lymphocytosis ***	• ↑ **Circulating lymphocytes** - Dog: > 5,000/µl - Cat: > 7,000/µl - Youth: < 6 months . Puppies: 5,700-6,100/µl . Cats may even be higher • Common causes: - Fear in cats - Epinephrine-induced: transient rise, especially young **cats** (≥ 24,000/µl) - Following vaccination in dogs - Chronic ehrlichiosis (dogs) - Hypoadrenocorticism (dogs) - Chronic lymphocytic leukemia (CLL) (dog) - Young age	• Asymptomatic • CS of cause	• Hx (youth, vaccination, fear) • Lymphocyte morphology: infectious: slightly enlarged lymphocytes resembling plasma cells, ± hyperglobinemia • Ehrlichiosis: serology • Bone marrow biopsy: neoplasm	• Tx 1° cause





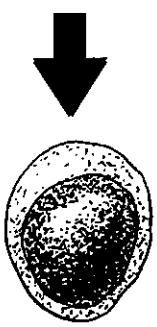




DDx - Lymphocytosis

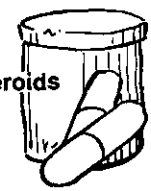
- **Young age**
- **Epinephrine-induced (cats)**: Severe exertion, Physiological stress, Vaccination
- Infectious - antigen stimulation: FeLV, Chronic Ehrlichia canis, Rickettsia rickettsia & systemic fungi (blastomycosis)
- **Modified live vaccines** (dog)
- Neoplastic: Metastatic lymphoma in 20% of lymphoma cases, Acute or chronic lymphoid leukemia
- Hypoadrenocorticism (< 20%)

Lymphopenia ****	• ↓ **Lymphocyte counts** - Dog: < 1,000/µl - Cat: < 1,500/µl • One of most common CBC abnormalities in sick dogs & cats - Due to stress leukogram (endogenous corticosteroids) - Also seen w/ loss of lymph & acute viral dizs	• **Obvious clinical abnormalities**	• **Generally "ignore" leukopenia (don't pursue) in sick animals** • Reevaluate after resolution of clinical abnormalities	• **Tx 1° diz**



DDx - Lymphopenia

- **Corticosteroid - induced stress leukogram**
  - Endogenous steroids
    - . Debilitating diz
    - . Hyperadrenocorticism
    - . Surgery
    - . Shock, Trauma
    - . Heat or cold exposure
  - Exogenous
    - . Glucocorticoid therapy
    - . ACTH therapy
- Reduced lymphopoiesis
  - Chemotherapy
  - Irradiation
  - Prolonged steroid Tx
- Acute infectious
  - Viruses (canine distemper, FeLV, FIV, parvovirus)
- Loss of lymphocytic-rich lymph
  - Chylothorax
  - Intestinal lymphangiectasia

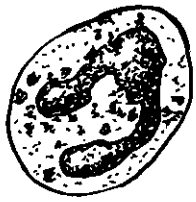


Basophils

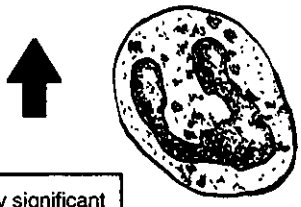
M8k 51; E-hb 704; I2M 1180, 1184; IM 914; IM-WW 516; 5min 222; Cat 733; E 1921; RP-CBC 28

- Least numerous WBC in healthy dog & cat blood
- Function: similar to tissue mast cells? Immune-mediated inflammatory reactions (anaphylaxis, cutaneous hypersensitivity), plasma lipolysis, rejection of parasites, tumor cytotoxicity
- Basophilic granules stain poorly in dogs & cats
  - Dog: reddish-violet granules
  - Cat: orange-gray granules
  - Mistaken for toxic PMNs in dogs & faded eosinophils in cats

Basophilia



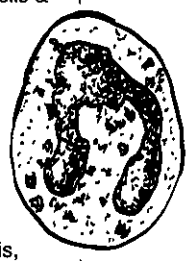
- ↑ Circulating basophils: > 200/µl or > 2% of WBCs
- **Generally associated w/ eosinophilia**



Basopenia: not clinically significant

DDx - Basophilia

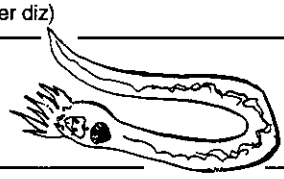
- Any cause of eosinophilia
  - Parasites: **Heartworm** & Hookworm
  - **Allergic**: hypersensitivity - IgE increased mast cells & basophils
- Inflammatory diz
  - GI diz
  - Respiratory diz
  - Neoplasms
    - . Mast cell tumors
    - . Lymphomatoid granulomatosis
    - . Basophilic leukemia (dog) rare
- Hyperadrenocorticism
- Hyperlipoproteinemia (Diabetes mellitus, nephrosis, chronic liver diz)

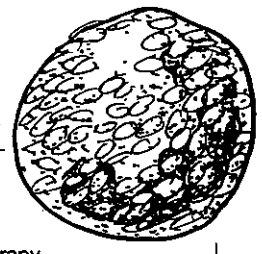


Eosinophils

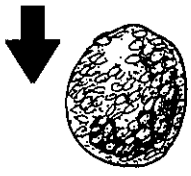
M8k 50; SAP 158; H2B 744; E-hb 702; I2M 1180, 1183; IM 914; 5min 222; Cat 732; E 1919; Pa-T 306; Lab 68; RP-CBC 28

- Distinct pink-to-orange granules & segmented nuclei
- Function: kill parasites (phagocytes) & modulation of hypersensitivity reactions





Eosinopenia



- < 100/µl circulating eosinophils
  - Common part of stress leukogram & usually of little clinical significance
    - Not significant on WBC count, use hemocytometer & diluent for absolute eosinophilic count
  - Mechanism: steroids enhance margination, decreases bone marrow release & reduces bone marrow production

DDx - Eosinophilia

- Stress or corticosteroids
  - Stress leukogram
  - Exogenous: steroid or ACTH therapy
    - . Eosinopenia in few hours which normalizes in a day
- Hyperadrenocorticism
- Acute infection - 2° to steroid release

Eosinophilia

SAP 158; H2B 744; E-hb 702; I2M 1180, 1183 Cat 731; IM 918; IM-WW 516; E 1919; RP-CBC 28

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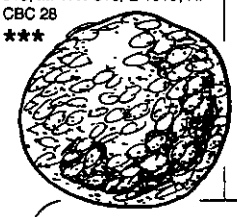
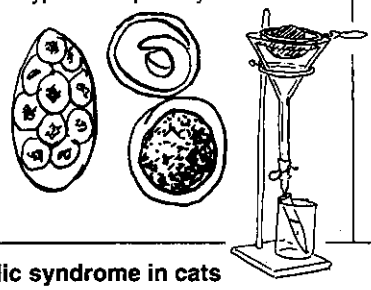


- **↑ Circulating eosinophils > 1000/µl**
- Common causes
  - **Parasitic diz** (skin, respiratory or GI tract)
  - **Hypersensitivity** (Pathophysiology: IgE causes mast cell degranulation which in turn attracts eosinophils)
  - Cat: also eosinophilic granuloma complex, bronchial asthma, eosinophilic gastroenteritis

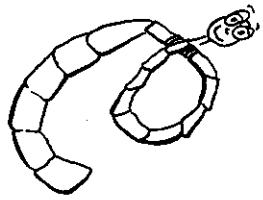
Presentation

- Related to 1° disorder

- **R/O parasitic diz 1st**
  - Fecal exam, tracheobronchial washes, thoracic radiographs & heartworm serologic or concentration tests
- Then check for other causes
  - Tracheal wash: pulmonary infiltrates
  - Endoscopic biopsy: eosinophilic gastroenteritis
  - Hypersensitivity testing
  - Tumor removal - normalization or
  - Hypereosinophilic syndrome in cats



- **Treat 1° disorder**
  - **Tx parasites**
  - Hypersensitivity: eliminate allergen + antihistamine & steroid
  - Remove tumor
  - Hypereosinophilic syndrome
    - . Poor response, steroids, Megestrol acetate or hydroxyurea (anecdotal success)



DDx: Eosinophilia

- **Parasitic**
  - *Ancylostoma* spp, *Trichuris vulpis*, *Toxocara canis*, *Dirofilaria immitis*, *Dipetalonema reconditum*, lungworms (*Aleurostrongylus abstrusus*, Capillaria spp, Filaroides spp), *Paragonimus kellicotti*
- **Hypersensitivity** reactions &/or inflammation
  - Anaphylaxis
  - Fleas, Food, Grasses, Nonspecific allergens
  - Feline asthma
  - Allergic dermatitis/Staphylococcal dermatitis
  - Eosinophilic pneumonitis
  - Eosinophilic gastroenteritis
- Eosinophilic granuloma
- Paraneoplastic syndrome/tumor associated
  - Fibrosarcoma
  - Anaplastic mammary carcinoma
  - Mast cell tumor
  - Lymphoma
- Eosinophilic leukemia
- Hypereosinophilic syndrome in cats
- Neoplastic/metastatic carcinoma
- Chronic inflammation of skin, GI, Respiratory or urogenital
- Hypoadrenocorticism

- **Hypereosinophilic syndrome in cats**
  - **See GI pg 62** - Uncommon, infiltration of eosinophils into many organs (GI, liver, spleen, lymph nodes, lungs)
  - Cause: idiopathic, difficult to differentiate from eosinophilic leukemia
  - CS: anorexia, weight loss, fever, vomiting, diarrhea & lymphadenopathy
  - Dx: CS, Hx, eosinophil count: 40,000 /µl (3-130,000)
  - DDx: Indistinguishable from eosinophilic leukemia
  - Tx: poor response, steroids, Megestrol acetate or hydroxyurea (ancedotal success)
  - Prognosis: Poor to guarded - usually fatal, death from organ dysfunction caused by tissue infiltration

Cancer, Tumors, Neoplasia, Oncology

E-hb 223; H2B 799; SAP 185; I2M 1091; IM 833; Cat 755; E 466; F-N 425; NB 14.1

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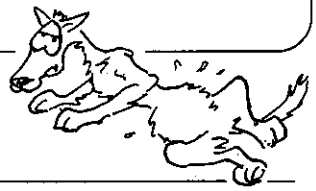
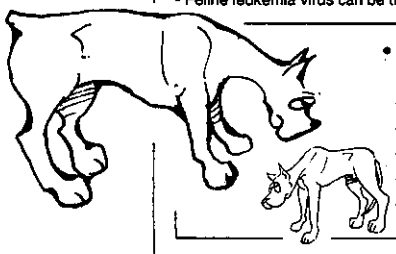
- **Definitions:**
  - **Oncology**: the study of tumors
  - **Tumor**: swelling; new, uncontrolled & progressive growth of tissue cells
  - **Neoplasm**: any new & abnormal growth
  - **Cancer**: a cellular tumor - fatal
  - **Malignant**: progressive to death
    - Anaplasia: loss of differentiation of cells & of their orientation to one another
    - Metastasis: spread to distant sites (e.g., lung, liver)
  - **Benign**: nonmalignant; not recurrent; favorable for recovery
- **Incidence** of all cancers
  - Dog: 4/1,000 (> human frequency)
  - Cat: 1.5/1,000 (< human frequency)
- **Malignancy**
  - Cat: 80%
  - Dog: 35%
- **Age: peak at 6-14 years**
  - Young animals
    - Canine: cutaneous histiocytoma, papilloma, osteosarcoma
    - Feline: lymphosarcoma, fibrosarcoma (FeLV associated)
- Sex factors: few instances of difference
  - Mammary
  - Prostatic tumors
- Congenital tumors are rare in the dog & cat
  - Embryonal nephroma
  - Feline leukemia virus can be transmitted epigenetically to the unborn fetus

Causes of Cancer

- Environment
- Chemicals: tar, ß-naphthylamine
- Hormones: neutered bitches before estrus 200 x risk as those neutered after 2.5 years-old
  - Intact bitches: 7 x mammary tumors
  - Cats: long term progesterone Tx - mammary adenocarcinoma
- Irradiation: squamous cell carcinoma - sun-exposed white cats
- Oncogenic viruses (e.g., **Feline leukemia virus**, Feline sarcoma virus, papilloma virus)
- Parasites:
  - *Spirocerca lupi* - esophageal tumors
  - *Clonorchis sinensis* - bile duct
- Nutritional factors: malnourished animals tend to develop tumors more frequently
- Diet
- Traumatic factors:
  - Osteosarcoma: repeated trauma to growth plates
  - Bone tumors after metallic implants for fractures
- Transplantation: canine transmissible venereal tumor (TVT): only transplantable tumor (coitus)



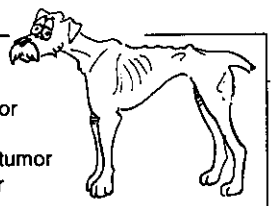


- **Breeds:**
  - Boxer: highest incidence of tumors
  - Great Dane & St. Bernard - osteosarcoma
  - Osteosarcoma: giant breeds 60 x small breeds of dogs
  - Melanoma: Boxer, Scottish terrier
  - Mastocytoma: Boxer, Bulldog, Boston terrier
  - Hemangiosarcoma: German shepherd

- **↑ Prevalence in pets due to ↑ Life expectancy**
- **Majority are controllable**

Histogenetic classification - neoplasia

- Prefix denotes predominant tumor cell
- Suffix denotes biologic behavior of the tumor
  - "**-oma**" denotes a benign tumor
  - "**-sarcoma**": malignant connective tissue tumor
  - "**-carcinomas**": malignant epithelial tumor

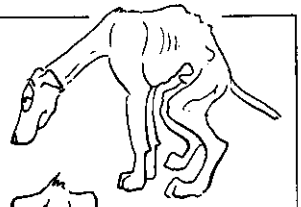


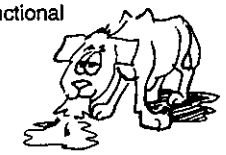
1. Epithelial neoplasm (e.g., skin, gastrointestinal tract)
   - Adrenocortical adenoma
   - Adrenocortical carcinoma
   - Gastric polyp
   - Gastric carcinoma
2. Connective tissue neoplasm (e.g., bone, fat, muscle)
   - Osteoma
   - Osteosarcoma
   - Fibroma
   - Fibrosarcoma
3. Hematopoietic & immune system
   - Lymphosarcoma (lymphoma)
   - Thymoma
   - Malignant thymoma
4. Nervous system
   - Meningioma
   - Meningeal sarcoma
5. Multiple histogenetic cellular origin
   - Benign teratoma
   - Malignant teratoma
6. Miscellaneous neoplasms
   - Hemangioma
   - Hemangiosarcoma

Characteristics	Benign	Malignant
	Usually encapsulated	Nonencapsulated
	Usually noninvasive	Invasive
	Highly differentiated	Poorly differentiated
	Rare mitoses	Mitoses relatively common
	Slow growth	Rapid growth
	Little or no anaplasia	Variable anaplasia
	No metastasis	Metastasis

Clinical signs

- **Asymptomatic**
- **Cachexia** (ill health & malnutrition)
- **Anorexia**
- **Fever**
- **↓ Resistance to infection**
- Lymphatic obstruction may result in lymphedema
  - Obstruction of hollow organs such as the trachea or intestines may cause acute signs
  - 2° infection may complicate ulceration
  - ± Pressure atrophy
  - ± Bleeding from any site
- Coagulopathies - DIC
- Neuropathy associated with cancer
  - Peripheral neuropathy - direct invasion or compression
  - Encephalopathy - metabolic
- Hormonal complications:
  - Neoplasms of endocrine glands may be functional or nonfunctional
  - Ectopic hormone production/paraneoplasia
- **Death**

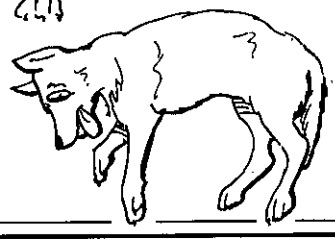




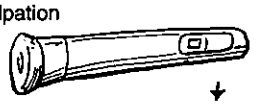
- Tend to be geriatric patients, so check:
  - Renal system
  - Hepatic system
  - Cardiovascular system

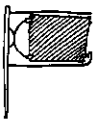
Client/Owner

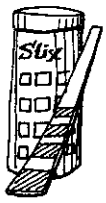
- Stages of grief
  - Denial of truth
  - Anger (towards bearer of bad news)
  - Grief
  - Resolution: acceptance of what you cannot change

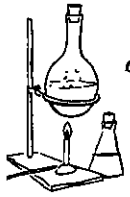


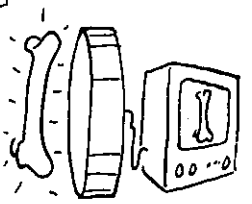
Diagnosis: early detection desirable
- **Client counseling**:
  - Set goals & expectations of client
- History (onset, duration, growth rate & prior Tx)
- Physical examination: palpation of mass, lymph nodes
- CBC & chemistry
- Urinalysis
- **Radiology**:
  - Detect metastasis
  - Determine bone involvement
  - Localize tumor
  - Contrast: GI, genitourinary
- Ultrasound:
  - Closeness to large vessels
  - Cavitary or cystic nature of mass
- Nuclear medicine (scintigraphy): radiodetectable tumors have >10,000,000 cells
- CAT scans (computed axial tomography)
- Endocrine assays
- Biopsy: & cytology or histopathology
  - Closed: fine needle aspiration
  - Semi-open: keyhole
  - Open: surgical biopsy - incisional, excisional
  - Don't over-interpret biopsy
- Buffy coat preparations

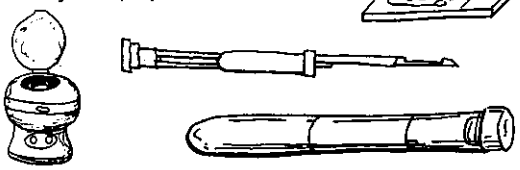










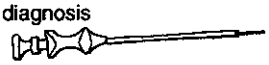


Clinician has right & obligation to question the diagnosis if inconsistent with the clinical picture !!!

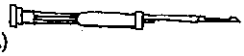
- Clinical Staging of Tumors
  - Nomenclature: "TNM" System
    (World Health Organization)
  - "T" describes size & invasiveness of 1° tumor
  - "N" describes status of local lymph nodes
  - "M" describes distant metastasis

- **Determine the tumor's behavior**
  - Nonmetastasizing: benign tumors
  - Late metastasizing: metastasis does not occur until tumor reaches moderate size
  - Early metastasizing

Biopsy: the cornerstone of diagnosis



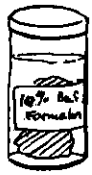
- Indications:
  - . Therapy will be altered by result
  - . Confirmed diagnosis of neoplasia before treatment or euthanasia
- Misconception: properly performed biopsies don't increase future metastasis nor decrease future control!
- Incisional: use if findings would influence treatment
  - At least one margin if possible
  - Examples:



  - . Fine needle aspirate (FNA)
  - . Cutting needle biopsy (true–cut, Vim–Silverman)
  - . Key punch biopsies
  - . Fibre-optic scope obtained biopsies

  - Tissue management
  - . Impression smears prior to fixation
  - . Margins submitted !!!
  - . Proper labeling & fixation

- Excisional
  - Potentially curative tissue orientation & margins can be evaluated
  - Small, easily accessible mass (<1"/<3 cm), freely movable & no tissue invasion (e.g., cutaneous malignancies & most canine mammary tumors)
  - Include complete margin of normal tissue (preferably 1" in all directions)
  - Indications for excisional biopsy: Lymph node, Small skin nodules, Mammary gland tumor, Decompression of CNS, Masses discovered by laparotomy or thoracotomy
  - Therapeutics if complete tumor removal verified histologically or benign tumor or low grade malignancy
- Interpretation of results - don't overinterpret
  - Malignant vs benign
  - Histological classification
  - Histological grade (if available)



- 5-10% of biopsy results are incorrect! Reasons:
  - Poorly fixed or prepared samples
  - Poor sampling (i.e., assuming sample is representative)
  - Lack of orientation of sample
  - Species inexperience
  - Failure to remember that invasion & metastasis are the most reliable indices for determining malignancy (e.g., oral tumors)
  - Incomplete requisition

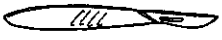
Treatment - Neoplasia:

- **Treat the patient & tumor**

- **Euthanasia**: immediately or as an option if other treatment fails - inform owner of all variables - cost

- Most cancer patients also have systemic disorders
  - Treat (e.g., supportive & nutritional therapy)

- Therapy may increase the pet's quality of life by:
  - Decreasing or alleviating pain & suffering
  - Controlling the cancer
  - Rarely curing the cancer



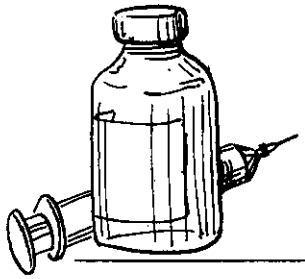
Surgery - localized or regional tumors
- Indications:
  - Curative excision (1st surgery has the best chance for a "cure")
  - Cytoreduction ("debulking"): incomplete excision to be followed with other treatment modalities
  - Palliation - decrease pain and/or signs

Chemotherapy
- Few cancers are chemosensitive (lymphoid neoplasia most sensitive)
- Nonlymphoid tumors are only moderately sensitive & rarely is life extended w/ chemotherapy alone
- Used alone or in combination w/ surgery, radiation, hyperthermia
- Indications:
  - Systemic neoplasia (e.g., lymphosarcoma)
  - Metastatic neoplasia or likely to metastasis
  - Cytoreduction
  - Nonresectable neoplasia
- Contraindications: severe underlying multiple organ dysfunction
- Tumor cells can develop resistance
- Normal cells able to repair damage whereas cancer cells can't
  - Therefore need to time drug doses to allow normal cells to repair

Radiation Therapy
- Local & regional neoplasia
- Control vs cure
  - Increasing availability
  - Often combined with other modalities

Investigational: immunotherapy (biological modifiers), hyperthermia, photodynamic etc., very early in development & understanding

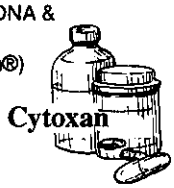
Patient Follow-up: rechecks should occur at 1, 3, 6, 9, 12, & 15 months following "curative therapy" & then every 6 months thereafter in general



Complications of chemotherapy:
- Myelosuppression & infection
- Hypersensitivity (e.g., L-asparaginase)
- Phlebitis (e.g., doxorubicin)
- Anorexia & vomiting
- Gastrointestinal toxicity - direct effect on mucosa
- Cardiotoxicity (e.g., Doxorubicin)
- Nephrotoxicity (e.g., Cisplatin)
- Hemorrhagic cystitis (e.g., Cyclophosphamide)

Types of Chemotherapy Drugs C12T 1447

- **Alkylating agents**: cross-link DNA & therefore prevent replication
  - . Cyclophosphamide (Cytoxan®)
  - . Chlorambucil (Leukeran®)
  - . Melphalan (Alkeran®)
  - . Cisplatin (Platinol®)



- **Antimetabolites**: structural analogues (fakes) substitute for normal purines & pyrimidines
  - . Methotrexate (Methotrexate®)
  - . Cytosine arabinoside (Cytosar-U®)

- **Antitumor antibiotics**: cross-link DNA
  - . Doxorubicin (Adriamycin®)
  - . Bleomycin (Blenoxane®)
  - . Mitoxantrone (Novantrone®)

- **Plant (vinca) alkaloids**: disrupt mitotic spindle
  - . Vincristine (Oncovin®)
  - . Vinblastine (Velban®)

- **Hormones**
  - Prednisone
  - Diethylstilbestrol
  - Tamoxifen (Nolvadex®)

- **Miscellaneous**
  - Asparaginase (Elspar®)
  - Dacarbazine (DTIC-Dome®)

Lymphosarcoma

Condition	Facts/Causes	Presentation

Lymphosarcoma, LSA, Lymphoma, Malignant lymphoma, Reticulum cell sarcoma, Lymphomatosis, Lymphoreticular neoplasm

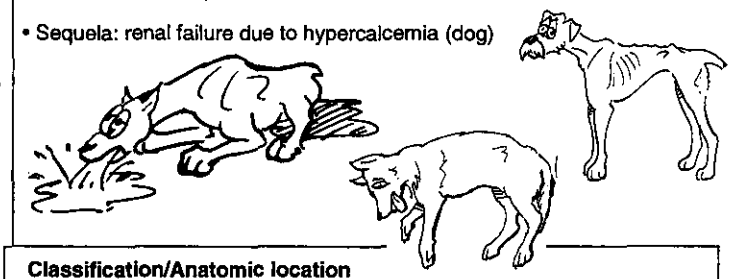
M8K 37, 53, 555; Mk 39, 32; E-hb 235, 709; H2B 785, 1197; SAP 82, 193, 816; I2M 1123; IM 861, 954; IM-WW 529; 5min 792(F), 794; Cat 776, 680; Derm 1064; D-Sy 130, 202; D-Mi 476; F-N 427; NB 14.4; Pa-T 324

**

- **Uncommon**
- **Lymphoid malignancy originating from solid organs** (e.g., lymph nodes, liver, spleen)
  - Differentiates from lymphoid leukemia which originates from bone marrow (malignant cells in the blood & bone marrow)
- Cause:
  - **Feline: feline leukemia virus (FeLV)**
  - **Canine: unknown** - virus-like particles?
  - Genetic
  - Carcinogenic agents
- Incidence:
  - **Cat: 30% of all tumors**
    . Peak at 1-3 years - 70% FeLV positive
    . Second peak - 7-8 years - most FeLV negative
    . No breed or sex predisposition
    . Pedigree cats at risk at a younger age because of cattery
  - Canine
    . 5-10% of all neoplasms
    . Middle-age to older - 5.5-9 years (mean of 7 yrs)
    . Breeds: Boxer, Scottie, Basset, St. Bernard, Airedale, Bulldog & Lab
    . Intact females appear at decreased risk

FeLV

- **CS related to the site of tumor involved**
- **Often vague** - anorexia, lethargy & weight loss
  - Edema if obstructs lymph flow
- Much overlapping in anatomical forms
  - Multicentric: generalized lymphadenopathy (enlarged lymph node[s]), PU/PD
  - GI: vomiting & diarrhea
  - Skin (rare): plaques to nodules (firm, dermal or SQ, ± alopecia, red to purple)
    . Pruritic (50%), may mimic other skin disorders (seborrhea, pemphigus, pyoderma), crusts, erythema, ulceration, alopecia
  - Mediastinal: dyspnea, edema, PU/PD (Ca+)
  - Extranodal: highly variable (ocular, cutaneous, renal, neural)
- Sequela: renal failure due to hypercalcemia (dog)



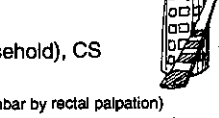
Classification/Anatomic location

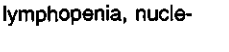
Dog	Cat
• Multicentric (84%)	• Mediastinal & multicentric: 80%
• Anterior mediastinal/thymic (2%)	• Renal: 50%
• Alimentary (7%)	• GI: 30%
• Cutaneous (6%)	• Skin: minority
• Miscellaneous extranodal sites (< 1%) - CNS, heart, bone, nasal cavity, ocular structures	

Lymphoid - Solid organs
CS: Depend on anatomical form
Dx: Hx, CS, PE, Lab, UA, FeLV, Rads, Aspiration
Tx: Chemotherapy - Remission

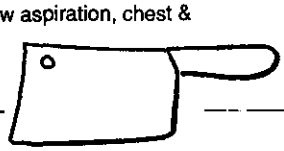
Diagnosis - Lymphosarcoma:

- **History** (especially in multiple cat household), CS
- **Complete physical exam**
  - Palpate all lymph nodes (including sublumbar by rectal palpation)
  - Pallor or petechiae of mucous membranes (bone marrow)
  - Check for kidney or liver diz (uremic ulcers, icterus)
  - Ophthalmic exam (1/3 of LSA dogs)
- **CBC/chemistries**
  - Variety of nonspecific abnormalities - **rarely diagnostic**
  - CBC abnormalities from neoplastic bone marrow infiltration or immune-mediated abnormalities (thrombocytopenia [rare in cat], anemia)
  - **Anemia** of chronic diz - normocytic, normochromic, nonregenerative)
    . Dogs: 30% - LSA dogs (occasionally hemolytic Coombs' positive)
    . Cats: 70% - FeLV (+), only 10 % - FeLV (-), most nonresponsive
  - Leukogram
    . ± Atypical circulating lymphocytes
    . ±Thrombocytopenia, eosinopenia, lymphopenia, nucleated RBCs
    . Dogs: lymphocytosis - 20%
    .. 50% have immature lymphocytes
    .. Total WBC count: normal, leukemic (27%) or leukopenic
    . Cats: most leukemic cats are FeLV positive
    .. Neutropenic cats may also be FeLV positive
  - Serum Chemistries: abnormalities often indicate advanced diz
    . Liver: ↑ SGPT, SAP, ± Increased bilirubin
    . Kidney: ± BUN, creatinine elevation
    . **Calcium elevation** - 10-40% of LSA dogs, rare in cats
    .. Indicates bone marrow invasion
    . Gammopathies ? hyperproteinemia (rare), hyperviscosity syndromes
- **Bone marrow aspirate**/core biopsy (important for clinical staging)
  - ± ↑ Myeloid:erythroid ratio
  - ± Neoplastic lymphocyte infiltrate





- ± Hyperproteinemia with a gamma spike
- **Urinalysis:**
  - ± Low urine specific gravity
  - ± Proteinuria may occur
- **Virology (feline)**
  - **FeLV**: 77% positive (80% mediastinal & multicentric, 50% renal, 30% GI, minority of skin) An effective immune response to FeLV doesn't guarantee protection from LSA
  - Positive test not diagnostic for LSA
  - FIV
- **Radiography: varies w/ type**
  - Chest & abdominal films: organomegaly (hepatomegaly, splenomegaly, renomegaly), lymphadenopathy
  - 50% of LSA dogs - enlarged sternal & sublumbar lymph nodes, spleen & liver
  - Chest films for masses & recommended for dogs w/ hypercalcemia of unknown origin
  - Clinical staging (extent of involvement)
  - Contrast: most GI LSA abnormal
- Ultrasonography: changes in echogenicity of parenchyma & size changes of organ
- **Aspiration biopsy/cytology**: confirmation in 90% of dogs & 75% of cats, especially for extranodal, mediastinal & GI forms
  - Lymph node aspiration: popliteal or prescapular preferred sites
    . Avoid very large or soft nodes (necrosis distortion) & submandibular if dental diz is present
    . Mostly immature lymphoid cells suggestive, histologic for conclusive Dx
  - Other tissues: liver, kidney, lung, spleen
  - Cytology over histology - cheaper
- Excisional or incisional biopsy: if aspiration questionable
- Thoracocentesis: mediastinal if hydrothorax present
  - ± Neoplastic lymphocytes or chyle (thoracic duct invasion) - mediastinal form
- Stage diz (CBC, bone marrow aspiration, chest & abdomen films)
- Necropsy



Staging: a clinical classification

- Stage 1: Involvement limited to a single lymph node or lymphoid tissue in a single organ (excluding bone marrow)
- Stage 2: Involves many lymph nodes in a regional area
- Stage 3: Generalized lymph node involvement
- Stage 4: Liver &/or spleen involvement + Stage 3
- Stage 5: Manifestation in the blood & involvement of bone marrow &/or other organ systems + Stages 1-4

* World Health Organization in 1979
Each stage is subclassified into a (without systemic signs) & b (with systemic signs).

DDx: Lymphadenopathy

- Infections (bacterial, viral, rickettsial, parasitic & fungal
- Immune-mediated dizs (e.g., systemic lupus erythematosis)
- Other hematopoietic tumors: leukemia, multiple myeloma, mast cell neoplasia, malignant histiocytosis
- Metastatic tumors to lymph nodes: malignant melanoma, mammary adenocarcinoma, osteosarcoma, peritectal adenocarcinoma, prostatic adenocarcinoma, soft tissue sarcomas, squamous cell carcinoma
- Others vary w/ site of LSA

Lymphosarcoma

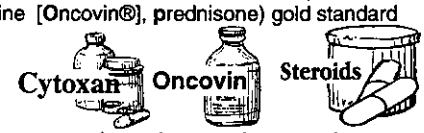
Treatment of lymphoma

- **Incurable** in both cats & dogs
- **Goal: prolong & improve quality of life**
  - Some cures are obtained
- **Thoroughly inform client about nature of diz, including prognosis, cost & side effects**

- **Chemotherapy**: mainstay of Tx because lymphoma are or will be systemic neoplasms
- Chemotherapy + surgery &/or radiation for localized lymphomas
- **Bactericidal ABs** if severe leukopenia (WBC < 2,500) or sepsis develops
- ± Blood transfusions & anabolic steroids
- Anorexia 40-50% of cats from cyclophosphamide
  - Cyproheptadine (Periactin®): anti-serotonin - stimulates appetite

Chemotherapy: combination superior to single drug

- **Induction of remission** - 6-8 weeks
  - **Cats: COP** (cyclophosphamide (Cytoxan®), vincristine [Oncovin®], prednisone) gold standard



  - **Dog**: many chemotherapeutic protocols
    . **COAP**: (cyclophosphamide [Cytoxan®], vincristine [Oncovin®], cytosine arabinoside [Cytosar-U®], prednisolone])

  - Remission: > 85% of dogs & 75% of cats

- **Intensification**: if only partial remission w/ induction therapy, stimulate complete remission
  - L-asparagines (Elspar®) for dogs
  - Doxorubicin (Adriamycin®) in cats

- **Maintenance:**
  - **LMP ("lump")** (IM 868): chlorambucil (Leukeran®), methotrexate, prednisone all given PO
  - Maintains remission for 3-6 months

- **Rescue (reinduction of remission)** & then put back on maintenance:
  - Most cats can't be rescued
  - 70% of dogs can be rescued from 1-4 times
  - COAP if good initial response
  - ADIC if COAP poor (Adriamycin® [doxorubicin], DTIC [dacarbazine]

- **Extranodal or solitary lymphomas**
  - Controversial
  - Chemotherapy (induction, maintenance & rescue) ± surgical resection &/or radiation

Cost of chemotherapy (1992)
- **Cat: $500-800**
- **Dog: $1200-1800**

Monitor carefully:
- Monitor for thrombocytopenia (<75,000/µl) & neutropenia (< 2500/µl) usually at 7-8 days of Tx
  - Stop Tx until numbers rebound, then reinstate at lower doses
- Remission Tx: monitor weekly for complete disappearance of all neoplastic masses (give vincristine [Oncovin®] at this time)
  - Client: monitor pet's appetite & activity level, palpate lymph nodes if lymphadenopathy present originally, rectal temperature (rises w/ neutropenia & sepsis)
- Maintenance: every 6-8 weeks - Clients as above

Prognosis:
- Grave w/o Tx die in 4-6 weeks
- **Poor** for long term survival over 1 year w/ Tx
  - Cat life expectancy 6-9 months
  - Dog life expectancy 12-16 months
- **Cats FeLV positive: grave** (usually anemic & die within a few weeks). FeLV negative cases live longer

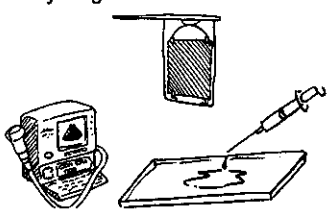
- Remission rates
  - Dog: 80-90%
  - Cat: 65-75%
- Staging important for prognosis
  - Dogs: advanced cases (stages 4 & 5) grave (rarely survive longer than a few weeks while lesser stages may survive 2 years or more)
- Rescue once remission relapse: 1-4x in dogs, rare in cat
  - Chance & length of new remission about half of previous Tx
- Dogs: most complete & lengthy remission - good quality of life
- Cures rare, remission of varying lengths common
- Bone marrow involvement decreases long term survival
- GI, skin & leukemic forms have poorer prognosis then multicentric form
- Controversy on prognostic value of staging
- Response to therapy - stages
  - Dogs - stage 1: 90% remission rate for 15 months
    . Stage 4: < 50% remission rate for 5 months
  - Cats: lower than dogs
    . 80% with lymphosarcoma & 27% with leukemia of 5 months
    . Thymic form appears to respond best to therapy

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Anterior mediastinal or Thymic lymphosarcoma M8k 555; Mk 39; E-hb 371; SAP 193; H2B 785; I2M 1124, 1120; IM861; IM-WW 530(f), 532; 5min 792; Cat 778; Sx-WW 109; Sx-G 95; X-RD 107; X-T 309 **	• **Cats 40%**, dogs 4% **of all LSAs** • **80% FeLV positive** • Average age of cats 2.5 years • ± Enlargement of the thymus, anterior mediastinal lymph nodes, or both • Restrictive or obstructive pulmonary diz due to hydrothorax or airway compression respectively • Characterized by mediastinal LSA w/ or w/or bone marrow involvement	• **Good condition at time of presentation** • **Dyspnea** • **Cyanosis** • Dysphagia (regurgitation) • ± Horner's syndrome - uni- or bilateral (cat > dogs) • ± Hypercalcemia (dogs) - PU/PD - Anorexia, weakness • Sequela: - Chylothorax (erosion of thoracic duct)	• Hx, CS • Physical exam - **Noncompressible cranial thorax in the cat** • Auscultation: muffled heart sounds - **Decreased bronchovesicular sounds, displacement of lung sounds to dorsocaudal thorax** • **Percussion: dull ventral thorax** • Blood values: - Variety of nonspecific abnormalities - Rarely diagnostic - CBC abnormalities from neoplastic bone marrow infiltration or immune-mediated abnormalities (thrombocytopenia [rare in cat], anemia) - **Hypercalcemia 50% of LSA dogs**, rare in cats • **Virology (feline) 77% FeLV+** • Radiology: - **Anterior mediastinal mass** - **Dorsal displacement of trachea** - ± Pleural effusions • Ultrasound • **Thoracocentesis:** - Immature lymphocytes in pleural effusion - Histology/cytology • **Fine needle aspiration** cytology: easy diagnosis	• **Incurable in both cats & dogs** • Goals - prolong & improve life • **Inform client**: diz, Px, cost & side effects • **Chemotherapy**: mainstay of Tx • **Induction of remission** - Cats: COP (cyclophosphamide, Oncovin®, prednisone) - Dog: COAP - Remission: > 85% dogs & 75% cats • **Intensification**: helps stimulate complete remission - L-asparaginase (Elspar®) for dogs - Doxorubicin ((Adriamycin®)) in cats • **Maintenance**: LMP/"lump" (Leukeran®, methotrexate, prednisone). All given PO - Maintains remission for 3-6 months • **Rescue** (reinduction of remission): - **Most cats can't be rescued** **Prognosis:** • **Grave**: w/ out Tx die in 4-6 weeks • **Poor** for long term survival over 1 year w/ Tx, Cat life expectancy 6-9 months • Cats FeLV positive: grave (usually anemic & die within a few weeks). FeLV negative cases live longer.

Cats, FeLV+
CS: Dyspnea
Dx: Hx, PE, Rads, Biopsy
Tx: Incurable - Chemo

Cost of chemotherapy (1992)
- Cat: $500-800
- Dog: $1200-1800

DDx:
- Ectopic thyroid tumors
- Heart base tumor
- Thymoma
- Pulmonary lymphomatoid granulomatosis
- Blastomycosis



Lymphosarcoma

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
LSA - Alimentary M8k 557; Mk 39, 32; SAP 193; I2M 1124; IM 861; IM-WW 530; H2B 785; 1377; C11T 599; 5min 177, 792; Cat 778; E-hb 708; Pa-T 324 **	• Occurrence: 15% of cats & 7% of dogs with LSA **- Most common extranodal LSA** • Cats average 8 yrs • Most - 70% **FeLV negative** • 1° B-lymphocyte neoplasm • Site: - Anywhere in the GI tract from stomach to colon - Also mesenteric lymph nodes - Occasionally kidneys • Solitary, diffuse or multifocal GI tract infiltration w/ or w/o intra-abdominal lymphadenopathy	• **Weight loss** & lethargy • **Vomiting & diarrhea** • ± Melena • ± Tenesmus • Sequelae: - GI obstruction - Peritonitis (rupture of lymphomatous mass)	• Hx, CS • Physical exam: - ± Icterus, uremic ulcers - Palpation of abdomen . Mass (± mesenteric lymphadenopathy or ↑ thickness of gut wall) . Organomegaly • Virology (feline) 70% FeLV **negative** • CBC - Chem - ± Azotemia, liver enzymes - Anemia uncommon in cats, 30% of dogs • Radiology: - Plain films (<50%) . Hepatomegaly, splenomegaly . Mid-abdominal masses - **Positive contrast**: usually positive . Mucosal irregularities . Luminal filling defects . Irregular thickening of wall - Check chest for metastasis • Ultrasonography: changes in echogenicity of parenchyma & size changes of organ • Fine needle aspiration cytology: easy diagnosis	• **Incurable in both cats & dogs** • Goals - prolong & improve life • **Inform client**: diz, Px, cost & side effects • **Chemotherapy**: mainstay of Tx - **Induction of remission** . COP (Cyclophosphamide, vincristine [Oncovin®], Cytosine arabinoside, prednisolone) • **ABs:** Sulfadiazine-trimethoprim (Tribrissen®) • **Monitor carefully** Steroids Cytoxan Oncovin **Prognosis: Grave** without Tx • **Poor** for long term survival over 1 year w/ Tx - Solitary better than diffuse - Dogs: worse lymphoma prognostically
Cats > Dogs, FeLV neg **CS: Wt. loss, Vomiting, Diarrhea** **Dx: Hx, CS, PE, Rads, Biopsy** **Tx: Incurable - Chemo, ABs**		**DDx:** • Lymphocytic plasmacytic enteritis • Other GI tumors • Granulomatous bowel diz • Hypereosinophilic syndrome		
Cutaneous lymphosarcoma, Mycosis fungoids Mk 32; SAP 193; I2M 1125; IM 861; IM-WW 531(f), 532; H2B 785; Derm 1064; D-Sy 130, 202; D-Mi 476; Cat 785; Pa-T 507 *	• **Rare in dogs**, extremely rare in cats • Single or multiple skin lesions • Mycosis fungoids may progress to LSA	• **Can mimic any skin lesion** (seborrhea, pemphigus, pyoderma) • Begin as mild eczematous pruritic plaque • Nodular tumor - Donut-shaped, raised, red, mass • Pruritus (50%) • Crusts, erythema, ulceration, alopecia	• CS, Physical exam • Fine needle aspiration cytology: easy diagnosis **DDx:** • Infectious dermatitis • Immune-mediated disorders • Parasitic skin dizs • Other skin neoplasia	• **Controversial** • Chemotherapy (induction, maintenance & rescue) • ± Surgical resection &/or radiation • Prognosis: **guarded**; progressive w/ metastasis to lymph nodes, liver & spleen

Multicentric lymphoma, Generalized lymphosarcoma M8k 555; SAP 193; I2M 1124; IM 861; IM-WW 530, 531; H2B 785; E-hb 708; 5min 972; Cat 782; Pa-T 324 **	• **Most common form in dogs** - Occurrence: 45% of cats & 77% of dogs with LSA • Cats average 4 years • Generalized lymphadenopathy (lymph nodes), spleen, liver, kidneys or any combination of these sites - ± Bone marrow involvement, especially as diz progresses	• Depend on the tissue(s) involved • ± ↑ Lymph node size - nonpainful • Nonspecific signs - Anorexia - Weight loss - Lethargy • Hypercalcemia (dogs) PU/PD • Renal: uremia & renal failure - Urinary incontinence • Liver (anemia, jaundice, weight loss, vomiting) • Eye 33%: uveitis, ocular hemorrhage	• Hx, CS • Palpation - **Generalized lymphadenopathy** - Diffuse splenomegaly - Gums for pallor (BM involvement) - ± Icterus, oral ulcers • CBC - chemistry - Hypercalcemia 20% of LSA dogs - Anemia - Kidney & liver involvement • **80% FeLV positive** • **Radiography: varies w/ type** - Abdominal films: organomegaly (hepatomegaly, splenomegaly, renomegaly), lymphadenopathy (mesenteric or iliac) - 50% of LSA dogs - enlarged sternal & sublumbar lymph nodes, spleen & liver - Chest films for masses & recommended for dogs w/ hypercalcemia of unknown origin . Tracheobronchial lymphadenopathy, interstitial, bronchoalveolar or mixed pulmonary infiltrates, pleural effusions (rare) • Ultrasonography changes in echogenicity of parenchyma & size changes of organ • Aspiration biopsy/histology • Excisional or incisional biopsy: if aspiration questionable • Stage diz (CBC, bone marrow aspiration, chest & abdomen films)	• **Incurable in both cats & dogs** • Goals: prolong & improve life • **Inform client:** diz, Px, cost & side effects • **Chemotherapy**: mainstay of Tx • **Induction of remission** - Cats: COP - Dog: COAP - Remission: > 85% dogs & 75% cats • **Intensification:** - L-asparaginase (Elspar®) for dogs - Doxorubicin in cats • **Maintenance:** LMP/"lump" (Leukeran®, methotrexate, prednisone); all given PO - Maintains remission for 3-6 months • **Rescue** (reinduction of remission): **- Most cats can't be rescued** • **ABs** if severe leukopenia (WBC < 2,500) or sepsis develops • ± Blood transfusions & anabolic steroids • Anorexia 40-50% of cats from cyclophosphamide - Cyproheptadine (Periactin®): anti-serotonin, stimulates appetite • **Monitor carefully** • Client: monitor pet's appetite & activity level, palpate lymph nodes, rectal temperature (rises w/ neutropenia & sepsis) Cytoxan Oncovin Steroids **Prognosis:** • Grave: Tx die in 4-6 weeks • **Poor** for survival over 1 year w/ Tx • Cats FeLV positive: grave • Better Px than GI, cutaneous & leukemic forms
#1 LSA in dogs **CS: Varies w/ sites** **Dx: Hx, CS, PE, Rads, FeLV, Biopsy** **Tx: Incurable - Chemo • Px: Poor**				

Lymphosarcoma

Condition	Facts/Causes	Presentation/CS	Diagnosis	Treatment
Extranodal/ Miscellaneous/ Unclassified LSA SAP 194; IM 861; IM-WW 530(f), 532; H2B 785; 5min 972; Cat 783; Pa-T 324 *	• Occurrence: 3% of cats & 5% of dogs with LSA • Cats average 8.5 years old • **GI most common** (see above), eye, central nervous system, kidneys, urinary bladder & nasal cavity, skin • Other sites: brain, spinal cord, peripheral nerves, myocardium, bone, lungs, etc. • Dog: cutaneous & ocular • Cat: nasopharyngeal, ocular, renal & CNS (renal & CNS associated?) • Eye (cat > dog) - Retrobulbar mass - Third eyelid mass - Corneal infiltration - Uveal infiltration & hemorrhage	• Varies w/ site - usually due to compression or displacement of normal parenchymal cells • **Renal**: (cat > dog) anemia, weight loss • **Eye** (cat > dog): photophobia, blepharospasm, epiphora, hyphema, hypopyon, ocular masses, anterior uveitis, chorioretinal involvement, retinal detachment, retrobulbar mass, third eyelid mass, corneal infiltration • **CNS**: - Brain: seizures, ataxia, blindness, behavior aberrations, motor deficits - Spinal cord: paresis or paralysis • Cutaneous form: multiple firm, nonpainful cutaneous nodules • **Reproduction system:** - "Fading kittens", infertility, stillbirths & abortions • Others: lung, heart, urinary bladder	• Hx, CS • Physical exam - Palpation - Evidence of different organ involvement • Stage diz (CBC, bone marrow aspiration, chest & abdomen films) - Important to see if part of more common multicentric form	• Extranodal or solitary lymphomas - Controversial - Chemotherapy (induction, maintenance & rescue) ± surgical resection &/or radiation
*** LSA other than lymph nodes**				
Lymphangioma HB 784 *	• **Rare, benign tumor of lymphatic origin** - Dilated cystic, fluid-filled cavities lined by flattened endothelial cells • Cause unknown • Pathophysiology: - Lymphedema & lymphangiectasia 2° to lymph vessel proliferation • 1/2 are in 1 year-olds; remaining middle-aged to older • Course: protracted - months to years	• **Large, smooth, fluctuant masses in subcutis** - Limbs, head, retroperitoneally in axillae, nasopharyngeal • Skin lesion ± leak milky white fluid or draining tracts • Sequelae: - Obstruction of organs possible: interferes w/ muscle function, breathing, urination or GI function	• Hx, CS • Surgical biopsy & histopath - definitive • Fluid analysis: proteinaceous chyle **DDx:** • Abscesses • Enlarged lymph nodes • Neoplasms • Congenital cysts	• **Surgical removal** • Marsupialization if removal not possible - Allow lymph to drain to outside • Prognosis: too few cases to tell, likely good w/ complete excision
*** Benign tumor, SQ mass, Surgical removal**				

Leukemia

• Myeloproliferative syndrome, MPD, ML
• Lymphoproliferative syndrome, LL

M8k 53, 37; Mk 39; E-hb 704; SAP 197; H2B 745; I2M 1135, 1140(f); IM 871, 876; IM-WW 517; E 1923; 5min 770; Cat 789, 500, 509; Pa-T 307; Lab 72, 94

*

• **Leukemia**: malignant neoplasms originating from bone marrow
- Encompasses all hematopoietic cell lines: RBCs, WBCs & platelets
- **Myeloproliferative syndromes/myeloid leukemia, ML**:
. Proliferation of bone marrow constituents (nonlymphoid)
.. Nonlymphoid: granulocytes, monocytes, RBCs, megakaryocytes, mast cells
- **Lymphoproliferative syndrome/lymphocytic leukemia, LL**:
Lymphoid cells: lymphocytes & plasma cells

Also see pg 165, 692

• **Acute or chronic**
- **Acute**: aggressive behavior (rapid death w/o Tx), immature (**blast**) cells in bone marrow &/or blood
. Myelogenous leukemia, erythemic myelosis, acute megakaryoblastic leukemia
- **Chronic**: protracted course, **adult cells** (cell lines can be recognized)
. Polycythemia vera, chronic granulocytic leukemia, essential thrombocytopenia; Extremely rare in cat
• Presence or absence of neoplastic cells in blood
- **Leukemia**: suggests ↑ WBCs & many neoplastic cells
- **Subleukemic**: normal or ↓ WBCs & few neoplastic cells
- **Aleukemic**: suggests normal or ↓ WBCs & no neoplastic cells in blood
• Myeloid: pertaining to bone marrow
• Myelophthisis: reduction of cell forming by bone marrow
• Transition from one cell line to another can occur
• Multiple cell lines may be involved
• Eventually infiltrate various tissues unless aleukemic
• **Incidence:**
- **Cat: rare - 2 cases/1,000**, 15-35% of all hemolymphatic neoplasms (rest lymphoma)
. 90% FeLV positive
- **Dog: rare 0.3/1,000**, 10% of all hemolymphatic neoplasms (rest lymphomas); Myeloid > lymphoid leukemias
• Lymphoid malignancies including lymphosarcoma
- 90% of all leukemias in dog
- 70% in cat
• Cat: associated w/ feline leukemia virus (**FeLV**)
• Cats > dogs for both LL & ML

Presentation:
ACUTE
• **Variable & vague**
• Asymptomatic
• **Rapid weight loss**
• Lethargy
• Anorexia
• Persistent fever
• Dyspnea
• Vomiting & diarrhea
• Shifting limb lameness
• ± CNS
CHRONIC
• Asymptomatic 50%
• Prolonged Hx of vague signs
• Sequelae to tissue infiltration
- Infections
- Severe anemia
- Hemorrhage
- Organ dysfunction
- Death from any of above

Diagnosis:
• Dx may be straightforward or difficult
• Hx (acute or chronic), CS
• Physical findings
- Splenomegaly, ± Hepatomegaly
- ± Slight lymphadenopathy or enlarged tonsils
- Pale mucous membranes
- ± Icterus (liver infiltration)
- Fever & emaciation
• Romanovsky's- staining of blood or bone marrow smears for well differentiated cells
• Cytochemical stains for undifferentiated cells
• Electron microscope
• Blood
- Acute leukemia
. Abnormal (leukemic) cells
. Cytopenias in most
. Total WBC (mean - 300,000/µl)
. Anemia in most
. Thrombocytopenia (most)
• **Cat: FeLV & FIV**
• **Bone marrow aspirate** to evaluate extent of diz
• Cytochemical stains if blasts present to differentiate ML from LL

Treatment:
• **Euthanasia when debilitated**
• **Refer to an oncologist**

• **Acute:**
- Unrewarding, remission rare
- Chemotherapy: different protocols
. Prednisolone, cytosine arabinoside, chlorambucil, busulfan & hydroxyurea
• Supportive therapy includes blood transfusions, antibiotics, fluids, corticosteroids & vitamins

• **Chronic** leukemias
- None if asymptomatic
- Symptomatic or organomegaly, or blood abnormalities
. Chemotherapy CLL: Prednisolone, Chlorambucil (Leukeran®) & vincristine
. CML: Hydroxyurea PO bid
.. No Tx for blast crisis

• Complications: increased susceptibility to infections after chemotherapy

Leukemias:
Myeloproliferative disorders
• Granulocytes
- Granulocytic (myeloid, PMNs) leukemia
- Eosinophilic leukemia
- Basophilic leukemia
• Monocytes
- Monocytic leukemia
• Erythrocytes
- Erythremic myelosis
- Polycythemia vera
• Megakaryocytes
- Megakaryocytic leukemia (myelosis)
• Mixed cell lines
- Myelomonocytic leukemia (PMNs & monocytes)
- Erythroleukemia (RBCs & granulocytes)
• Miscellaneous
- Mast cell leukemia
- Undifferentiated leukemia
Lymphoproliferative disorders
• Lymphocytes
- Acute lymphoblastic leukemia
- Chronic lymphocytic leukemia
• Plasma cells

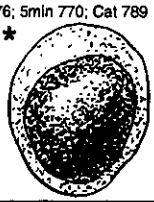
DDx:
• Lymphoma
• Malignant histiocytosis
• Mast cell diz
• Rickettsial diz (dog)
• Hemobartonellosis
• Storage diz
• Tuberculosis

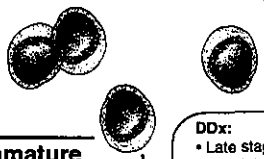
Prognosis:
• **Acute**
- **Grave**
- **Untreated die in 3 weeks**
- **Remissions rare, & survival rarely over 3 months**
- ALL: better than AML, but worse than lymphoma
- Remissions 20-40%
• Chronic leukemia survival CLL > 2 years

Refer

Leukemia

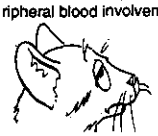
Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Acute lymphoblastic leukemia, ALL SAP 197, H2B 745; IM 872, 876; 5min 770; Cat 789 **	• Acute: abnormal proliferation of morphologically **immature lymphoblasts** in bone marrow or peripheral blood • Chronic: normal proliferation of **mature** lymphocytes in bone marrow &/or peripheral blood - Small lymphocytes • Rare in dog • **Acute: uncommon in cat:** young associated w/ FeLV) (T cells); chronic rare • **Rapidly progressive** • **Responds poorly to treatment**	• Acute: - Fever - Generalized or abdominal pain - **Lethargy, anorexia**, vomiting, diarrhea - ± **Bleeding** - Sequela: infections • Chronic: prolonged course - **Asymptomatic** 50% of dogs - Weight loss, lethargy, anorexia • PU/PD, Bleeding tendencies • Enlarged lymph nodes • Lameness, collapse - Sequelae: Richter's syndrome - terminal CLL (dogs) large cell lymphoma	• Hx, CS • **Pale mucous membranes** • Palpation: splenomegaly, hepatomegaly, lymphadenopathy • Blood values: - ± **Anemia** - ± **Thrombocytopenia** - **Leukocytosis** • **FeLV+: in acute majority of cats; negative in chronic** • **Blood smear: diagnostic if lymphoblasts ≥ 20,000/µl for acute** • **Bone marrow biopsy**: core biopsy preferred, multiple biopsies may be required - Mainly **lymphoblasts** & signs of myelophthisic ??? . ≥ 30% abnormal cells in BM diagnostic - 10% aleukemic (BM involvement w/o peripheral blood involvement)	• **Acute: Poor response to Tx is the rule; Refer** - Euthanasia?? - **Chemotherapy** - immediately because rapid diz - ±Transfusion - Monitor: if granulocyte count < 1,000/µl stop • **Chronic: Don't treat unless symptomatic** - Prednisolone & Chlorambucil (Leukeran®) - Prednisolone & Chlorambucil & vincristine - Monitor for relapse **Prognosis:** • **Acute: Grave**: mean survival time 68 days, shorter survival than LSA • Chronic: Good for response to Tx - 75%; **Poor** for long-term survival - median survival of 1 year





Lymphoblasts - Immature
CS: Lethargy, ill, Bleeding
Dx: Hx, CS, FeLV, Blood & BM
Tx: Poor response - Chemo

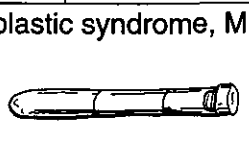
DDx:
- Late stage of lymphoma
- Physiological lymphocytosis
- Antigenic stimulation (chronic canine ehrlichiosis)
- Chagas' diz

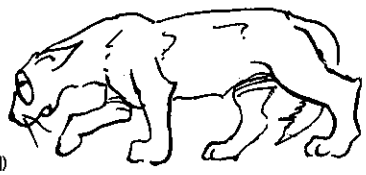


Hemopoietic dysplasia, Preleukemic syndrome, Myelodysplastic syndrome, MDS

HB 752; I2M 1141; IM 877; IM-WW 520; 5min 520; Cat 506, 512;

- Hematologic abnormalities not characteristic of leukemia
- Precedes acute myelogenous leukemia by months to years
- FeLV positive, may progress to overt leukemia, stabilize or resolve
- CS: lethargic, depressed, anorexia, fever
- Dx: PE (hepatosplenomegaly, pallor ± lymphadenopathy)
  - Characterized by cytopenias & hypercellular bone marrow
  - Normochromic anemia ± macrocytic & metarubricytosis, Neutropenia ± left shift or hypersegmented PMNs, bizarre platelet
- Tx: controversial - supportive (fluids, transfusions, antibiotics & low dose cystosine arabinoside, anabolic steroids [nandrolone decanoate])





Lymphoid leukemia,

Lymphatic leukemias
IM-WW 519; E-hb 738, 758; SAP 197; H2B 745

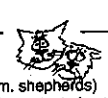
- Separate diz from lymphosarcoma because it's a lymphoma originating in the bone marrow, not in the organs
  - In LSA, marrow involvement is often a late manifestation - 10% in dogs & 30% in cats
- Occurrence: Dog - uncommon; 10% of all lymphatic tumors
  Cat - may constitute up to 33% of feline lymphoid neoplasms (other lymphoma)
- Currently considered part of LSA (Hardy)

- Types:
  - Chronic lymphocytic leukemia
  - Acute lymphoblastic leukemias

Plasma cell neoplasm, PCN, Multiple myeloma

E-hb 706; SAP 198; HB 845; IM 625; Cat 790; Pa-T 310
*

- **Rare leukemia**, Plasma cells: synthesize immunoglobulins (Ig); **Multiple myeloma** (MM) most common PCN; Aged dogs (Germ. shepherds)
- CS: **Nonspecific** (anorexia, listlessness, PU/PD); **Hyperviscosity; Epistaxis**, CNS; Infections (fever, pneumonia); **lameness** (pathologic fractures)
- Sequelae: **Kidney failure**, Sepsis - infections; ↑ Incidence of other tumors; Amyloidosis
- Dx: **2 of the following: Monoclonal gammopathy; ↑ plasma cells in bone marrow; Bence-Jones proteinuria; Osteolytic lesions (dors. spinous vertebral processes)**
- Tx: Combo - antineoplastics: Melphalan (Alkeran®), Cyclophosphamide (Cytoxan®), Prednisolone; Surgery for fractures; **Supportive therapy** (± ABs; ± Diuresis; ± Furosemide)
- Px: Short-term usually good, Long-term remission the rule about 12 months



Myelofibrosis & osteosclerosis

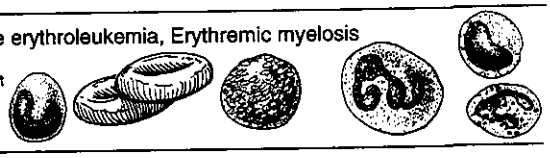
E-hb 738; SAP 155; H2B 755; Cat 794, 505

- Bone marrow replaced with fibrous tissue (fibroblasts), Cause: FeLV, 2° to myeloproliferative diz, inflammation, necrosis, neoplasia, toxic agents, pyruvate kinase deficiency
- Dx: Hx, **Core biopsy for myelofibrosis ± osteosclerosis**; CBC: Pancytopenias in severe cases, Poikilocytosis (dacryocytes & schizocytes), Bone marrow aspiration: usually "dry tap" (blood w/o marrow particles)
- DDx: Pyruvate kinase deficiency, myelotoxic drugs or radiation therapy
- Tx: No successful Tx has been described

Erythroleukemia complex in cats, Erythroid myeloproliferative diz, Reticuloendotheliosis, Acute erythroleukemia, Erythremic myelosis

E-hb 705; SAP 163; HB 753; IM 872; Cat 793
*

- Rare, Cats > dog, Proliferation of RBCs & WBCs
- Complex consists of: Chronic erythremic myelosis, Erythroleukemia (RBCs & WBCs), associated w/ FeLV in cat
- Dx: Severe anemia, Blast cells, nucleated RBCs, megaloblastosis, PMN giantism, hypersegmentation
- Tx: no known effective treatment
- Prognosis: grave



Megakaryocytic leukemia, Essential thrombocythemia

E-hb 705; SAP 163; H2B 755; Cat 794, 505, 511

- Rare type of leukemia, Reported in dog & cat; Megakaryocytic leukemia - Bizarre platelets; Essential thrombocytopenia: proliferation of platelets *
- CS: Bleeding, Thrombosis
- Dx: Thrombocytosis (platelet > 1 million/µl, Splenomegaly)
- Prognosis: survival of 1-14 months

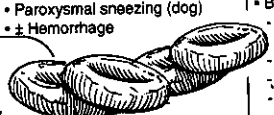
Chronic MP diz, Polycythemia vera, PV, Polycythemia rubra vera, Erythrocytosis

E-hb 705; SAP 163; H2B 731; IM 909, 123; IM-WW 513; Cat 794, 504, 511
*

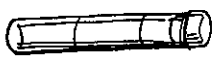
- Chronic myeloproliferative diz
- **Abnormal proliferation of RBC precursors in bone marrow**
- Characterized by a striking increase in the number of RBCs & total blood volume & blood viscosity
- Rare diz in dog & cat

DDx:
- Primary PV
  - RL cardiac shunts
  - Tumors producing erythropoletin-like substanc..
- Relative polycythemia (loss of plasma volume)
  - Dehydration
  - Hypoadrenocorticism
  - Hemorrhagic gastroenteritis

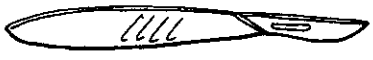
- **Dark skin**
- **PD/PU**
- ± Neurologic disorders (behavior, motor or sensory changes) 50%
- ± Neuromuscular disorders
- Paroxysmal sneezing (dog)
- ± Hemorrhage



- Hx, CS
- Physical exam
  - **Dark, brick-red mucous membranes** & skin
  - **Splenomegaly**
- Blood values
  - Polycythemia **(65-80% PCV)**
  . RBC count often >12,000,000/µl
  - ± Leukocytosis
  - ± Thrombocytosis
  - Normal plasma protein concentrations
  - **Serum erythropoietin levels: low or low-normal, expensive test**



- **Phlebotomy:** remove 10 ml/kg/day until PCV in midnormal range, often all that is needed
  - Simultaneous isotonic fluid replacement
  - Repeat monthly or bimonthly
- Chemotherapy requires more monitoring & more toxic
  - Hydroxyurea PO bid, maintain PCV of 50-60%
  - Monitor weekly - stop Tx if leukopenia or thrombocytopenia



Prognosis:
- May be managed for many months w/ periodic phlebotomies

Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Splenic mass, Localized splenomegaly E-hb 710, 40; IM 943; IM-WW 533; Cat 680; F-H 800; Pa-T 327; Sx-S-hb 329; Sx-S 951; Sx-4B 707; Sx-G 209; Sx-B 544; X-RP 166, 167; X-T 461 **	• **Focal area of splenic enlargement** **Splenic mass - causes** • Neoplastic: - **Hemangiosarcoma** (#1 tumor) - Hemangioma (rare) - Fibrosarcoma - Leiomyoma - Leiomyosarcoma - Lymphoid neoplasm - Liposarcoma - Malignant fibrous histiocytoma - Osteosarcoma - Chondrosarcoma - Rhabdomyosarcoma - Myxosarcoma - Undifferentiated sarcoma - Metastatic tumors - rare • Nonneoplastic - **Hematoma** (#1) - Abscess (rare) - Nodular hyperplasia (common) - Myelolipoma (very rare)	• **Asymptomatic for small or benign ones** • Nonspecific due to large mass as for diffuse splenomegaly - Abdominal distention & pain - Anorexia - Lethargy & depression - Vomiting & diarrhea - Weight loss - PU/PD • ± Abdominal effusion • **Hemangiosarcoma:** weakness, dyspnea, collapse, shock	• Hx, CS often vague • Physical exam - **Palpate cranial abdominal mass,** not all enlarged spleens palpable & not all palpable spleens are abnormal • Body cavity aspiration • CBC (complete blood count) - **Anemia** - DIC - prolonged prothrombin time &/ or activated partial thromboplastin time . Thrombocytopenia . Hypofibrinogenemia - ↑ Fibrin/fibrinogen degradation • **Radiology**: abdominal mass - **Chest film for metastasis** • Ultrasound • Not recommended percutaneous fine needle aspiration • Exploratory laparotomy & splenectomy: Histopath, biopsy other organs	• **Treat underlying cause** • **Splenectomy,** complete - Curative for hematoma, nodular hyperplasia, hemangioma, myelolipoma - Only palliative for sarcomas because of metastasis • Supportive care: - Stabilize before surgery . IV fluids, corticosteroids . Whole blood transfusions - ABs if sepsis or abscesses

DDx:
• Transient splenomegaly
• Hepatomegaly
• Abdominal lymphadenopathy
• Other organ enlargement

Total splenectomy: double ligate the splenic vessels close to the hilus of the spleen to preserve the short gastric & left gastroepiploic aa. to the stomach (2 or 3 vessels can be included in each ligature).

Focal enlargement
Dx: Hx, PE, Rads, US, Laparotomy
CS: Asymptomatic, Nonspecific to collapse
Tx: Cause, Splenectomy, Supportive

Prognosis:
• **Hemangiosarcoma: grave to poor**
• **Hematoma: good** if doesn't rupture

Hemangiosarcoma,
Hemangioma
M8k 704; SAP 180, 201; H2B 795; E-hb 710; I2M 1143; IM 947; IM-WW 533; 5min 646; Cat 687; F-H 799; Pa-t 327; NB 14.4; E 1938; Sx-S-hb 329; Sx-S 951; Sx-4B 707; Sx-B 544; Sx-G 209; Sx-WW 203; X-RP 168; X-T 461
**

• **Hemangiosarcoma: #1 splenic neoplasm**
- Common in **dog**, rare in cat
• Hemangioma: rare
• Both arise from vascular endothelium
• Site: spleen, heart, skin
• Very invasive, fast growing
- Metastasis common
• Middle-aged or older
• Medium to large breeds, especially German shepherds

• **Abdominal distention & pain**
• **Progressive anorexia, lethargy & weakness**
• Intermittent weakness w/ spontaneous recovery
• **Acute collapse, shock**
• Dyspnea (hemothorax from rupture of metastatic tumor)
• **Vomiting & diarrhea**
• **Weight loss**
• PU/PD
• Hemoperitoneum (common)
• Sequela: DIC (disseminated intravascular coagulation)

• Hx, CS
• Physical exam:
- **Palpate cranial abdominal mass**
- Pale, ± icteric mucous membranes
• **Body cavity aspiration**
- Hemoperitoneum, hemothorax, or hemopericardium
. Nonclotting fluid
. Reactive mesothelial cells
• CBC:
- **Anemia**
- Nucleated RBCs, poikilocytosis, acanthocytes, schistocytes
- DIC: prolonged prothrombin time &/or activated partial thromboplastin time
. Thrombocytopenia
. Hypofibrinogenemia
- ↑ Fibrin/fibrinogen degradation prod.
• Radiology: **Chest film for metastasis**
• Ultrasound
• Fine needle aspiration for cytology
• **Ultrasound guided or laparotomy for biopsy & histopath** (√ coagulation 1st - PT, PTT, platelets)

• **Splenectomy,** complete
- **Only palliative** for sarcomas because of metastasis
• Supportive care
- Stabilize before surgery
. IV fluids, corticosteroids
. Whole blood transfusions
- ABs if sepsis or abscesses
• Chemotherapy: vincristine (Oncovin®), doxorubicin (Adriamycin®), cyclophosphamide (Cytoxan®) may prolong survival time
• Periodic radiographic or US of thorax & abdomen for metastasis
• Periodic check for DIC & anemia

DDx:
• Transient splenomegaly
• Hepatomegaly
• Abdominal lymphadenopathy
• Other organ enlargement

Dog > Cat, Metastasis
CS: Vague
Dx: Hx, CS, PE, CBC, Rads
Tx: Grave Px

Prognosis:
• **Grave to poor:**
• Death common due to metastasis, even if not evident at splenectomy

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Splenic hematomas
E-hb 762; H2B 795; Sx-S-hb 330; Sx-S 954; Sx-B 544; Sx-G 209; Sx-4B 707; X-RP 167; X-T 461
**

• **Most common localized splenic mass**
• Not usually associated w/ traumatic event

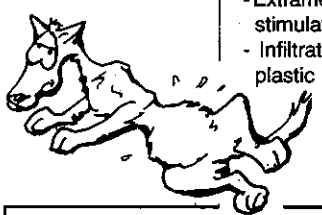
• **Asymptomatic**

• Radiographs- splenic mass
• Ultrasound (m/ not be able to differentiate from splenic neoplasia)

• **Splenectomy** is curative

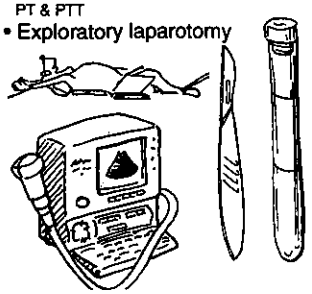
Prognosis:
• Good if doesn't rupture

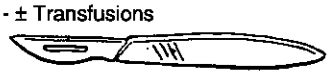
Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Splenomegaly E-hb 710; SAP 178; H2B 791; IM943; Sx-S-hb328; Sx-S951 ***	• **Diffuse enlargement of the spleen** - **Cats: more common than masses** - **Dogs: less common than masses** • Causes: - Inflammatory - Hyperplastic splenomegaly - Congestive splenomegaly - Infiltrative splenomegaly • **Pathophysiology:** - Congestive splenomegaly: impedes flow through the spleen - Hyperplastic: ↑ lymphocytes & plasma cells & splenic mass due to immunological stimulation & ↑ phagocytosis due to blood-born antigens & RBC destruction - Inflammation: cell infiltrates (relatively uncommon) - Extramedullary hematopoiesis: dizs stimulating splenic production - Infiltrative: neoplastic or nonneoplastic	• **Asymptomatic** • Vague, usually related to 1° diz • Nonspecific - Abdominal distention - Abdominal pain - Anorexia - Lethargy & depression - Vomiting & diarrhea - Weight loss - PU/PD - Depression • Splenic torsion: collapse, shock, pain, vomiting, depression	• **Hx, CS** (of different conditions) • **Physical exam** - Abdominal palpation usually detects - Pale mucous membranes - Tense, painful abdomen • CBC - Anemia, thrombocytopenia, leukopenia - Abnormal RBC morphology - ± Spherocytes, Heinz bodies - ± Erythroparasites - ± Neoplastic WBCs • Biochemical abnormalities are rare - ± Hypercalcemia - lymphoma or multiple myeloma - ± Hyperglobulinemia • Bone marrow: ± Neoplasia • Immunological test: Coombs, ANA, RF • Hemoglobinemia/hemoglobinuria (lysis of RBCs) • Radiology: splenomegaly • Ultrasound • Fine needle aspiration for cytology • Ultrasound guided/laparotomy for biopsy & histopath, Check coagulation first (Platelets, PT & PTT • Exploratory laparotomy	• **Treat underlying cause** - Chemotherapy: neoplasia - ABs: infections - Immunosuppressive Tx: immune-mediated diz • Splenectomy: for neoplasm, rupture, hematoma, torsion, mastocytosis, immune-mediated disorders (nonresponsive to drugs) • Supportive care: - Fluid ± steroids - ± Sodium bicarbonate - ± Transfusions **Prognosis: varies** w/ cause (grave to good)

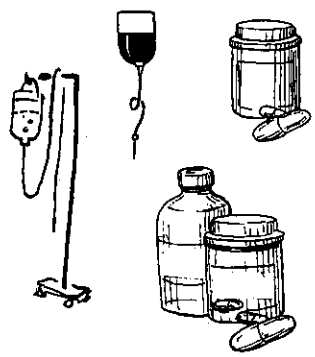


Cats > masses, Dogs < masses
CS: Asymptomatic, Vague, nonspecific
Dx: Hx, CS, PE, CBC, chem., etc.
Tx: Splenectomy

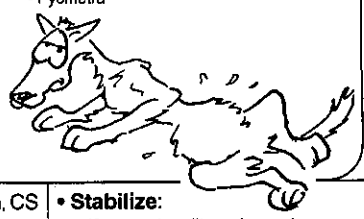
• Hemogram
- Nucleated RBCs
- ↑ % of reticulocytes
- Target cells
- Acanthocytes
- Schistocytes
- Howell-Jolly bodies
- Thrombocytosis



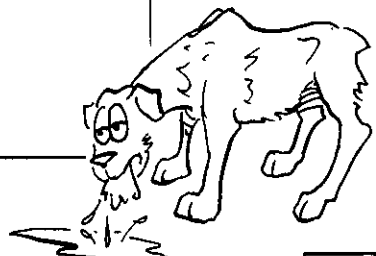




Splenomegaly - Causes
• **Congestion**
- **Splenic torsion** w/ or w/o gastric torsion
- **Portal hypertension**
. Chronic diffuse liver diz
..Hepatic cirrhosis
.. Hepatitis
.. Lipidosis
. Rt. sided congestive heart failure
. Obstruction of vena cava
.. Neoplasia
.. Heartworm diz
- **Barbiturate**, tranquilizers & inhalants
• **Infiltrative:**
- **Neoplastic**:
. Primary neoplasms
.. Lymphosarcoma
.. Myeloproliferative diz/leukemia
.. Systemic mast cell diz (mastocytosis) (cats)
.. Multiple myeloma
.. Malignant histiocytosis (rare)
. Metastatic neoplasms - rare
- Nonneoplastic:
. Amyloidosis
• **RE hyperplasia/hyperfunction**
- Hemolytic anemia
. Immune-mediated anemia
. Heinz body
. Babesiosis
. Pyruvate kinase deficiency
- Systemic lupus erythematosus
- Chronic bacteremia
. Canine brucellosis
. Bacterial endocarditis
- Canine ehrlichiosis
- Protozoal infections
. Leishmaniasis
. Trypanosomiasis
. Cytauxzoonosis
- Histoplasmosis
• **Inflammatory:**
- Bacterial:
. Penetrating wounds
. Foreign bodies
. Hematogenous infection
. Septicemia
. Septic peritonitis
. Pyometra
. Toxoplasmosis
. Salmonellosis
. Canine brucellosis
. Mycobacterium (TB)
- Protozoal diz:
. Haemobartonellosis
. Leishmaniasis, trypanosomiasis, cytauxzoonosis
- Viral dizs:
. Infectious canine hepatitis
. Feline infectious peritonitis
- Mycotic:
. Histoplasmosis
. Blastomycosis
. Sporotrichosis
- Hypereosinophilic syndrome (cats. rare)
- Canine ehrlichiosis
• Extramedullary hematopoiesis:
- Infiltrative bone marrow Diz
- Chronic hemolytic anemias, AIHA
- Chronic inflammatory dizs
- Pyometra



Splenic torsion H2B 791; SAP 180; Sx-S-hb 329; Sx-B 544 **?	• **Twisting of spleen w/ or w/o gastric dilation-volvulus complex** • Life-threatening, demanding rapid diagnosis & correction • Large, deep chest dogs	• **Collapse, shock** • **Anorexia** • **Vomiting** • **Depression** • **Tense, painful abdomen**	• Hx (usually acute, m/b several weeks), CS • Physical exam: - **Palpation: splenomegaly** - Pale mucous membranes - Tense, painful abdomen • Anemia, thrombocytopenia, leukopenia • Hemoglobinemia/hemoglobinuria (lysis of RBCs) • Radiology: **displaced C-shaped spleen** • Palpation splenomegaly ± M/b rotation of stomach - gastric volvulus • Ultrasound (distended splenic veins)	• **Stabilize**: - If gastric dilatation, decompress, treat shock - IV fluids, steroids ± whole blood - Stabilize • Exploratory celiotomy, untwist & check for thrombosis • **Splenectomy it thrombosis** **Prognosis: Good early, poor late**



Large, deep chested dogs
CS: Collapse, shock
Dx: Hx, CS, PE, Rads
Tx: Stabilize, Splenectomy • Px: Guarded

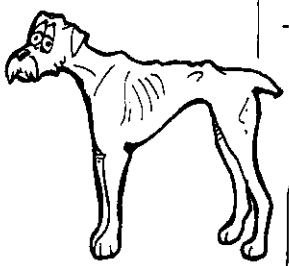
Spleen

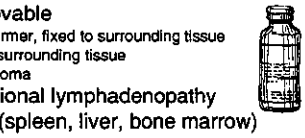
CIRCULATORY SYSTEM

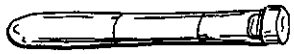
Condition	Facts/C	Presentation	Diagnosis	Treatment
Splenic trauma/ rupture SAP 180; H2B 797 **	• Cause - Trauma - Iatrogenic - Underlying diz	• Hemorrhagic shock • **Vague signs of abdominal discomfort** • Asymptomatic	• **Hx, CS** • **Radiographs**	• **Treat hypovolemic shock** • **Splenectomy** • **Surgical repair** **Prognosis: shock & death** if hemorrhage not controlled
Splenic abscess/ inflammation SAP 180; H2B 795 **	• **Uncommon in dog & cat** • Localized or associated w/ other abdominal inflammatory diz • Localized or diffuse enlargement • Acute, subacute or chronic	• Vague , usually related to 1° diz - Anorexia. weight loss - **Abdominal pain** - **Abdominal distention** - Vomiting - Depression - PU/PD (marked enlargement) • + or - splenomegaly	• **Palpate: ± enlarged spleen** • Radiographs - Locally or generalized enlargement - Dystrophic calcification if chronic infec. - Gas forming bact. air in splenic parenchyma or w/ In splenic vessels • Ultrasound • Serum biochemical abnormalities rare	• Treat 1° cause • Systemic antibiotics Prognosis: **Guarded**
Accessory spleens H2B 797; F-H 799; Sx4B 707	• Congenital ectopic splenic tissue supplied by splenic artery. Unknown cause • No signs, no treatment			
Splenosis SAP 180; H2B 797	• Ectopic regenerated autotransplanted splenic tissue, Cause: traumatic fragmentation of spleen • No signs, No treatment needed			
Postsplenectomy sepsis IM 951; SAP 183 *	• **Rare** but well-documented • 3% of splenectomized dogs • Predisposition: immunosuppressive therapy • Rapid onset	• **Acute death** (hours to days)	• Hx (splenectomy) • CS: sepsis	• **Ineffective once develops** **Prevention: Prophylactic ABs postoperative** - Gentamicin or amikacin w/ cephalothin Prognosis: **Dead**

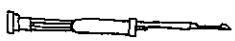
Lymphedema H2B 779 **?	• **Endematous swelling** from mechanical failure of lymphatic drainage • Primary lymphedema, no underlying diz • 2° lymphedema: diz that obstructs lymphatics or lymph node • Cause: - Primary lymphedema . Idiopathic . Genetic .. Lethal generalized lymphedema (Eng. bull dogs) . Mild trauma, superficial skin infection - 2° lymphedema • Divisions of 1° lymphedema: aplasia, hypoplasia, hyperplasia	• **Painless** • **Pitting swellings** - Usually commencing in lower extremities - ± Whole body edema • Sequela: - Premature death **DDx:** • Lymphedema - 1 limb - Inflammation, Trauma, Venous obstruction - 2° lymphedema - Arteriovenous shunts • Both forelimbs - Thrombosis of cranial venal cava - Compression of cranial vena cava by mediastinal mass • Bilateral hindlimb - Obstruction of sublumbar lymph nodes (neoplasia) • All 4 limbs - Hypoproteinemia	• Hx, CS • Abnormalities of the venous system - Circulatory failure - Lipoalbuminemia ??? • Check for secondary causes	• **Bandaging** for several months - Robert-Jones splints - Diuretics & gluco-corticoids • **Surgery**: excision of SQ edematous tissue & superficial fascia Prognosis: • Congenital: guarded, may improve spontaneously or become permanent
Contagious streptococcal lymphadenopathy E-hb 707	• Draining purulent lesion of lymph node; Reported in **kittens** in a cattery • CS: Diarrhea, Fever, Cervical lymphadenopathy (enlarged lymph nodes, draining purulent lesions) • Dx: Hx, CS, physical exam - palpation • Tx: Penicillin: most respond • Px: **Good**			
Puppy strangles, Juvenile cellulitis, Juvenile moist pyoderma SAP 371; H2B 958	• Cutaneous cellulitis of head & neck & cervical lymphadenopathy • 4-12-week-old puppies • Cause: unknown - Hypersensitivity reaction to bacterial antigens • Breeds: Golden retrievers, Dachshunds, Pointers, Labs, Beagles • 1 or more in litter may be affected	• **Swelling - head & neck** • Red edematous pinna • Pustular, ulcerative, exudative dermatitis • Mandibular nodes - purulent exudate • ± Systemic signs: fever, anorexia & depression • Sequela: Scarring (may not be apparent for months - **Death** (cause unknown)	• **Hx (young puppies**, breeds), CS • **Palpate head neck & lymph nodes** • Fine needle aspiration • CBC: inflammatory leukogram • Poor response to ABs in many • No bacteria in most cultures • Responds to immunosuppressive doses of steroids	• **Steroids** - immunosuppressive doses • Topical astringent soaks • ABs (cephalexin) Prognosis: • Good if responds in 4-5 days

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Lymphadenopathy E-hb 706; H2B 779; SAP 195; IM 941; E 1930 ***?	• **Lymph node enlargement** • Distribution: - **Superficial solitary or regional**: localized inflammation/infection or metastatic neoplasia - **Deep solitary or regional**: metastatic neoplasia or systemic infection - **Generalized**: most due to systemic fungi, rickettsia or lymphoma, nonspecific hyperplasia • Types: - **Reactive lymphoid hyperplasia**: proliferation of normal cells in response to antigenic stimuli (vaccination, infection) - **Lymphadenitis**: PMNs & macrophage infiltrate usually 2° to infection . Suppurative: PMNs predominate . Granulomatous: macrophages predominate . Pyogranulomatous: PMNs & macrophages . Eosinophilic: eosinophils predominate . Lymph node abscess: liquefaction - **Infiltrative (neoplastic) proliferative lymphadenopathy**: displacement of normal lymph tissue by neoplastic or inflammatory cells . Neoplasms: 1° malignant lymphoma or 2° (metastatic) . Lymphoma common cause dog	• **Enlarged superficial lymph node(s)** • Variable - Systemic (systemic mycosis, salmon poisoning, Rocky Mountain spotted fever, ehrlichiosis, Leishmaniasis, acute leukemia) - No systemic CS: chronic leukemias, most lymphomas, vaccination reaction • Vague: - Anorexia - Weight loss - Weakness - Vomiting, diarrhea - ± PU/PD (if hypercalcemia)	• **History & physical findings** - Age, signalment, geography, season, vaccination - Distribution of lymphadenopathy: solitary, regional, generalized • Palpate: mandibular, superficial cervical, superficial inguinal, popliteal - Usually firm, irregular, painless, movable . Exception: Lymphadenitis - softer, tender, warmer, fixed to surrounding tissue .. Lymphomas or metastasis may be fixed to surrounding tissue - Marked enlargement (5-10x): abscess or lymphoma • Check area drained in solitary or regional lymphadenopathy • Check other hemolymphatic organs (spleen, liver, bone marrow) • Blood values: - ± Inflammatory response (leukocytosis, neutrophilia, left shift & monocytosis) - ± Blast cells in acute leukemia - ± Marked lymphocytosis: chronic lymphocytic leukemia, ehrlichiosis - ± Anemia - ± Thrombocytopenia - ± Pancytopenia - Hypercalcemia 10-20 % in dogs w/ lymphoma or multiple myeloma - ± Monoclonal hyperglobulinemia - multiple myeloma, lymphoma, ehrlichiosis - ± Polyclonal hyperglobulinemia: FIP, ehrlichiosis, lymphoma • Blood smear: histoplasmosis, haemobartonellosis, trypanosomiasis, Babesiosis • Titers: Bacterial, Viral, Fungal, Rickettsial, Protozoal, Immune (ANA) • **Lymph node aspiration**: usually definitive - Note: not largest lymph node (abscess) or mandibular - Normal: 1° small lymphocytes, few macrophages, large lymphocytes, plasma cells & mast cells - Reactive: lymphocytes in different stages of development - Lymphadenitis: PMNs or macrophages - Metastatic: vary - 1° lymphoid: monomorphic population of immature lymphocytes • Lymph node biopsy: if aspiration not definitive, excise whole node, section & take impression smears for cytology & fix in 10% formalin • Bone marrow aspirate or core biopsy: hemolymphatic neoplasia or systemic infection • Survey radiography: lymphangiography • Ultrasonography: for intra-abdominal lymphadenopathy • Exploratory surgery **Palpable lymph nodes** • Always palpable: Mandibular, Prescapular (superficial cervical), Axillary (50%), Superficial inguinal, Popliteal • Palpable when enlarged: Facial, Retropharyngeal, Mesenteric, Sublumbar (Iliac)	• Tx cause







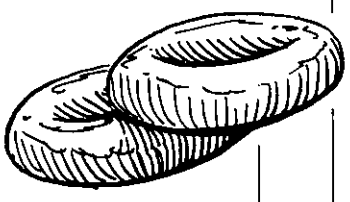


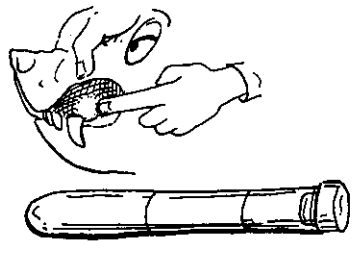
Enlargement
CS: Variable
Dx: Aspiration
Tx: Tx cause

DDx/causes - Lymphadenopathy

• Proliferative	• Infiltrative
- Infectious: Bacterial, Rickettsial, Algal, Parasitic, Viral	- Neoplastic
- Noninfectious	. Primary hematopoietic
. Postvaccination	. Metastatic
. Immune-mediated	- Nonneoplastic
. Localized inflammation	. Mast cell infiltration
	. Eosinophilic granuloma complex

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Erythrocytosis, Polycythemia SAP 156; IM 909; E-hb 705, 103; H2B 753; E 197	• **Relative erythrocytosis** (common) - Related to fluid depletion (dehydration or hemoconcentration) - Transient splenic contraction from excitement, fear - Greyhounds normal PCV 60% • Absolute erythrocytosis (rare) - Sustained increase in circulating RBCs	• **Asymptomatic** • **Dark red gums** • Paroxysmal sneezing (viscosity of nasal mucosa) • CNS (behavior, motor or sensory changes) • ± Cardiopulmonary CS	• **R/O dehydration** (relative erythrocytosis 1st) - Erythrogram returns to normal after fluid replacement - Retake PCV after patient relaxes (if suspect splenic contraction) • Hx (stress or fluid loss), CS • Physical exam - **Dark red mucous membranes** - Slow capillary refill time • **CBC** - **↑ PVC** - **Relative: ↑ plasma proteins** • Hypoxia: lung diz or rt-to-lt shunts • Renal diz/neoplasia: urinalysis, radiography, US, Biopsy, azotemia • Erythropoietin levels not readily available	• **Relative** - **Correct causes** • Absolute - Remove inciting cause: nephrectomy - Phlebotomy • Polycythemia rubra: hydroxyurea (Hydrea®) - Phlebotomy





Relative - dehydration
CS: Dark red gums
Dx: R/O, Hx, PE, ↑ PVC
Tx cause

Types of erythrocytosis
• Relative erythrocytosis (common)
- **Dehydration or hemoconcentration**
- Transient splenic contraction from excitement, fear
- Greyhounds
• Absolute erythrocytosis
- 1° erythrocytosis (polycythemia vera)
. Low serum erythropoietin
. Defect in intrinsic stem cell defect (leukemic)
- 2° erythrocytosis: overproduction of erythropoietin
. Hypoxia (chronic pulmonary diz, high altitudes, cardiac diz w/ right-to-left shunts)
. Erythropoietin-producing tumors (renal lymphoma, renal carcinoma, nasal fibrosarcoma
. Renal diz (pyelonephritis)
. Hyperadrenocorticism - dogs
. Hyperthyroidism - cats
- Erythroleukemia in cats - rare

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Erythropoietin abnormalities H2B 546; C12T 1435t, 345t; C11T 484	• **Glycoprotein hormone**: regulates normal erythopoiesis of bone marrow; Origin? juxtaglomerular apparatus in kidney? Renal hypoxia: major stimulus for secretion - **↓ Erythropoietin**: Chronic renal failure, Polycythemia vera (myeloproliferative disorder, ↑ RBCs negative feed back on erythropoietin, 1° polycythemia (high PCV)). Tx: renal failure (fluids, k/d Hill's diet, erythropoietin [Epogen®]) or polycythemia vera - **Normal ↑**: Right to left cardiovascular shunts, High altitude, Hemoglobinopathy, Respiratory center depression - **Inappropriate ↑**: Tumors secretion (renal carcinoma, hepatoma, urinary leiomyoma, ovarian carcinoma, pheochromocytoma, adrenocortical neoplasms, renal lymphosarcoma, nasal fibrosarcoma), Parenchymal renal diz: renal cysts, hydronephrosis, polycystic kidneys), Hormonal stimulation: androgen therapy, high dosage of adrenocortical steroids. Tx cause			

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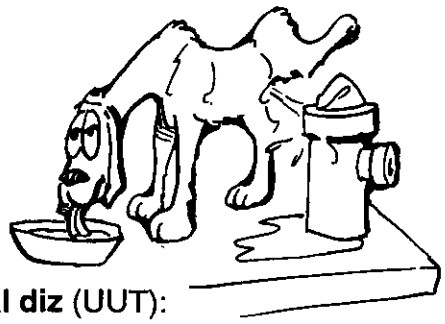
Urinary tract disorders

IM 449; E-hb 635; H3B 493; 5min 60; IM-WW 323; E 1706; X-T 442

- Urinary problems:
  - Renal & ureter
  - Lower urinary tract (bladder & urethral)
  - Prostate



Renal diz (UUT):

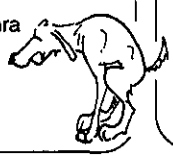
- **Renal diz:** morphologic or functional lesions in one or both kidneys
- **Renal failure:** reduced renal excretion, 1st detected when *75%* of the nephrons are nonfunctional
- **Azotemia:** ↑ blood urea nitrogen (BUN) &/or creatinine
  - **Prerenal azotemia:** result of reduced renal perfusion
  - **Renal azotemia:** due loss of 75% of the nephrons
  - **Postrenal azotemia:** impaired elimination of urine from the body (obstruction)
- **Uremia:** clinical syndrome due to accumulation of metabolic waste products due to renal failure
  - All uremic patients are azotemic, but not all azotemic patients are uremic

Clinical signs of renal diz

- **PU/PD** (polyuria/polydipsia - ↑ amount/ ↑ drinking)
- **Nocturia** (uncontrolled urination at night)
- **Oliguria - anuria (acute)**
- **Pollakiuria** (↑ frequency)
- **Dysuria/stranguria** (painful)
- **Incontinence** (no control of urination urge)
- **Hematuria** (blood in urine)
- **Renal pain**
- **GI: vomiting, diarrhea**
- **Fever** (Upper urinary tract infections)
- **Asymptomatic**

DDx - Renal pain

- Renal diz: swelling of renal parenchyma & stretching of renal capsule
- Acute hydronephrosis: partial or complete obstruction of urine flow
  - Urinary calculi
  - Neoplasia
  - *Dioctophyma renale* (kidney worm)
  - Accidental ligation of ureter when spaying
  - Inflammation & stricture of ureter or urethra
  - Extra-urinary lesions – abdominal masses
  - Congenital causes:
    - . Torsion or kinking of ureter due to displacement of kidney
    - .. Stenosis or atresia of urethra
    - .. Aberrant renal vessels
- Acute nephrosis - usually toxic
  - Ethylene glycol
  - Arsenic



DDx - Polyuria (↑ volume)

- **Physiologic polyuria #1**
- Pituitary diabetes insipidus
- Nephrogenic diabetes insipidus
- Pyometra (uterine infection)
- Psychogenic polydipsia
- Diabetes mellitus
- Chronic renal failure
- Acute renal failure
- Hyperadrenocorticism (Cushing's syndrome)
- Liver diz
- Primary hyperparathyroidism
- Hypoparathyroidism
- Hyperthyroidism
- Hypoadrenocorticism
- Lymphosarcoma

DDx - Oliguria (↓ volume)

- Physiologic oliguria
  - Reduced renal perfusion
    - . Dehydration
    - . Shock
    - . Cardiac diz
    - . Hypoadrenocorticism
- Pathologic oliguria:
  - Acute primary renal failure
    - . Acute nephritis
    - . Early in the course of chronic dizs
    - . 1° polyuric renal failure if prerenal conditions develop
  - Partial postrenal obstruction

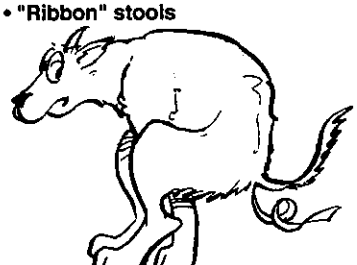
Lower Urinary Tract Disorders (LUT)

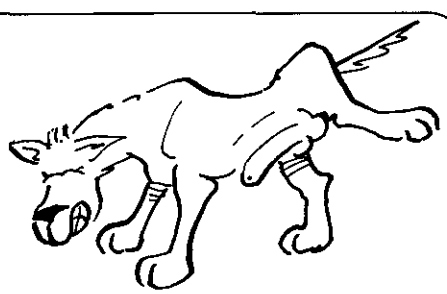
Clinical signs:

- **Often asymptomatic**
- **Dysuria**
- **Urinary incontinence**
- **Urethral discharge**
- **No fever usually**

Prostatic diz

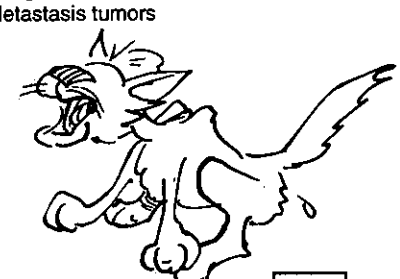
- **Constipation, tenesmus**
- **"Ribbon" stools**





DDx - Dysuria = difficult micturition

- Indicative of lower urinary tract diz (bladder, urethra) & occasionally prostatic diz
- Bacterial infection
  - Cystitis = inflammation of bladder
- Feline urologic syndrome (FUS)
- Cystolithiasis - bladder stones
- Ureterolithiasis
- Bladder atony
- Bladder neoplasia
  - Benign anaplasia
  - Malignant tumors
  - Metastasis tumors

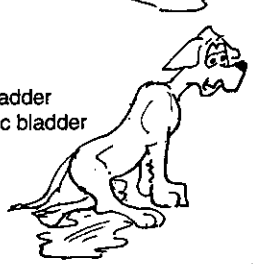


DDx - Urethral discharge

- Preputial discharge
- Urethritis
- Urethral trauma
- Urethral neoplasms (rare)
  - Transitional cell carcinoma, leiomyoma & squamous cell carcinoma
  - Secondary tumors - transmissible venereal sarcoma & malignant lymphoma
- Bacterial prostatitis
- Prostatic cysts

DDx - Urinary incontinence

- Nonneurogenic incontinence:
  - Hormone responsive
  - Ectopic ureters
  - Patent urachus
  - Behavioral problem
  - Obstruction
  - Urge incontinence
  - Pseudohermaphrodite (rare)
- Neurogenic incontinence:
  - Lower motor neuron - atonic bladder
  - Upper motor neuron - automatic bladder
  - Detrusor- urethra disorders



Diagnosis of Renal Diz

E-hb 648; IM 466, IM-WW 324; E 1706

- As a veterinarian, answer the following questions:
  - Primary renal diz?
  - Predominantly glomerular, tubular, interstitial or a combination?
  - Extent or severity?
  - Acute or chronic?
  - Reversible or irreversible?
  - Progressive or nonprogressive?
  - Azotemic? Prerenal, renal or post renal?

History: may help, but often nonspecific & renal diz may not be suspected

- Age:
  - Young - congenital, infectious or toxic causes
  - Old - degenerative or neoplastic disorders

Questions to ask client (history)

- Acute or chronic?
- Progressive or nonprogressive?
- Previous drug treatment?
  - Aminoglycosides, , amphotericin B, thiacetarsamide, NSAIDs?
- Heartworm treatment?
- Previous trauma?
- Antifreeze changed recently?
- Urination habits: change in frequency, volume, or color? Painful urination?
- Urinating during the night?
- Reluctance to move?
- Age?
- Breed?
- Water intake: diminished, normal, increased?
  - Normal water intake = < 100 ml/kg/day
  - Polydipsia = >100 ml/kg/day

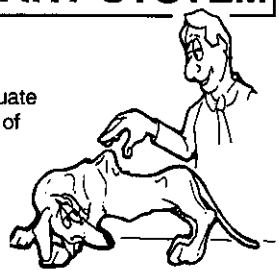
Changes in urination

- Normal urine volume = 25-40 ml/ kg/day for dog, & 20-30 ml/kg/day for cat
- Anuria: no urine
- Oliguria: < 1.0 to 2.0 ml/kg/hour
- Polyuria: > 50 to 60 ml/kg/day

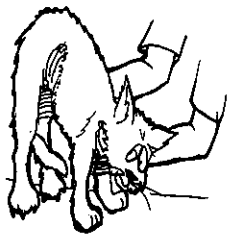
Physical exam

E-hb 648; E 1706; IM-WW 324

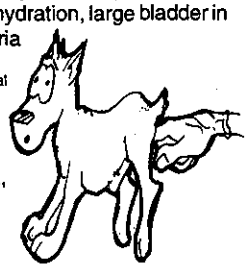
- Hydration status: evaluate skin turgor, moistness of mucous membranes, retraction of eyeballs
- Weight loss - note overall body condition



- Oral cavity:
  - Pallor: anemia
  - Uremic stomatitis/ulcers (dogs > cats)
- Eye exam for hypertension (vascular tortuosity, retinal edema, retinal hemorrhage & detachment)



- Abdominal palpation
  - Kidneys: size, shape, contour, pain
    - Both kidneys palpable in cats; caudal, left kidney palpable in dog, right kidney can't be palpated
  - Bladder: size in relation to hydration, large bladder in dehydrated animal - polyuria
- Thoracic auscultation - usually normal
  - Uremic myocarditis - arrhythmias
  - Respiratory: uremic pneumonitis, crackles



- Rectal exam: pelvic urethra, prostate, trigone of bladder to DDx from LUT (lower urinary tract)

Blood chemistries

M8k 1129; E-hb 635; H3B 493; IM-WW324; IM-WW 324; E 1707; CP-RP 61; CP-C 190

- **Azotemia: ↑ BUN & creatinine**
  - Crude GFR (glomerular filtration rate)
- **↑ BUN** (blood urea nitrogen) end product of protein catabolism
  - Normal BUN: Dog: 9-26 mg/dl; Cat: 15-31 mg/dl
  - Interpret in relation to SpG
    - Hi BUN w/ normal SpG: prerenal azotemia
    - Hi BUN w/ isosthenuria (1.010): 1° renal problem
    - Hi BUN + dysuria: for postrenal
  - > 75% loss of renal function to cause increase
    - BUN not very sensitive, numerous variables influence levels: GI bleeding, high protein diet, infection, fever, stress, steroids, etc.
- **↑ Creatinine** (end product of muscle metabolism)
  - Normal Creatinine: Dog: 0.5-1.6 mg/dl; Cat: 0.5-1.9 mg/dl
  - Creatinine clearance approximates GFR (glomerular filtration rate); more specific indicator of GFR than BUN (variations have little effect on creatinine filtration)
  - Sequential ↑ creatinine more guarded prognosis than ↓ levels
- Hyperphosphatemia: due to reduced GFR
- Calcium: may be low, normal or high
- ± **Low bicarbonate**: failure to excrete acid & to reabsorb
- ± ↑ Amylase & lipase: reduced renal clearance
- Hypercholesterolemia: association w/ chronic glomerular diz
- ± Hypoalbuminemia: association with glomerular diz

Plasma Proteins:

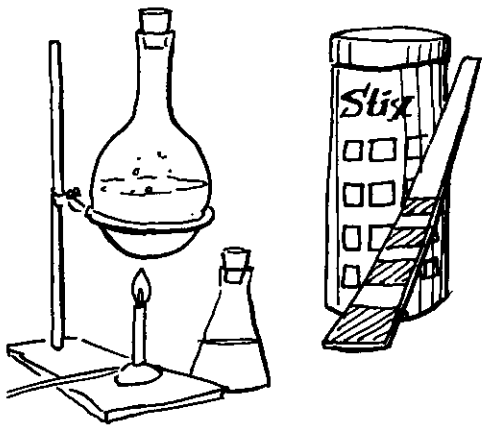
- **Hypoproteinemia**: may be seen in chronic diz: esp., glomerular diz
  - Albumin is primary protein lost
- ± Hyperproteinemia: ↑ in serum globulin levels due to chronic inflammation

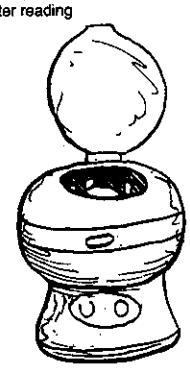
CBC (complete blood cell count)

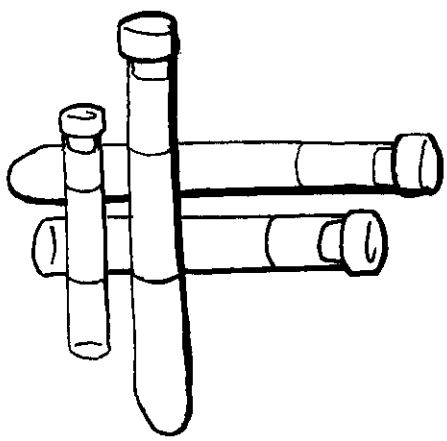
- RBC (Red Blood Cells): variable response
  - Acute blood loss: usually regenerative anemia
  - Chronic renal diz: usually nonregenerative (normochromic, normocytic) anemia
    - Lack of erythropoietin seen with destruction of kidney tissue, producing bone marrow erythroid hypoplasia
    - Chronic inflammation
    - ± Regenerative anemia w/ chronic blood loss from urinary tract
- White Blood Cells:
  - Leukocytosis: usually seen with acute diz, inflammation & infections
  - Leukopenia: may be seen with chronic diz
  - Stress response may be in either acute or chronic diz

Phenylsulfophalein test (PSP test)

- Measures proximal tubular secretion
- Not routinely used
- PSP excreted primarily by proximal tubules
- Excretion test measures renal plasma flow & proximal tubular function
- Test results altered by renal diz, reduced renal blood flow & severe dehydration
- Technique:
  - Draw 4 ml heparinized blood as control at time 0
  - Inject PSP IV at I mg/kg body weight
  - At 60 minutes, draw 4 ml heparinized sample
  - PSP concentration figured by colorimeter reading
- Interpretation of results:
  - Normal = < 80 ug% at 60 minutes
  - > 120 ug% at 60 minutes indicative of renal functional problems
  - 80-120 ug% suspicious for renal functional problems







UA (Urine anlysis)

M8k 1128; E-hb 636; H3B 494; IM 469; IM-WW 324; E 1707; Dx-L 589

- Early morning best, analyze as soon as possible or w/in 4 hrs if refrigerated
- Sample collection
  - Cystocentesis (preferred method)
    . Least likely to be contaminated
  - Catheterization (greatest risk of contamination to animal)
  - Midstream "free catch"

- **Color:**
  - Colorless - light yellow - normal - low SpG
  - Darker color - normal or abnormal - high SpG
  - Pink, red, brown or black - hemoglobinuria or myoglobinuria
  - Blue or green - bilirubinuria or stored urine

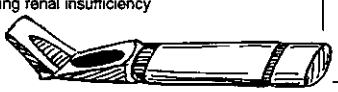
- **Clarity**
  - Turbid - epithelial cells, blood, WBCs & bacteria or cooling

- **Water deprivation test:**
  - Checks for medullary washout in PD/PU or consistently low SpG
  - Best to gradually deprive patient of water over a 3 day period to compensate for medullary washout
  - Technique:
    . Patient should have normal BUN & hydration
    . Withhold food 12 hours prior to total water deprivation or feed food with low moisture content during gradual test
    . At time 0, catheterize & empty bladder - weigh patient - determine urine specific gravity - initiate total water deprivation
    . 12 hours later, empty bladder & determine urine specific gravity - weigh patient
    . 24 hours after start, empty bladder & determine urine specific gravity - weigh patient
    . If urine specific gravity is < 1.030: dog or < 1.035: cat after 24 hours, check BUN & continue water deprivation for additional 6–12 hours. Repeat urine specific gravity, BUN, & weight determinations after additional deprivation time
  - Discontinue test when:
    . BUN becomes abnormally elevated
    . Patient loses 5% of its body weight, or
    . SpG reaches 1.030 in dog or 1.035 in cat

DDx: Low SpG
- 1° renal insufficiency
- 2° disorders
  - Diabetes insipidus
  - Pyometra
  - Hyperadrenocorticism
  - Diuretics
  - Corticosteroid Tx
  - Psychogenic polydipsia

• Urine Specific Gravity (SpG)

- **1.013 - 1.035** (generally ≥ 1.035)
  . Drop in SpG precedes azotemia in renal insufficiency
  . Cats can concentrate as high as 1.080 (azotemia may proceed a drop in SpG)
- **1.008-1.012 - isosthenuria** (same as plasma/glomerular filtrate)
  . Unable to concentrate or secrete water
  . Do a 2nd test or a water deprivation test if there are no signs of dehydration or azotemia
- **< 1.008 - hyposthenuric:** abnormal in dehydrated or azotemic patient
- **1.013-1.029:** at least some ability to concentrate
  . Check 2nd time before saying normal. If remains low do additional tests before diagnosing renal insufficiency

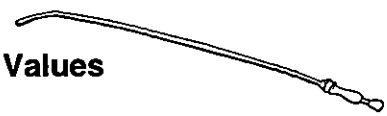


ADH (antidiuretic hormone) test:
- Evaluates ability to respond to ADH
- Technique:
  - Vasopressin/kg body weight SQ
  - Withhold all food & fluids during test
  - 30 minutes after injection of ADH, empty bladder
  - Collect urine samples at 30, 60, 90 & 120 minutes post-ADH injection & determine urine specific gravity of these samples
- Interpretation of results:
  - 1.020–1.035 or greater: normal response
  - <1.020 indicates:
    . Generalized renal diz
    . Renal diabetes insipidus, or
    . Error in performing test

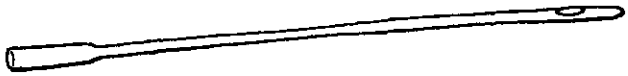
Interpretation water deprivation:

1.030 (dog) or 1.035 (cat)	Adequate concentrating ability
< 1.030 (dog) or < 1.035 (cat) (no azotemia or dehydration)	Impairment of ADH release Generalized renal diz ADH unresponsive kidney tubules Error in performing test
< 1.030 (dog) or < 1.035 (cat) (with azotemia)	Generalized renal diz
< 1.020 (dog) or < 1.035 (cat) (with dehydration)	Diabetes insipidus Generalized renal diz

Urinalysis - Values



Parameter	Dog	Cat
Color	Light yellow	Yellow
Turbidity	Clear	Clear
Specific gravity	1.015-1.045	1.015-1.060
Osmolality (mOsm/kg)	500-2400	500-2800
Volume (ml/kd/d)	24-40	22-30
WBCs	< 5/hpf	
Semiquantitative tests		
Protein	Negative	Negative
Ketone, glucose	Negative	Negative
Urobilinogen	Negative	Negative
Bilirubin	Trace	Trace
pH	5.0-7.0	5.0-7.0
Quantitative tests		
Creatinine (mg/dl)	100-300	110-280
Urea g/dl)	1.0-2.5	1.0-3.0
Protein (g/dl)	0-300	0-20
Sodium (mEq/l)	20-165	
Potassium, (mEq/l)	20-120	
Calcium (mEq/l)	2-10	
Phosphorus (mEq/l)	50-180	
Amylase (SU)	50-150	3-120

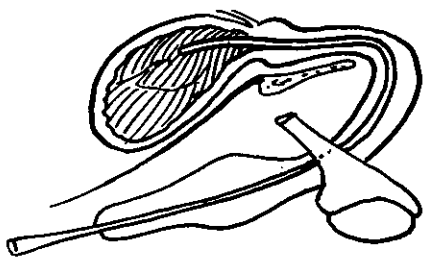


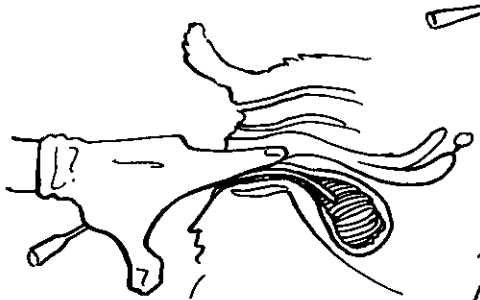
Changes in urination

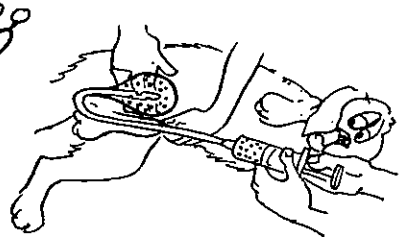
- Normal urine volume =

Dog:	25-40 ml/kg/day
Cat:	20-30 ml/kg/day
- Anuria:	no urine
- Oliguria:	< 1.0 to 2.0 ml/kg/hour
- Polyuria:	> 50 to 60 ml/kg/day

Male cat



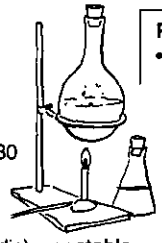




Chemical analysis (UA)

M8k 1129; IM-WW 324

- Reagent strips - dipstick
- Graded: 0, trace, 1+, 2+, 3+ & 4+
  - Relate to specific gravity
    1+ at 1.010; 2+ at 1.020 or 3+ at 1.030



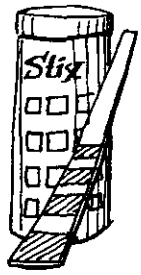
- **pH**
  - **pH 5-7 normal in dogs & cats**
    . Varies w/ diet: high meat lowers (acidic), vegetable diet - alkaline, urolithiasis diets - acidic
    . Some bacteria split urea to produce alkaline urine and thus can be used to monitor treatment
    . Note: pH tends to increase over time; measure on fresh sample

Proteinuria:

- All positive dipstick values must be checked with an APT (urine + sulphosalicylic acid)
- **U-Pr/Cr ratio** (urinary protein to creatinine)
  - Use for all high (3+) proteinuria in absence of inflammatory urine sediment to determine significance of protein
    . Interpret w/ caution if inflammatory urine sediment
  - Normal values:
    . Dog: < 1.0 (< 0.2)
    . Cat: < 0.5
  - Guidelines for interpretation (dogs)
    . Pr/Cr < 5: glomerulosclerosis or atrophy
    . Pr/Cr = 5-13: nonamyloid glomerulopathy
    . Pr/Cr > 13: severe glomerulopathy or amyloidosis

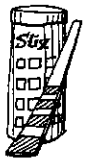
DDx: Proteinuria

- **Glomerular diz**
  - **Glomerulonephritis**
  - **Amyloidosis**
- Fanconi's syndrome
- Nonmalignant & malignant hyperglobulinemias
  - Plasma cell myelomas (Bence-Jones proteins)
- Congestive heart failure
- **Inflammation of urinary tract**
- Stress
- Fever
- Exercise
- Hyperthermia & hypothermia



Glucose

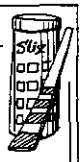
- 0.0 - normally
- > 0.0 requires further evaluation
  - Indicates blood values > 180 mg/dl (renal **threshold**)
  - Intermittent glycosuria: R/O pre-diabetic state by Hx of stress or 1-hour-fed plasma glucose test



DDx - glycosuria

- Diabetes
- Transient
  - Stress (cats > dogs)
  - After eating
  - Hyperadrenocorticism + pre-diabetic state

Ketones: Dipstick

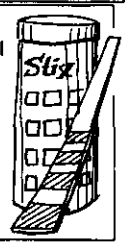


DDx- Ketonuria

- Diabetic ketoacidosis
- Starvation
- Persistent fever
- Impaired liver function
- Hypoglycemic syndromes

Bilirubin

- Dog: Trace to 1+ - normal
- Cat: none normal

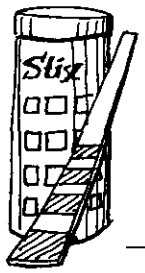


DDx -Bilirubinuria

- Liver diz
- Biliary obstruction
- Cholelithiasis
- Hemolysis

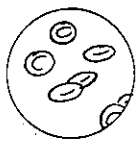
Occult Blood

- Dipstick: does not differentiate hematuria from myoglobinuria or hemoglobinuria
  - To differentiate hematuria: presence of intact RBCs on sediment exam
  - To differentiate myoglobin from hemoglobin: ammonium sulfate precipitation, electrophoresis



DDx - Hematuria

- Transfusion reactions
- Immunological reactions
- Infections
- Renal or postrenal bleeding
- Trauma
- Coagulopathy
- Infection
- Inflammation
- Urolithiasis
- Neoplasia
- UTI
- Genital diz (prostatitis, metritis)
- Parasites
- Contamination of cystocentesis
- Myoglobinuria (muscle necrosis)



Urine sediment

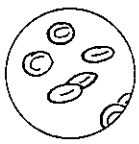
- Centrifuge 5-10 ml of urine - 2,000 rpm for 5 min.
  . Examine wet or dry, stained or not stained
- Examine under a microscope - average the elements seen on 10 fields

RBC (hematuria): Normal < 5 /hpf

- > 5 requires further diagnostic tests (hematology, serum chemistries, radiographs, urine cultures)

DDx - Hematuria (RBCs)

- Trauma
- Inflammation/infections
- Uroliths
- Coagulation abnormalities
- Tumors
- Toxins
- Infarction
- Prostatic diz (dog)



Casts

- Occasional hyaline or granular cast - normal in concentrated urine
- Hyaline casts < 0-2/400X field (mucoproteins)
- Granular casts < 0-1/400X field (degenerative cells + protein)

DDx - Hyaline casts

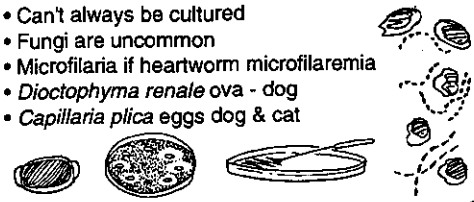
- Proteinuria (renal & extrarenal)

DDx - Granular casts (RBC, WBC or epithelial?)

- Acute renal injury
  - Toxins
  - Trauma
  - Infections
  - Ischemia
  - Immune-mediated processes
- Glomerular proteinuria
- Dehydration
- Diuresis

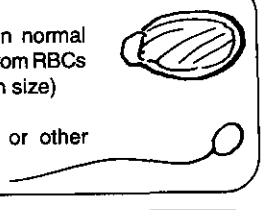
Microorganisms

- Bacterial: best in cystocentesis samples
- > 10,000 /ml for bacilli or > 100,000 /ml cocci
- Can't always be cultured
- Fungi are uncommon
- Microfilaria if heartworm microfilaremia
- *Dioctophyma renale* ova - dog
- *Capillaria plica* eggs dog & cat



Miscellaneous:

- Fat droplets common in normal feline urine; distinguish from RBCs (float, refractile & vary in size)
- Spermatozoa
- Contamination: pollen or other plant materials



WBC: pyuria
> 5-10/hpf w/ < 5 RBCs/hpf

DDx - Pyuria

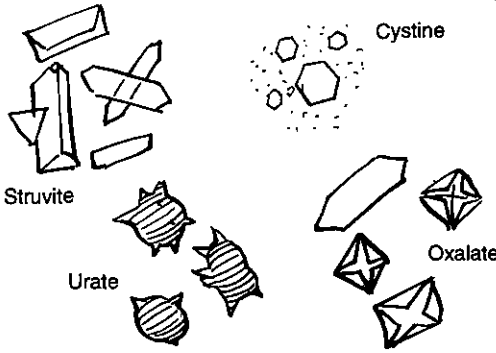
- Infection
- Uroliths
- Trauma
- Tumors
- Toxins

Epithelial cells

- Occasionally squamous, transitional or renal tubular cells seen in normal urine
- ↑ Numbers in inflammation or neoplasia

DDx - Crystals

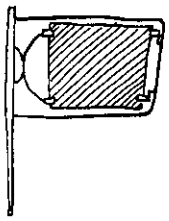
- Small numbers normal in concentrated & refrigerated urine
- Struvite (triple phosphate) crystals: significant if inflammation or radiodense uroliths
- Oxalate or hippurate crystals
  - Ethylene glycol toxicity
    - Absence doesn't rule out antifreeze toxicity
- Ammonium biurate ('thorny apple') crystals: normal in dalmatians
  - Other breeds suggestive of hepatic insufficiencies (portosystemic shunts)



Radiographs - Urinary System

E-hb 638, IM 471; I2M 594, IM-WW 327; CM 431; E 1717; X-RP 173; X-T 442; X-Gr 134

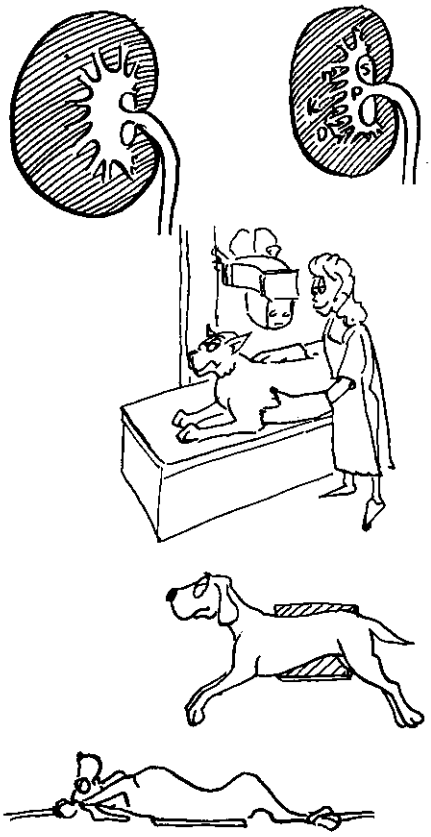
- Animal preparation: fasted, colon evacuation (enema)
- Perform right lateral & VD view
- Note size, shape, number, contour, & radiodensity of kidneys
  - VD (ventrodorsal) view
    . Size...
    .. Dog: 2.5 to 3.5 times length of L2
    .. Cat: 2.4 to 3.0 times length of L2
    . Location: right kidney cranial to left
    .. Dog: right kidney: T13 to L3
    left kidney: L2 lo L4
    .. Cat: right kidney: L1 - L4
    left kidney: L2-L5



- Visualization of borders is relative to perirenal & retroperitoneal fat
  - Easier to see in cats & obese dogs
  - Harder to see in young & emaciated animals & those w/ retroperitoneal diz (effusions)
  - Right kidney harder to see than left because touching liver
- Both kidneys should have smooth borders & be the same size
- Ureters are not normally seen (small, retroperitoneal location)

Intravenous urogram, excretory urography:
E-hb 656; IM 471

- Indications:
  - To locate kidneys or identify renal size & shape if cannot be found on plain films or ultrasound
  - Evaluate for hydronephrosis, obstructive nephropathy, or ectopic ureter
  - Qualitatively evaluation of renal function
  - Diagnose urinary tract rupture
  - Before nephrectomy or nephrotomy to evaluate kidney function (GFR)
- Procedure:
  - Iodinated contrast agent IV
    . If abnormal renal function (↑ BUN & creatine) need more contrast agent
  - Radiograph immediately, at 5 min & 10-15 min, ± 20-30 min if delayed excretion
  - Oblique radiographs may help to evaluate distal ureters & uterovesicular junctions
  - Abdominal compression may help to maximize filling & visualization of renal diverticuli & pelvis
- Precautions/Contraindications:
  - Animals with reduced renal function may take longer time & need a higher dose of contrast agent to yield adequate study
  - Renal failure/insufficiency: this procedure can decrease GFR for several days afterwards. Use caution if compromised renal function & be sure to provide adequate pre- & post-diuresis



Cystogram, pneumocystogram & double contrast cystogram: IM 472

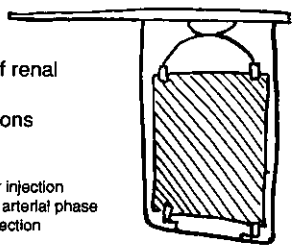
- Indications:
  - Visualizations of size, shape, position & integrity of urinary bladder
  - Evaluation of intramural, intraluminal & extraluminal filling defects of bladder
  - Urachal remnants
  - Bladder defects
- Procedure:
  - Catheterize bladder & remove urine
  - Cystogram: distend bladder w/ iodinated contrast medium
  - Pneumocystogram: distend bladder w/ room air or CO2
  - Double contrast cystogram: infuse 2-5 ml of undiluted iodinated contrast & follow w/ distention of bladder w/ air

Urethrogram IM 472

- Indications:
  - Visualization of location, contour & integrity of urethra & bladder neck
  - Evaluation of prostatic diz
- Procedure:
  - Insert a balloon-tipped catheter in distal end of urethra & inflate
  - Undiluted iodinated contrast injected to fill urethra (5-10 ml)
  - Lateral & ventrodorsal radiographs during infusion

Angiography

- Indications:
  - Evaluate architecture of renal vascular supply
    . Congenital malformations
    . Primary vascular diz
- Technique - 3 phases
  - Arterial phase: 0.5-3.0 sec after injection
  - Nephrogram: immediately after arterial phase
  - Venous phase: 2-4 sec after injection



Vaginogram - urinary

- Indications:
  - Visualization of integrity, size & location of vagina
  - Identification of ectopic ureter entering vagina
- Procedure:
  - Balloon tip catheter is placed within the vagina & inflated
  - Undiluted iodinated contrast injected to fill vagina
  - Lateral & ventrodorsal oblique radiographs

Pneumoperitoneogram

- Indications:
  - Visualization of visceral surfaces of kidneys, ovaries, bladder & uterine body
  - Visualizations of abnormal abdominal mass & other organs
- Procedure:
  - Indwelling cannula placed in peritoneal cavity
    . CO2 or nitrous oxide injected into peritoneal cavity
    . Right & left lateral, dorsoventral & ventrodorsal radiographs are taken

DDx - Normal-sized kidney

- Normal kidney
- All dizs, except aplasia

DDx - Small kidney

- Congenital - aplastic or hypoplastic
- End stage inflammatory diz
  - Chronic generalized renal diz
    . CIN
    . Amyloidosis
    . Pyelonephritis
    . Glomerulonephritis 1° or
    . 2° glomerulonephritis
    .. Lupus erythematosus
    .. Pyometra
    .. Malignancies
    .. *Dirofilaria immitis*
    .. Adenovirus - infectious hepatitis
    .. *Ehrlichia canis*

DDx - Enlarged kidney

- Bilaterally
  - Acute nephritis
  - Acute nephrosis
  - Hydronephrosis (uncommon)
  - Amyloidosis - irregular contour
  - Polycystic kidneys - irregular contour
  - Lymphosarcoma or metastatic tumor
  - Feline infectious peritonitis (FIP)
  - Perirenal mass/cyst
  - Subcapsular hematoma (rare)
- Unilateral
  - Compensatory hypertrophy
  - Subscapular hematoma
  - Primary or metastatic renal neoplasm
  - Renal cyst
  - Hydronephrosis

DDx - Irregular kidney

- Cysts (smooth, round)
- Tumor (smooth or irregular)
- Infarcts (depression)
- Subscapular hematoma (smooth)

DDx - ↑ Renal density

- Nephrocalcinosis
  - Hyperadrenocorticism
  - Hyperparathyroidism
  - Hypercalcemia
  - Ethylene glycol poisoning
  - Renal tubular defects
  - Idiopathic
- Renal calculi

DDx - Failure to visualize a nephrogram

- Acute or chronic renal failure
- Renal artery obstruction
- Avulsion of renal artery
- Insufficiencies in dose of contrast
- Absent kidney
- Diffuse renal neoplasia
- Hydronephrosis
- End-stage kidney diz

DDx - Enlarged urinary bladder

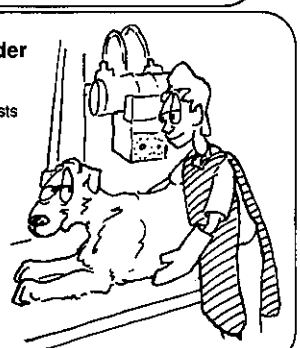
- Bladder obstruction
  - Urethral calculi
  - Urethral compression by intrapelvic mass
  - Urethral & urinary trigone neoplasms
- Neurogenic atony
  - Spinal cord compression of transection
  - 2° to long-standing dysuria & urine retention

DDx - Small bladder

- Cystitis
- Congenital anomaly
- Herniation into perineal, femoral or abdominal locations
- Bladder rupture
- Recent voiding?

DDx - Abnormally shaped bladder

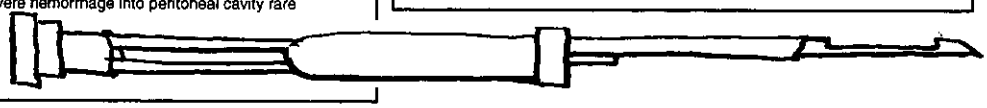
- External compression
  - Uterine enlargements
  - Prostatic enlargement of paraprostatic cysts
  - Uterine stump abscess or granuloma
  - Colonic neoplasm
- Infiltrative diz w/in bladder wall
  - Chronic cystitis
  - Previous surgery & scar
  - Neoplasia of bladder wall
  - Urethral diverticuli

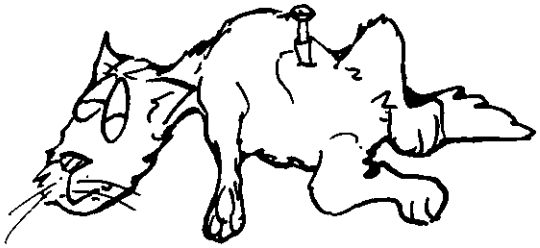


Renal biopsy

E-hb 638; SAP 821; IM 472; I2M 601; IM 327; IM-WW 327; 5min 1018; E 1718; CM 429; Sx-S-hb 484; Sx-S 1438; C12T 940

- **Indications:**
  - Only after less invasive tests used
  - When outcome of biopsy may alter therapeutic management (e.g., bacterial pyelonephritis)
  - To differentiate between protein-losing nephropathies (glomerulonephritis vs. amyloidosis)
  - Differentiate acute from chronic renal failure
  - Evaluate tubular basement membrane in acute renal failure
  - To defect neoplasia
  - To determine prognosis or progression of renal diz (e.g., acute tubular necrosis)
- **Contraindications:** pyelonephritis, renal abscess, hydronephrosis, coagulopathy, single kidney or questionable function of 2 very small marginal kidneys
- **Types:**
  - Percutaneous biopsy: via ultrasound guidance
  - Laparoscopy
- Technique:
  - Evaluate bleeding time & estimate platelet numbers
  - Direct through long axis of kidney, solely through cortical tissue
  - Brisk fluid diuresis after procedure to prevent clot formation in renal pelvis
  - Send to pathologist
- Complication: Hemorrhage - subscapular common, macroscopic hematuria less common, severe hemorrhage into peritoneal cavity rare



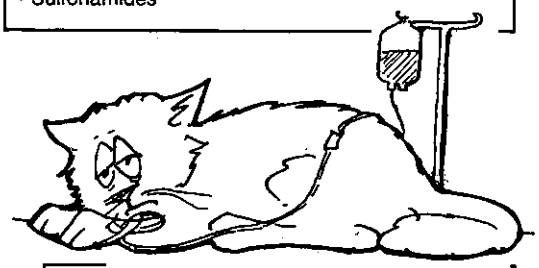


Peritoneal dialysis:

- 1.5-4% glucose & balanced electrolyte solutions most often used
  - Use potassium-free dialysate if hyperkalemia
- Mildly distend abdomen
- Allow equilibration for 30-60 minutes & then remove
- Repeat dialysis according to signs shown by patient
- Indications:
  - Acute renal failure
  - Chronic renal failure
  - Overhydration
  - Intoxications
- Contraindicated:
  - Ruptured diaphragm or extensive intraabdominal adhesions

Antibacterial drugs for renal & lower urinary tract infection (culture & sensitivity)

- Chloramphenicol
- Tetracyclines
- Penicillin & derivatives
- Fluoroquinolones: enrofloxacin, norfloxacin, ciprofloxacin
- Streptomycin
- Carbenicillin
- Erythromycin
- Furadantin
- Cephalosporins
- Trimethoprim
- Sulfonamides



Diuresis:

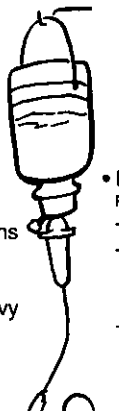
- **Rehydrate first**
- 10% glucose IV TID (osmotic diuresis)
  - Check for glycosuria & reasonable urine flow (2–8 ml/minute)
  - ± K^+ (approx. 20 mEq/liter fluids)
  - Can use 0.9% saline for diuresis

Fluid therapy

Replacement = % dehydration x lb x 500 ml
Maintenance = 30 ml/lb/24 hr

M8k 1129; SAP 64; IM 515; IM-WW 329

- **Rehydration:**
  - Estimate degree of dehydration
  - **Replacement (ml) = % dehydration x BW (lbs) x 500 ml**
  - Isotonic fluids: Ringer's solution, lactated Ringer's, saline, 5% dextrose
  - Maintenance: insensible water loss & urine flow
    - . Lactated Ringer's or Ringer's IV
    - . Approximately 30 ml/lb/24 hours or maintenance chart
  - Evaluation of replacement therapy:
    - . Weigh frequently - once rehydrated, animal should not show marked gains or losses
    - . Monitor BUN: rising BUN implies inadequate urine flow
    - . Monitor urine flow: failing kidney cannot conserve water or excrete heavy water load

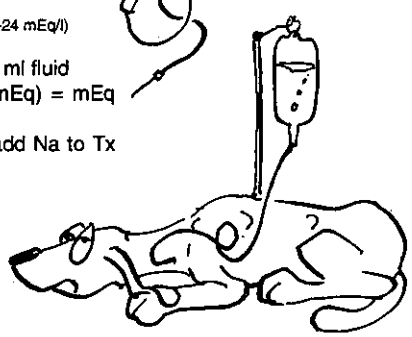


- **Metabolic Acidosis:** plasma bicarbonate < 12 mmol/l or blood pH < 7.2
  - $NaHCO_3$ (sodium bicarbonate)
    - . Oral sodium bicarbonate - initially 8-12 mg/kg TID (maintain at CO_2 at 18-24 mEq/l)
    - .. Baking soda can also be used (1g = 12mEq $NaCO_2$)
    - . Evaluate by blood gases or add 10-15 mEq $NaHCO_3$ per 250 ml fluid
    - . Or kg body weight x 0.6 x (25 – patient's bicarbonate in mEq) = mEq bicarbonate (give slowly over 24 hour period)
  - Ca lactate may be given for acidosis if it is not desirable to add Na to Tx schedule

- **Hyperkalemia:**
  - Occurs in obstruction - follow by serum electrolytes
  - ECG for signs of cardiotoxicity (spiked T waves)
  - Severe hyperkalemia:
  - 10-25 mEq $NaHCO_3$ IV over 30-45 minutes
  - 0.35 units of insulin per pound of body weight. IV
    - . Follow insulin with dextrose (2 gm dextrose/unit insulin) - give 25% IV over 5 minute period & remainder in fluids to make 2.5% dextrose solution
  - May give dextrose solution alone IV
  - Ca gluconate (10%) counteracts effects of K+ on heart, but does not lower K+ levels
    - . Do not exceed 0.5 ml/kg IV over 10-15 minutes
    - . Do not use in fluids with $NaHCO_3$

- **Hyponatremia & hypokalemia** (may result when FUS cat is unblocked due to polyuric phase)
  - Monitor by serum electrolytes
  - Hyponatremia
    - . Salt tablets (1 gm tid PO)
    - . Normal saline IV
  - Hypokalemia
    - . Potassium elixirs
    - . Potassium salts in parenteral fluids (not to exceed 20 mEq/hr)

Sodium bicarbonate (↓ chance of acidosis)
- 1 gm NaHCO3/5 kg BW (2 gm NaHCO3 = 1/2 tsp baking soda)

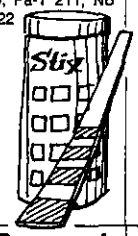


Azotemia

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Azotemia

M8k 1134; Mk 877; E-hb 645; SAP 799; H3B 493; 5min 216; I2M 585; IM 463; IM-WW 323; CM 424, 470; Pa-T 211; NB 21.22



- **↑ Blood Urea Nitrogen (BUN) &/or creatinine**
- **Types: prerenal, renal or postrenal azotemia**
- **Differentiating the type is important for accurate diagnosis, treatment & prognosis**
- **Uremia:** clinical syndrome resulting from the accumulation of metabolic waste products due to renal failure

Prerenal azotemia	Reduced renal perfusion	↑ BUN & creatine ↑ Urine specific gravity > 1.030
Renal Azotemia	Loss of 75% of nephrons	↑ BUN & creatinine ↓ Urine specific gravity < 1.017
Postrenal azotemia	Blockage of urine outflow	↑ BUN & creatinine Oliguria or anuria Hyperkalemia

DDx: Azotemia

- **↑ BUN - normal creatinine** - normal GFR
  - **High protein diet**
  - Excess protein catabolism
    - . Intestinal bleeding
    - . Fever
    - . Trauma
    - . Infection
    - . Toxemia
  - ↑ Fractional reabsorption of urea as with dehydration

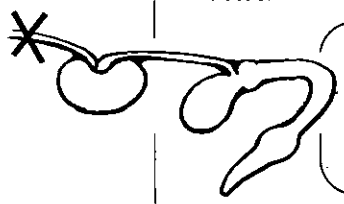
• Prerenal azotemia ***

- **↓ Renal perfusion** causing ↓ glomerular filtration of metabolites
  - Results in ↑ BUN &/or creatinine in bloodstream
  - Urine concentration ability remains normal (tubular function remains normal)
- If decreased perfusion corrected rapidly kidney will return to normal function
- If not corrected: renal ischemia & kidney destruction

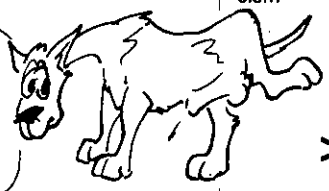
- CS of cause
- Anuria, oliguria
- Sequela:
  - Renal diz
  - Renal failure

- **↑ BUN & creatine**
  - If ↑ BUN & normal creatinine check diet or protein catabolism
- **High urine specific gravity > 1.030**
- Adrenocorticotrophic hormone stimulation test to diagnose hyperadrenocorticism

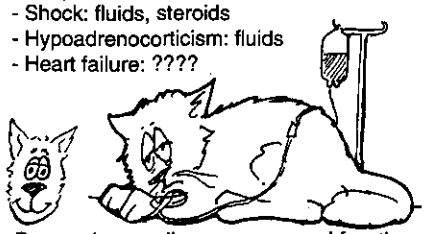
- **Kidney normal**
- **Restore circulating fluid volume & renal perfusion**
  - Correct electrolyte abnormalities
- Treat cause:
  - Dehydration: fluids
  - Shock: fluids, steroids
  - Hypoadrenocorticism: fluids
  - Heart failure: ????



Causes - prerenal azotemia
- **Dehydration**
- **Shock**
- **Hypoadrenocorticism**
- **Heart failure**



> 1.030

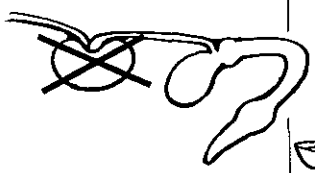


- Prognosis: usually resume normal function when re-perfusion reestablished if not prolonged ischemia

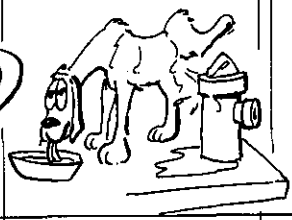
• Renal (1°) azotemia ***

- **↓ GFR due loss of > 75% of nephrons**
- Renal diz resulting in azotemia = renal failure
  - Acute renal failure: reversible or irreversible
  - Chronic renal failure: irreversible

< 1.017



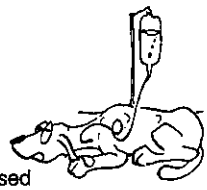
- Acute
  - Anuric, oliguric, occasionally polyuric
- Chronic
  - PU/PD
  - GI (vomiting & diarrhea)
    - . Oral ulcers



- **↑ BUN & creatinine**
- Acute & chronic
  - Low SpG < **1.017**

Cause renal azotemia
- Acute renal failure
  - Ischemia (prerenal)
    - . Dehydration
    - . Hypovolemia
  - Toxins
    - . Ethylene glycol
    - . Aminoglycosides
    - . Heavy metals
  - Hypercalcemia
  - Infections (leptospirosis)
  - Others
- Chronic renal failure

- **Acute:**
  - **Support until repair itself**
    - . Fluids, Tx hyperkalemia & acidosis
    - . Initiate urine flow (Lasix, mannitol)
- Chronic:
  - NO cure, palliative
  - Fluids
  - **Diet:** restrict proteins & phosphorus (Hill's k/d



Prognosis:
- Acute: may be reversed
- Chronic: irreversible

• Postrenal azotemia ***

- **Blockage of urine outflow**
- **Hyperkalemia** develops (potassium can't be eliminated)
  - **Life-threatening:** effects cardiac conduction, causing bradycardia & death
- Initially kidneys resume normal function if corrected. With time obstruction may result in renal lesion; e.g., hydronephrosis

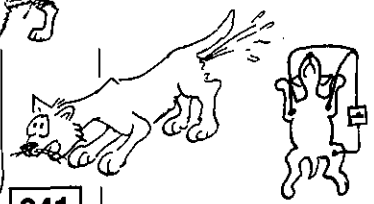
- **Oliguria**
- **Straining**
- **Abdominal discomfort**

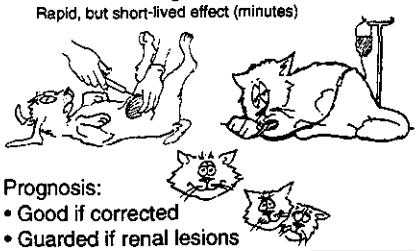
- Sequelae:
  - Heart failure: hyperkalemia
  - Hydronephrosis

- ↑ BUN & creatinine
- Oliguria or anuria
- CS: dysuria, discomfort
- ECG (hyperkalemia)
  - Bradycardia
  - Spiked T-waves
  - Absence of P-waves
- Check creatinine of abdominal fluid if rupture suspected

- **Hyperkalemia - priority**
  - Unblock animal
  - Cystocentesis if can't immediately unblock
  - Fluid therapy
    - . **Sodium bicarbonate:** 0.5-1 mmol/kg by slow IV over 15 min
    - . **20% dextrose:** 0.5-1 g/kg IV w/ ≤1 U regular insulin per 3 g dextrose
    - . **10% calcium gluconate:** up to 0.5-1 g/kg IV. Rapid, but short-lived effect (minutes)

Cause - postrenal azotemia
- Urinary obstruction
  - Calculi: renal pelvis, ureter or urethra
  - Tumor block
  - Entrapment of urinary tract (hernia)
  - Trauma, stricture
  - Iatrogenic: surgery or catheterization
- Ruptured urinary tract





Prognosis:
- Good if corrected
- Guarded if renal lesions

Chronic Renal Failure

Condition	Facts/Cause	Presentation/CS	Diagnosis

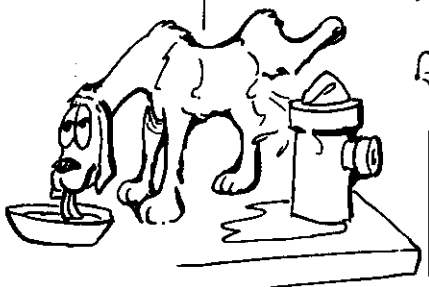
Chronic renal failure, CRF

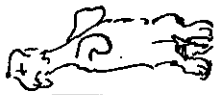
M8k 1135; Mk 877; SAP 804; H2B 572; H3B 512; 5min 1018, 130; I2M 621; IM 487; IM-WW 331; IM-WW 512; E-hb 643; E 1734; C12T 948, 963; C11T 842, 853, 857; Sx-S-hb 472; Sx-S 1400, 1440; Pa-T 211, 236; X-T 450; X-Gr 134; NB 21.21

★★★

Facts/Cause

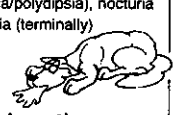
- **Progressive, irreversible** damage over **months to years**: loss of renal tissue
  - Hyperfiltration: compensation by remaining functional nephrons results in glomerulosclerosis
- Loss of function: glomeruli or tubules
  - ↓ **Excretion**: retention of nitrogenous substances (BUN, creatinine)
  - ↓ **Sodium & water resorption**: electrolyte changes, metabolic acidosis & PU/PD
  - ↓ Synthesize erythropoietin: anemia
  - ↓ **Vit D conversion to D3**: impaired calcium absorption & 2° renal hyperparathyroidism
  - Hypertension: pathogenesis not determined
- **> 75%** of nephrons destroyed: progresses to end-stage failure
- Distinguish from acute, which may be reversible (Hx, CS, test & ± renal biopsy)
- Dogs >>> cats (12/1000 cats admitted)
  - Siamese, Burmese, Maine Coon, Abyssinian
- Older animals usually (but congenital forms also)



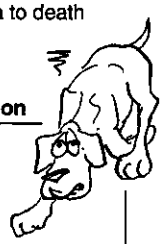


Presentation/CS

- **Subtle progressive signs**
- **PU/PD** (polyuria/polydipsia), nocturia
- ± Oliguria or anuria (terminally)
- **GI (uremia)**
  - **Vomiting**
  - ± Diarrhea
  - **Oral & GI ulcerations**
- **Nonspecific**
  - **Anorexia, lethargy**
  - Weight loss
  - **Dehydration**
- **Cardiovascular**
  - **Anemia**, bleeding tendencies
  - **Hypertension**
  - **Weakness** & tiring (CHF)
- Osteodystrophy: bone pain & pliability - "rubber jaw"
- Fast breathing (anemia)
- Edema or ascites
- **Terminal stages**
  - **CNS**: depression, convulsions, coma to death



- **Sequela:**
  - **Infections**
  - **Hypertension**

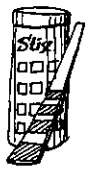


DDx PU/PD:

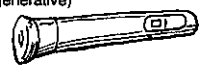
- Diabetes insipidus
- Diabetes mellitus
- Pyometra
- Pyelonephritis w/o renal failure
- Hyperadrenocorticism
- Adrenal insufficiency (also vomits & azotemic)

Diagnosis

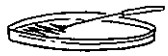
- **If advanced usually can't identify underlying cause**
- Hx (familial, toxins, drugs, infections), CS (PU/PD)
- Physical exam (PE):
  - **Pale gums** (anemia), scleral injection (toxic)
  - **Oral ulcers** (uremic stomatitis)
  - Check hydration
  - Retinal changes (hypertension)
  - Palpation: small, firm, "lumpy bumpy" kidneys or enlarged kidneys w/ tumors or hydronephrosis
  - SQ edema or ascites (hypoproteinemia)
  - Rectal (prostate, pelvic urethra & trigone of bladder)



- Laboratory:
  - ↑ **BUN, creatinine** (if 75% of nephrons nonfunctional)
  - Cat: BUN >35 mg/dl, creatine > 1.9 mg/dl
  - ↑ **Phosphorus usually (hyperphosphatemia)**
  - **Anemia** (normocytic, normochromic, nonregenerative)
  - **Metabolic acidosis**



- UA (urinary analysis)
  - **Sp. Gr. fixed at 1.008-1.012** Isosthenuria (cats maybe able to concentrate 1.006-1.040)
  - Inactive sediment, no casts
  - ± Proteinuria in glomerulonephritis
  - Urine protein:creatine ratio >1 abnormal, > 5 - glomerular diz



- Urine culture: cystocentesis to R/O (rule out) urinary tract infection
- **Radiology:**
  - **Small, irregular kidney** (unless tumor), uroliths
  - Contrast (excretory urography) often reduced excretion limits this technique)
  - Osteoporosis, osteodystrophy

- Ultrasound (US): hydronephrosis, polycystic diz, uroliths
- Renal biopsy: cautiously in rare cases
- **Hypertension (↑ systemic blood pressure)** (> 50%)
  - Dog: > 180 (systolic) & > 100 (diastolic) mmHg
  - Cat: > 200 mmHg (systolic) > 120 (diastolic)

- Cardiac arrhythmias (uremia, hypoxia [anemia], acidosis)

Acquired - CRF

SAP 804; H2B 572; IM 488

- Idiopathic
- Infectious (CIN)
  - Pyelonephritis
  - Leptospirosis
  - FIP (feline infectious peritonitis)
  - ± Lyme diz
- Chronic obstruction
- Glomerulonephritis
  - 2° to other organ diz
  - Immune complex deposition
- Nephrotoxins - chronic exposure
  - Ethylene glycol
  - Aminoglycoside ABs
  - Hypercalcemia
- Immunological disorders
  - Glomerulonephritis
  - Systemic lupus
  - Vasculitis (FIP)
  - Amyloidosis
- Neoplasia
  - 1° renal adenocarcinoma
  - Lymphosarcoma
  - Metastatic diz
- Fibrosis following acute renal failure
- Bilateral hydronephrosis
- Parasite: *Dioctophyma renale*
- Infarction
  - DIC (disseminated intravasc. coagulation)
  - Emboli - bacterial endocarditis

Congenital causes - CRF

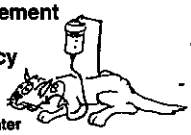
• Renal dysplasia	Shih Tzu, Samoyed, Soft-coated Wheaton terrier, Domestic long-haired & Persian
• Unilateral renal agenesis	Beagle
• Cortical hypoplasia	Cocker spaniel
• Tubulointerstitial fibrosis	Cocker spaniel
• Tubular dysfunction	Basenji
• Polycystic renal diz	Cairn terrier
• Glomerular atrophy	Pembroke Welsh corgi
• Tenlangiectasia	Norwegian elkhound
• Tubulointerstitial fibrosis	Lhasa apso
• Glomerulosclerosis	Doberman pinscher
• Idiopathic polycystic diz	Domestic long-haired & Persian cats
• Amyloidosis	Abyssinian cat

Patient monitoring:

- Mild renal failure (azotemia, impaired concentrating ability) evaluate every 3-4 months
- Moderate to advanced CRF: evaluate every 1-2 months
- Physical exam - weight loss & hydration
- Laboratory: (PCV, chem, electrolytes, total CO2, UA)
- Blood pressure

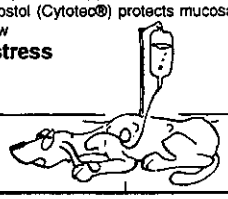
TREATMENT - CRF

- **No cure, but can be managed**
  - **Treat cause if identified**
    - ABs for pyelonephritis
    - Remove obstruction
    - Avoid corticosteroids + tetracycline
  - **Goal: medical management**
- **Tx for renal insufficiency**
  - **Fluid therapy**
    - **Rehydrate if needed**
    - **Unlimited fresh drinking water**
    - SQ fluids in cats (some owners will do)

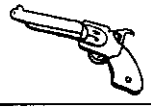


  - **Dietary management - k/d (Hill's)**
    - ↑ proteins & phosphorus, + high quality protein
    - Stimulate appetite: diazepam if all else fails

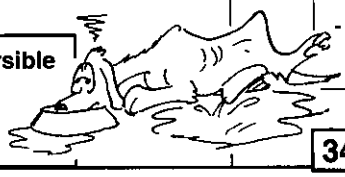
  - **Vit B & C** (water soluble - lost in urine)
  - Metabolic acidosis - pH < 7.2
    - Oral $NaHCO_3$ (baking soda)
  - **Tx hyperphosphatemia:**
    - Early: dietary restriction, check in 2-4 weeks
    - Later may need intestinal phosphorus binders (aluminum hydroxide [ALternaGEL®], aluminum carbonate, calcium carbonate [Tums®, Titralac®], calcium acetate)
  - **Antiemetic**: trimethobenzamide (Tigan®), metoclopramide (Reglan®), chlorpromazine (Thorazine®)
  - **H2 antagonist:** ↓ stomach acid & vomiting
    - **Cimetidine** (Tagamet®), Ranitidine (Zantac®) H2 antagonists
    - Sucralfate (Carafate®) protects mucosa
    - ± Misoprostol (Cytotec®) protects mucosa by ↑ blood flow
  - **Avoid stress**



- **Added Tx for chronic renal failure**
  - **Nonregenerative anemia**: dog: PCV < 30%, cat < 25%
    - **Androgens**: months before benefits seen, usually poor results (stimulates RBC production)
      - Nandrolone decanoate (Deca-Durabolin®), stanozolol (Winstrol®), oxymetholone (Anadrol®)
    - **Transfusion**: if CS referable to anemia (weakness, lethargy, dyspnea), raise PCV to 25%
  - Ca^+ or Vit D if documented hypocalcemia
  - **Hypertension**: maintain systolic pressure at 120-160 mmHg & diastolic at 60-100 mmHg
    - Gradual dietary sodium restriction
    - Furosemide (Lasix®) only if dietary doesn't work
    - Propranolol (Inderal®) or atenolol (Tenormin®) β blocker
    - Prazosin (Minipress®): vasodilator
    - Enalapril (Vasotec®) or Benazopril (Lotensin®)
      - ACE inhibitor: stop angiotensinogen conversion
  - **Oral ulcers**: local chlorhexidine or lidocaine
  - **Tx hypokalemia (especially in cat)**
    - Potassium supplementation - oral
      - Potassium chloride solutions
      - Potassium elixirs
      - Potassium gluconate powder
  - ± **Valium®** (diazepam) appetite stimulant
  - **Euthanasia - consider**
- Renal transplantation (SX-WW 160)



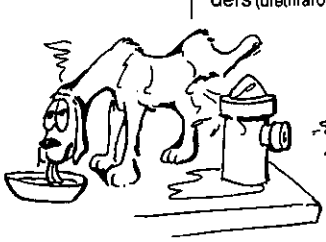
Progressive - months-years - Irreversible
CS: PU/PD, GI, Heart
Dx: Hx, CS, 1.008-1.012, BUN
Tx: NO cure - manage: diet, fluids

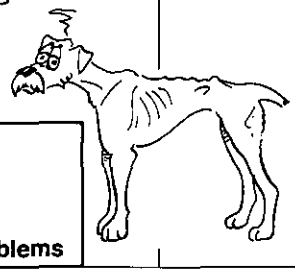


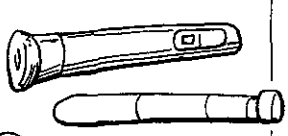
Prognosis: Poor long-term

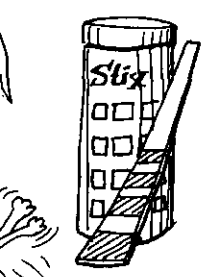
- Can live months to years but most eventually die of uremia

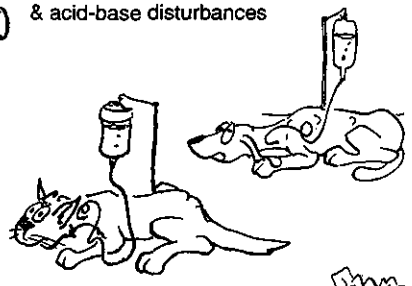
Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Uremia, Uremic syndrome IM 481, 754; IM-WW 323, 462; H2B 263, 572, 575, 119, 86; E-hb 117, 134; 5min 216; C12T 951, 966, 971; C11T 846; NS-C 75, 161, 188, 226; NS-O 264; NS-L 79Sx-S 1401; Pa-T 211; H-T/M 321 ***	• **Uremia: retention of protein by-products in blood & resulting toxic condition** - Generally associated w/ **renal failure** - Not uncommon in geriatric animal - All uremic patients are azotemic, but not all azotemic patients are uremic • Pathophysiology: constellation of CS - Metabolic acidosis & uremic toxicity, anemia & fluid overload - GI complications - Cardiovascular: myocardial irritability - **Systemic hypertension** (CRF) - Pulmonary edema to pneumonitis - Anemia - Encephalopathy - Acidosis - ↑ or ↓ $^{+}$ & Ca^{++} serum level (ECG) • Cause: Renal failure, Postrenal disorders (urethral obstruction, urinary bladder rupture)	• **PU/PD** (polyuria/polydipsia) • Depression, lethargy • Anorexia, weight loss • GI complications - Vomiting (dogs > cats) - GI bleeding - Stomatitis/oral ulcers • Respiratory distress (dyspnea, tachypnea) from uremic pneumonitis & metabolic acidosis • CNS/encephalopathy: - Behavioral alterations - Dementia, delirium - Seizures may occur w/ terminal uremia - Coma • Osteodystrophy	• **Hx, Clinical signs (CS)** • ECG: - Nonspecific ECG abnormalities - Conduction defects or arrhythmias • Laboratory: - ↑ **BUN, creatinine** - ↑ phosphorus . Nonregenerative **anemia** - ↑ or ↓ potassium & calcium - **Acidosis** • Urinalysis: isosthenuria (1.010)	• **Manage uremia & underlying cause** - Parenteral fluids - Diet restriction of protein & phosphorus - Phosphate binders - ± Calcitriol & erythropoietin • **Manage concurrent heart failure** (challenging & often frustrating) - Check renal failure in cardiac patients before fluids & diuretics - Rehydrate carefully w/ low sodium fluids (half strength saline & dextrose) - Reduce dose or avoid cardiac drugs eliminated by kidney (Digoxin) . Monitor kidney function & electrolytes frequently if using ACE inhibitors (captopril or enalapril) or digoxin . Digitoxin can be substituted for digoxin . Hydralazine & nitroglycerine can be substituted for ACE inhibitors - Monitor & control hypertension, electrolyte & acid-base disturbances







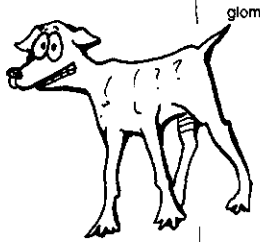
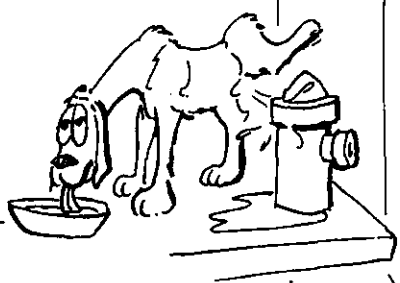


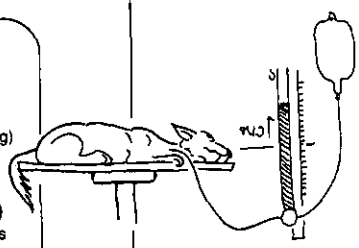


Toxic - Renal failure
CS: PU/PD, dyspnea, vomiting
Dx: ↑ BUN, creatinine
Tx: Renal & concurrent cardiac problems

Prognosis:
• **Guarded:** resolution of uremia may improve ECG abnormalities

Renal hypertension, **Glomerulosclerosis** SAP 496; E-hb 644; H2B 155; IM 478, 489; 5min 875; E 1023; C11T 310; H-F 578; Pys -B 190 ***	• **High arterial blood pressure (BP)** • Identification impeded by technique of determination & wide variation if normal values • **Secondary renal hypertension:** common in dogs & cats • **Renal diz** (cause & effect of hypertension) - 50-90% have hypertension - Glomerular diz (85% have hypertension) - Interstitial/infectious diz - Pyelonephritis - **Chronic renal failure (75% of cases)** - Tumors: renin-producing (RAAS) - Renal arterial diz (arteriosclerosis, thromboembolism) • Cause: mechanism not clear - Activation of renin-angiotensin system (RAAS) - Anemia due to chronic renal failure causes ↑ cardiac output & blood pressure - Na+, H2O retention • Pathogenesis: - Sustained hypertension results in lesions in small arteries & arterioles - Glomerular arteriole scarring (sclerosis) - Affects brain, heart, kidney & eye - Focal & segmental glomerular proliferation & glomerulosclerosis - progressive	• **Renal problems** - PU/PD - ↓ Appetite - Weight loss • **Acute blindness,** hyphema (bloodshot), hemorrhage • Epistaxis • **Hypertrophy** of left ventricle (pressure overload) • CNS: hypertensive encephalopathy: depression, seizures, dementia, (vascular hemorrhage) • **Sequela:** - **Progression of renal failure** - Blindness	• **Often missed** • Hx (chronic renal diz), CS • PE: **Eye:** retinal changes: hemorrhage, papilledma, detachment • Auscultation: systolic & diastolic murmur in cat (mitral regurgitation) & atrial (S4) gallop (ventricular stiffness) - cat • **Lt ventricular hypertrophy** - Radiology, echocardiology & ECG • Proteinuria, azotemia (BUN) • Pressures measurements - Dog: > 180-185 mmHg systolic & > 100 mmHg diastolic - **Cat: >200 mmHg systolic; >100-130 mmHg diastolic** - Direct cannulation of artery - Indirect (inflatable cuffs): Doppler, Oscillometric, few clinics have these	• **Treat underlying dizs** • **Dietary: sodium restriction** (< 40 mg/kg/day) h/d or k/d Hill's diet, poorly accepted by animal, gradual introduction, garlic salt - Control obesity • Drugs - empirical - try for 2-4 weeks - **Diuretics** (furosemide [Lasix®]) - **Propranolol** (Inderal®) or atenolol (Tenormin®) - **Vasodilators** . **Prazosin** (Minipress®) . Hydralazine w/ diuretic & propranolol . Diltiazem . Enalapril (Vasotec®), Benazopril • **Crisis - emergency Tx** - **Acepromazine** IV (alpha blocker) - Nitroprusside (Nipride®) IV • Monitor Tx: - Hypotension: weakness, depression, syncope, acute renal failure . Reduce dosage if CS



DDx - renal hypertension
1° "essential" (rare)
• Secondary:
- **Endocrine**
. **Hyperadrenocorticism** (dog)
. **Hyperthyroidism** (Cats)
. Hypothyroidism (Dogs)
. Hyperparathyroidism (Ca+)
. Pheochromocytoma: catecholamines
. Acromegaly
- Anemia
- Old age
- **CNS disorders**

↑ BP, 2° diz
CS: CNS, Blind, PU/PD
Dx: Eye, Pressure
Tx: Low Na diet, Diuretics, Prazosin, Propranolol

Prognosis:
• **Depends on cause**
• Expect gradual response to Tx: days to weeks

Condition	Facts/Causes	Presentation	Diagnosis	Treatment

Renal 2° hyperparathyroidism (RSHP), Rubber jaw, Renal rickets, Renal osteodystrophy

M8k 835; Mk 835; SAP 230, 806; IM 490, 624; H2B 573, 1281, H3B 513; 5min 698, 204, 1281; E-hb 645, 649; E 1093, 1734; C11T 644, 853, 857; Lab-C 236; Pa-T 272, 439; Sx-S-hb 512; Sx-OP 723; NB16.20

**

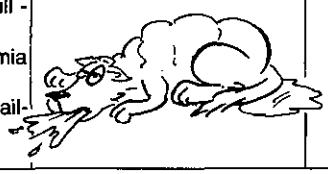
Facts/Causes

- **Can develop 2° to chronic renal failure**, less commonly to acute renal failure
- **Excessive rate of parathyroid hormone (PTH) secretion** in attempt to maintain Ca/P homeostasis
- Pathophysiology:
  - **Hyperphosphatemia** from ↓ renal excretion inhibits conversion of 25-hydroxycholecalciferol to active Vit D (calcitriol)
  - ↓ Vit D = ↓ gut calcium absorption
  - PTH secretion ↑ to maintain serum calcium levels = ↑ mobilization of Ca from bone
    . Generalized osteoporosis, commonly seen in cancellous bones of skull - **"rubber jaw"**
- High phosphatemia + hypercalcemia leads to soft tissue mineralization
  - Exacerbates progression of renal failure

See Endo pg 679 also

Presentation

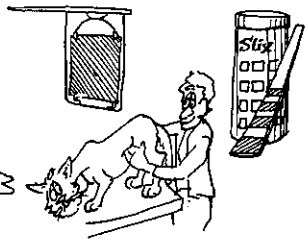
- **GI signs**
  - **PU/PD, vomiting, oral ulcers**
- **Bone demineralization**
  - Osteopenia & potential pathologic fractures
  - "Rubber jaw": replacement of bone by fibrous tissue
- Sequela:
  - Neuropathy
  - Bone marrow suppression
  - Mineralization of soft tissues
  - Myopathy
  - Insulin resistance
  - Pruritus



Diagnosis

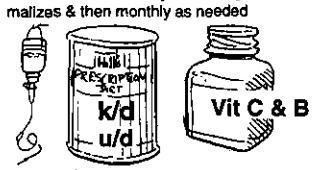
- Hx (history), CS (clinical signs)
- Blood values:
  - **Hyperphosphatemia**
  - Calcium can be normal, ↓ or ↑
  - Azotemia (↑ BUN, creatinine)
  - ± Nonregenerative anemia
  - ↑ PTH + azotemia
  - Cross products Ca x P (normal < 50-70)
- Urinalysis:
  - **Isosthenuria - low SpG**
  - Proteinuria

- Radiology:
  - **Small irregular kidneys**
  - **Soft tissue mineralization**



Treatment

- **CRF therapy: fluids + protein restricted diet (k/d or u/d) + Vit C & B + avoid stress**
- **Hyperphosphatemia**
  - Early: protein-restricted diets are also phosphorus-restricted (k/d)
  - **Intestinal phosphorus binders + dietary restriction**
    . Aluminum hydroxide (ALternaGEL®), aluminum carbonate, calcium carbonate (Tums®, Titralac®), calcium acetate
  - Vit D3 (calcitriol) &/or calcium supplementation cautiously
    . Only when phosphorus reduced or serum calcium x phosphorus < 50-70
- Monitor serum P every 10-14 days until normalizes & then monthly as needed



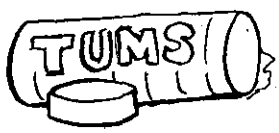
Prognosis: **Poor**

CRF - hyperphosphatemia

Mk 835; SAP 806; IM 490; H2B 574, 1281; E-hb 645; E 1734; C11T 644, 853, 857

***

P+



- Common finding in CRF, parallels BUN
- Can cause renal 2° hyperparathyroidism
  - Renal osteodystrophy
  - Soft tissue mineralization
  - Enhanced progression of CRF

- **CRF therapy**
- **Phosphorus-restricted (k/d)**
- **± Intestinal phosphorus binders + dietary restriction**
  - Aluminum hydroxide (ALternaGEL®), aluminum carbonate, calcium carbonate (Tums®, Titralac®), calcium acetate
- Vit. D3, calcitriol (Rocaltrol®) &/or calcium supplementation cautiously.
  Only when phosphorus reduced or serum calcium x phosphorus < 50-70
- Monitor serum P every 10-14 days until normalizes & then monthly as needed

CRF - GI

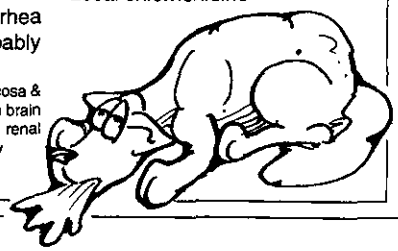
Mk 835; SAP 804; IM 491; H3B 513; H2B 575, 5min 1019; E-hb 643; E 1734

***

Clinical signs

- **Vomiting**
- ± Diarrhea
- **Oral ulcerations**
- Discoloration & necrosis of tongue
- GI hemorrhage
- Cause of vomiting & diarrhea in CRF not clear & probably multifactorial
  - Uremic toxins may alter GI mucosa & trigger chemoreceptor zones in brain
  - High serum gastrin (impaired renal excretion) - gastric hyperacidity
  - Uremic gastric irritability
  - Vascular focal ischemia

- **CRF therapy - fluids + protein-restricted diet (k/d) + Vit C & B + avoid stress**
- **Antiemetic**
  - Trimethobenzamide (Tigan®)
  - **Metoclopramide** (Reglan®) DOC
  - Chlorpromazine (Thorazine®) alpha b lockers on ly if others are ineffective
- **H2 antagonist:** ↓ stomach acid & vomiting, **Cimetidine** (Tagamet®), **Ranitidine** (Zantac®)
- Sucralfate (Carafate®) protects mucosa
- **Oral ulcers**
  - Local chlorhexidine



CRF - hypokalemia

Mk 835; SAP 806, 70; IM 487; H2B 575, 1281; E-hb 645; E 1734

***

- **Occurs in 30% of cats** w/ clinical renal diz & CRF, uncommon in dogs
- Renal loss exceeds intake, fluids for CRF

Presentation/CS

- **Generalized muscle weakness**
  - Drooping, ataxia & ascending paralysis
  - Ventral flexion of neck (cat)
- **PU/PD**
- **Anorexia, lethargy**
- Mild cardiac rhythm disturbances

Treatment:

- CRF therapy: fluids + protein-restricted diet (k/d) + Vit C & B + avoid stress
- **Hypokalemia** < 3.5 mEq/l
  - Oral route safest
  - Potassium supplementation, oral
  - Potassium chloride solutions
  - Potassium elixirs
  - Potassium gluconate powder

CRF - Acidosis

Mk 835; SAP 806; IM 489; H2B 575; E-hb 644; E 1734; C11T 845

***

- Hydrogen ion retention & ↑ bicarbonate loss
  - Protein restricted diet may increase acidosis (↓ renal ammoniagenensis)
  - Acidosis not usually progressive - stabilized by blood (Hg) & bone CaPO4 buffers

Clinical signs:

- Fast breathing
- Anorexia, nausea, vomiting, muscle weakness, lethargy, weight loss

- Treat if blood pH < 7.2 or plasma bicarbonate < 14 mmol/l
- Oral $NaHCO_3$ (baking soda)
  - Adjust dose by blood pH, plasma bicarbonate or total CO_2
  - Goal maintain blood pH >7.2, plasma bicarbonate > 14 mmol/l, & CO_2 > 15 mmol/l
  - May aggravate hypertension or create ionized calcium deficits
  - Discontinue if urine pH ↑ above 7.0 or plasma bicarbonate > 18-20 mEq/l
  - Urine monitoring of pH not recommended

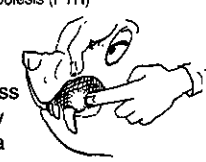
CRF - Anemia **

Mk 835; SAP 806; IM 492; H2B 575; H3B 1019; 5min 1019; E-hb 644; E 1734

- Normocytic, normochromic, nonregenerative anemia (no reticulocytosis)
  - 30-70% of cats w/ CRF
  - Kidney synthesizes erythropoietin, stimulates bone marrow to produce RBCs
- Cause:
  - ↓ erythropoietin (↓ renal mass)
  - Serum inhibitors of erythropoiesis (PTH)
  - Shortened RBC life span
  - GI blood loss

CS:

- Weakness
- Lethargy
- Dyspnea



- **CRF therapy - fluids + protein restricted diet (k/d) + Vit C & B + avoid stress**
- **Nonregenerative anemia:**
  - No Tx if PCV dog > 30%, cat > 25%
  - **Androgens:** weeks to months before benefits seen & benefits minimal at best, promote positive nitrogen balance & Ca deposition in bones & stimulates RBC production
    . **Nandrolone decanoate** (Deca-Durabolin®),
    . Stanozolol (Winstrol®)
    . Oxymetholone (Anadrol®)
  - Recombinant human erythropoietin (r-HuEPO) (Epogen®, Amgen®) to raise PCV if PCV < 20%
    . Effective but expensive in large dogs
    . ± Antibody rejection reaction
  - **Transfusion**: for those w/ CS referable to anemia (weakness, lethargy, dyspnea), raise PCV to ≥ 25%
    . Do if PCV dog <20%, cat <15%

Acute Renal Failure

Condition	Facts/Cause	Presentation/CS	Diagnosis

Acute renal failure, ARF

M8k 1136, 1134; Mk 878; SAP 799; H2B 569; H3B 508, 503; 5min 1016, 572, 640; E-hb 639; IM 482; I2M 614; IM-WW 327; E 1720; CM 455; C12T 943; C11T 829; Sx-S-hb 471; Sx-S 1398; X-T 450; X-Gr 134; NB 21

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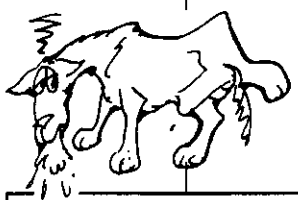
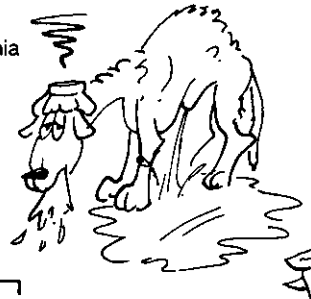


Days - weeks, Reversible, Rx
CS: Oliguria, Dehydration, GI
Dx: < 1.017, BUN
Tx: Tx cause, Fluids, Diuresis

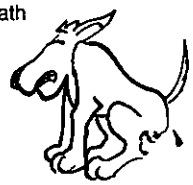
Facts/Cause

- **Rapid deterioration of renal function over days to weeks**
  - **Inability to regulate water, electrolytes, acid-base balance & excrete metabolic wastes**
  - **↓ Glomerular filtration rate (GFR)**
  - **Azotemia**: retention of nitrogenous wastes
- **Reversible or irreversible** depending on degree of damage
- Less common than chronic renal failure
- **Causes - ARF** (see box)
  - **Iatrogenic**
  - Toxins
    - **Ethylene glycol** #1 cause in small animals
    - **Aminoglycoside ABs** (#2)
    - Amphotericin-B (#3)
  - Renal ischemia: uncommon cause
  - Vasculitis
  - Infections
  - Hypercalcemia

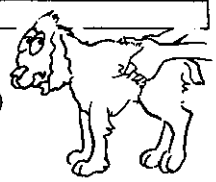


Presentation/CS

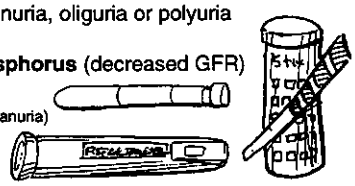
- Anorexia, depression
- **Dehydration**
- **Good flesh & condition** usually
- ± Oral ulcerations
- GI signs
  - Diarrhea
  - **Vomiting**
- Depression
- **Oliguria or anuria**, occasionally polyuric
- Hypothermia
- Fever if infective
- Death



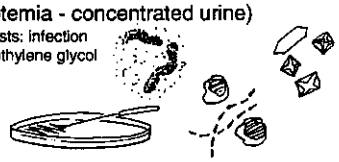
Diagnosis



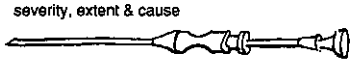
- History (**toxic exposure**)
- Palpation: **renal pain, enlarged kidney**
- Rule out postrenal azotemia (obstruction)
- Differentiate from chronic, because acute is reversible
- Physical exam: nonspecific: dehydration, hypothermia, depression & oral ulcers
  - Palpation: normal or enlarged kidney
  - Monitor urine output for anuria, oliguria or polyuria
- Laboratory:
  - **↑ BUN, creatinine, phosphorus** (decreased GFR)
  - Metabolic acidosis
  - **Hyperkalemia** (if oliguria or anuria)
  - Hypocalcemia (if ethylene glycol)
  - Hypercalcemia (assoc w/ CRF)

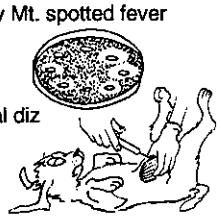


- UA (urine analysis)
  - **SG 1.007-1.017** (isosthenuric) hallmark, inability to concentrate usually (DDx prerenal azotemia - concentrated urine)
  - Casts (tubular pathology), WBC casts: infection
  - Ca oxalate or hippurate crystals - ethylene glycol
  - Proteinuria
  - Glycosuria
  - Pyuria, bacteriuria
  - Darkfield if suspect leptospirosis
  - Urea:creatinine < 0.08



- Urine culture: all cases - by cystocentesis to R/O urinary tract infection
- Serology: if lepto., ehrlichiosis or Rocky Mt. spotted fever
- Radiology:
  - Renal size, radiopaque uroliths
  - Contrast: rupture or obstruction
- Ultrasound: Uroliths, renal parenchymal diz
- **Renal biopsy** m/b necessary to determine severity, extent & cause



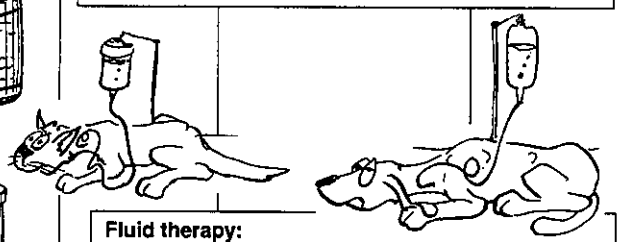


Causes of renal failure

- **Toxins:**
  - **Ethylene glycol** (#1)
  - Carbon tetrachloride, chloroform, pesticides, herbicides, solvents, Vit D_3 toxicity
  - Heavy metals
  - Arsenic: rodenticides, heartworm Tx (thiacetarsamide)
  - Lead, mercury, cadmium, chromium
  - Antibiotics:
    - **Aminoglycoside ABs** (#2)
    - Amphotericin B (#3)
    - Tetracyclines, Cephalosporins, Sulfonamides
  - Pancreatitis: Ischemia tissue toxins
- Anesthetics: methoxyflurane
- Endogenous pigments
  - Hemoglobin
  - Myoglobin
- Iodinated contrast agents
- NSAIDs (nonsteroidal antiinflammatory drugs)
  - Aspirin, Ibuprofen, Phenylbutazone
- Ischemia:
  - Severe dehydration (prerenal)
  - Anesthetic procedures
  - Hypovolemia, hemorrhage, shock (prerenal)
  - DIC, burns, trauma, hyperthermia, hypothermia
  - Hypotension
  - Pancreatitis: Ischemia tissue toxins
- Infectious causes:
  - *Leptospira* spp
  - *Rickettsia rickettsia, Ehrlichia canis*
  - Canine adenovirus type 1
  - Pyelonephritis-causing bacteria
    - *E. coli*, Proteus, Pseudomonas, Staph., etc.
  - Emboli 2° to bacterial endocarditis
- Pyometra
- Hypercalcemia: malignancies (lymphosarcoma or anal sac adenocarcinoma)

Monitoring patient:

- Body weight & hydration BID
- Hematocrit SID
- Serum electrolytes, BUN, creatinine SID
- If severe hyperkalemia or metabolic acidosis as needed
- Fluid in susceptible patients to over hydration (CHF)- CVP &/or "ins & outs"
- Urine output (urinary catheter) in oliguric or anuric



Fluid therapy:

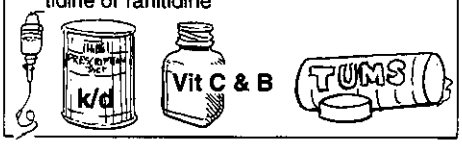
- For all: **Lactated Ringer's** unless hyperkalemia then 0.9% NaCl
- **% dehydrated X Body weight (kg) X 1000**
  - Maintenance 7-14 days, alternate lactated Ringer's w/ 5% dextrose to avoid hypernatremia
  - Taper off once BUN & creatinine normal or oral fluids tolerated w/o vomiting
  - Monitor urine production (over hydration)
  - Na bicarbonate (acidosis) 1/4 tsp/5kg BW PO
- **Tx hyperkalemia:** if serum levels > 8 mEq/l or signs of cardiotoxicity (tall peaked T waves, widened QRS complexes, prolonged PR intervals, absent P waves, ventricular arrhythmias)
  - **Na bicarbonate** (to push K+ into cells)
  - Dextrose 20% stimulates insulin release
  - Calcium gluconate 10% to antagonize cardiotoxic effect, stop if progressive bradycardia
- Tx hypokalemia (may occur especially in diuretic phase)
  - Potassium Cl (Kaon®, KayCiel®)
- Acid base imbalance: most corrected by fluid therapy if pH > 7.15
  - Bicarbonate if pH < 7.15

TREATMENT - ARF

- **Supportive to allow repair**
- **Tx cause** (**if known**)
  - Stop any nephrotoxic drugs
    - Emesis or gastric lavage if ingested toxins - recent
    - Activated charcoal & sodium sulfate
  - ABs for infections
  - Ethylene glycol: **Ethanol 20%** , 4-methylpyrazole, ± Diuretics &/or NaHCO3 may be indicated
  - Arsenic: **Dimercaprol (BAL®)**

- **Fluid: Lactated Ringer's** for all until stabilizes
  - Monitor for hyperkalemia, hypokalemia or acidosis
- **Diuresis**: promote urine flow if less than 20 ml/kg/d
  - Fluids, if doesn't improve then:
  - Volume expanders
  - Furosemide (Lasix®)
  - Osmotic diuresis (glucose, dextrose or mannitol)
  - Renal vasodilators (dopamine) increases GFR

- **Failure to establish urination**
  - Euthanasia or $$ peritoneal dialysis or hemodialysis
- **Tx renal insufficiency**
  - **Unlimited access to water**
  - **Diet**: restrict protein & phosphorus & Na: **k/d** (Hill's)
  - Vit B & C
  - $NaHCO_3$ (baking soda) - ↓ acidosis
  - ± Phosphate binders (aluminum hydroxide [Tums®])
  - ± H2 blockers for gastric hyperacidity: Cimetidine or ranitidine

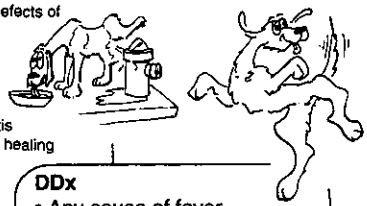


Prognosis: Overall poor

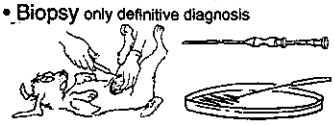
- Fair to good if survive initial insult, may take weeks to regenerate
- Sooner Tx better prognosis so monitor those receiving nephrotoxic drugs

Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Pyelonephritis, **Chronic interstitial nephritis?,** **Upper urinary tract infection** M8k 1133; Mk 873; E-hb 589; SAP 807, 562; H2B 562; H3B 500; 5min 994; IM 494; IM-WW 328, 339; E 1775; CM 456, 479; DDx 554; Sx-S 1437; X-Gr 134; Pa-T 234 ***	• **Inflammation of kidney (interstitium) & renal pelvis** - Term often used for bacterial infection of kidney • Unilateral or bilateral, chronic >> acute • Incidence dogs: 6-25% > cats: 10% • Caused by pyogenic bacteria: Staph, Strep., *E. coli*, Proteus, Klebsiella, Pseudomonas sp., Enterobacteria, Pasteurella sp. - **Ascend from urinary bladder up ureters** or periureteral lymphatics **#1** - Hematogenous (uncommon, septicemia, periodontal diz, bacterial endocarditis, diskospondylitis) - Direct extension from adjacent infection • Predisposing factors - Urinary stasis - Micturition disorders - Acquired or congenital defects of bladder wall - Urolithiasis - Immunosuppression - Diabetes mellitus - Hyperadrenocorticism - Infectious canine hepatitis • Suppurative necrosis with healing by replacement fibrosis	• **Acute:** - **Fever** - Anorexia, Depression - Vomiting - **Arched back** - lumbar pain - Dehydration - PU/PD • **Chronic pyelonephritis:** - **Subclinical often** - Nonspecific (weight loss, anorexia, PU/PD) • Lower urinary tract signs - Pollakiuria (frequent), stranguria, dysuria • Discolored or malodorous urine • Sequela: Acute or chronic renal failure	• **Difficult to differentiate from lower urinary tract infection** • Hx, CS • Palpation: **Acute: painful** &/or enlarged kidneys - Chronic: nonpainful, small/normal kidneys • Blood values: - **± Leukocytosis** (PMNs w/ left shift) - acute - ± Anemia in chronic & RF - ± Azotemia (increased BUN, creatinine) & increased phosphorus if renal insufficiency - Rule out systemic diz (DM or Cushing's) • Urinalysis (cystocentesis) - **Pyuria** (>6 WBC/hpf [high powered field]) - Proteinuria - **± WBC casts (pathognomonic)**, granular casts - **± Bacteriuria** - SpG may be low - Normal urinalysis doesn't R/O infection • **Urine culture** - preferably cystocentesis - Positive indicates infection - doesn't localize - Cystocentesis: > 0 (10^3 indicates infection) - Catheterization > 10^5 indicates infection • **Radiographs:** - **Plain films** - normal or slightly enlarged . Chronic - ± smaller & irregular in outline - **Contrast intravenous urogram** . ± Distorted or irregular diverticuli (calyces) . ± Retention of contrast in pelvis • Biopsy only definitive diagnosis	• **Antibiotics for minimum of 4 wks** (based on culture & sensitivity) - Broad spectrum in absence of culture, guesses possible from gram stains: . Ampicillin, amoxicillin, trimethoprim/sulfas, cephalosporins, chloramphenicol, aminoglycosides, fluoroquinolones .. *E. coli*, Enterobacter - trimethoprim-sulfa .. Proteus, Staph., Strep - ampicillin .. Klebsiella - cephalosporins .. Pseudomonas - tetracycline . Gram positive: ampicillin/amoxicillin . Gram negative: trimethoprim-sulfa, enrofloxacin (Baytril®) - Re-culture in 3-5 days & continue same drug or change depending on culture, Re-culture in a further 3-5 days - **Re-culture** 5-7 days after antibiotics stopped . If + look for predisposing causes & treat it .Reinstitute antibiotics for **6-8 weeks** (preferably another antibiotic) - Re-culture after 2-8 weeks . If positive: broad spectrum ABs **1/4** dose sid at night for **4-6 months** . Re-culture - m/ need lifelong therapy • **Induction of polyuria** to flush bacteria - High-salt diet **Hi Salt** - Diuretics - Animal bouillon, broth, etc. to encourage drinking • Adjust urine pH for Antibiotics - Acid urine (ammonium chloride): penicillin, carbenicillin, tetracycline, nitrofurazone - Alkaline: aminoglycosides, erythromycin - Not needed: chloramphenicol, sulfonamides, cephalosporins • If renal failure treat (fluids, diet, etc.) **Prognosis: Guarded** ABs

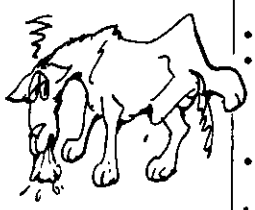
Ascending
CS: fever, pain, PU/PD
Dx: CS, PE, Pyuria, Rads
Tx: ABs min 4 weeks

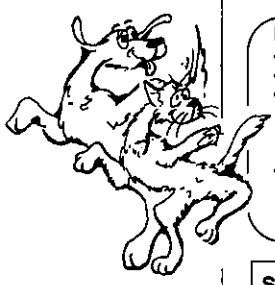


DDx
- Any cause of fever
- Any cause of leukocytosis
- Any cause of acute abdomen
- Lower urinary tract infection
- Nephro- or ureterolithiasis



Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Leptospirosis, **Interstitial nephritis** M8k 1134; Mk 874; E-hb 186, 516; SAP 128; H2B 1207, 561, 910; H3B 498; 5min 768, 142; IM 417; CM 456; C11T 829; NS-L 84, DDx 553 **	• **Bacterial diz of dogs & humans** - **Cats: clinical diz not seen** - Public health - **zoonosis** • *Leptospira interrogans*: all pathogens - *L. icterohaemorrhagiae* - *L. canicola* - *L. grippotyphosa* • Filamentous, motile spirochete • Spread in **urine**: months - years - Penetrates skin or mucosa - Wild animal reservoir (rodents) - Leptospiremia in 4-12 days • **Targets kidney (chronic interstitial nephritis) & liver** • ± DIC (disseminated vascular coagulation) • Latent or acute • Endemic areas	• **Subclinical in vaccinated dogs & all cats** • **Peracute** - Fever, myalgia, vomiting - Shock, vascular collapse - Bleeding diathesis - Death • **Acute to subacute** - Fever, anorexia - Depression - Vomiting, dehydration - Reluctance to move (pain: kidneys, muscle or meningitis) . **Stiff gait** w/ severe muscle or lumbar pain - Acute renal failure . **Oliguria or anuria** - **Icterus** - Petechial & ecchymotic hemorrhages (melena, hematemesis, epistaxis, hemorrhagic gastroenteritis) • Occasional manifestations - Abortion or stillbirths - Uveitis (immunologic) - Meningitis • **Chronic (most cases)** - Fever, anterior uveitis - Anorexia, weight loss - Frequently subclinical • **Sequela** - **Chronic renal failure** . PU/PD . Stomatitis	• Hx, CS • **Serology in conjunction w/ CS** • Physical exam: congested mucosa • Blood values - Leukocytosis (PMNs w/ left shift) - ± Thrombocytopenia, fibrinogen products - Azotemia - ↑ BUN & creatinine . Hyperphosphatemia - ↑ liver enzymes (ALT, AST, LDH) & bilirubin - Electrolyte imbalances • UA (urinalysis) - Proteinuria - Pyuria - Cylindruria (granular casts) - Bilirubinuria (liver) - **Isosthenuria** (SpG 1.010) - Microscope - leptospires (darkfield) • Serology: - **Microscopic agglutination test (MA)** . 4-fold ↑ in paired sera . Single titers: 1:1000 highly indicative • Urine or blood culture: definitive but difficult to do & to identify so use serology w/ CS • Histo of silver-stained biopsy of kidney or liver	• **Antibiotics (ABs)** - **Penicillin** G IM, SQ BID - 2-4 wks for acute infections - Dihydrostreptomycin or Doxycycline 4-6 wks (once nonazotemic) to eliminate carrier state • **Supportive Tx** - Fluids: shock, dehydration, renal failure - Rehydrate & establish urine flow, Lasix® anuria/oliguria - DIC: blood transfusion • Monitor renal function • Immunize after recovery • Zoonotic - shed in urine therefore good hygiene (Betadine®) Prevention: • **Vaccination:** 9, 12, 15 wks of age (3 doses required) - Revaccinate annually (endemic areas every 4-6 months) **Prognosis:** • **Guarded** if severe, renal & hepatic damage may be permanent

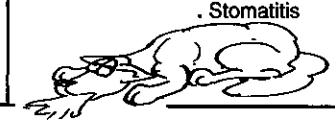


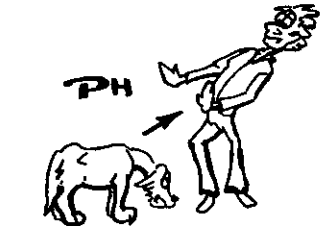


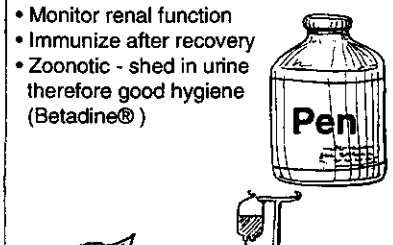
DDx:
- Other causes of anterior uveitis
- Other causes of persistent fever
- Other causes of acute renal failure
  - Ethylene glycol toxicity
  - Pyelonephritis
  - Toxins
- Other causes of acute hepatitis
  - Infectious canine hepatitis
  - Toxins
  - Bacterial infections

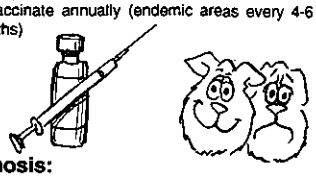
See pg 92, 592 & 695 also

Spirochete, Urine
CS: Renal CS, bleeding, fever
Dx: CS, Serology (MA)
Tx: Pen G, Dihydrostreptomycin









Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Ethylene glycol, Antifreeze toxicity JAVMA 205(4) p5571994, M8k 2035; E-hb 162; SAP 803;H3B 1274; H2B 1330, 566; 5min 572; IM 482, 756; IM-WW 330; E 317; CM 456; Cat 240; Tox 49, 54, 398; Tox-WW 317, 59, 60t; NB 20.15 **	• **Relatively common** • **Car radiator antifreeze** - Fall & spring when radiators are drained - **Tastes sweet!** Some pets like - Newer types of antifreeze non-toxic • 5 tablespoons (dog), 1 tbsp (cat) of 50% radiator fluid can be lethal • Oxidized by liver alcohol dehydrogenase - Severe renal tubule necrosis . Azotemia in 36-72 hours (dog), 12-24 hrs (cat) . Ca oxalate crystals may form in kidney	• **Acute (< 12 hrs) stage 1** - **Like alcohol intoxication** - Trembling or convulsions - Vomiting, nausea - Anorexia - PU/PD - Labored breathing (hyperpnea) - Dehydration - Ataxia - Depression - Coma/Death (if enough) - Renal pain • Stage 2: 12-24 hours - Nondescript - seems to be recovering • Stage 3: 24-72 hours - **Renal signs** (uremia) . Severe depression . Oliguria/anuria . Anorexia & vomiting . Oral ulcers (common) . Death from RF & acidosis • Sequela: **Acute renal failure**	• **Hx (antifreeze)**, CS • Urinalysis - Proteinuria - **Ca oxalate** crystals - Hematuria - Isosthenuric (1.010) • Blood values: - ↑ BUN, creatinine & phosphorus hyperglycemia, hypocalcemia - Hypo- to normochloremic metabolic acidosis w/ ↑ anion gap - Stress leukogram • Ultrasound: hyperechoic kidney - dystrophic calcification • Necropsy: birefringent crystals on impression smears of kidney - polarized light **DDx:** • Other causes of acute renal failure • Ketoacidotic diabetes mellitus • Pancreatitis • Gastroenteritis • Garbage intoxication • CNS disorders	• **Medical emergency** • If w/in 6 hours - Induce emesis, gastric lavage - Activated charcoal • **20% Ethanol IV** (vodka or the like) w/in 24 hours • ***4-methylpyrazole** (4-MP): alcohol dehydrogenase (ADH) Inhibitor, doesn't depress CNS like ethanol • Thiamine & pyridoxine helps convert to non-toxic metabolites • Supportive care: - Fluids & electrolytes to maintain urine output - Bicarbonate - ± Diuretics if well hydrated for urine output - Consider peritoneal dialysis if in renal failure Prevention: • Use new antifreezes that don't contain ethylene glycol • Proper disposal of ethylene glycol Prognosis: • **Poor if renal failure** * 4-MP can be obtained from Aldrich chemical Co., Milwaukee, WI

Antifreeze - deadly
CS: Drunk, Uremia
Dx: Hx, CS, UA (oxalate crystals)
Tx: Emergency: 20% Ethanol IV , 4-methylpyrazole

Arsenic
*

See Tox pg 735: Rare, Sources: farm products (ant poisons, herbicides, insecticides) & heartworm medication; Inhibit cellular respiration
CS: **Acute - Oliguria**, depression, vomiting, nausea, whining & abdominal pain, bloody diarrhea, ataxia, paralysis - coma - death
Sequela: Shock, **Renal failure**
Dx: **Hx, CS**, Lab, Necropsy
Tx: Emesis, lavage, charcoal early; Fluid; **BAL®**
Px: Poor to guarded for acute toxicosis

Aminoglycoside toxicity
**
Gentamicin

See Tox pg 726: Broad spectrum ABs; Nephrotoxicity major concern
CS: **Nephrotoxicity - nonoliguric renal failure:** PU/PD, uremia
- Ototoxicity: peripheral vestibular signs: ataxia, incoordination, nystagmus
Dx: Hx, CS, **UA**
Tx: **Stop Rx, Tx renal failure**

Capillaria, Capillariasis
M8k 1134; E-hb 668, SAP 815; H2B 564; H3B 502; 5min 414, 30; DDx 557; Pa-T 237
*

- **Rare** parasite of urinary tract: raccoon & fox > cat & dog
- High rate of infection may occur in kennels on grass or soil surfaces
- *Capillaria plica*: dog
- *C. feliscati*: rare in USA, high prevalence in Australia
- Earthworm paratenic host

- **Asymptomatic** usually
- Heavy infection
  - Dysuria from cystitis
  - Hematuria

- **Ovoid operculated egg** in urinary sediment

DDx:
- Other causes of cystitis & hematuria
- Respiratory capillariasis
- *Trichuris vulpis* (larger egg)

- **Tx not always needed**
  - Spontaneous loss of parasite in 12 weeks
- Fenbendazole, Ivermectin (not in collies), Albendazole

Prognosis:
- **Good:** spontaneous remission often

Rare
CS: asymptomatic
Dx: Operculated egg
Tx: ? - Ivermectin

Dioctophyma renale, **Giant kidney worm**
M8k 1134; Mk 874; SAP 815; CM 466; H2B 563; H3B 502; Sx-G 221; Sx3B 367; Sx-S-hb 483; Sx-S 1437; DDx 555; Pa-T 237
*

- **Very rare kidney worm, Large** - up to 1 m
- Dog, cats (resistant) & other mammals
  - Mink principal definitive host

Transmission: injection of larvae or paratenic host (usually fish/catfish) w/ encysted larvae
Found: usually abdominal cavity or pelvis of the kidney, may also be found in urethra or urinary bladder

- **Asymptomatic** usually
- No renal failure if unilateral

- Sequela:
  - Peritonitis & adhesions
    . Abdominal distention

- **Ova** in urine or abdominal fluid
  - Double operculated egg (brownish) in urine sediment or peritoneal fluid

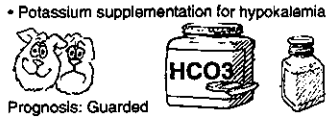
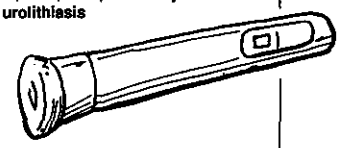
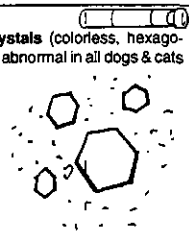
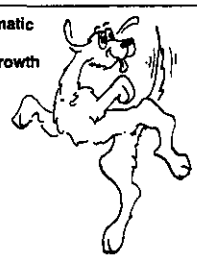
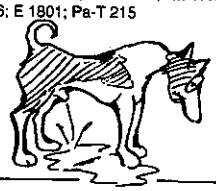
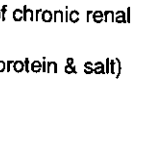
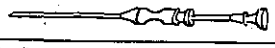
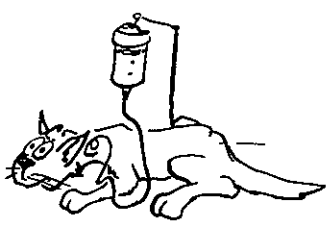
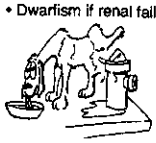
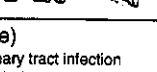
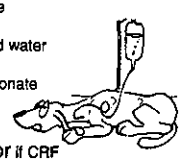
Exploratory surgery or necropsy
- ± Peripheral eosinophilia
- ± Hematuria

- **No medical Tx effective**
- Nephrectomy or nephrotomy
- Exploratory surgery if peritonitis - remove worms

Prevention: block access to raw fish

Prognosis:
- Good if isolated to 1 kidney
- Guarded to peritonitis

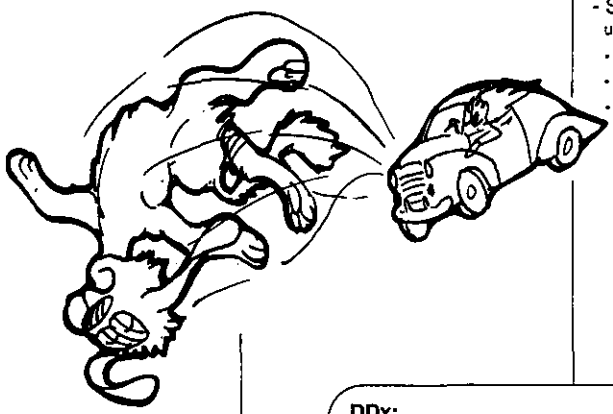
Very rare - large

Condition	Facts/Cause	Presentation	Diagnosis	Treatment
Renal tubular acidosis, RTA M8k 1139; Mk 882; E-hb 665; SAP 811; H2B 564; 5min 1020; IM-WW 337; E 1802 *	• **Rare** • Proximal RTA (type II): bicarbonate washout, part of Fanconi's syndrome in certain breeds & reported in gentamicin toxicity • Distal RTA (type I): inability to secrete hydrogen ions & produce acid urine - Reported in 1 cat w/ pyelonephritis & 1 cat w/ hepatic lipidosis	• **PU/PD** • **Anorexia** • **Lethargy** **DDx:** • Urease + infections 	• Blood values: hypokalemia, hyperchloremia, **metabolic acidosis** w/ a normal anion gap hallmark • UA: isosthenuria, pH > 6.0 in distal (type 1) RTA, pH <5.5 in proximal (type 2) RTA • Sodium bicarbonate infusion to differentiate proximal from distal RTA - Proximal RTA - ↑ urine pH - Distal RTA no increase	• **Treat cause if known** • Sodium bicarbonate or potassium citrate to control acidemia • Potassium supplementation for hypokalemia  Prognosis: Guarded
Cystinuria E-hb 665; SAP 812; H2B 564; IM-WW 337; E 1803; Pa-T 215 * 	• **Defect in tubular transport of amino acid cystine** • **Dachshund** & English bulldogs • **All males**	• **Stranguria, dysuria** • **Hematuria** Sequela: predisposes to **cystine urolithiasis** 	• Hx, CS • UA: **cystine crystals** (colorless, hexagonal), considered abnormal in all dogs & cats 	• Cystine urolithiasis: **surgically** remove • Medical dissolution of crystals - **u/d Hill's diet** - Alkalinize urine: potassium citrate or Na bicarbonate - D-penicillamine or MPG • Sx for those that obstruct or don't dissolve Prevention: u/d diet, potassium citrate, D-penicillamine & don't breed males Prognosis: **Guarded**
Nephrogenic diabetes insipidus, NDI *	**See pg 378: Renal tubules nonresponsive-ness to ADH;** Congenital (rare); Acquired: Renal & metabolic disorders CS: **PD/PU**, Nocturia, Distended abdomen Dx: Hx (no brain trauma), **Urine SpG: 1.001–1.006;** Water deprivation + ADH tests little response < **1.025** Tx: Acquired - **Tx predisposing cause (reverses), Unlimited water supply** Congenital (rare): Unlimited water, Low sodium & protein diet, Chlorothiazide (Diuril®) diuretics			
Primary renal glucosuria * M8k 1139; Mk 881; SAP 812; H2B 564; IM-WW 337; E 1801; 2027; Pa-T 215 	• **Benign condition** • Defective proximal tubular transport of glucose, enzymatic defect in active glucose resorption • **Norwegian Elkhound** predisposed, seen in other breeds, Scottish terriers & mixed breeds	• **Asymptomatic** • **PU/PD** • **Stunted growth** 	• Hx & physical: ± signs compatible w/ cystitis • Blood values: normal fasting blood glucose - Normal or below normal glucose tolerance test • UA: **Persistent glycosuria** - ± Evidence of urinary tract infection - High urine specific gravity 	• **Benign condition, no treatment required** Prognosis: **Good**
Fanconi's syndrome, **Renal glucosuria** M8k 1139; Mk 881; E-hb 665; SAP 812; H2B 564; 5min 582; IM-WW 336; E 1801; Pa-T 215 * 	• **Multiple renal tubular defects** in transport of H2O, glucose, PO4, Na, K, amino acids & HCO3. Results in **glucosuria,** aminoaciduria & phosphaturia • Cause: believed to be inherited - Reported in dogs treated w/ gentamicin & streptozotocin (acquired) • Breeds: **Basenji**, Norwegian elkhound, Shetland Sheepdog, Schnauzer • 1–6 years • Progressive to renal failure or papillary necrosis	• **PD/PU** • Weight loss • **May develop uremia & die** • Sequelae: - Chronic renal failure - Papillary necrosis	• Hx (breed), CS • UA: Low urine specific gravity: 1.001- 1.018 - **Persistent glycosuria** • Blood values - **Normal blood glucose** - ± Hypophosphatemia - Hypokalemia • Renal clearance test: excessive loss of protein, amino acids, glucose, bicarbonate, phosphate & potassium 	• **Bicarbonate** as needed to control acidosis, maintain 12-18 mEq/l of HCO3 • ABs for urinary tract infections • **Potassium** if hypokalemic (maintain 3.5-5.5 mEq/L • **Tx: chronic renal failure** • Free choice water  • Monitor for acidosis, hypokalemia or declining renal function Prognosis: **Poor**: progressive to chronic renal failure or papillary necrosis
	Multiple renal tubular defects - glucose; Basenji Tx: HCO3 • Px: Poor		**DDx:** • 1° renal glucosuria	
Congenital renal disorders M8k 1130; Mk 871; H2B 559; 5min 1014; E 1794; C12T 977; Sx-WW 154; Sx-S 1428; Pa-T 213 ** 	• **Uncommon**, Cause: unknown • Predisposing factors: - Infectious diz, stress during pregnancy, environmental chemical, drugs & inborn errors of metabolism - Hereditary suspected	• **Chronic renal failure** • **PU/PD**, precedes signs of uremia • Dwarfing if onset of renal failure occurs w/ in 1st few months of life • **Severe renal failure at 6 mo to 2 yrs**	• Hx (**young**), CS (CRF) • Urinalysis to R/O urinary tract infection - ↓ SpG - isosthenuric (1.010) - ± Glycosuria, proteinuria & hematuria • **Radiology**, plain films - Agenesis, other enlarged, compensatory hypertrophy - Dysplasia or hypoplasia: both kidneys smaller than normal - Polycystic renal diz: both kidneys usually enlarged & irregular • Contrast intravenous urogram - Size, shape & # of functional kidneys - Visualize collecting system (diverticuli, pelvis & ureters) • Ultrasound • Renal biopsy 	• **No definitive Tx** • Symptomatic Tx of chronic renal failure - Fluids, diet (low protein & salt)  Prognosis: **Poor** if chronic renal failure (CRF)
	Congenital renal disorders • **Agenesis/aplasia**: complete failure of formation, unilateral or dead, relatively common in cat, rare in dog, incidental finding • **Renal hypoplasia**: see below: partial failure of formation • **Ectopic renal location**: pelvic or caudal abdominal kidney • **Horseshoe kidney/ring kidney**: fusion of embryonic kidneys • **Renal duplication**: double kidneys • **Polycystic kidney diz**:see pg 356 - Persians & other LH cats, cairn terrier • **Amyloidosis**: see pg 361 - disposition of glycoprotein • **Renal telangiectasia**: Pembroke corgi 			
Renal cortical hypoplasia/ dysplasia M8k 1130; Mk 872; H2B 559; Sx-WW 157 ** 	• Young animal, peaks at 12 months • Breeds: Lhasa apso, Shih Tzu, Cocker, Dachshund, Norwegian Elkhound, Ger. shepherd, Pekingese • No sex predilection • Inherited or congenital, aplastic or hypoplastic • Acquired causes: chronic generalized renal diz (amyloidosis, pyelonephritis, glomerulonephritis)	• **PU/PD** • **Uremia** • Dwarfism if renal failure early in life 	• Hx (breed & age) • Urinalysis to R/O urinary tract infection - ↓ SpG - isosthenuric (1.010) • Blood values - ↑ BUN & Creatinine - Anemia - Metabolic acidosis • Radiology: both kidneys small • Ultrasound • Renal biopsy to confirm: fibrous 	• **Tx as for CRF** (chronic renal failure) • Mange but no cure - Low protein diet - Fluids - unlimited water - Vit B & C - ± Sodium bicarbonate  Prognosis: **Poor** if CRF

Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Renal cysts; Polycystic kidneys, Congenital cystic kidneys M8k 1130; Mk 872; E-hb 683; SAP 813; H2B 560; 5min 964; Sx-WW 157; Sx-G 226; Sx-B 367; X-Gr 134; X-RP 179; Pa-T 214 **	• **Dilated nephron segments**, single or multiple (polycystic) - May involve glomerular capsule or any part of renal tubules • **Congenital polycystic diz** - Cairn terriers, long-haired cats, Persians • **Acquired cystic diz**: more common, develops from any type of chronic renal diz • Unilateral or bilateral • Pyelonephritis common finding	• **Hereditary** - Normal at birth - **Abdominal enlargement** (renomegaly) 2-6 weeks - Most kittens died of uremia • **Acquired cystic disorders** - Little clinical significance unless enlarge or become infected - Abdominal enlargement - Pain (rupture, hemorrhage or infection) - Fever (infection) • **Asymptomatic** if solitary or multiple cyst that don't enlarge • **± Progressive renal diz** - Vomiting, anorexia, weight loss, PU/PD	• Hx, CS • Palpation: abdominal mass (kidney), nonpainful • Laboratory - Leukocytosis, pyuria, hematuria, proteinuria if infected - ± ↑ PCV in long-haired cats - ± ↑ BUN, creatinine & phosphate if RF • Urine culture for infection • Radiology: plain . Enlarged & irregular kidney . Solitary cysts smooth enlargement of 1 part of kidney - **Contrast radiographs: IV urogram** . Radiolucent filling defect during nephrogram phase . Renal pelvis normal or distorted depending on size & location of cyst • Exploratory laparotomy • **Ultrasound to diagnose & differentiate from neoplasm** • Aspiration biopsy to confirm fluid-filled	• **None if not infected** • Polycystic diz progressive & no specific therapy • **Infection**: problem getting antibiotic into cyst - Chloramphenicol, clindamycin, erythromycin, tetracyclines, trimethoprim better - Ampicillin & aminoglycosides poor • Treat RF if present: fluids & diet • Nephrectomy if unilateral & other kidney confirmed to be functional Prognosis: • Poor for bilateral progressive polycystic diz • Good for unilateral nonprogressive diz
Feline perirenal pseudocysts, Capsular hydronephrosis M8k 1131; SAP 813; H2B 560; H3B 479; 5min 932; Sx-S 1438 *	• **Rare** • Accumulation of fluid external to renal parenchyma (between parenchyma & capsule or outside capsule) • 5 reported cats, all male, > 8 years old • Cause: unknown • Not true cysts (not lined w/ epithelium) **DDx:** • Other causes of renomegaly - Neoplasia - Hydronephrosis - Congenital cysts • Other causes of cranial abdominal or retroperitoneal masses	• **Progressive abdominal enlargement** only sign	• Hx, CS (abdominal enlargement) • Palpation: nonpainful mass in region of kidney • Renal tests & urinalysis normal • **Radiographs:** - Large, fluid-filled mass in kidney region - Urogram (kidney in fluid-filled structure) • **Ultrasound:** fluid-filled mass next to kidney • Fluid aspiration (transudate)	• **Surgical drainage** & resection of cyst wall Prognosis: Good after surgery

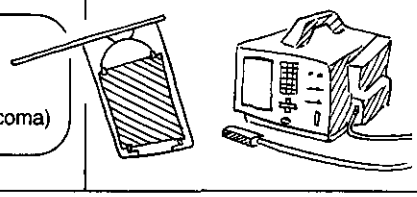
Ureteral obstruction, Acute hydronephrosis, Obstructive uropathy Mk 879; E-hb 687; SAP 819, 823; H2B 606, 572, 579, 588; H3B 528; 5min 688; CM 461; Sx-WW 162; Sx-S 1435, 1448; Sx-B 369; Sx-G 222, 230; X-Gr 134; X-RP 178; X-T 453, 450; Pa-T 236 ** **Obstruction - pressure atrophy** **CS: Asymptomatic, pain ARF** **Dx: Urogram** **Tx: Unblock**	• **Dilation of renal pelvis associated with atrophy & cystic enlargement of kidneys** • Pathophysiology: - Partial or complete **obstruction** of ureter - Urine retention = ↑ pressure - **Dilation** of renal pelvis & **atrophy** of renal parenchyma - Accumulation of waste products - Bilateral destruction before big change - uremia & death - Unilateral: no signs for long period of time if unaffected kidney functional - If bilateral dies before atrophy of kidney **Hydronephrosis: causes** • Acquired causes - Urinary calculi - Neoplasia - *Dioctophyma renale* - Accidental ligation of ureter when spaying - Inflammation & stricture of ureter or urethra - Extraurinary lesions: abdominal masses - Blood clot • Congenital causes - Ectopic ureter - Torsion or kinking of ureter due to displacement of kidney - Stenosis or atresia of urethra - Aberrant renal vessels	• **Asymptomatic** if unilateral • Early signs may be related to cause • Fever • ± Uremia CS • **Pain** • **Acute renal failure** - Vomiting - Dehydration - Hypothermia - Severe depression • Stranguria, Dysuria • ± Hematuria • Abdominal pain • **Renal failure, rapidly** • Sequela: purulent nephritis	• Hx, CS • Palpation for pain • **Unilateral goes undiagnosed** unless palpated, due to compensation • Serum potassium, if arrhythmias • ECG give presumptive Dx of **hyperkalemia**, bradycardia, peaked T waves, ↑ P-R interval, widened QRS complex, atrial standstill • Plain films: enlarged, but initially m/ appear normal - Contrast (intravenous urogram) . **Renal pelvis dilated & distorted.** M/b only cortical rim of renal tissue • Ultrasound • Exploratory on radiographic evidence	• **Treat primary cause** • **Remove obstruction** • **IV fluids**, Normal saline, Sodium bicarb added to correct acidosis & hyperkalemia • **Dextrose or insulin** + dextrose: if severe hyperkalemia & arrhythmias to drive potassium into cells • Monitor serum electrolytes, body weight, urine output, PCV to adjust fluids • **Unilateral nephrectomy** often required (check other kidney first!) Insulin Prognosis: • Poor if bilateral • Kidney damage reversible if corrected in < 1 week
Ureteral tumors M8k 1137; H2B 591; SAP 919; E 1799; Sx-G 232; X-Gr 134 *	• **Malignant: Leiomyosarcoma** - Extension of bladder or prostatic tumors . Transitional cell carcinoma . Squamous cell carcinoma . Adenocarcinoma . Rhabdomyosarcoma • **Benign tumors: Leiomyoma**	• **Asymptomatic** • ± Persistent or recurrent hematuria • ± Vague abdominal pain • Sequela: Hydronephrosis (obstruction) - Abdominal distention	• Physical exam: enlarged kidney, pain • Urinalysis: hematuria, 2° Pyuria & bacteriuria, ± neoplastic cells • Radiography: renomegaly, ureteral mass - Contrast excretory urography: hydronephrosis/obstruction - Chest radiographs for metastasis • Ultrasound: ± hydronephrosis • Exploratory laparotomy	• **Surgical excision** of tumor or ureterotomy & nephrotomy (TOC) - Monitor renal function tests at 1,3,5 & 30 days after Sx, is remaining kidney functional? - Monitor for metastasis at 3 & 6 months Prognosis: Poor for transitional cell carcinomas • Guarded for other tumors

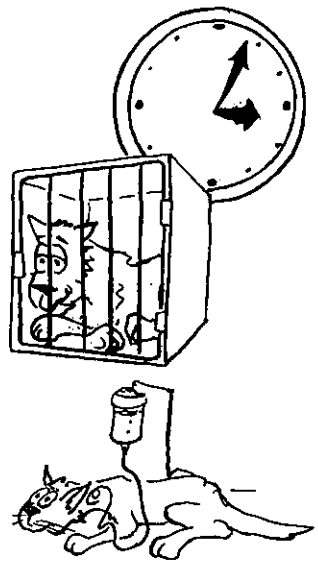
Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Renal/ureteral trauma H2B 581; 592; H3B 522; CM 491; SAP 817; Sx-WW 158; Sx-S 1430; DDx 554 **	• **Usually mild, inapparent & self-limiting** • Causes: - Contusion from blunt trauma (HBC [hit by car] & falls) - Laceration & hematoma - Avulsion or vascular pedicle (uncommon, but severe) - Penetrating wounds (gunshot, fights)	• **CS of body trauma** • Renal SC usually mild & self-limiting • **Hematuria** • Pain • Sequela: - Retroperitoneal space - blood & urine . Cellulitis & pain - Sterile peritonitis uroperitoneum) . Abdominal discomfort . Fever . Uremia (urine in abdomen) .. Abdominal enlargement & pain	• Hx (HBC), CS (hematuria) • Palpation for high sublumbar abdominal pain • Blood values: ± Azotemia • Urinalysis: - **Hematuria** - RBC casts • Abdominocentesis - ± Urine - creatine > 2 x serum (initially) • Radiography: - ± Blood or urine - retroperitoneal . Asymmetry, displacement obscure renal shadow . ± Displaced colon - Peritonitis: "ground glass", loss of detail to abdomen - **Excretory urography:** . Extravasation of contrast if rupture of parenchyma, pelvis or ureters . ± Contrast under renal capsule - parenchymal injury w/ intact capsule . ± Nonvisualization of kidney if avulsion of renal vessels • Ultrasound	• **Usually mild & self-limiting** - Correct shock: fluids & support • Surgery considered if uroabdomen or crushing injury - Laceration of capsule or parenchyma - Partial nephrectomy if injury only at pole - Nephrectomy (check function of other kidney first!) Prognosis: • **Good** if mild, or if other kidney ok & nephrotomy



Mild: self-limiting, HBC
CS: Hematuria
Dx: Hx, CS, Rads, US
Tx: Support

DDx:
• Trauma to back
• Urinary tract trauma
• Other retroperitoneal dizs (hemangiosarcoma)

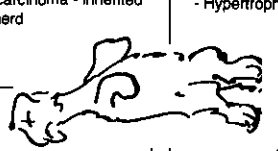




Renal neoplasia, Kidney cancer/ tumor

M8k 1140; Mk 882; E-hb 660; SAP 816, 823; H2B 580; H3B 520; 5min 330; IM-WW 354; IM-WW 354; E 1788; C11T 919; CM 463; Sx-WW 159; Sx-B 367; Sx-S 1440; X-Gr 134; X-RP 178; Pa-T 239; DDx 555
*

• **Rare - 2% of all dog tumors**
• **Metastatic tumors** > 1° renal tumors
- Kidneys likely location for metastatic carcinomas & sarcomas due to large blood volume & abundant supply of capillaries
• **Most 1° renal tumors are malignant**
- Can effect any tissue component
• Benign renal tumor: very rare
- Adenoma – occur in renal cortex
- Lipoma – usually subcapsular
• Cat: 1° renal lymphosarcoma & renal cell carcinoma most important
- 1° renal tumors 2.5% of all cat tumors
• Causes:
- 1° renal tumor in dog: unknown
- 1° renal lymphosarcoma in cat - FeLV
- Renal cystadenocarcinoma - inherited in German shepherd



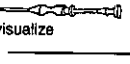
• **Benign renal tumor (15%)**
- Adenoma
- Lipoma
- Others – fibroma, leiomyoma, angioma, chondroma, myxoma, osteoma, papilloma, hemangioma, hamarotoma
• **1° malignant renal tumors:**
- Renal carcinoma & cystadenocarcinoma
- Nephroblastoma
- Transitional cell carcinoma of renal pelvis
- Squamous cell carcinoma
- Other primary malignant tumors:
. Fibrosarcoma
. Liposarcoma
. Myxosarcoma
. Leiomyosarcoma
. Rhabdomyosarcoma
• **Metastatic tumors**
- Lymphosarcoma
- Hemangiosarcoma
- Melanomas
- Mast cell tumors
- Carcinomas
- Osteosarcoma

Rare

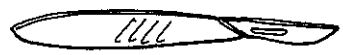
• **Death usually before CS or renal diz**
• Presence may be hard to establish clinically
• Vague signs
- Lethargy, anorexia
- Progressive weight loss
- Abdominal distention
• **If renal failure**
- Vomiting
- PU/PD
• Hematuria

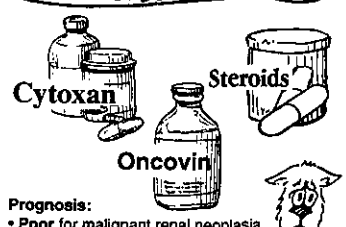
• Sequelae:
- **Respiratory distress - metastasis**
- Hypertrophic osteopathy

• Hx, CS
• Physical exam
- **Palpation for renomegaly**, cranial abd. mass
- Check for tumors & masses in other locations
• Blood values
- ± Polycythemia (carcinoma, fibrosarcoma) erythropoietin - > 60%, RBC > 10x 10^6
- ± Anemia
- Bilateral renal failure: azotemia (BUN, creatinine), hyperphosphatemia, especially in cats w/ lymphosarcoma
• Urinalysis
- Tumor cells rare in sediment
- Hematuria
• Lymphosarcoma: Feline leukemia ELISA (50%)
• **Radiology**
- ± Uni- or bilateral renomegaly (cranial mass)
- ± Large, unidentifiable mass (kidney)
- Radiograph thorax for metastasis (especially renal cell carcinoma)
- Excretory urography to DDx adrenal, ovarian, hepatic & pancreatic masses & other causes of renomegaly
• **Ultrasonography**
• **Renal biopsy for definitive Dx**
- Fine needle aspiration in cats w/ lymphosarcoma
- Others - renal biopsy
. Surgical biopsy maybe to visualize



• **Chemotherapy:**
- **Lymphosarcoma**
. COP: Cytoxan®, oncovin, prednisone (gold standard) ± doxorubicin (Adriamycin®)
• **Nephrectomy** TOC (Tx of choice) for all, but lymphosarcoma
- Evaluate contralateral kidney function 1st (excretory urogram)
- Thoracic films for metastasis
- Remove kidney & ureter, perineal fat & regional lymph nodes
- Submit all for histo





Prognosis:
• **Poor** for malignant renal neoplasia
• Poor if metastasis
• Mean survival time after nephrourectomy 6-12 months - dogs

Benign renal tumor:
• Adenoma: occur in renal cortex - Rare
- Single or multiple, usually of small size

Renal carcinoma
• Middle aged & older, male > female
• #1 malignant renal tumor dog & cat
• Originates from tubular epithelium
• Often located at pole
• Frequently metastasize to **lungs**, also to other kidney, skin, lymph nodes, liver, spleen, heart, brain, bone & eyes

Nephroblastoma, embryonic nephroblastoma, nephroma,
• More common in **young animals**
• Derived from vestigial embryonic tissue which has retained its primitive characteristics
• Usually unilateral

• Microscopic appearance variable
• Frequently metastasize via blood & lymphatics to liver, lungs, & regional lymph nodes
• Except for age incidence, other findings same as for renal carcinoma

Transitional cell carcinoma of renal pelvis
• Common 1° renal tumor in dog
• May invade other parts of kidney, ureter, &/or metastasize
• Often cause obstruction - secondary hydronephrosis before becoming very large

Lymphosarcoma (LSA)
• Most common 1° tumor of cats, also occurs in dogs
• Often associated w/ alimentary or multicentric forms of LSA
• Only 1/4 - 1/3 of cats w/ renal LSA are FeLV positive
• Usually bilateral

Glomerulonephropathies

Condition	Facts/Causes	Presentation	Diagnosis

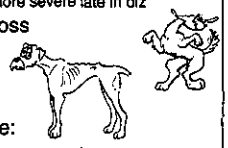
Glomerulonephropathies

M8k 1137; Mk 880; E-hb 649; SAP 808; H2B 566; H3B 504; 5min 637; I2M 605; IM 474; IM-WW 333; CM 448; C11T 823, 827; Pa-T 224; DDx 555

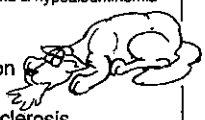
**

- Hallmark: **proteinuria in absence of urinary tract inflammation**
- Causes: unknown in most cases
  - Immune complexes in glomerulus in most
  - Amyloidosis rare cause
- Can lead to nephrotic syndrome

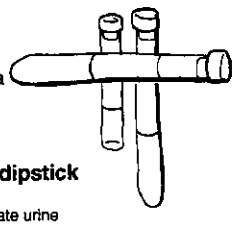
- **Some asymptomatic** w/ proteinuria
- CS of predisposing illness
- PU/PD more severe late in diz
- Weight loss



- Sequelae:
  - **Uremia**: if >75% of nephrons effected
    - . Anorexia, depression
    - . Vomiting
    - . Diarrhea
    - . Oliguria or anuria
    - . Oral ulcers
  - **Pulmonary thromboembolism**, hypercoagulable states (loss of antithrombin 3)
    - . Panting
    - . Acute dyspnea
  - **Nephrotic syndrome** from prolonged proteinuria & hypoalbuminemia
    - . **Edema**
    - . **Ascites**
  - Hypertension
  - ± Blindness
  - Glomerulosclerosis



- Look for predisposing diz - Hx, PE, lab.
- CS
- Physical exam: ± peripheral edema, ascites, thin, poor hair coat
  - Enlarged, normal, or small kidneys
- Blood values:
  - Nonregenerative anemia
  - **Hypoalbuminemia**/hypoproteinemia
  - Hypercholesterolemia
  - Metabolic acidosis

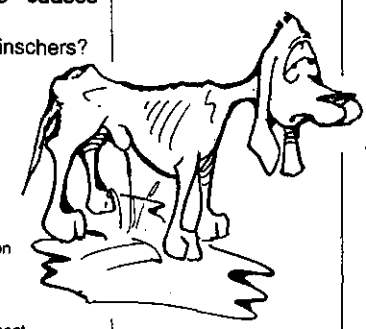


- **UA** (urinalysis)
  - **Persistent proteinuria (hallmark): dipstick**
    - In absence of pyuria or hematuria
    - Specific gravity variable, often able to concentrate urine
    - Unremarkable sediment findings: acid pH, hyaline castes, RBCs
- **Assess magnitude of proteinuria**
  - **U Pr:Cr ratio** (urine protein:creatinine) alternate to 24 hr collection
    - . U Pr:Cr > 1 abnormal
    - .. 1-5 - chronic interstitial nephritis; 3-40 - glomerulonephritis; 10-40 - amyloidosis
  - 24 hour loss of protein in urine
    - . Abnormal: dog: > 30 mg/kg/d; Cat: > 35 mg/kg/d
  - Late: progressive tubular involvement
    - Loss of ability to concentrate
    - Hypoproteinemia, hypoalbuminemia or dilute urine
    - Hypercholesterolemia
    - Hypertension
  - If renal failure/decreased GFR
    - . Hyperglobulinemia
    - . Azotemia (BUN)
    - . Hyperphosphatemia if RF
  - Low specific gravity

- **Renal biopsy** only way to differentiate glomerulonephritis from amyloidosis, **Do only w/ caution**

Associated conditions - causes

- **Idiopathic**
- Familial - Doberman pinschers?
- Infectious
  - Bacterial endocarditis
  - Infectious canine hepatitis
  - Brucellosis
  - Ehrlichiosis
  - Pyometra
  - Dirofilariasis
  - Borreliosis (Lyme diz)
  - Systemic mycosis
  - Feline leukemia virus infection
  - Feline infectious peritonitis
- Miscellaneous
  - Hyperadrenocorticism
  - Chronic glucocorticoid treatment
  - Bacterial endocarditis
  - Mercury intoxication
- Neoplasia
  - Lymphosarcoma
  - Mast cell tumor
  - Others
- Inflammatory/immune mediated
  - Systemic lupus erythematous (SLE)
  - Chronic pancreatitis
  - Chronic pyoderma
  - Polyarthritis



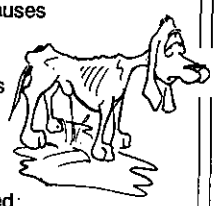
GN or amyloidosis to nephrotic syndrome
CS: Asymptomatic to Edema
Dx: Proteinuria, U Pr:CR
Tx:: Diet, Vasodilators, Diuretics

• Glomerulonephritis, GN, Immune complex glomerulonephritis

M8k 1138; E-hb 649; SAP 808; H2B 566; H3B 507; I2M 605; IM 474; IM-WW 334; E 1769; CM 450

**

- Causes: unknown in most cases
  - 2° to inflammation/infectious dizs, neoplasia or other causes
- Pathophysiology:
  - Deposition of antigen-antibody complexes in glomeruli
  - Immune complexes changes permeability of glomerulus
  - **Proteinuria & hypoproteinemia**
- Dogs over 5 years old, cats
- Familial - Dobermans?
- Reversible or irreversible



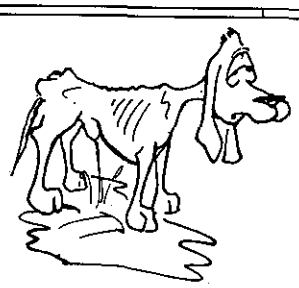
Prognosis: guarded

• Amyloidosis

M8k 1138; E-HB 649; SAP 809; H2B 568; 5min 338; IM-WW 335; I2M 607; IM-WW 334; E 1763; CM 448; C11T 823; Pa-T 229

*

- **Disposition of fibrillar glycoprotein in organs**
  - Results in organ dysfunction
  - Dogs: disposition primarily in glomeruli
    - . Results in protein losing glomerulonephropathy
  - Cats: disposition 1° in renal medullary interstitium
    - . Results in chronic renal failure
- Causes:
  - Idiopathic
  - 2° to inflammatory of neoplastic process
    - Tissue injury stimulates liver amyloid precursor
    - . Liver, spleen, & kidney primarily affected
    - . Progressive kidney dysfunction
- Familial form in Shar Pei, Abyssinian & possibly Beagles



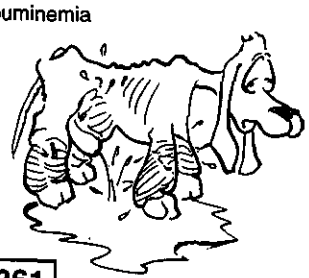
Prognosis: poor

• Nephrotic syndrome; NS

Mk 880; E-hb 543; SAP 808; IM 477; IM-WW 333; H2B 567; 5min 874, 19; IM-WW 333; CM 453; C11T 827; NB 21.24

*

- **Descriptive term, not a diagnosis - edema, ascites**
- **Proteinuria, hypoalbuminemia, hypercholesterolemia & edema**
  - Proteinuria of sufficient magnitude to cause hypoalbuminemia
    - .↓ Oncotic pressure - edema
  - Hypercoagulopathy - loss of antithrombin III protein
    - . Thromboembolism
  - ± Compromised immunological system
- Dogs & cats
- Cause:
  - Glomerulonephritis
  - Amyloidosis
- Most patients w/ glomerular diz don't develop nephrotic syndrome



Treatment:

- **Difficult & often unrewarding**
- **Treat underlying cause if found**
- Corticosteroids controversial, not recommended unless specific underlying diz indicates (SLE)
- **Diet**:
  - Sodium restricted diets
  - Protein restricted diet (Hill's k/d)
    - . If proteinuria remains great consider protein supplementation (boiled egg)
- Enalapril (Enacard®) vasodilator, ↓ sodium retention in some, ↓ proteinuria hypertension in some
- Diuretics as needed w/ caution
- Anticoagulants Tx if antithrombin III < 70% of normal & fibrinogen > 300 mg/dl
  - Aspirin, Coumadin®, heparin
- Vitamin B & C, Free choice water

- **Amyloidosis**
  - No specific treatment proven effective - most terminal
  - DMSO & Colchicine mentioned in addition to above Tx
- Glomerulonephritis: often unrewarding, but may be reversible as apposed to amyloidosis

Prognosis:

- **Glomerulonephritis: Guarded**
- **Amyloidosis: Poor,** diz relentlessly progressive to CRF & uremia
- Nephrotic syndrome: Guarded

Urinary Tract Infection

Condition	Facts/Causes	Presentation	Diagnosis

Urinary tract infection, UTI

M8k 1132; Mk 872, E-hb 653, 673; SAP 826; H2B 596; H3B 532; 5min 776; I2M 632; IM 494, 450; IM-WW 339; E 1775, 1833; C11T 909; Gr 158, 169; CM 472; X-T 459; X-Gr 138; DDx 556

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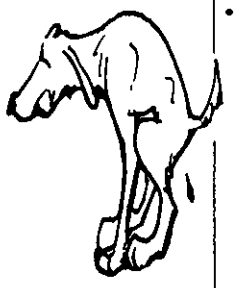


Facts/Causes

- **Bacterial UTI: Dogs >>>>>>> cats**
  - 5-17% of hospital admission of dogs due to UTI
  - < 1% in cats, but inflammation common in cat - FUS
- Viruses, fungi, mycoplasma, chlamydial, yeast & algae - all rare
- Females > males
- Route of infection
  - **Ascending** up urethra most common
  - Descending or hematogenous
- Location of infection affects Dx, Tx & Prognosis: bladder & urethra majority
  - Pyelonephritis: inflammation of kidney
  - Cystitis: inflammation of bladder
  - Urethritis: inflammation of urethra
  - Prostatitis: inflammation of prostate
- Acute: Uncomplicated UTI starts as cystitis usually
- **Chronic** (complicated UTI):
  - **Complicated UTI**: chronic infection, recurring infections, involvement of kidney & prostate, other complications (calculi, neoplasia, anatomic abnormalities, ↓ host resistance)
    . All UTIs of intact male dogs considered complicated **(assume prostate involved)**
  - Recurrence due to relapse or reinfection
- Predisposing factors:
  - Urinary stasis/retention (obstruction, urinary disorders, pain)
  - Micturition disorders
  - Defects in bladder wall (urachal remnant)
  - Inflammation: calculi, neoplasia
  - Immunosuppression: decreased host resistance
  - Corticosteroids (iatrogenic or **hyperadrenocorticism**)
  - Catheterization (iatrogenic)
  - PU - polyuria (lowers osmolarity)
  - Diabetes mellitus (glycosuria, PU, immunosuppression)
  - Prostatic diz

Presentation

- **Asymptomatic**
- **Hematuria**
- **Dysuria**
- **Stranguria**
- **↑ Frequency urination** (pollakiuria)
- **Incontinence**
- **Inappropriate urination** (in house-trained animal - can't wait,

- ± PU/PD
- Normal temperature
- Alert & active
- Systemic signs are rare

- Sequelae:
  - Septicemia
  - Discospondylitis
  - Calculi - urolithiasis
  - Incontinence
  - **Prostatitis**
  - Pyelonephritis
  - Renal failure
  - Bladder neoplasia & polyps
  - Chronic infection
  - Recurring infections

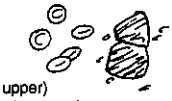
DDx:
- **Prostatic diz**
- **Upper or lower urinary tract infection**

Diagnosis

- **Localize - R/O prostate or upper urinary tract**
- Hx (long term steroids, hypoadrenocorticism, DM)
- CS: dysuria, hematuria

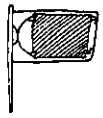
- **Palpation:**
  - Thickening of bladder wall
  - Paln on palpation - kidney
  - Kidney for pain, enlargement, asymmetry, contour
  - Rectal exam: masses, **prostatic diz**
  - Catheterize if obstruction expected
  - If pain (walking or PE) Neuro & orthopedic exam
  - Watch urination

- **Urinalysis**
  - Cystocentesis for bladder or upper UT
  - Voided specimen for urethral problems
  - **Bacteria** (indicates infection)
  - pH may be alkaline (urease-splitting bacteria - *Staph. aureus*, proteus, Ureaplasma) normal urine is acidic from fasted animal
  - Pyuria (> 5 WBC/hpf*) suggestive of UTI
  - Proteinuria
  - **Hematuria**
  - Epithelial cells
  - No cellular casts in lower UTI (DDx from upper)

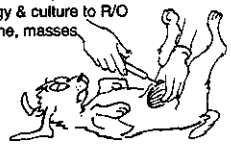


- **Urinary culture**: all animals w/ dysuria, pyuria, bacteriuria & Hx of steroids (Cushing's/iatrogenic)
- **Blood values: usually normal**
  - Azotemia not expected in lower UTI
  - Rule out systemic diz (diabetes or Cushing's)

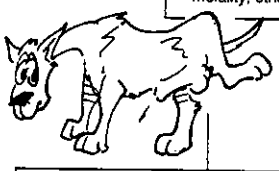
- **Radiology**: bladder small or normal
  - Double contrast cystogram
    . Acute m/b normal bladder
    . Chronic - bladder wall thickened & irregular
    . Calculi
    . Urachal diverticuli vary in size & shape

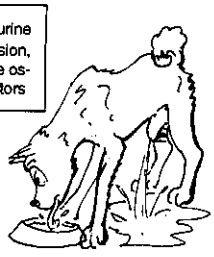


- ± Prostatic fluid analysis: cytology & culture to R/O
- Bladder biopsy: not routinely done, masses
- Laparotomy



Urinary tract defenses: urine flow, inhibition of bacterial adhesion, normal urethral flora, high urine osmolality, other antibacterial factors





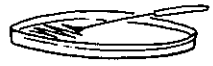
Common etiologic agents
- **Dog: *E. coli* #1, Staph, Proteus, Klebsiella spp, Strep**
- Cat: *E coli* #1, Pasteurella spp. Proteus spp. Staph, Strep.
- Polymicrobes (multiple isolates common 8% dog, 2% cat)
- "L-forms" or "protoplasts" - bacterial variants which are resistant to many antibiotics & not identifiable by routine culture methods

Susceptibilities - UTI

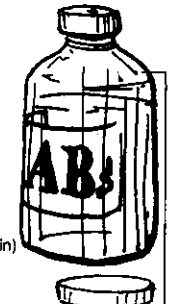
Bacteria	Antibiotic
E. coli	Sulfonamide-trimethoprim, cephalexin
Staphylococcus	Ampicillin, penicillin
Streptococcus	Ampicillin, penicillin
Proteus	Ampicillin, cephalexin
Pseudomonas	Tetracycline
Klebsiella	Cephalexin
Recurrent UTI	Fluoroquinolone (enrofloxacin)

Dog >>> cat, Ascending, Prostatitis
CS: Asymptomatic, Dysuria, Incontinence, PU/PD
Dx: CS, PE, UA, Culture
Tx: ABs, Reculture, Acidifiers

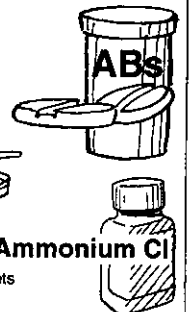
Treatment:
- **Correct predisposing factors**
- **Treat asymptomatic if significant bacteriuria since sequelae independent of signs**

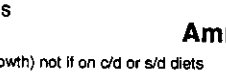


- **Uncomplicated UTI**: usually easily treated
  - **Antibiotics for ≥ 2-3 weeks** based on culture & sensitivity by cystocentesis
    . Broad spectrum antibiotics if no culture & sensitivity (chloramphenicol, trimethoprim-sulfa, ampicillin)
    . **Culture 5-7** days after ABs stopped
    . If positive restart ABs for ≥ 2-3 more weeks & reculture as above



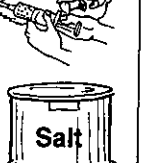
- **Complicated UTI** (i.e., concurrent prostatitis or failure of above Tx)
  - **Antibiotics for 4-6 weeks**
    . **Reculture** 3 days after therapy stopped
    .. If + restart ABs for 4-6 weeks & reculture as above
    . **If + after 2 therapy regime**
    .. **ABs 1/4 dose for another 4-6 months**



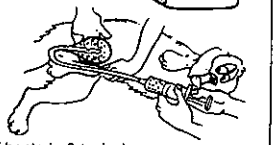


    . **Reculture:** if +
    .. Check for complication - prostatitis, pyelonephritis
    .. **Lifelong antibiotics** m/be required

  - **Urinary acidifiers** (less favorable environment for bacterial growth) not if on c/d or s/d diets
    . Acid urine enhances activity of penicillins, tetracyclines, furadantin, & methenamine
    . **Ammonium chloride (NH4Cl)**: acidifier of choice 21-30 days PO
    . Monitoring urine pH (≤ 6.5) 2-3x/day to adjust dose
    . Other acidifiers: D, L-**Methionine (Odortrol®)**, Ascorbic acid (Vit. C), Ethylenediamine dihydrochloride
  - ± Urease inhibitor



  - **Urinary antiseptics** (long-term suppression for antibiotic-resistant organisms)
    . **Methenamine mandelate (Mandelamine®)**: cyclic hydrocarbon (forms formaldehyde in acid environment - use w/ ammonium chloride)
    . Avoid those containing methylene blue in cats
  - Irrigation of urinary bladder (prophylactic measure when catheterization)
  - **↑ Urine volume to flush bacteria**
    . Salt: increase water consumption, may be given indefinitely
    . Moist food will ↑ water intake



  - Encouraging micturition (minimize stasis of urine & enhance elimination of bacteria & toxins)
    . Salt in diet, water in food, clean litter box, walking dog, etc.

Prognosis: **Acute = Good;**
Chronic/recurrent = Guarded to poor

Cystitis

Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Cystitis M8k 1132; Mk 873, E-hb 653; H2B 596; H3B 532; 5min 776; I2M 573; IM 494, 450; C11T 909; Gr 160; Pa-T 243; CM 472, 477; X-T 459; X-Gr 138; DDx 556 ***	• **Inflammation of urinary bladder** • Dogs > cats • Causes: - Bacterial most common: dog, also viruses, fungi, yeast & algae - Idiopathic: cat - Noninfectious causes: urolithiasis, neoplasia, chemicals, trauma & 1° inflammatory conditions • Route of infection - **Ascending** up urethra most common - Descending or hematogenous • Acute or chronic • Common etiologic agents: - Dog: *E. coli*, Staph, Proteus, Klebsiella, Strep - Cat: *E. coli*, Pasteurella, Proteus, Staph, Strep. - Polymicrobes (multiple isolates common 8% - "L-forms" or "protoplasts" – bacterial variants which are resistant to many antibiotics & are not identifiable by routine culture methods) • Infec. ascend urethra to bladder • Predisposing factors - **Prostatitis** - Urinary stasis - Micturition disorders - Acquired or congenital defects in bladder wall - Urolithiasis - Immunosuppression - Assoc w/ prostatic diz & or cystic calculi	• **Asymptomatic** in many • **Hematuria**, especially at end of urination • **Dysuria** • Frequent urination (pollakiuria) • Inappropriate urination • **PU/PD** • Incontinence • Temperature usually normal • Alert & active • Sequelae: - Septicemia - Discospondylitis - Urolithiasis - Incontinence - **Prostatitis** - Pyelonephritis - Renal failure - Bladder neoplasia - Recurrent UTI	• **Hx, CS** • **Palpation:** - Thickening of bladder wall - Pain on palpation - Watch urination • **Urinalysis & culture** cystocentesis preferred to catheterization - **Bacteria** (indicates infection) - pH may be alkaline - Pyuria - Proteinuria - **Hematuria** - Epithelial cells - May be normal • **Urine culture**: only reliable evidence of UTI (quantitative) Blood values: usually normal - Azotemia not expected in Lower UTI - Rule out systemic diz (diabetes or Cushing's) • Radiology - Plain films: . Bladder small or normal . Calculi - Contrast - double contrast cystogram . Acute m/b normal bladder . Chronic: bladder wall thickened & irregular . Thickening local or general (local common in cranioventral aspect) . Urachal diverticuli vary in size & shape . If bladder wall localized thickening - rule out neoplasia • Ultrasound • Endoscopy: possible in medium to large dogs, ± arthroscopy in smaller female dogs	• Like pyelonephritis • **Antibiotics for 3 weeks** based on culture & sensitivity - Broad spectrum ABs if no culture & sensitivity - Chloramphenicol, trimethoprim-sulfa, ampicillin • **Re-culture 5-7** days after antibiotics stopped - If - then stop - If + reevaluate for predisposing causes - **Antibiotics for 6-8 weeks** • **Re-culture** 3 days after Tx stopped - if + - **Antibiotics 1/4 dose for 4-6 months** • **Re-culture:** if + - **Lifelong antibiotics** m/ be required Prognosis: •**Acute = good, Chronic = guarded** • Recurrence common, especially if concurrent prostatitis

Ascending, *E. coli*, Dog >>> cat
CS: Dysuria, PU/PD, Hematuria
Dx: Hx, CS, PE, UA, Rads
Tx: ABs - Re-culture

Cyclo-phosphamide-induced cystitis, Cytoxan®, Sterile hemorrhagic cystitis
E-hb 682; SAP 834; IM 969; H2B 805; E 1859; DDx 557

• Alkylating drug
- Commonly used **antineoplastic & immunosuppressive** drug (cancer-immune-mediated)
• Causes sterile hemorrhagic cystitis after prolonged use (8 weeks)
- Prevalence of 7% after 22 weeks of therapy
- May occur after single injection
• Cause:
- Cyclophosphamide metabolite (acrolein) contact w/ bladder mucosa
. Causes hemorrhage, edema & necrosis
- May lead to fibrosis, necrosis & rarely neoplasia

• **Hematuria**
• **Dysuria/stranguria**
• Pollakiuria
• May resolve if drug stopped
• Anorexia (mainly cats)
• Myelosuppression

• **Hx, CS (drug + hematuria & dysuria)**
• Palpation: small, thickened bladder
• Urinalysis: sterile hemorrhagic inflammatory reaction
• CBC every 2-4 weeks to monitor myelosuppression during Cytoxan® Tx
• Radiography & US if stopping drug doesn't resolve problem
- Double contrast cystogram or ultrasonogram
- Rule out confounding problems: cystic calculi, necrotic bladder mucosa & neoplasia
• Biopsy if stopping drug doesn't resolve to confirm Dx

• **Discontinue drug immediately**, consider replacing w/ another alkylating agent (**chlorambucil**)
• Diuresis
• ± Methenamine mandelate: mild cases
• ± DMSO : intravesicular instillation if signs persist after 2 weeks
• If hemorrhage persists
- Alum or **1% formalin** instilled into bladder under anesthesia to coagulate mucosa
• Surgery may be necessary to remove necrotic mucosa or obtain biopsy to R/O neoplasia

Prevention:
• Restrict use of drug when possible
- Small daily doses instead of weekly dosing
• Diuretics: Lasix® or thiazide
• Concurrent corticosteroids
• Promote diuresis (salt added to food)
• Encourage frequent urinations

Prognosis: **Good to excellent**

Mycoplasma UTI *
H2B 597; IM 495

• Recently associated w/ cystitis
• Unclear if 1° urinary tract pathogens

Emphysematous cystitis *
H2B 596

• Infection w/ gas-producing bacteria
- Gas-filled vesicle w/in bladder wall
- Pneumaturia: air in bladder lumen
• Associated w/ diabetic dogs & cats

• Asymptomatic
• Lower urinary tract diz
- Dysuria
- Stranguria
- Incontinence

• Hx, CS
• Urinalysis: Glycosuria usually present

DDx:
• Air added by catheterization

• **ABs** - as in other causes of cystitis
• Check for diabetes mellitus

Prognosis: **Good**

Candidal UTI
H2B 597
*

• **Rare**; Compromised host defenses, Indwelling urinary catheters, Long term antibiotic Tx, Diabetes mellitus
• CS: Dysuria, stranguria, incontinence
• Dx: Urine sediment exam or culture
• Tx: Restore normal host defenses, Alkalinization of urine, Itraconazole or ketoconazole recommended

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Polypoid cystitis, Proliferative cystitis, Follicular cystitis
H2B 596
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• Chronic bacterial cystitis; fold, villus-like or polypoid projections of bladder mucosa, core of connective tissue & mononuclear cells
• CS: Cystitis
• Dx: Double contrast cystography
• Tx: Surgical removal, long term ABs 6-8 weeks
• Prognosis: **Good** if Tx early

Bladder atony/ Pelvic bladder
E-hb 90; E 170; Sx-S-hb 471

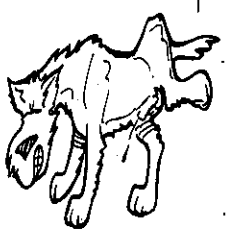
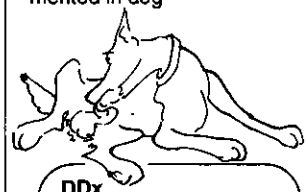
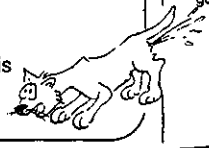
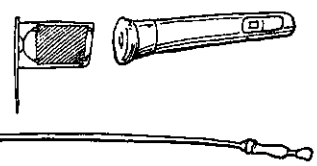
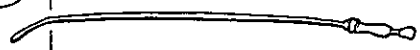
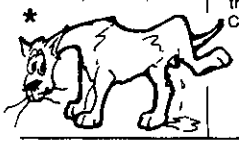
• Causes: **Neurological** (LMN, UMN, dysautonia) **Muscular** (inflammation, muscle weakness dizs, intrapelvic bladder [perineal hernia])
• CS: **Urine retention** more common than incontinence; Complication: **azotemia, infection**
• Dx: Palpation, PE; Lab; Radiography & ultrasound, ± Contrast radiography, Excretory urogram (cystogram)
• Tx: **Treat 1° disease & complication**; keep empty, ± alpha-adrenergic antagonists (phenoxybenzamine), muscle relaxants (Valium®), ± cholinergic drugs (bethanechol)

Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Trauma of urinary bladder, Ruptured bladder SAP 832, 840; E-hb 676; H2B 607; H3B 542; CM 492; Sx-WW 166; Sx-S 1455; Sx-S 1455; X-Gr 138; X-T 459 **	• Cause: - **HBC** (hit by car) - **Iatrogenic: catheterization, surgery,** excessive abdominal palpation (rare) - **High falls** - Spontaneous rupture . Urolithiasis - obstruction . Neoplasia . Necrotizing cystitis . Atony • Fundic portion most common site • Pathophysiology: - Self-limiting mucosal hemorrhage most common - Small rent in bladder may seal spontaneously, urine readily resorbed - **Sterile peritonitis:** continual urine into abdomen: . Postrenal azotemia: urea & creatine & electrolytes absorbed into plasma .. Creatine absorbed slower than BUN	• Nonspecific - **Hematuria** - Anuria - **Dysuria** • Ruptured bladder - Abdominal distention (ascites) - Abdominal discomfort (peritonitis) - Uremia . Depression & vomiting • Other signs of trauma - Lameness, abrasions, shock, etc. • Sequela: Death in 2-4 days of bladder rupture w/o Tx	• **Can be very difficult to Dx** • Hx (HBC), CS • R/O rupture for any abdominal or pelvic trauma • Impalpable bladder after fluid therapy suggestive of rupture • Physical exam: - **Evaluate/stabilize trauma patient 1st** - Examine for bruising in inguinal region - Abdominal palpation . Painful if ruptured . Impalpable bladder suggestive - Rectal palpation . Pelvic fxs, hematomas, perineal hernia containing urinary bladder • **Observe urination: normal urination doesn't R/O bladder trauma** - If dysuria: catheterize urethra & bladder to rule out obstruction, bladder avulsion or tears • Urinalysis: - **Hematuria** - Urine SpG • CBC & chemistries: - Postrenal azotemia (↑ BUN & hyperkalemia followed by ↑ creatinine in time if uroperitoneum) - ± Metabolic acidosis - ± Hyponatremia, hypochloremia, hyperkalemia • Radiology: - Survey: normal to peritoneal effusion (ground glass) - Positive contrast cystogram best: see contrast in abdomen if open rupture • Abdominocentesis: - **Creatine in abdomen 2x serum uroperitoneum**	• **Tx life threatening problems first** (hemorrhage, shock, respiratory insufficiency) - Fluids IV • **No Tx if mild hematuria or pollakiuria & no tears** • Marked persistent, gross hematuria & no tears in bladder - Atraumatic: catheterize bladder & **lavage w/ very cold water** to slow hemorrhage • Small bladder tear/ no peritoneal fluid - **Indwelling catheter** to keep bladder empty while heals • **Uroperitoneum** in stable animal - Surgically repair & lavage abdominal cavity • Uroperitoneum in an unstable animal - Remove fluid before repair . Urethral bladder catheter . Penrose drain or peritoneal dialysis catheter to drain peritoneal cavity . If hyperkalemic: isotonic saline . Broad spectrum antibiotics • Peritoneal hernia of urinary bladder - Decompress bladder w/ urethral catheter - Surgical repair when animal stable Prognosis: **Good** if early Tx; **guarded** if unstable at Sx

HBC, Uroperitoneum
CS: Hematuria
Dx: Hx, Hematuria
Tx: Tx life-threatening problems 1st

Neoplasia of urinary bladder M8k 1141; Mk 883; E-hb 660; SAP 831; H2B 605; H3B 541; 5min 1116, 1034; I2M 574; IM 451; IM-WW 356; E 1791; C12T 1014; Sx-WW 166; Sx-B 377; Sx-G 242; Sx-S 1458; X-T 459; Pa-T 244; DDx 556 *	• **Rare:** < 1% of all canine tumors - #1 site of neoplasia in urinary system • Rare in cat • 10 yrs old, increased incidence w/ age • Female > male • **Most malignant & 1°** • #1 Transitional cell carcinoma - Trigone of bladder usually - 50% metastasize • Diffuse infiltrate > discrete masses • Cause: unknown • Malignant tumors - **Transitional cell carcinoma** #1 dog & cat - Squamous cell carcinoma < 10% of bladder tumors - Adenocarcinoma - Fibrosarcoma - Leiomyosarcoma - rare (rarely metastasize) - Rhabdomyosarcoma (RMS) embryonic, young large dogs, 20% metastasize - Hemangiosarcoma • Benign - Papilloma #1 benign, may transform into carcinoma - Fibroma - Leiomyoma, hemangioma - Fibromas - Others – Neurofibroma, rhabdomyoma, angioma, & myxoma • Metastatic tumors < 0.01%, extension of malignant 1° tumors of adjacent organs (prostate, bowel, uterus, ovary). A diagnostic dilemma when present	• **Resemble UTI** & commonly treated for UTI • **Hematuria: #1**, persistent or recurrent • Dysuria & stranguria if obstruct trigone or urethra • Pollakiuria • ± Incontinence (dribbling) • Anorexia & weight loss • M/b asymptomatic • Sequela: - Hydronephrosis (blocks ureter) - Uremia (if bladder rupture or obstruction) vomiting, lethargy, depression, anorexia & dehydration) - Urethral obstruction - Cystitis **DDx:** • **Chronic UTIs** • **Cystic calculi** • **Anatomic defects of bladder** • **Other causes of hematuria**	• **Hx, CS, cytologic & Rads** • **Unresponsive UTI,** suspect • Physical exam (PE): - Abdominal palpation . Thick, distended bladder . Caudal mass - Rectal palpation . Enlarged sublumbar lymph nodes . Caudal abdominal mass CBC - chem: for postrenal azotemia - ± Anemia • Ultrasound (same info as rads) • Urinalysis: **Hematuria always** • **Cystoscopy for definitive Dx** - Bladder wash cytology - ± Cancer cells (anaplastic epithelial cells diagnostic) • Radiographs: - Contrast or double contrast cystography - Chck sublumbar lymph nodes, chest, pelvis for metastasis - **Excretory urogram if tumor to access trigone or ureteral invasion** - Space-occupying easier to see than infiltrative lesions - Cysts, pyogranulomatous masses or benign tumors appear the same as malignancy	• **Palliative** • **Euthanasia** • Partial cystectomy if: - Small tumor - No metastasis - Trigone & neck not involved - Take lymph node biopsy • Otherwise not much works • Cisplatin for transitional cell carcinoma **Prognosis:** • **Generally poor,** low 6 month survival despite Tx - Late diagnosis, high rate of metastasis - Involvement of trigone = grave
Congenital urinary bladder defects M8k 1132; E-hb 675; H2B 595; H3B 531; E 835; X-Gr 138 *	• Types - Persistent urachal diverticulum (pouch from ventral apex of bladder) - Persistent patent urachus (urine out umbilicus) see Repro pg 387 - Congenital bladder wall diverticulum - Duplication, dysplasia, agenesis & dystrophy (absence of ventral bladder wall & abdominal wall) • May precipitate or exacerbate persistent infection or inflammation of urinary bladder • Dx: physical exam, observe urination & contrast radiography • Tx: depends on defect & may include surgery (repair/correction) • Px: Variable depending on defect, Sx repair/correction, development of CRF			

Urethritis

Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Urethritis, **Urethrocystitis** H2B 621; H3B 559; IM-WW 339; Gr 160; Sx-S 1463; X-T 475; Pa-T 243 ***	• **Inflammation of urethra w/ or w/o infections** • Cause: - Noninfectious . **#1 catheterization** (iatrogenic) .. **Polyvinyl** - less urethritis then polypropylene catheters . Strictures, trauma, urethral calculi, neoplasia . Excessive licking . Masturbation - Infectious: . **Associate w/ cystitis, prostatitis or vaginitis** . Rarely an isolated clinical entity . Associated w/ catheterization - Idiopathic  **Catheterization** **CS: Stranguria, dysuria** **Dx: Hx, CS, PE, UA** **Tx: Tx UTI + time**	• **Stranguria, dysuria** • Pollakiuria (incr. frequency) • Dribbling of blood • Licking prepuce, vulva • Obstruction in cat, poorly documented in dog  **DDx** • Anatomic abnormalities • Stricture • Masses • Uroliths • Prostatitis • Cystitis • Vaginitis  	• **Hx (catheter), CS** • **Physical exam** - Examine urethral, penis & prepuce (male), vulva, vagina, urethral opening (female) - Rectal digital palpation: prostate, masses, enlargement or pain • Urinalysis & culture by cystocentesis to see if UTI proximal to urethra • Urethral discharge: neutrophils & bacteria • Radiography: - Retrograde urethrogram: luminal swelling, strictures, calculi or masses - Contrast cystography: to differentiate 1° urinary bladder diz • Urethral pressure profile - May help diagnose neurological cause of stranguria & dysuria  	• **Treat primary causes** - Stricture & anatomical abnormalities - surgery - Remove uroliths - **Treat UTI**, neoplasia, prostatitis, vaginitis . Resolution will generally eradicate urethritis . Trimethoprim-sulfa or erythromycin recommended over ampicillin - **Catheterization urethritis** . **Remove catheter & then ABs** - Castration for masturbation • Severe urethritis - ± Antispasmotics or antiinflammatory Tx **Prevention:** • **Limit indwelling catheters** to relief of obstruction, urine retention & urine measurement in critically ill animals • Polyvinyl catheters for indwelling catheters • Catheterize for as short a time as possible Prognosis: Good
Granulomatous urethritis E-hb 681; H2B 621; E 1859 *	• **Clinically indistinguishable from neoplasia** • Multifocal, nodular to coalescing aggregates of lymphocytes & macrophages infiltrating mucosal & submucosal layers Cause: unknown 	• Stranguria, dysuria • ↑ frequency of urination • Dribbling of blood • Licking prepuce, vulva • Obstruction in cat; poorly documented in dog 	• CS • Examine urethral, penis & prepuce (male), vulva, vagina, urethral opening (female) - Rectal digital palpation • Urinalysis & culture by cystocentesis - UTI • Urethral discharge: neutrophils & bacteria • Retrograde urethrogram: luminal swelling, strictures, calculi or masses - Contrast cystography 	• **Antibiotics** if infection present • **Steroids (prednisolone) &/or cyclophosphamide** • Maintain indwelling catheter until dog can urinate • ± Urethral bypass or urinary diversion **Steroids** **Cytoxan** Prognosis: Guarded to poor

Congenital/hereditary urethral diz E-hb 675; H2B 619; E 1835

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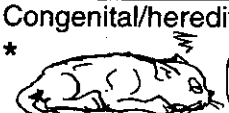
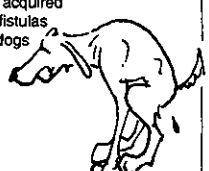
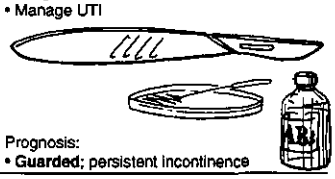
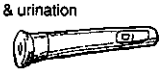
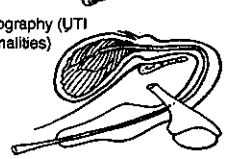
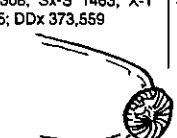
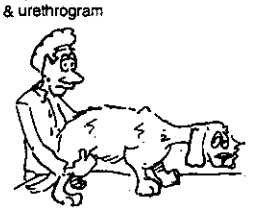
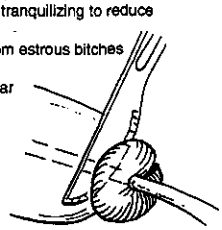


• Reported
- Urethral agenesis
- Imperforate urethra
- Hypospadia
- Epispadia
- Urethral duplication
- Urethral diverticula
- Urethrorectal fistula
- Urethral stenosis
- Hermaphroditism & pseudohemaphroditism

Urethral fistulas, Urethrorectal fistula E-hb 728; H2B 619; H3B 558; E 1835; Sx-S 1463 *	• **Congenital** > acquired • Urethrorectal fistulas - English bulldogs 	• **Urethrorectal fistula** - Hematuria - Dysuria 2° to UTI - Urine from anus & urethra - CS noted at weaning • Urinary incontinence 	• Hx (history), CS (clinical signs) • Urethral catheterization difficult/impossible • Vaginal speculum • Contrast retrograde urethrography or voiding cystourethrography - Excretory urogram to evaluate kidney, ureter & ectopic ureters • Urinalysis of UTI (cystocentesis)	• **Surgical correction** • Manage UTI  Prognosis: • **Guarded**; persistent incontinence
Hypospadia E-hb 675; H2B 669, 619; 5min 1058, 719; Sx-S 1462 *	• **Abnormal location of external urethral orifice** - Ventral surface of penis between ischial arch & tip of penis: glandular, penile, scrotal, perineal • Congenital defect of closure • Breeds: Beagle, Boston terrier, Ger. Shepherd, mixed breeds, Shih Tzu & toy poodle • Cause: exogenous progesterone or estrogen during pregnancy 	• **Urinary incontinence** • Odd outlet for urine • Cutaneous urine scalding at opening • Excessive licking of opening area • Complication: - Incomplete penis & prepuce, cryptorchidism, unilateral renal agenesis, persistent Mullerian structures - **UTI**	• Hx (**young**), Cs • Observe external genitalia & urination • Catheterization of urethra • Urinalysis: UTI • Radiology: - Intravenous urography (UTI & other abnormalities)   **DDx:** • Patent urachus	• Mild: surgically reconstruct urethra • **Prescrotal urethrostomy** for most - Concurrent excision of the urethral groove & remnant of penis & prepuce • Castration & scrotal urethrostomy if opening cranial to scrotum Monitor: for postsurgical hemorrhage • Vaseline for any urine scalding at new opening Prognosis: • Guarded to good depending on location
Urethral prolapse E-hb 675; H3B 609; H2B 670, 620; E 1835; C12T 1027; CM 496; R-M 550; E&R 694; Sx3B 391; Sx-G 308; Sx-S 1463; X-T 475; DDx 373,559 *	• **Rare** • **Prolapse of male urethra out external urethral orifice** • Young intact Eng. bulldogs, Boston terrier • Cause: idiopathic (unknown); excessive sexual excitement & masturbation or urethral calculi? infection • 9 months - 3 years • Not reported in neutered males 	• **Asymptomatic** • **Small pea-shaped mass at end of penis** • ± Hemorrhage from mass • Stranguria • Discomfort • Excessive licking of penis • Bleeding from tip of penis - Increase in presence of estrous bitch **DDx:** • Urethral & penile tumors • Transmissible venereal tumors	• Hx, CS • **Physical exam of prolapse** • Further workup for underlying urinary diz - Urinary catheter passage, urinalysis & culture - Abdominal radiographs - Rectal exam - prostate - Cystogram & urethrogram 	• **Manual reduction** (soft urinary catheter) - Maintain w/ temporary purse string suture • **Amputation of prolapsed mass** preferred (less recurrence) - Postoperative tranquilizing to reduce excitement - Keep away from estrous bitches • Castrate all • Elizabethan collar  Prognosis: • **Guarded to good** depending on chronicity

Urethra

Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Urethral neoplasia M8k 1140; Mk 883; SAP 847; E-hb 661; H2B 622; H3B 561; IM-WW 357; E 1794; Sx-S 1468; X-T 475; Pa-T 244; DDx 559 *	• **Rare** in dogs, extremely rare in cats • **Usually malignant**, epithelial - Transitional cell carcinoma - Squamous cell carcinoma - Adenocarcinoma - Benign polyps & granulomatous urethritis rare • Cause: none known • Older dogs (10 years) • Females 10 x males	• **CS indistinguishable from UTI** • Asymptomatic • Dysuria • Hematuria • Urinary incontinence • May temporarily respond to ABs • Sequelae: - Bacterial infections common, compromised defenses - Obstruction: uremia: depression & vomiting	• Hx (old females + lower UT CS) • Physical exam: - Palpation of thickened or irregular urethra by rectal or vaginal digital exam highly suggestive - Palpate metastatic sublumbar lymphadenopathy in some dogs • Cytology of urine: ± neoplastic cells • Urinalysis & culture: bacterial infection common • Radiology: - Thoracic & abdominal rads for metastasis (lungs, sublumbar lymph nodes, lumbar vertebrae, pelvis) - Excretory urogram & positive contrast urethrocystogram for urinary tract involvement • Urethral endoscopy: access urethral mucosal involvement & guided biopsy • Biopsy: vaginoscopy, endoscopic, catheter biopsy, exploratory surgery	• **Medical Tx: none reported** • **Surgery: salvage rarely feasible** - Urethrectomy & prepubic urethrostomy - Urethrocystectomy & urinary diversion Prognosis: **Poor**
Urethral stenosis or stricture E-hb 676; SAP 851; H2B 620; CM 493; Sx-S 1471; X-T 475; DDx 558 **	• Cause: - Surgery, trauma, removal of urethroliths, inflammation, foreign bodies, etc. - Congenital condition: unknown cause - Ureterocele - Urethral prostheses - male cats . Use of shunts not recommended - Physiologic urethral stenosis: reflex dyssynergia	• **Dysuria** - Stranguria - Hematuria • Incontinence • Sequelae: - Hydroureter - Hydronephrosis - Bladder distention	• Hx, CS • Catheterize **CS: Dysuria, Incontinence** **Dx: Hx, CS, Catheterize** **Tx: Surgical correction**	• **Surgical correction** - Surgical repair - Prescrotal urethrostomy - dog - Perineal urethrostomy - cat - Urinary diversions in proximal urethral stenosis Prognosis: Guarded, may recover

Urethral trauma, Ruptured urethra SAP 846; E-hb 676; H2B 623; H3B 562; CM 493; Sx-WW 168; Sx-S 1469; X-T 475; DDx 558 **	• Cause: - **HBC** (hit by car) most severe . Fractures of pelvis . Fractures of os penis - **Catheterization #1** but less severe - Bite wounds, gunshot - Foreign bodies - Urolithiasis • #1 location: near junction w/ bladder - Retroperitoneal, perineal or SQ abdominal urine accumulation • Male dog > female dog & cats	• **Asymptomatic** in some • **Dysuria** (if partial obstruction) • **Hematuria** • **Urinary incontinence** • Large lacerations - Anuria (complete obstruction) - Depression (uremia) - Abdominal, inguinal, perineal swelling & bruising • Sequelae: - Postrenal azotemia - Obstruction . Urethral stricture . Periurethral hematoma/inflammation - Urethral cutaneous or rectal fistulas (rare)	• Hx (**trauma - HBC**) • Palpation of rectum for pelvic fxs - Palpate inguinal ring for swelling or bruising - Catheterize urethra to determine if rupture • Urinalysis: inflammation • Radiography: - ± Peritoneal effusion - Positive contrast urethrogram to Dx & rule out bladder trauma • Abdominocentesis: check abdominal & serum creatinine for uroperitoneum • CBC & chemistries - For systemically ill or not responding to Tx **HBC, Catheterization** **CS: Dysuria, hematuria** **Dx: Hx, PE, Rads, Centesis** **Tx: Sx, Stent**	• **Surgical** repair necessary if laceration complete • Small urethral deficit - Stenting w/ urinary catheter or urinary diversion via tube cystostomy for 10-14 days • ABs if contaminated Prevention: • **Use of flexible catheters**, gentle manipulation & aseptic technique • Immobilize pelvic fx as soon as possible Prognosis: **Guarded**, may develop stenosis

Urolithiasis

Condition	Facts/Causes	Presentation	Diagnosis	Treatment

Urolithiasis - Dog

M8k 1143; Mk 886; E-hb 676, 668; H3B 560, 537; H2B 601; 5min 77, 1124, 172; SAP 814, 828; I2M 688, 574, 573; IM 501, 451; IM-WW 341; E 1837; C12T 980; C11T 886, 892, 900; CM 480; Sx-WW 157, 164, 167; Sx-S-hb 500; Sx-S 1488; Pa-T 241; DDx 558

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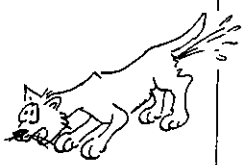


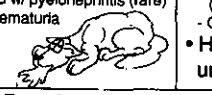
Facts/Causes

- **Uroliths: crystal of minerals in matrix material**
  - 95% organic or inorganic crystalloids, < 5% organic matrix
  - **Struvite #1 in dog & cats**
- Dog: < 3% prevalence, 3-7 yrs old
- **Location:**
  - **Urinary bladder: bladder stones**
  - **Urethra:** partial or complete obstruction
  - Ureter calculi (rare): hydronephrosis
  - Kidney (rare): pyelonephritis
  - Usually originate in bladder, but may come from kidney or ureter into bladder
- **Cause in dogs:**
  - **UTI** (urinary tract infec.) commonly present in all, except oxalate uroliths (cat not due to UTI)
    - **Staphylococcus aureus** or proteus spp (split urea to ammonium)
  - Alkaline urine precipitates
  - Metabolic disorders
    - Urate:
      - Dalmatian: inborn error in purine metabolism
      - Portal vascular shunts
    - Cystinuria: cystine uroliths
    - Calcium phosphate: hyperparathyroidism
  - Dietary factors
    - High magnesium alkalinizing - struvite
    - Corn gluten or soybean hull diets - silica
    - Hi Ca or P diets - calcium phosphate
  - Idiopathic conditions: Ca oxalate, sterile struvite, silica

DDx:
- **UTI**
- **Neoplasia of bladder**
- **FUS**
- **Coagulation disorders**

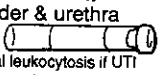
Presentation

- **Variable** depending on size, # & location of uroliths
- Asymptomatic in some:
  - **Lower UTI** (cystitis/urethritis)
    - Dysuria (painful)
    - Pollakiuria (frequent)
    - Bloody (hematuria)
    - Strong ammonium odor
    - Lumbar pain
- **Partial obstruction:**
  - **Dribbling or urine**
  - Stranguria
- **Obstruction - males:**
  - Anuria
  - Frequent attempts to urinate
  - Reduced force & size of urine stream
  - Uremia: vomiting, anorexia, Depression
- If associated w/ pyelonephritis (rare)
  - Fever & hematuria



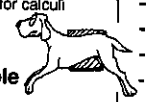
Diagnosis

- Hx, CS
- Palpation: bladder & urethra
- Blood values



  - CBC usually normal leukocytosis if UTI
  - Postrenal azotemia: in obstruction
- **Urinalysis** (UA): UTI
  - Hematuria
  - Pyuria/Bacteriuria

  - Urease- producing - *Staph. aureus* - struvite
  - ± **Crystalluria - ID** usually same as uroliths, not always
  - pH: see chart
- **Urine culture & sensitivity**
- **Radiographic density** (see chart)
  - Kidneys, ureters & urethra for calculi
  - **0 = not visible**
  - **1+ = barely visible**
  - **2- 4+ = readily visible**
  - Ultrasound



- Uroliths analysis - quantitative (crystallographic)
  - Commercial kits not recommended
- Hepatic function tests if urate uroliths (except in Dalmatians)

Breeds:

Struvite: Females > males: Miniature Schnauzer, also Welsh Corgis, Dachshunds, Poodles, Pugs, Pekingese, Beagles, Scottish terriers

Oxalate: Males - Miniature Schnauzer, Miniature Poodles, Yorkshire terriers, Lhasa Apsos, Shih Tzus & Dalmatians

Urate: dalmatian (60% of all urate uroliths) Portosystemic shunts (Miniature Schnauzers, Yorkshire terriers, Pekingese)

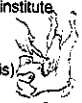
Silica: German shepherd

Cystine: Males: Dachshund, also Basset hounds, English bulldogs, Yorkshire terriers, Irish terriers, Chihuahua

Treatment

- **ABs for 2-3 wks for UTI & struvite**
  - Ampicillin if no culture or trimethoprim-sulfonamide
  - Give after urination & discourage urination as long as possible to keep drug where needed
  - Re-culture 5 days after stop ABs, if + reinstitute

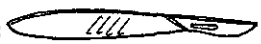
- **Obstruction**
  - Fluid & electrolytes immediately
  - Relieve bladder distention (cystocentesis)
  - Open urethra: catheter &/or flush



- **Medical: for struvite, urate & cystine**
  - Not effective for oxalate, Ca-P, or silica
  - Dissolve uroliths w/ diet, urine pH manipulation & drugs (see chart)

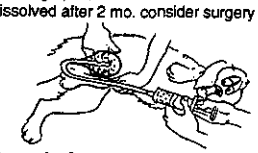
- **Surgical removal**
  - **For obstruction**
  - **Required for Oxalate, Ca-P, or silica**
  - **Those that med. Tx doesn't effect**
  - Flush back into bladder & cystostomy

Prevention:

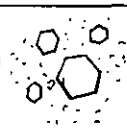


- 5-50% recur
- Diet, urine pH modification & drugs (see chart below)

Monitor monthly for dissolution of uroliths: Complete urinalysis & radiographs; ABs - culture & sensitivity if UTI. If not dissolved after 2 mo. consider surgery



Prognosis: **Guarded to good**, depending on calculi & owner/dog dietary compliance

Types of stone	Facts/cause	Rads	Diagnosis	Treatment	Prevention
• **Dogs & Cats** - **Struvite** (magnesium ammonium-phosphate)	**90% Cats - 60% Dogs** Urease-producing bacteria - *Staph. aureus* - dog - Sterile in most cats	**2 -4+**	**pH: alkaline** **UTI** - urease bacteria (UA) Smooth, rounded or faceted	**Med: ABs (UTI)** s/d Hill's diet (don't add salt) ± Acetohydroxamic acid Sx: those that don't dissolve or obstruct	**<pH** Control UTI c/d Hill's diet (low-protein, Ca, P)
- **Oxalate** (Ca, Mg, & ammonium)	**20% - dog -** Calcinuria (hyperparathyroidism, excessive Vit D intake, osteolytic neoplasm, hypercalcitonism & prox. renal tubular damage)	**4+**	UTI Hypercalcemia pH: variable Rough, quartz-like	**Sx - removal**	Hill's u/d diet? Urocit-K® ± Thiazide diuretics
- **Urate** (ammonium)	Dalmatians & others Hepatic dysfunction/shunts 5% dog, 4% cats 2+ years old	**0- 2+**	UTI pH: neutral - acidic Smooth, round, oval - Jack-stone	**Med:** ABs (UTI) u/d diet Allopurinol ± Correct hepatic diz + k/d Sx: those that don't dissolve or obstruct	Alkalinize urine (Bicarb) Allopurinol (Zyloprim®) u/d diet (low purine) **>pH**
- **Ca-phosphate** (apartite)	Metabolic disorders Excessive Ca & P diet, renal tubular acidosis, Hyperparathyroidism	**4+**	Hypercalcemia Smooth, round or faceted	**Sx - removal**	Acidify urine **<pH** s/d diet?? Control hypercalcuria - diet?
• **Dog Only** - **Cystine** (amino acid cystine) 	Genetic defect/metabolism < 2%, 1.5 - 4 years	**1-2+**	**pH: acidic** **Urinary cystine** Smooth, small round to oval	**Med:** u/d diet Potassium citrate (alkalinizes) D-penicillamine or MPG Sx: those that don't dissolve or obstruct	u/d diet Potassium citrate (alkalinize urine) D-Penicillamine Don't breed males **>pH**
- **Silica calculi**	Rare < 2%- Many breeds (Germ. Shepherd) Diet: corn gluten, soybean hulls	**2 - 4+**	UTI pH: neutral - acidic Jack stone	**Sx - removal**	Meat-based diet, Salt (diuresis)
• **Mixed**	**15%**				

FUS

Condition	Facts/Causes	Presentation	Diagnosis

Feline urolithiasis

FUS

Feline urologic syndrome,

Urethral plug,

Idiopathic lower urinary tract diz, ILUTD; FLUTD, Feline lower urinary tract diz

M8k 1149; Mk 889; H2B 598; SAP 844; E-hb 673; I2M 651, 575; IM 509; IM-WW 352; IM-WW 352; 5mln 590; E 1829; C12T 981, 1007; C11T 883, 905; Sx-B 386; Sx-G 254; Sx-S-hb 495; Sx-S 1473; X-T 475; DDx 55

*

Facts/Causes

- **Variety of lower urinary tract disorders**
  - Cystitis
  - Urethritis
  - Obstruction: urethral plugs or urethral stenosis
- Male > female, house cats 2-6 years
  - 4-10% of all cat hospital visits
  - **Urethral obstruction in males**
  - Cystitis & urethritis in female
- Struvite plugs/uroliths (see box)
- Cause: unknown
- **Predisposing factors:**
  - Bacterial, viral infection
  - Decreased activity (house cats, castration, weather, illness, obesity)
  - Dirty litter box
  - Alkaline urine
  - High Mg/ammonium diets
  - Castration
  - Urethritis/cystitis, urethral abnormalities
  - Dry >> canned food
- High incidence of recurrence - 30-70%
- **Penile urethra #1 blockage site**

DDx:
- **Constipation (straining)**

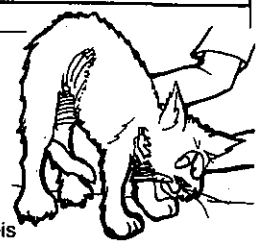
Presentation

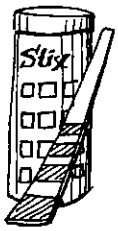
- **Calculi w/o obstruction** (females & males)
  - **Dribbling of urine**
  - **Frequent urination** (pollakiuria, owners think trying to defecate)
  - Strong ammonia-like odor
- **Obstruction males**
  - Squat & strain (stranguria)
  - Hematuria, anuria
  - Lick penis (traumatize)
  - **Screaming** (vocalization)
- **Postrenal uremia**, depending on duration:
  - Anorexia, lethargy, depression
  - ± Vomiting & dehydration
  - Bradycardia
  - Hypothermia, muscle weakness
  - Coma & death in 3-5 days if complete obstruction
- Sequelae:
  - Chronic renal diz due to ascending pyelonephritis (especially if repeated catheterization)
  - Rupture bladder

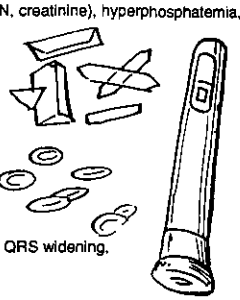
Diagnosis

- **History** (house cat, etc.)
- **CS (straining to urinate)**
- Physical exam - palpation
  - **Obstructed cat**
    - **Distended, turgid bladder**, inability to express bladder (careful)
    - Hard, inflamed, discolored penis
    - ± Protruding plug
    - Thickened bladder wall w/ grating
  - Unobstructed cat
    - Painful bladder &/or caudal abdomen
    - Bladder usually empty
  - Lumbar pain
- Blood values (obstructed)
  - CBC no specific abnormalities, ↑ PCV/TP (dehydration), stress leukogram
  - **Hyperkalemia** (may be life threatening)
  - **Acidosis** (life-threatening), ↓ Blood pH & HCO_3
  - **Postrenal azotemia** (increased BUN, creatinine), hyperphosphatemia, hyperglycemia (stress)
- Urinalysis (UA):
  - **Hematuria**
  - ±**Struvite crystalluria** (variable)
  - Aciduria
  - Culture 90% sterile
- **ECG if uremic: hyperkalemia**
  - **Tall T waves**
  - **Bradycardia**
  - ↑ PR interval, no P waves, ST depression, QRS widening.
- Radiology: not used to Dx FUS
  - Obstructed - distended bladder
  - Non-obstructed or rupture - small bladder
  - Contrast (after stabilized) retrograde of urethrography, cystourethrography, pneumocystography (obstruction)
- US (ultrasound) often equivocal: Thickening of bladder wall

- **Urethral plugs:** sand in organic matrix, like toothpaste, poorly organized - protein matrix, struvite crystals (magnesium ammonium phosphate) & cellular debris; etiology unknown
- **Urolithiasis: Struvite**: magnesium-ammonium-phosphate 80% of uroliths, **sterile 80%**, sand-like, crystalluria (microscopic ppt) or urolithiasis: macroscopic aggregates
  - Ammonium urate uroliths: uncommon: portal vascular anomalies
  - Calcium oxalate uroliths: % of uroliths becoming more common as struvite is decreased due to diet dissolution
  - Calcium phosphate uroliths: uncommon, hyperparathyroidism

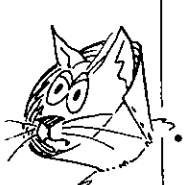






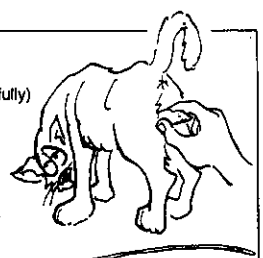
Treatment:

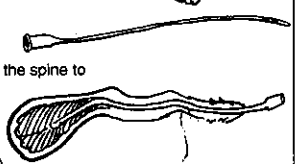
- **Obstruction**
  - **Emergency:** life-threatening hyperkalemia, acidosis, postrenal azotemia or ruptured bladder
  - IV catheter (draw blood for electrolyte & acid-base)
  - **Unblock cat** (see box) (before giving fluids), sedate
    - Massage penis or catheterization
    - Cystocentesis if can't immediately unblock
  - Indwelling catheter 1-3 days to prevent re-blocking
    - Routine use not recommended, remove as soon as possible (12-36 hours)
  - **Fluids** to stabilize cat & for life-threatening hyperkalemia & acidosis
    - Saline + unblocking will quickly ↓ potassium
  - **Antibiotics** 7-10 days
  - **Polyuric renal failure** often ensues following relief of obstruction:
    - Hyponatremia: Salt tablets: 1 gm tid initially PO, normal saline IV to correct
    - Hypokalemia: K+ elixirs PO, K+ salts in parenteral fluids (< 20 mEq/hour)
  - Elizabethan collar if self-trauma
  - Monitor for re-blockage
  - Atonic bladder from over distention: manually express 1-3 days
    - Bethanechol (Urecholine®) if detrusor atony
- **Treatment of unobstructed/unplugged cat**
  - Hill's Feline s/d diet - to dissolve struvite uroliths (acid, low Mg, hi salt)
    - Only long enough to dissolve crystals (30 d past radiographic evidence)
  - Dysuria/stranguria
    - Propantheline bromide (Pro-Banthine®), diazepam (Valium®)
  - Corticosteroids - controversial
  - ABs if infection
- **Surgery:**
  - **Penile urethrostomy** m/b considered w/ multiple recurrence (≥ 2x)
    - Altered cat m/b more prone to cystitis



Unblock cat (before giving fluids)

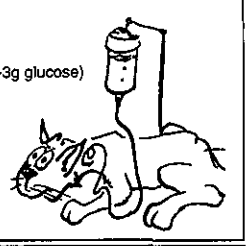
- **Sedate, don't stress** - fatal arrhythmias w/ catecholamine & hyperkalemia (not required in moribund cat, but most others, PAINFUL, carefully)
  - Gas anesthesia: mask down - Isoflurane & O2
  - Acepromazine: reduce dose - <0.1 mg total IV
  - Ketamine (reduced dose because removed by kidney) - <5 mg/kg IV
- **Massage distal end of penis** to try to dislodge distal plug
  - Protrude penis & massage
  - Keep gentle pressure on urinary bladder (if dislodges, urine will flow, yeah!)
  - Manually empty bladder
  - If this doesn't work:
- **Catheterize** (lubricated Tom cat catheter)
  - Extrude penis (pull caudally on prepuce to line the penis up parallel w/ the spine to straighten its normal curve)
  - Advance catheter (gently, if obstruction)
  - Gently flush calculi back to bladder (occlude penis around catheter)
  - Collect urine for urinalysis & culture
  - Lavage bladder w/ sterile saline to remove all crystalluria (100 -200 ml)





Fluids for life-threatening hyperkalemia & acidosis

- **ECG rhythm strip to evaluate**
- **0.9% saline** + unblocking will quickly ↓ potassium
  - If doesn't: glucose & insulin therapy IV (IU Regular insulin w/1-3g glucose)
  - Bicarbonate if acidotic (pH < 7.2) 1-2 mEq/kg IV slowly
  - Calcium gluconate if life-threatening arrhythmias (0.5-1 ml/kg of 10% solution) slowly IV
  - Fluid therapy for dehydration & maintenance, postobstructive diuresis, phenomena in unblocked cats
  - Monitor & replace fluids and electrolytes (K+)



Prevention:

- Tends to recur in 70% of cats
- **Low Mg diet** (Hill's c/d diet or homemade) <2 0 mg of magnesium/100 kcal
- Canned food over dry, Mix water w/ food
- Salt food lightly (not if S/D diet)
- Encourage exercise, free choice water
- ± Urinary acidifiers: methionine, ammonium chloride added to diet if not on c/d or s/d
- Prednisolone considered for persistent hematuria & urethritis
- Clean litter box often

< pH

Prognosis:
- **Guarded**

Male, neutered, obese house cat on dry food
CS: Straining, Uremia
Dx: Hx, PE, UA
Tx: Unblock, Fluids, ABs, S/D diet, Sx

Condition	Facts/Causes	Presentation	Diagnosis

Polyuria & polydipsia; PU/PD

M8k 412, 1734; E-hb 85; SAP 269, E 159; H2B 502, 556f, 574; 5min 130; I2M 581; IM 458, 598, 527; IM-WW 53 Pys-R 195; DDx 55; Dx-L 39

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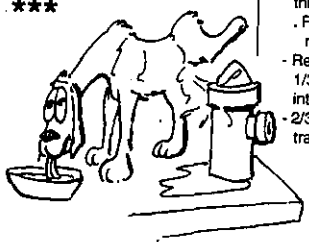


- **Increased thirst & urine production**
  - Urine production > 25 ml/lb/day (50 ml/kg/day)
  - Water consumption > 50 ml/lb/day (100 ml/kg/day)
- **Manifestation of diz; not a diagnosis**
- PU & PD usually exist concurrently
- Mechanism of polydipsia:
  - Low plasma osmolality stimulates chemoreceptors in thirst center (hypothalamic supraoptic nuclei)
    . Posterior pituitary gland releases ADH (antidiuretic hormone)
  - Renal response to ADH is to concentrate urine requiring 1/3rd functioning nephrons & a hypertonic renal medullary interstitium
  - 2/3rds nonfunctional nephrons for kidney not to concentrate urine (polyuria)

- **Polyuria**
  - Nocturia
  - Inappropriate urination
  - Incontinence
  - Pollakiuria (frequent urination)
- **Polydipsia** (excess drinking)

- **History** (empty water dish, constant drinking)
  - Lymphadenopathy (lymphoma), cataracts (diabetes mellitus), symmetrical alopecia (hyperadrenocorticism), vaginal discharge (pyometra), small kidney (chronic FR)
- Metabolism cage: **Urine volume: 25-45 ml/kg/24 hrs**
- Urinalysis:
  - USpG (urine specific gravity)
    > 1.030 unlikely to be polyuria
    < 1.007 (hyposthenuria) tentative Dx of CDI, NDI or PPD
    >1.025 + PU/PD suggests hypoadrenocorticism, diabetes mellitus or renal glycosuria
- Blood values:
  - Azotemia (↑ BUN/creatinine) indicates renal diz
  - Liver enzymes
  - CBC: infection (pyometra)
- Radiographs, ultrasound
- Other tests
  - Lymph node biopsy (lymphoma)
  - Low dose dexamethasone suppression test (hypoadrenocorticism)
- Provocative tests to differentiate normal psychogenic polydipsia, hyperadrenocorticism, pituitary DI, nephrogenic DI or medullary washout
  - **Water deprivation** if PU/PD & no signs or diz (kidney, liver, etc.)
    . USG > 1.025 - **psychogenic polydipsia or Cushing's diz**
    . USG < 1.025 - then do ADH test
  - **ADH test**
    . USG > 1.025 - **pituitary diabetes insipidus** (no ADH)
    . USG < 1.025 - then do gradual H_2O deprivation test
  - **Gradual H_2O test** (to correct possible medullary washout)
    . USG > 1.025 - **psychogenic polydipsia or Cushing's diz**
    . USG < 1.025 - then do ADH test
  - **ADH + gradual H_2O deprivation tests**
    . **USG < 1.025 - kidney unresponsive to ADH**
    . USG > 1.025 - pituitary diabetes insipidus

DDx - Polyuria/Polydypsia

- **Dipsogenic diabetes insipidus (DDI)/Psychogenic polydipsia**
- **Pituitary diabetes insipidus**
- **1° renal diz**
  . Chronic primary renal failure
  . Hydronephrosis??
  . Renal amyloidosis
  . Chronic pyelonephritis
  . Familial renal diz
  . Primary renal glycosuria
  . Fanconi's Syndrome
  . Acute renal failure
- Pyometra (uterine infection)
- **Hyperadrenocorticism**
- **Liver diz**
- Hypercalcemia
- Hyperparathyroidism
- Hypoparathyroidism
- Hyperthyroidism
- Hypoadrenocorticism
- Lymphosarcoma
- Pheochromocytoma
- **Diabetes mellitus**

Isosthenuria:	1.008-1.012, same as plasma
Hyposthenuria:	< 1.007: inability to concentrate urine
Minimal concentration:	1.013 -1.030 dog, 1.013 - 1.035 cat
Hypersthenuria:	> 1.030 dog, > 1.035 cat

Polyuria (USG < 1.025 & normal serum glucose)

NO azotemia (normal BUN) ← → Signs or kidney diz; Signs or liver diz (low BUN) → **Liver diz**

NO azotemia → **Abrupt H_2O test**

- USG < 1.025 → **ADH test**
  - - USG < 1.025 → **Gradual H_2O test** (to correct medullary washout) → - USG < 1.025 → **ADH test** → + USG > 1.025 **Pituitary DI (CDI)**
  - + USG > 1.025 → Evaluate for hyperadrenocorticism
    - Normal - **Psychogenic polydipsia** (medullary washout)
    - Abnormal - **Hyperadrenocorticism**

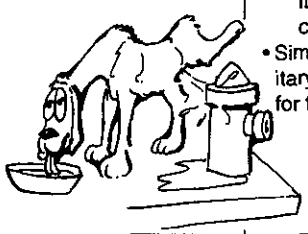
ADH

Abrupt H_2O test + USG > 1.025 → - USG < 1.025 **Kidney DI (NDI)**

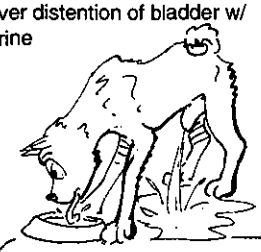
Water deprivation test:

- Determines if:
  - 1. ADH released in response to subclinical dehydration
  - 2. If kidneys can respond to ADH & concentrate urine
- Contraindications (potentially dangerous - death):
  - Dehydration
  - Azotemia (BUN, creatinine)
  - Hypercalcemia
- Terminate test when:
  - Urine concentrated > 1.025
  - > 5% weight loss
  - Azotemia
  - Dehydration
- **Abrupt water deprivation test**
  - Normal animal concentrate USG to 1.075 - cats: 1.045 - dogs: > 1.025 considered adequate for test
  - **Negative** result (failure to concentrate - USG < 1.025) w/o renal diz or other laboratory abnormalities indicates **neurogenic** or **nephrogenic diabetes insipidus** &/or **medullary washout (DDI)**
- **Gradual water deprivation test**
  - For **psycogenic polydypsia** w/ medullary washout (can't concentrate on abrupt test), allows gradient to be reestablished
  - Procedure: Reduce water intake by 5% daily
  - Results: **Negative** result (failure to concentrate) w/o renal diz or laboratory abnormalities indicates **neurogenic** or **nephrogenic diabetes insipidus** not **DDI**
- **ADH response test** (after abrupt of gradual H2O deprivation tests)
  - If inadequate concentration after water deprivation test
  - Tests renal tubular ability to concentrate urine
  - Procedure:
    . Vasopressin (Pitressin®) IM
    . Measure USG at 30, 60, 90 & 120 min
  - Interpretation:
    . **Negative Water deprivation + positive ADH concentration** > 1.025 diagnostic of **neurogenic DI**
    . Both **negative water deprivation & negative ADH tests** indicates **nephrogenic DI** or DDI if after abrupt H2O deprivation

Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Diabetes insipidus M8k 412, 1734; H2B 502, E-hb 85, 549; Dx-L 39	**3 basic types - Also see Endo pg 670** 1. Nephrogenic DI (NDI) partial or complete renal tubule insensitivity to ADH - Neg H_2O & ADH test 2. Central DI (CDI): partial or complete primary deficiency of ADH - Neg. H_2O, positive ADH 3. Dipsogenic DI or psychogenic polydipsia/polyuria: excessive water intake - Positive H_2O (abrupt or gradual)			
Nephrogenic diabetes insipidus, NDI M8k 412, 1734; E-hb 666, 85, H3B 514; H2B 502, 564; SAP 268, 812; IM-WW 338; IM 458, 528; IM-WW 338; 5min 514, 130, 1020; E 1804; Cat 1410; R&F 2; R&E-M 251; Lab-C 219; Psy-R 195; DDx 68; Dx-L 39 **	• **Renal tubules nonresponsiveness to ADH** - Distal tubules & collecting ducts - ADH levels normal to increased - Partial or complete unresponsiveness to ADH • Causes: see rounded box - Congenital: rare - Acquired secondary NDI . Renal & metabolic disorders affecting renal tubules' ability to respond to ADH - Most acquired forms reversible following correction of cause • Similar CS, Hx & physical to pituitary diabetes insipidus, except for trauma	• CS: similar to pituitary DI except for CNS signs & history of trauma • **PD/PU** • Nocturia • Distended abdomen related to over distention of bladder w/ urine	• Hx (no brain trauma), CS • Same as pituitary diabetes insipidus except for challenge test • Blood values normal • **Urine SpG: 1.001–1.006;** Normal kidney > 1.025 unless medullary washout • Water deprivation + ADH tests USG < 1.025 (tubules unresponsive) - Water deprivation = < 1.025 = - **No response to ADH** - USG **<1.025** (neg. test) - Gradual water deprivation + ADH: < 1.025 (neg.); normal kidney & CDI >1.025 • Biopsy	• **Aquired -** - **Tx predisposing cause** - most reversible following correction - **Unlimited water supply** • **Congenital (rare)** - **Unlimited water supply** - **Low sodium & protein diet** - **Chlorothiazide** (Diuril®) **diuretics** to enhance proximal tubular reabsorption of Na, Cl & H_2O - may reduce urine output by inhibiting sodium resorption, up to 60% reduction Prognosis: • 2° NDI: depends on response of underlying cause • 1° NDI (rare) guarded to poor

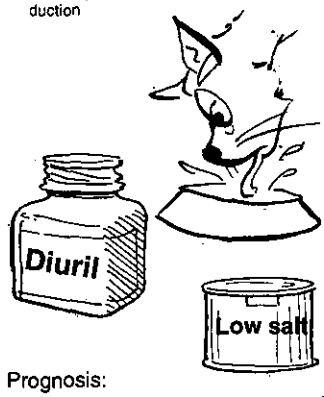


Unresponsive renal tubules
CS: PU/PD
Dx: No response to water or ADH tests
Tx: Tx cause, Unlimited H_2O



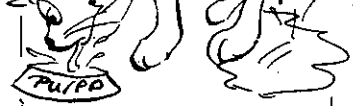
Nephrogenic diabetes insipidus

- **2° nephrogenic DI**
  - Renal disorders
    - . Acute renal failure
    - . Chronic primary renal failure
    - . Hydronephrosis
    - . Renal amyloidosis
    - . Chronic pyelonephritis
    - . Familial renal diz
    - . Primary renal glycosuria
    - . Fanconi's Syndrome
  - 2° renal disorders
    - . Pyometra (uterine infection)
    - . Diabetes mellitus
    - . Liver diz
    - . Lymphosarcoma
    - . Pheochromocytoma
  - Endocrine
    - . Hyperadrenocorticism
    - . Hypoadrenocorticism
    - . Hyperthyroidism
    - . Hypoparathyroidism
  - Metabolic disorders
    - . Hypercalcemia
    - . Hypokalemia
  - Drugs
    - . Corticosteroids
    - . Anticonvulsants
    - . Diuretic
- **Congenital 1° NDI (rare)**

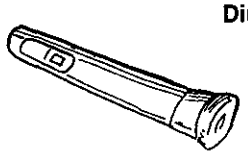


Pituitary diabetes insipidus, Central diabetes insipidus, CDI, Neurogenic diabetes insipidus, Neurohypophyseal diabetes insipidus * M8k 412, 1734; E-hb 549; IM 458, 527; SAP 268; H2B 502; E 1428; Psy-R 195; DDx 68; Dx-L 39	• **Lack of ADH (antidiuretic hormone):** either formation &/or release of endogenous ADH • Cause of CDI (central DI) - **Idiopathic** (most common) - CNS trauma - CNS infection - Parasitic migration - Neoplasia (craniopharyngioma, metastatic tumors - mammary carcinoma, lymphoma, melanoma, pancreatic carcinoma) or diminished blood flow - Congenital defects (rare) • Pathophysiology - ADH acts on distal tubules & collecting ducts ↑ reabsorption of water - ↓ ADH = water diuresis (polyuria)	• **PD/PU** • **Nocturia** • ± Weight loss (if preoccuppied with drinking) • ± **CNS signs** (expanding tumor) - Stupor, disorientation, circling, pacing, convulsions • Distended abdomen related to over distention of bladder with urine	• CS: PU/PD: Hx PU/PD >100 ml/kg/d normal 40-70 • **Urine specific gravity: Dog 1.000-1.007, Cat 1.008-1.012** - Partially concentrated • Physical exam: usually unremarkable, m/b thin (thirst overshadows hunger) - Dehydration if water unavailable for 4-6 hours • Lab: persistent hypernatremia, CBC normal or consistent with dehydration • Water deprivation + ADH tests - Water deprivation = SpG < 1.025 = (CDI or nephrogenic) - ADH + H_2O deprivation = USG > 1.025 = CDI unless medullary washout, so . **Gradual H_2O deprivation + ADH = > 1.025 - CDI**	• **Not mandatory if unlimited water** • **Unlimited water paramount** • Desmopressin (DDAVP® - synthetic vasopressin analog) drops in conjunctival sac - Limit water for couple of hours after Tx to avoid over hydration • Repositol vasopressin (Pitressin®) IM • **Chlorpropamide** (Diabinase®) sulfonylurea agent for **partial** CDI, potentiates renal tubular effect of ADH. Ineffective in complete CDI & NDI, needs some ADH • Chlorothiazide diuretics + oral salt restriction may reduce urine output by inhibiting sodium resorption; up to 60% reduction . Chlorothiazide (Diuril®), Hydrochlorothiazide • **Pituitary or hypothalamic tumors** - Cobalt radiation - Carmustine (BCNU) - Unpredictable; dramatic improvement in some **Prognosis:** • Good for idiopathic or congenital CDI usually become asymptomatic w/ Tx • Guarded if trauma-induced • Grave if tumor

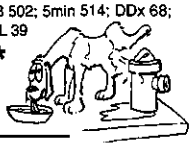
Lack of ADH
CS: PU/PD, ± CNS
Dx: + ADH tests
Tx: Unlimited water, Drugs

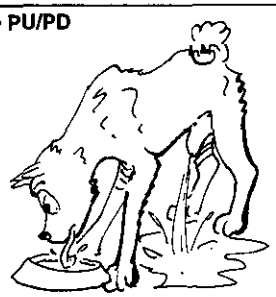


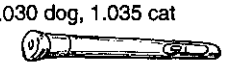
DDx:
- Nephrogenic diabetes insipidus
- Psychogenic polydipsia
- Other causes of PU/PD



Psychogenic polydipsia, Primary polydipsia, Dipsogenic diabetes insipidus, Compulsive water drinking M8k 412, 1734; E-hb 85; IM 459; H2B 502; 5min 514; DDx 68; Dx-L 39 **	• Cause: - Disorder of thirst centers, resulting in 1° PD - Behavior problem - Pharmacologic agents: salt, diuretics, glucocorticoids, fluids, anticonvulsants • **2° Polyuria** to rid excessive H_2O • Large breed dogs • Kidney is usually functional • Causes **medullary washout**	• **PU/PD**	• Hx (large breeds), CS (PU/PD) • **Urinalysis: USG 1.001-1.003** • **Water deprivation = concentrated urine** - Abrupt water deprivation: diagnoses 2/3rds of cases - Gradual water deprivation in other third to eliminate medullary washout - Results in concentrated urine > 1.030 dog, 1.035 cat	• **Nothing** • **Gradual water restriction** to restore renal hypertonic medullary interstitium • Behavior modification (diazepam (Valium®), chlorpromazine (Thorazine®) Prognosis: **Excellent**







Urinary Incontinence

Micturition disorders, Urinary incontinence

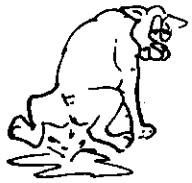
M8k 1141; Mk 884; E-hb 88; SAP 858; H2B 611, 613t; H3B 545; Smin 82, 86; I2M 659, 579; IM 456, 517; IM-WW 349; C12T 1018; C11T 875; CM 486; Pys-R 197; DDx 565; Sx-WW 169; Sx-S-hb 474; Sx-S 1404; DDx 565; Dx-L 345

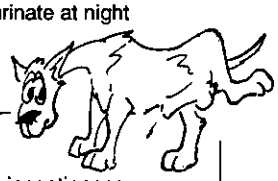
***

- **Inappropriate passage of urine**
- Needs to be differentiated from abnormal elimination behavior & inadequate house training
- Middle aged & geriatric dogs > 5 yrs-old
- Definitions:
  - **Micturition: voiding of urine**
    . 2 stage process: passive storage & active voiding
  - **Incontinent:** loss of voluntary control of micturition
  - **Enuresis:** urinary incontinence while animal is asleep
  - **Nocturia:** urge or need to urinate at night

Clinical signs

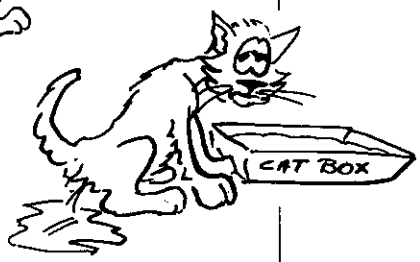
- **Urinary incontinence**
  - Dribbling of urine
  - Loss of voluntary control
  - Urine-scalding dermatitis
- **Abnormal micturition**
  - Inability to urinate
  - Disruption of urine stream (dyssynergia)
  - Stranguria/Dysuria
  - Abdominal pain/discomfort

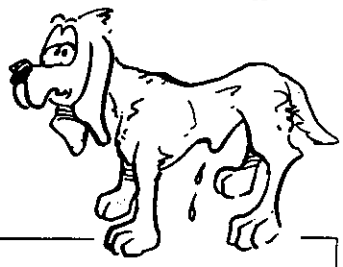


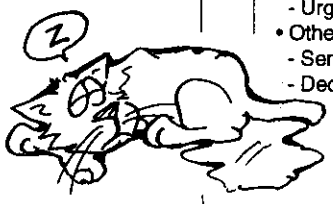


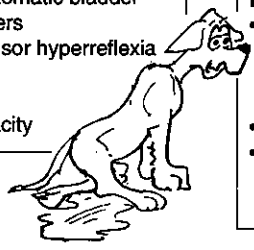
Causes: Incontinence

- Nonneurogenic
  - Hormone-responsive incontinence
  - Stress incontinence, urethral incompetence
  - Pelvic bladder
  - Urachal remnant
  - Idiopathic urinary incontinence
  - Ectopic ureters
- Neurogenic
  - Lower motor neuron, atonic bladder
  - Upper motor neuron, automatic bladder
  - Detrusor-urethral disorders
  - Urge incontinence, detrusor hyperreflexia
- Others
  - Senility
  - Decreased bladder capacity







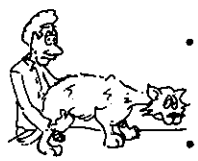


Normal micturition

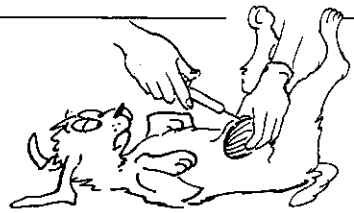
- Storage (filling) phase
  - Sympathetic (ANS): relaxes bladder detrusor muscle & increases internal urethral sphincter tone
  - Somatic: external urethral sphincter (urethralis muscle)
- Stretch of bladder wall: sensory fibers to reflex & brain
- Voiding (emptying) phase
  - Parasympathetic (ANS): contraction of detrusor muscle
  - Inhibition of sympathetic & somatic urethral sphincters

Diagnosis urinary incontinence:

- **History:** very important - Questions to ask:
  - Chronology of progression?
  - Ability to voluntarily initiate & maintain urination?
  - Reproductive status (neutered or not)?
  - Trauma?
  - Age of onset?
  - Previous problems (especially urinary)?
  - Description of abnormality - night? dribbling? etc.
    . Continuous or intermittent? Amount passed?
  - Frequency of urination?
  - Current medication?
  - Dysuria, nocturia, hematuria?

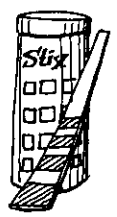


- Physical exam:
  - Examine perineum for urine scalding
  - **Palpation of urinary bladder before & after urination**
    . Small bladder: bladder hypercontractility or ↓ urethral resistance
    . **Distended bladder: ↑ urethral resistance or ↓ bladder contractility**
    . Evaluate distention, tone, ease of expression
    .. UMN - difficult
    .. LMN - easy
  - **Neurogenic exam:** check integrity of sacral reflex arc (pudendal nerve [sensory & motor] & sacral cord segment)
    . Perineal reflex: pinch perineum = contraction of anal sphincter & ventroflexion of tail
    . Bulbospongiosus reflex: squeeze distal penis or vulva = constriction of anus
  - Rectal exam: prostate gland, anal tone, pelvic diaphragm, pelvic urethra, trigone of bladder
  - Observe urination: Measure residual volume after urination (catheterization) normal < 0.4 ml/kg

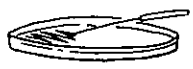


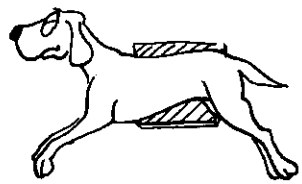
DDx:

- Causes of polyuria
- Causes of pollakiuria
- Causes of stranguria
- Causes of nocturia

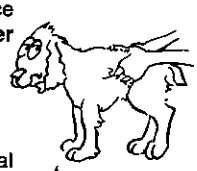


- Blood values
  - ↑ BUN & creatinine - renal function
- Urinalysis in all incontinent animals
  - Urine culture (cystocentesis)
- R/O Polyuria/polydipsias which can result in urge incontinence
  - Diabetes mellitus, pyometra, hyperadrenocorticism & hypercalcemia





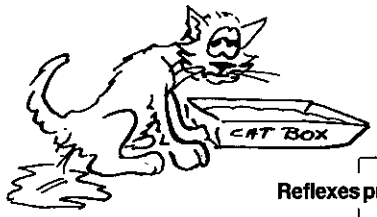
- **Radiography:**
  - Survey: for obvious abnormalities of bladder, urethra, pelvis or spine
  - Contrast radiographs
    . Excretory urogram
    . Positive contrast vaginogram
    . Vaginourethrography or retrograde urethrography



- Vaginoscopy w/ or w/o new methylene blue dye (dogs); visualization of contrast for ectopic ureter
  - Check for: urachal diverticulum, bladder wall thickening, calculi, prostatic enlargement, urethral strictures, pelvis bone abnormalities

- Urodynamic studies for micturition disorders
  - Cystometrogram: bladder tone & volume, detrusor reflex
  - Urethral pressure profile: intra-urethral resistances

- Electromyography (EMG): coordination of detrusor & urethral sphincter by checking anal sphincter



Incontinence

Reflexes present

Small bladder

Hormonal therapy → **Hormonal responsive incontinence**

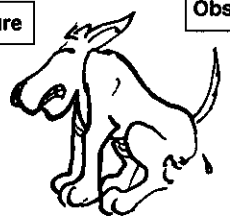
UA (Infection or inflammation) → Tx UTI or FUS
- Stops → **Urge incontinence UTI/FUS**
- Incontinence continues → **R/O Neoplasia, chronic cystitis, polyps, uroliths, or urachal remnant**

Young animal
- PE - urine from umbilicus → **Patent urachus**
- Contrast urogram → **Ectopic ureter**
- Digital vaginal exam, vaginoscopy, contrast vaginography → **Vaginal stricture**

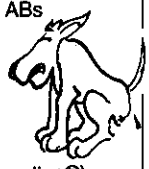
Large bladder

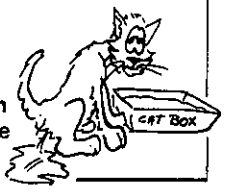
Difficult to express
- Urogram: calculi → **Obstruction**
- Spastic paresis HL → **UMN**
- CS: stops & starts → **Reflex dyssynergia**

Easily expressed HL - flaccid paresis → **LMN**



Condition	Cause	Clinical signs	Diagnosis	Treatment
Neurogenic				
LMN - atonic bladder	Trauma - LMN	Continuous dribbling Involuntary **Hindlimb: flaccid paralysis**	**No perineal reflex** **Large, expressible bladder**	**No effective Tx** Manually express tid ± Bethanechol (Urecholine®), ABs
UMN/automatic bladder	Trauma - UMN	Intermittent incontinence Involuntary **Hindlimb: spastic paresis**	**+ Perineal reflex** (hyperactive) **Large turgid, nonexpressible bladder**	**Intermittent catheterization** ABs - frustrating
D-U (reflex) dysynergia	Trauma - ANS	**Start & abrupt stop** urination w/ stranguria Voluntary	**CS**, + Perineal reflex **Large, nonexpressible bladder** Easily catheterized	**↓ Alpha sympathetic tone** - Phenoxybenzamine (Dibenzyline®) - ± Bethanechol (Urecholine®)
Nonneurogenic				
Hormone-responsive incontinence	**Older, spayed female**	Voluntary control Intermittent dribbling	**Hx, Tx response** Normal reflexes & bladder	**Diethylstilbestrol** ± Phenylpropanolamine (Triaminic®)
Urethral incompetence	**Stress**	Voluntary control Stressful incontinence	**Hx, Tx response** Normal reflexes & bladder	**↑ Alpha sympathetic urethral tone** - Phenylpropanolamine (Triaminic®)
Urge incontinence	**UTI, FUS**, etc.	Frequent small urinations Urine spraying, Stranguria	**Hx, CS (UTI, FUS) - Tx response** Hyperreflexive detrusor, normal bladder	**Treat cystitis/FUS** **Inhibit detrusor** - Propantheline (Pro-Banthine®)
Atony over distention	**Obstruction**	Continuous dribbling - long Involuntary	**Large, flaccid bladder** - Large residual urine volume Difficult catheterization	**Remove obstruction** **Indwelling catheter** Bethanechol (Urecholine®)
Paradoxical incontinence	**Partial obstruction**	Continuous dribbling - short Involuntary	**Large, turgid bladder** (nonexpressible) Normal reflexes	**Remove obstruction** **Indwelling catheter**
Ectopic ureters	**Young**	Continuous dribbling Voluntary urination	**Hx (young), CS** Bladder, reflexes normal	**Ureteral transposition** ± Phenylpropanolamine (Triaminic®)

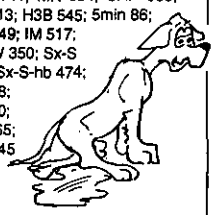




Neurogenic Incontinence — URINARY SYSTEM

Neurogenic incontinence

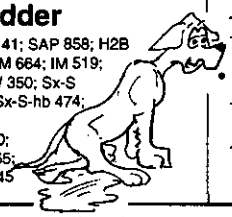
M8k 1141; MK 884; SAP 858; H2B 613; H3B 545; 5min 86; IM-X 349; IM 517; IM-WW 350; Sx-S 1404; Sx-S-hb 474; E-hb 88; CM 490; DDx 565; Dx-L 345

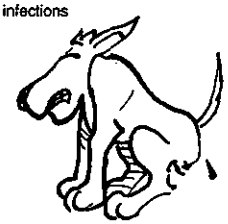


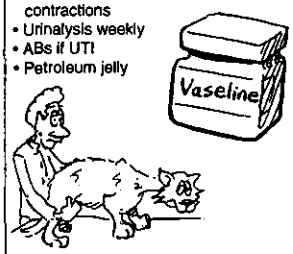
Micturition reflex:

- Detrusor muscle in bladder wall - internal bladder sphincter
  - Parasympathetic fibers via pelvic nerve causes contraction
  - ß Sympathetic fibers via hypogastric nerve causes relaxation, allowing bladder filling
- Urethralis muscle of pelvic urethra: external bladder sphincter; somatic control via pudendal nerve & sacral cord segment & modulated by alpha sympathetic fibers
- Smooth muscle in trigone area & urethra: internal bladder sphincter - Alpha sympathetic fibers
- Bladder smooth muscle stretches as urine collects, sensation over pelvic nerves & spinal cord to brain stem
  - Motor discharge from pons
  - UMN (upper motor neuron) down spinal cord to preganglionic parasympathetic neurons in S1–3 (1st LMN - lower motor neuron)
  - Pelvic nerves to postganglionic neurons (2nd LMN) in pelvic ganglia
    - . Postganglionic parasympathetic nerves activate detrusor muscle of bladder
    - . Detrusor muscle contracts, opening bladder neck
    - . Sympathetic & pudendal neurons (voluntary) simultaneously inhibited, relaxing both smooth & skeletal muscle of urethra
    - . Sensory discharge ceases when bladder is empty, resulting in bladder relaxation & closure of urethra

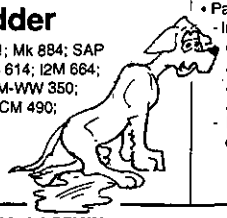
Condition	Facts/Causes	Presentation	Diagnosis	Treatment
LMN/Lower motor neuron bladder, Overflow incontinence, Atonic bladder, **Paralytic bladder** ** M8k 1141; SAP 858; H2B 613; I2M 664; IM 519; IM-WW 350; Sx-S 1404; Sx-S-hb 474; E-hb 8; CM 490; DDx 565; Dx-L 345	• Causes: - 1° lesion of bladder (long distention, severe inflammation of neoplasia) - **2° to damage to sacral spinal cord segments or pelvic nerve** - Intervertebral disc diz (rare in lumbar area) - Cauda equina syndrome - Sacroiliac luxations - Sacrococcygeal fractures/separation - Tumors (spinal lymphoma) - Sacral nerve roots, or both pelvic & pudendal nerves • Both detrusor & sphincter areflexia - Results in atonic bladder (flaccid paralysis) - Overflow incontinence	• **No attempt to urinate** • **Dribbling of urine** • **Paralysis of tail** • **LMN signs in pelvic limb - Flaccid paresis/paralysis** **- Decreased reflexes** • Sequelae: - Urine scalding - Decubital ulcers - Recurrent UTI (urinary tract infections	• Hx, CS • Palpation: **- Full bladder easily expressed manually** - Dribbling w/ full bladder **- Loss of sensation to perineum** perineal & bulbospongiosus reflexes • Cystometrogram: no detrusor reflex	• **Time & see** • **Manually express bladder tid-qid** • Long-term therapy not successful • Bethanechol may increase detrusor contractions • Urinalysis weekly • ABs if UTI • Petroleum jelly Prognosis: • Poor with sacral cord lesions • Good ?? better or guarded? with root lesions
Sacral or Pelvic n. **CS: Dribbling, flaccid paralysis** **Dx: Hx, CS, PE, Neuro - neg.** **Tx: Time, Express tid-qid**				

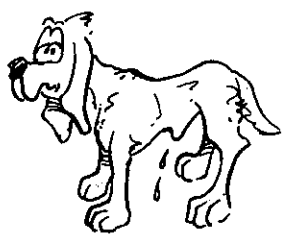


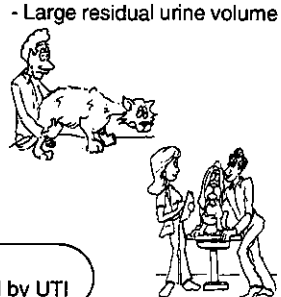




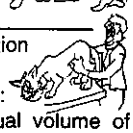
UMN/Upper motor neuron bladder, Detrusor hyperreflexia, **Automatic bladder** M8k 1141; Mk 884; SAP 858; H2B 614; I2M 664; IM 520; IM-WW 350; E-hb 88; CM 490; DDx 565; Dx-L 345 ***	• **Results in automatic bladder** (involuntarily empties when full) • **Cause: spinal cord lesion above sacral segments** - Intervertebral diz, trauma, tumor - Spinal shock from trauma or lesion - Lesions of cerebellum (cerebellum normally inhibits micturition through brain stem) • Pathophysiology: - Incomplete reflex detrusor contraction & spasticity of urethral sphincter . Incomplete emptying of bladder . Voluntary control is lost . Spinal reflexes return in days to weeks - Involuntary micturition initiated when threshold capacity of bladder reached (automatic bladder)	• **Incomplete & inappropriate urination** (automatic bladder) • No voluntary control of urination • **UMN signs** in pelvic limbs **- Spastic** paresis/paralysis - Increased reflex tone	• Hx (trauma) • CS (paresis/paralysis) • Physical exam (PE): **- Manual expression of bladder difficult/impossible at first** - Positive anal tone - Large residual urine volume	• **Catheterize,** aseptically tid to empty bladder - Don't initially manually express bladder . Rupture - Don't use an indwelling catheter - infection • Frequent UA - culture & sensitivity • Once automatic bladder develops, palpate after urination & manually express if large residual volume • **± Antibiotics** • Petroleum jelly protection • Long-term care for paralyzed animal (catheterization, diapers) Prognosis: **Poor**
Above sacrum **CS: Automatic bladder, Spastic paresis** **Dx: Hx, CS, PE** **Tx: Catheter & empty tid, TLC**		**DDx:** • Urge incontinence caused by UTI		

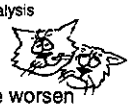






Detrusor – sphincter reflex dyssynergia, Detrusor-urethral dyssynergia M8k 1141; Mk 884; SAP 859; H2B 614; IM 520; IM-WW 350; CM 490; DDx 557,565; Dx-L 345 **	• Initiation of detrusor reflex & voiding followed by involuntary contraction of urethral sphincter • Cause: - Partial lesion of long spinal tracts (reticulospinal) - Increased sympathetic activity	• **Voiding initiated, often after hesitation, but then abruptly stopped** • Continue to strain & void a small amount in spurts	• Observe urination **- Start-&-stop** • Physical exam: - Large residual volume of urine in bladder - Nonexpressible bladder - Easily catheterized • Retrograde contrast cystourethrogram: no obstruction or stricture of urethra • Cystometrogram: intact pelvic nerve • **Urethral pressure profile:** increased urethral resistance	• **↓ Alpha sympathetic tone** **- Phenoxybenzamine** (Dibenzyline®) (alpha-adrenergic blocker) ↓ internal sphincter resistance: watch for hypotension - Diazepam (Valium®) & dantrolene (Dantrium®) ↓ external sphincter resistance - Baclofen (Lioresal®): CNS skeletal muscle relaxant - ± Bethanechol (Urecholine®) - May take weeks to determine correct combination of drugs • Monitor for UTI - urinalysis Prognosis: • **Guarded:** some worsen making Tx ineffective
Over distention **CS: Stop-&-start urination** **Dx: Hx, CS, PE, Urethral resistance** **Tx: ↓ Resistance (Dibenzyline, Valium®)**		**DDx:** • Mechanical obstruction (calculi)		





Incontinence — URINARY SYSTEM

Condition	Facts/Cause	Presentation	Diagnosis	Treatment
Hormone-responsive incontinence M8k 1141; Mk 884; SAP 859; H2B 614, 613t; H3B 545; 5min 86; IM-WW 349; I2M 665; E-hb 88; CM 486; Sx-S-hb 474; Sx-S 1405; DDx 565; Dx-L 345 ***	• **Very common** • **Spayed female dogs** >>> intact animals - Uncommon in castrated male dogs, rare in male & female cats • Older (mean: 8 years) • **Loss of sex hormones** which maintain normal urethral muscle tone & mucosal integrity	• **Normal voluntary urination** • **Involuntary dribbling when animal is relaxed or asleep** • Sequela: - Urinary tract infection (exacerbates incontinence)	• **Hx, CS** (intermittent - neutered) • Physical exam: small bladder • Urinalysis - ± Cystitis • Exclusion of other causes of incontinence • **Response to Tx**	• **Diethylstilbestrol** (DES®) for females - Estradiol cypionate not recommended (bone suppression) - Reduce slowly to lowest possible dose • ± **Phenylpropanolamine** (Triaminic®) or ephedrine (Mudrane®) as alternate or in addition to estrogen • Testosterone cypionate - males • Phenylpropanolamine tid: sympathetic alpha-agonist for those that develop tolerance to sex hormones (increases urethral tone) Prognosis: • **Excellent**
Urethral incompetence, Sphincter hypotonus, Stress incontinence M8k 1141; MK 884; SAP 859; H2B 616; H3B 545; 5min 86; IM-WW 349; IM-WW 351; E-hb 88; CM 486; DDx 565; Dx-L 345 ***	• **Most common nonhormonal cause** - Similar to female human stress incontinence: involuntary release of urine when increased abdominal pressure (sneeze) • Cause: urethral smooth muscle incompetence or urethral malposition	• **Intermittent incontinence under stress** • Able to urinate voluntarily	• **Hx (incontinence when stressed)** • PE: small bladder • Urinalysis: no infection • No radiographic abnormalities	• ↑ **Urethral tone** (alpha sympathetic) - **Phenylpropanolamine** (Triaminic®) or ephedrine (Mudrane®) sympathomimetic alpha-adrenergic agonist available in various cold medicines - Imipramine (Tofranil® tricyclic antidepressant) increases urethral tone Prognosis • **? Good?**

Spayed older female dogs - Sex hormones
CS: Involuntary dribbling
Dx: Hx, CS, Response to Tx
Tx: Diethylstilbestrol

Urinate under stress
Dx: Hx
Tx: ↑ urethra tone - Triaminic

Submissive urination IM 519; CM 487; DDx 565; Sx-G 234 ****	• **Puppies urinating when being petted as a sign of submission** • Common problem • Not true incontinence, although considered inappropriate urination by owners	• **Submissive posture** (exposing abdomen) • Urinating when petted	• Hx (puppies), CS	• **Allow them to grow up** • Don't excite them, slowly approach • Don't scold
Ectopic ureters M8k 1131; Mk 872; SAP 859; IM 517; IM-WW 351; H2B 617, 613t; Sx-WW 161; Sx-S-hb 489; Sx-S 1405; 1443 **	• Abnormal termination of ureters • Congenital anomalies - **young** • Female dogs 20 x males • Breed: Siberian Huskies, Poodles, Wire-Haired Fox Terriers, West Highland & White Terriers • Most frequently terminate in vagina	• Incontinence: continuous or **intermittent dribbling** • Ability to urinate voluntarily • Urine-soaked skin • Dysuria • **Licking at vulva** • Hematuria • Vaginal discharge • Sequela: - Vaginitis - Urinary tract infection (UTI) - Urethral incompetence	• Hx (**young**), CS • Palpation: usually small bladder • Intravenous urography • Retrograde cystourethrogram	• **Surgical transposition** of ureter(s) to trigone area - Check trigone of bladder through a ventral cystostomy for other ureter (25% have bilateral ectopic ureters) - Urinary incontinence may last for several months or permanently - ± **Phenylpropanolamine (Dexatrim®)** (alpha-adrenergic agonists) if urethral incompetence Prognosis: Good????
Patent urachus E-hb 92, 675; I2M 665; IM 521; E 1835; Sx-WW 164; Sx-S 1405, 1454; Pa-T 241 **	• **Urachus**: embryologic communication between urinary bladder & allantoic sac via umbilicus • Normally atrophies after birth to form a fibrous scar at the bladder vortex • Reported in both dog & cat	• **Patent urachus** - **Incontinence** - Passage of urine through umbilicus of young animal - Urine scalding of ventrum • Sequela: - Infection of umbilicus & bladder - UTI	• Hx (young), CS • **Physical exam: urine from umbilicus** • Radiography: - Positive contrast cystography	• **Surgical resection** Prognosis: • **Good???**

Young female - Vagina
SC: Dribbling
Dx: Hx, CS, Rads
Tx: Sx

Embryonic remnant
CS: Dribbling from umbilicus
Dx: Hx, CS, PE
Tx: Surgery

Congenital abnormalities
- Patent urachus
- Urachal diverticulum (nidus for infection)
- Umbilical urachal sinus
- Intra-abdominal urachal cyst

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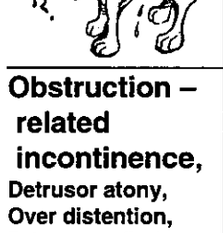
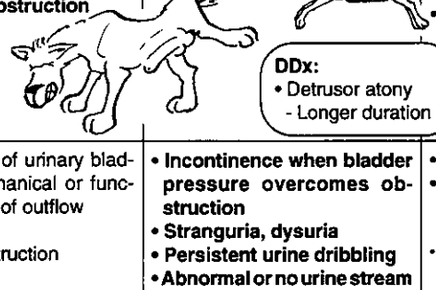
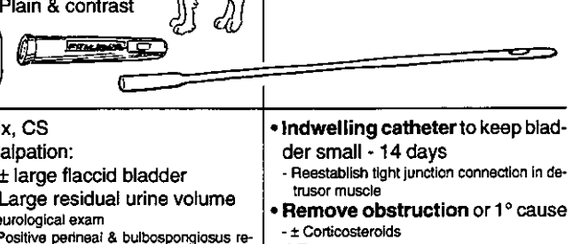
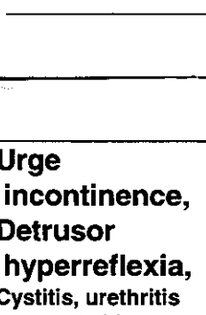
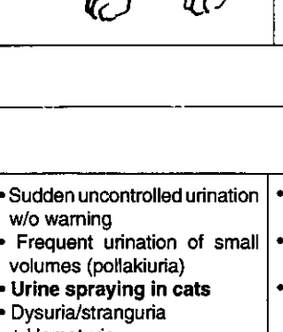
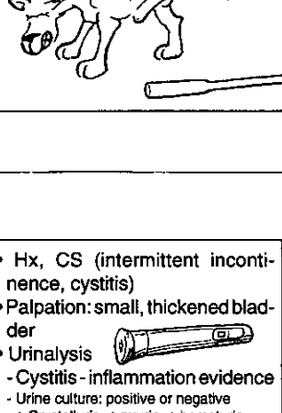
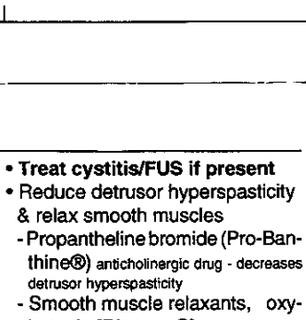
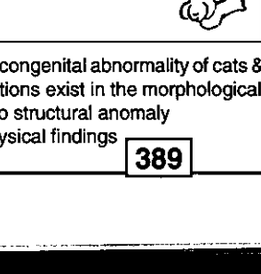
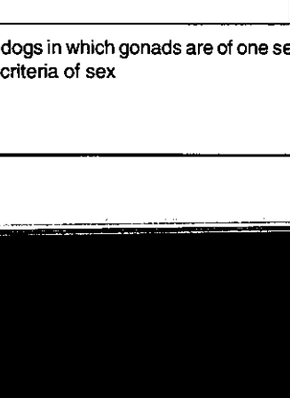
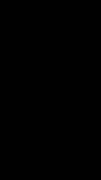
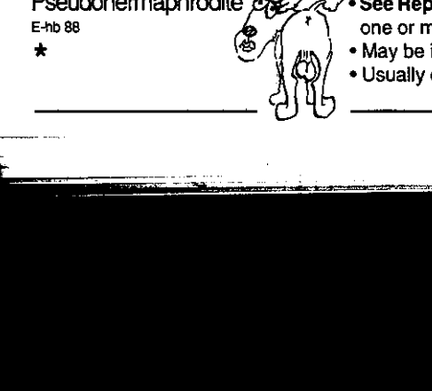
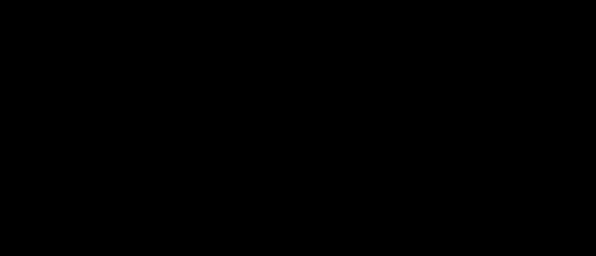
Condition	Facts/Cause	Presentation	Diagnosis	Treatment
Paradoxical incontinence M8k 1141; Mk 884; H2B 617; CM 486; DDx 565; Sx-S-hb 475; Sx-S 1405 ** 	• Involuntary dribbling associated w/ outflow obstruction • Similar to overflow incontinence from detrusor atony (over distention) - Detrusor contractions less effected • **Cause: partial obstruction** - Calculi - Neoplasia - Urethritis	• **Stranguria** • **Dribbling of urine**  **DDx:** • Detrusor atony - Longer duration	• Hx, CS • Palpation: large turgid bladder - difficult/impossible to express • Urethral catheterization if difficult • Urinalysis • Radiography - Plain & contrast 	• **Relieve partial obstruction** - Retropulsion - calculi - Urethrostomy - ureteritis - Surgical exploration - neoplasia • ± Indwelling catheterization: severe urethritis
Obstruction – related incontinence, **Detrusor atony, Over distention, Detrusor areflexia** M8k 1141; Mk 884; SAP 859, H2B 616; I2M 666; IM 517; IM-WW 350; E-hb 92; CM 486; DDx 565 **? 	• **Over distention** of urinary bladder due to mechanical or functional obstruction of outflow • Causes: - Mechanical obstruction . Calculus . Prostatic enlargement . Neoplasia . Severe inflammation . Congenital abnormality . Stricture of urethra - Functional obstruction (may have neurogenic component) . Excessive sympathetic urethral tone • Over distention separates tight junctions of detrusor muscle - Weakens contraction of detrusor muscle • Obstruction prevents normal micturition, but urine leaks when intravesical pressure is high enough	• **Incontinence when bladder pressure overcomes obstruction** • **Stranguria, dysuria** • **Persistent urine dribbling** • **Abnormal or no urine stream** • Sequela: - Urinary tract infection 	• Hx, CS • Palpation: - ± large flaccid bladder - Large residual urine volume • Neurological exam - Positive perineal & bulbospongiosus reflex - Ineffectual detrusor contractions (cystogram) 	• **Indwelling catheter** to keep bladder small - 14 days - Reestablish tight junction connection in detrusor muscle • **Remove obstruction** or 1° cause - ± Corticosteroids • ABs - frequent urinalysis & cultures • **Bethanechol** (Urecholine®) cholinergic to stimulate detrusor contraction (make sure patent first) • Phenoxybenzamine added to bethanechol if urethral resistance  Urecholine® Phenoxybenzamine
Urge incontinence, Detrusor hyperreflexia, **Cystitis, urethritis or prostatitis incontinence** SAP 859; H2B 616, 613t; I2M 665; IM 517; E-hb 88, CM 486; DDx 565 ***	• **Irritation = urge to urinate** - Sudden uncontrolled voiding with little warning - Involuntary detrusor contraction • Common in cats • Cause: - **Inflammation or irritation - cystitis, urethritis, prostatitis** - **FUS in cats** - Idiopathic form in dogs & cats - Hyperactive bladder from CNS dlz (rare)	• Sudden uncontrolled urination w/o warning • Frequent urination of small volumes (pollakiuria) • **Urine spraying in cats** • Dysuria/stranguria • ± Hematuria • Concurrent problem: - Urinary tract infections 	• Hx, CS (intermittent incontinence, cystitis) • Palpation: small, thickened bladder • Urinalysis - Cystitis - inflammation evidence - Urine culture: positive or negative - ± Crystalluria, ± pyuria, ± hematuria • Radiographs: - Cystography: thickened bladder wall 	• **Treat cystitis/FUS if present** • Reduce detrusor hyperspasticity & relax smooth muscles - Propantheline bromide (Pro-Banthine®) anticholinergic drug - decreases detrusor hyperspasticity - Smooth muscle relaxants, oxybutynin [Ditropan®] Pro-Banthine®  Prognosis: Good if cause controlled

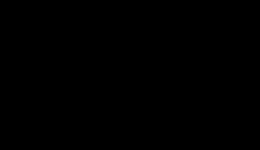


UTI irritation
CS: Pollakiuria, Spraying
Dx: Hx, CS, PE, UA
Tx: Tx UTI or FUS



Pseudohermaphrodite
E-hb 88
*

• **See Repro pg 459: Rare** congenital abnormality of cats & dogs in which gonads are of one sex, but one or more contraindications exist in the morphological criteria of sex
• May be incontinent due to structural anomaly
• Usually diagnosed by physical findings



Hematuria - Proteinuria

Condition	Facts/Causes	Presentation	Diagnosis	Treatment

Urine spraying - Cat

Cat 2, 171, 1475, 2; E-hb 98; H2B 1261; Sx-S-hb 476; Sx-S 1409; Dx-L 390

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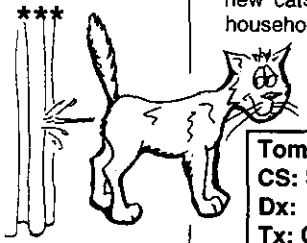
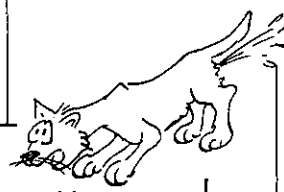
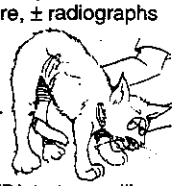


- **Male urine marking his territory**
  - Hormones: intact tomcats more than castrated & intact females more than anestrous queens
  - Stimulated: territorial, sexual. Seeing other cats out window; new cats, visitor or baby into household.

- **Spraying in standing posture, occasionally while squatting**
  - Tail held stiffly up & twitches
  - Not generally accompanied by scratching as it does in normal urination
  - Small amounts



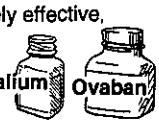
- Hx, CS
- R/O urinary problems: urinalysis, urine culture, ± radiographs



DDx:
- Cystitis
- PU/PD (Diabetes mellitus
- Neurogenic incontinence
- Diabetes insipidus
- Litter box aversion
- Location preference

Tomcat, territorial
CS: Spraying, standing
Dx: Hx, CS; R/O urinary problems
Tx: Castration, Valium, Ovaban •Px: Fair

- **Behavioral therapy**
  - Reduce number of cats in house
  - ↑ or ↓ time outside
  - Place food or toys where spraying occurs
  - Cover windows
  - Introduce new cat into closed room for a few weeks
- **Castration:** reduces in 90% of cases no matter age
- Drug therapy
  - Valium® (diazepam): suppresses in 70% of cats (DOC)
  - Progestin: Ovaban® (megestrol acetate) or medroxyprogesterone acetate (Depo-Provera)
    . Reduces spraying in 30%, many side effects (mammary hypertrophy, cushingoid appearance, or diabetes mellitus, increased appetite, ± increased affection
- Behavior modification is rarely effective, cat will spray when owner not around
- **Leave outside, cull**



Prognosis: **guarded to good**

Elimination problems

Cat 2, 171, 1475; E-hb 98; H2B 1261; IM-WW 351; Sx-S-hb 477; Sx-S 1409

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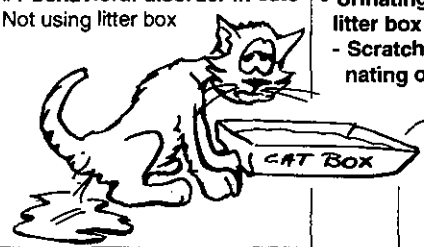
- **#1 behavioral disorder in cats**
- Not using litter box



- **Urinating & defecating outside litter box**
  - **Scratches before & after urinating or defecating**

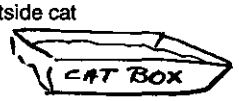
Causes:
- Diseases
  - Cystitis
  - PU/PD (Diabetes mellitus, D. insipidus, pyometra)
  - Diarrhea
  - Neurogenic incontinence
- Litter box aversion
- Location preference

- Hx, CS. PE
- R/O urinary problems
  - Urinalysis
  - Urine culture
  - ± Radiographs

DDx:
- Urine spraying (no scratching)

#1 Behavioral disorder in cats
CS: Urinating & defecating outside litter box
Dx: Hx, CS, R/O
Tx: Tx any diz, Litter box, Clean •Px: Good

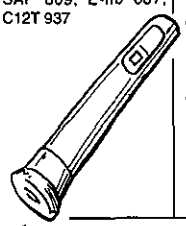
- **Treat any disease process**
- **Make litter box more attractive**
  - Remove urine & feces daily
  - Clean litter box thoroughly weekly
  - Avoid deodorized litter
  - ↑ # of boxes in multicat households (1/cat)
  - Conveniently place litter boxes
  - Change substrates (fine sand litter, or eliminate)
- ↓ Attractiveness of inappropriate places
  - Clean & deodorize areas to eliminate odor (do not use products that use ammonia)
  - Make are a feeding area
  - Change area: newspapers or thick plastic over carpeting, leave standing water in sinks
- Cull or make an outside cat



Prognosis: Good

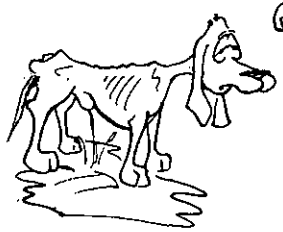
Proteinuria

12M 584, 591; IM 460; SAP 809; E-hb 687; C12T 937



- **Excessive protein in urine**
  - Normally only small amount of protein in urine
  - Clinical finding not a diagnosis
- **Always investigate <u>persistent</u> proteinuria**
  - Does it reflect underlying renal diz (glomerular)?
  - Will diz eventually cause morbidity or death?
- Persistent proteinuria in absence of active urinary sediment is invariably due to renal (glomerular) structural diz even when other aspects of renal function normal
- Main concern is glomerular diz

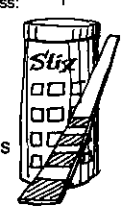
Causes - Proteinuria
- Physiologic/transient/functional:
  - Strenuous exercise
  - Seizures
  - Fever
  - Hyperthermia or hypothermia
  - Stress
  - Decreased activity
- Pathologic:
  - Urinary - nonrenal:
    . Cystourolithiasis
    . UTI - bacterial cystitis
    . Trauma/hemorrhage
    . Tumor
    . Cyclophosphamide cystitis
  - Urinary - renal:
    . **Glomerular diz** (glomerulonephritis, amyloidosis)
    . Abnormal tubular resorption (Fanconi's syndrome)
    . Parenchymal inflammation or hemorrhage (neoplasia or pyelonephritis)
  - Nonurinary/overload proteinuria
    . Bence-Jones proteins (plasma cell myelomas)
    . Hemoglobinuria/myoglobinuria
    . Hyperproteinuria
    . Congestive heart failure
    . Genital tract inflammation (prostatitis, metritis)

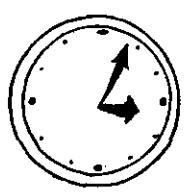


Diagnosis:
- Evaluate significance of proteinuria in relationship to urinary sediment & serum total protein & urine specific gravity
  - Hematuria & pyuria: may be associated with either upper or lower urinary tract
- Detected proteinuria usually by dipstick (semiquantitative)
- Always recheck by repeating urinalysis after several days
  - Sulfosalicyclic acid test (turbidity) (semiquantitative) for 2nd check or to check on 2nd positive dipstick
- If 2nd urinalysis confirms proteinuria: further diagnostic tests
- Check urinary sediment:
  - Occult blood - hematuria (check causes)
  - **Nonactive sediment** (< 8 WBCs/hpf) - glomerular diz
  - Active urinary sediment (> 8 WBCs/hpf) (pyuria) - UTI
    . Treat & recheck urinary protein once UTI controlled
- If glomerular diz suspected (proteinuria + nonactive sediment)
  - **U Pr:Cr ratio** (urine protein:creatine ratio) for quantitative protein loss:
    . More convenient than 24 hour urine collection
    . **Normal values: Dog: < 1, Cat: < 0.5**; Guidelines for dogs:

Pr:Cr < 1	normal or nonglomerular diz
Pr:Cr < 5	glomerulosclerosis or atrophy
Pr:Cr = 5-13	nonamyloid glomerulopathy
Pr:Cr > 13	severe glomerulopathy or amyloidosis

  - Check for hypoproteinemia (glomerular diz)
    . Check for edema & ascites (nephrotic syndrome)
  - Check for hyaline casts (glomerular diz)
- Urine Pr:Cr ratios may be used to monitor therapeutic response

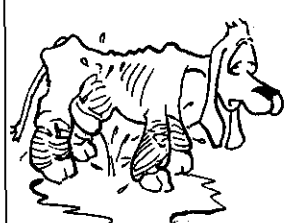




- Pathophysiology:
  - Renal
    . Glomerulus normally keeps large proteins out of urine
    . Smaller proteins mostly reabsorbed by renal tubule
    .. Transport maximum: above which get proteinuria
    . Kidney inflammatory exudate or discharge
  - Lower urinary tract hemorrhage or inflammatory (ureters, urinary bladder &/or urethra) may add protein to urine
  - Physiology causes result in transient permeability of glomerulus

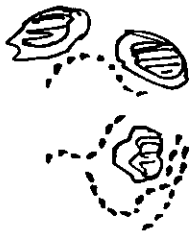
Hyaline casts

Treatment:
- Transient proteinuria usually resolves, recheck urine
- Mild, persistent, isolated proteinuria (clinical significance is uncertain)
  - Conservative
    . Evaluating patient every 3-6 months for presence of proteinuria or progression
- Treat cause of moderate or severe proteinuria
  - UTI - Tx & recheck urine
  - Glomerular diz: difficult & often unrewarding



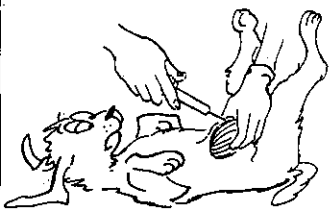
Bacteriuria

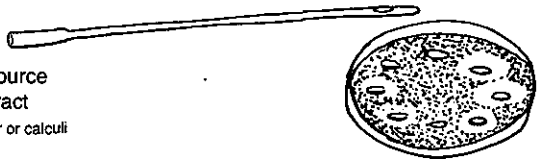
E-hb 653; SAP 827, 800; H2B 597, 1381; IM 450, 470, 497; C11T 910, 913t



- May be seen in normal animals due to contamination from prepuce or vulva or unrefrigerated collected urine
- Cystocentesis or catheterization - evaluate infection
- **Any bacteria in urine collected by cystocentesis is diagnostic of UTI**
- Semiquantitative: ≥ 1 bacteria/hpf (oil) suggestive
- Gram stain & culture for diagnosis & antibiotic sensitivity
  - Kirby-Bauer disk sensitivity
  - MIC (minimum inhibitory concentration) sensitivity test if highly resistant to Kirby-Bauer
- Urinary tract infections
  - Ascent of organisms from external genitalia
  - Hematogenous spread (rare)
- Differentiation of bladder source from renal source
  - Dysuria indicates problem in lower urinary tract
  - Bladder palpation may help: thickening of bladder or calculi may be detected
  - Radiology may be helpful
  - Leukocytosis more common with renal infection
  - Fever: renal > bladder

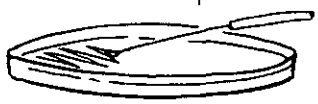
Persistent or recurrent bacteriuria
- Anatomic defects interfering with normal micturition
- Anatomic defects allowing ascent of organisms
- Immune deficiencies
- Inadequate eradication procedures for established infection
- **Chronic prostatitis** (recurrent UTI)





Significant bacteriuria	Dog	Cat
• General rule:	> 100,000 (10^5) bacteria/ml	
• Cystocentesis:	> 0 (>10^4/ml definite)	> 0
• Catheter	> 100,000	> 1,000
• Voided midstream	†	>10,000

Negative urine culture doesn't rule out infection
† 10^3-10^5/ml question & repeat, if similar or greater: significant



Bacteruria/pyuria - Causes
- Urinary tract infections
  - Cystitis
  - Urethritis
  - Pyelonephritis
- Catheterization
- Steroid therapy
- Urolithiasis
- FUS usually sterile
- Genital diz
  - Prostatitis
  - Metritis
  - Genital diz
- Contamination from prepuce or vagina/vulva
- Unrefrigerated urine

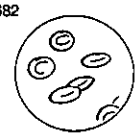
Pyuria

SAP 826; H2B 597; 656

- **Leukocytes** (WBCs) in large numbers in urine
- Suggestive of infection or inflammation
  - Pyuria in absence of bacteria indicative of inflammation or nonbacterial infection (virus, fungal)
- **Pyuria (> 5 WBC/hpf) is suggestive or UTI**
- A midstream catheterization, midstream voided or cystocentesis specimen with greater than 105 organisms/ml is indicative of infection rather than contamination

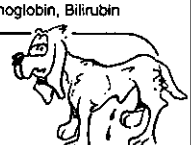
Hematuria

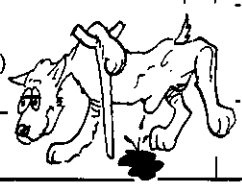
I2M 576; IM 453; Sx-S 1432; DDx 541, E-hb 682



- **Blood in urine**
- Nonspecific finding indicative of abnormal communication between vascular system & lumina of excretory or secretory pathways of genitourinary tract
- Differentiate form pigmenturia
  - Drugs (phenytoin, sulfas, tranquilizers)
  - Infectious agents: Pseudomonas
  - Endogenous products
    . Myoglobin, Hemoglobin, Bilirubin

Causes - Hematuria
- Kidneys
  - Renal parenchymal diz
  - *Dioctophyma renale* (rare)
- Lower urinary tract
  - Bladder: infection, calculi, trauma, neoplasia
  - Urethra: infection, calculi, trauma, neoplasia
- Extraurinary
  - Prostate: infection, abscess, cysts, neoplasia
  - Uterine: infection (pyometra), tumors (TVT)
  - Vagina tumors, trauma
  - Preputial: tumors, trauma
- 2° to systemic diz
  - Bleeding disorders
    . Hemolytic anemia (associated w/ hemoglobinuria)
    . Coagulation disorders
  - Hypercatabolic states
    . Fever
    . Chronic heart failure
    . Exercise-induced hematuria
    . Renal infarcts
    . Heat stroke
- Iatrogenic (catheterization)
- Normal hematuria < 5 hpf

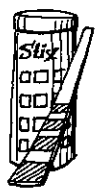




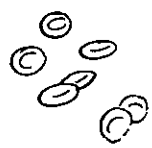
Nonspecific sign

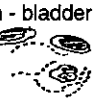
DIFFERENTIAL DIAGNOSIS

Renal hematuria
- ± Systemic signs (depression, lethargy, anorexia, vomiting, diarrhea, weight loss, abdominal pain)
- PE (physical exam)
  - Kidney palpation
  - Observe urination
    . **No dysuria - kidney or systemic**
- UA (urinalysis)
  - **Location throughout urine stream**
  - **RBC casts**
  - Dystrophic RBCs
  - Abnormal cystocentesis (also bladder, ureters or prostate)
  - ± Proteinuria: glomerular diz (if massive = ANA LE prep, electrophoresis, renal biopsy
- Blood & chemistry
  - **± ↑ creatinine, BUN w/o obstruction**
  - Leukocytosis, anemia
- Radiology/Ultrasound: size & contour
  - IV pyelogram: tumors, calculi, obstruction, polycystic diz
  - Arteriography



Lower urinary tract/prostate
- **CS: Dysuria, straining (prostate), vaginal or urethral discharge**
- PE: palpate bladder - distension, ease of expression, calculi or masses
  - Rectal exam: prostate, urethra & uterus
  - Observe urination
    . **Dysuria** ± pollakiuria: bladder, urethra or genitals
    . **Dripping of blood** independent of urination: vagina, uterus or urethra of female/penis, sheath, urethra or prostate of male
  - Location in urine stream
    .. Only at beginning: urethra
    .. End: urinary bladder
    . Catheterization for patency
- UA (urinalysis)
  - Blood at end of urination - bladder
    . Beginning - urethra
  - No RBC casts
  - WBC, bacteria
  - Crystals: calculi; Cytology: tumor cells, norm RBCs
- CBC chem: frequently unrewarding
  - + anemia, ± leukocytosis (rare)
  - Postrenal azotemia (↑ creatinine, BUN) obstruction
- Radiographs/Ultrasound
  - Survey & contrast studies: bladder, prostate, calculi
- Prostatic fluid (massage or ejaculate)



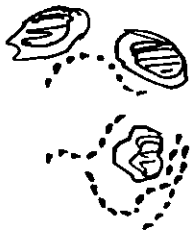


Bleeding disorders, fever or systemic diz
- PE: check mucous membranes
  - Normal micturition
  - Auscultate heart & lungs
- CBC & chemistry:
  - Platelet count/function tests (thrombocytopenia)- Clotting profile: prothrombin time, partial thromboplastin time, activated clotting time (coagulopathies)
  - Von Willebrand's diz
  - Cardiac evaluation

Iatrogenic hematuria
- History of catheterization, discrete spots or swirls in urine, Resolution w/in 24 hours
- Normal RBCs in urine
  - < 5 RBCs per high power field (hpf)
- Pigmenturia
  - No RBCs in urine
  - Spun urine clear in hematuria unless hemolysis

Bacteriuria

E-hb 653; SAP 827, 800; H2B 597, 1381; IM 450, 470, 497; C11T 910, 913t



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Persistent or recurrent bacteriuria
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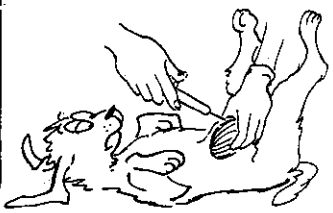
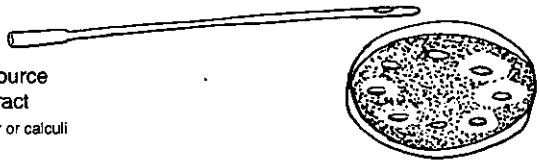
- **Chronic prostatitis** (recurrent UTI)





Bacteruria/pyuria - Causes
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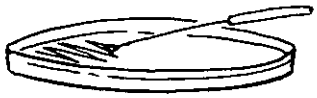
  - Cystitis
  - Urethritis
  - Pyelonephritis
- Catheterization
- Steroid therapy
- Urolithiasis
- FUS usually sterile
- Genital diz
  - Prostatitis
  - Metritis
  - Genital diz
- Contamination from prepuce or vagina/vulva
- Unrefrigerated urine



Significant bacteriuria	Dog	Cat
• General rule:	> 100,000 (10^5) bacteria/ml	
• Cystocentesis:	> 0 (>10^4/ml definite)	> 0
• Catheter	> 100,000	> 1,000
• Voided midstream	†	>10,000

Negative urine culture doesn't rule out infection

† 10^3-10^5/ml question & repeat, if similar or greater: significant

Pyuria

SAP 826; H2B 597; 656

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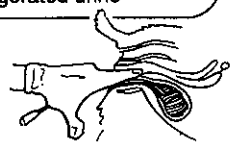
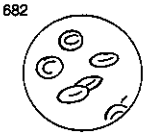
- **Pyuria (> 5 WBC/hpf) is suggestive or UTI**
- A midstream catheterization, midstream voided or cystocentesis specimen with greater than 105 organisms/ml is indicative of infection rather than contamination



Hematuria

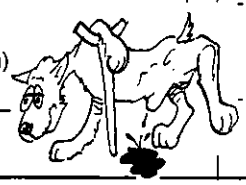
I2M 576; IM 453; Sx-S 1432; DDx 541, E-hb 682



- **Blood in urine**
- Nonspecific finding indicative of abnormal communication between vascular system & lumina of excretory or secretory pathways of genitourinary tract
- Differentiate form pigmenturia
  - Drugs (phenytoin, sulfas, tranquilizers)
  - Infectious agents: Pseudomonas
  - Endogenous products
    . Myoglobin, Hemoglobin, Bilirubin

Causes - Hematuria

- Kidneys
  - Renal parenchymal diz
  - *Dioctophyma renale* (rare)
- Lower urinary tract
  - Bladder: infection, calculi, trauma, neoplasia
  - Urethra: infection, calculi, trauma, neoplasia
- Extraurinary
  - Prostate: infection, abscess, cysts, neoplasia
  - Uterine: infection (pyometra), tumors (TVT)
  - Vagina tumors, trauma
  - Preputial: tumors, trauma
- 2° to systemic diz
  - Bleeding disorders
    . Hemolytic anemia (associated w/ hemoglobinuria)
    . Coagulation disorders
  - Hypercatabolic states
    . Fever
    . Chronic heart failure
    . Exercise-induced hematuria
    . Renal infarcts
    . Heat stroke
- Iatrogenic (catheterization)
- Normal hematuria < 5 hpf

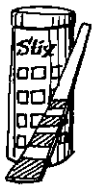


Nonspecific sign

DIFFERENTIAL DIAGNOSIS

Renal hematuria

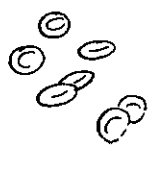
- ± Systemic signs (depression, lethargy, anorexia, vomiting, diarrhea, weight loss, abdominal pain)
- PE (physical exam)
  - Kidney palpation
  - Observe urination
    . **No dysuria - kidney or systemic**
- UA (urinalysis)
  - **Location throughout urine stream**
  - **RBC casts**
  - Dystrophic RBCs
  - Abnormal cystocentesis (also bladder, ureters or prostate)
  - ± Proteinuria: glomerular diz (if massive = ANA LE prep, electrophoresis, renal biopsy



- Blood & chemistry
  - ± ↑ **creatinine, BUN w/o obstruction**
  - Leukocytosis, anemia
- Radiology/Ultrasound: size & contour
  - IV pyelogram: tumors, calculi, obstruction, polycystic diz
  - Arteriography

Lower urinary tract/prostate

- **CS: Dysuria, straining (prostate), vaginal or urethral discharge**
- PE: palpate bladder - distension, ease of expression, calculi or masses
  - Rectal exam: prostate, urethra & uterus
  - Observe urination
    . **Dysuria** ± pollakiuria: bladder, urethra or genitals
    . **Dripping of blood** independent of urination: vagina, uterus or urethra of female/penis, sheath, urethra or prostate of male
  - Location in urine stream
    .. Only at beginning: urethra
    .. End: urinary bladder
    . Catheterization for patency



- UA (urinalysis)
  - Blood at end of urination - bladder
    . Beginning - urethra
  - No RBC casts
  - WBC, bacteria
  - Crystals: calculi; Cytology: tumor cells, norm RBCs
- CBC chem: frequently unrewarding
  - + anemia, ± leukocytosis (rare)
  - Postrenal azotemia (↑ creatinine, BUN) obstruction
- Radiographs/Ultrasound
  - Survey & contrast studies: bladder, prostate, calculi
- Prostatic fluid (massage or ejaculate)

Bleeding disorders, fever or systemic diz

- PE: check mucous membranes
  - Normal micturition
  - Auscultate heart & lungs
- CBC & chemistry:
  - Platelet count/function tests (thrombocytopenia)- Clotting profile: prothrombin time, partial thromboplastin time, activated clotting time (coagulopathies)
  - Von Willebrand's diz
  - Cardiac evaluation

Iatrogenic hematuria

- History of catheterization, discrete spots or swirls in urine, Resolution w/in 24 hours
- Normal RBCs in urine
  - < 5 RBCs per high power field (hpf)
- Pigmenturia
  - No RBCs in urine
  - Spun urine clear in hematuria unless hemolysis

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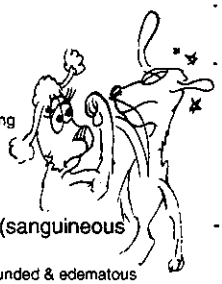
Estrous/Reproductive cycle - Bitch

E-hb 605; IM 633; E 1604; SAP 932; H2B 637; I2M 838; R-M 453, 463; R-R 676, 411; Endo 320; DDx 377; Sx-S-hb 440; Sx-S 1294; NB 19.5, 19.6

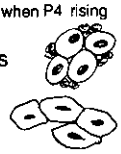
- **Bitch: monestrous: 1-3 cycles per year**
  - . Independent of season of the year in most breeds
  - . Basenji: 1 season annually, in the spring (m/b sled-dogs also)
  - . German Shepherd will cycle every five to six months
- **Interestrus interval**: time betw. 2 consecutive estrous cycles **7 months (4-13)**, variable within bitch (can't predict next interval); smaller breeds - shorter cycles than large breeds

- Sequence of estrous cycle: bitch
  - Proestrus (swelling & bleeding)
  - Estrus (accepts male)
  - Metestrus/Diestrus (abrupt loss of cornified cells)
  - Anestrus (low progesterone levels)
  - **"Heat" or "season"**: proestrus & estrus (follicular phase of cycle, sexual activity) (breeders use term "heat" for period of sexual receptivity [estrus] only)
    - . Body size has no influence on length of time in "heat"



Parts of estrous cycle

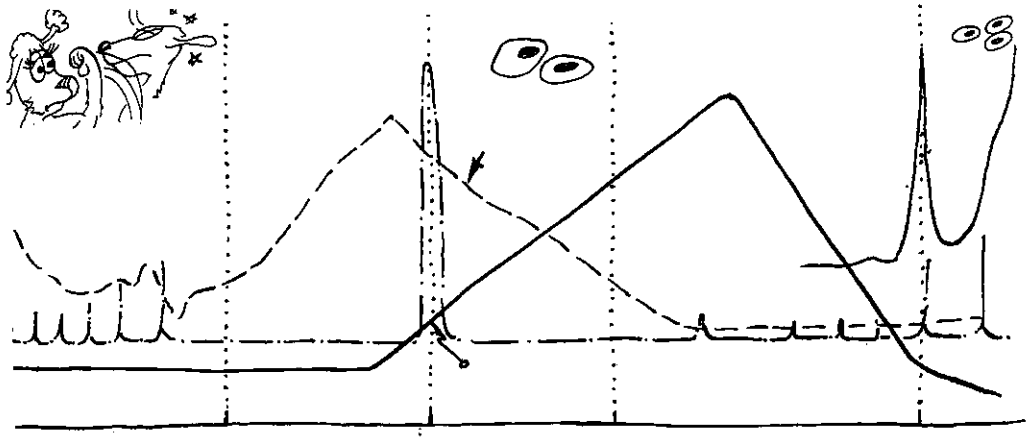
- **Proestrus**: begins when vulvular swelling & bleeding 1st noted, ends when bitch is receptive to male
  - Duration: 9 days (3-17 days)
  - Physical changes:
    - . **Vulvular swelling, bleeding** (sanguineous discharge)
    - . Vaginoscopy: vaginal folds enlarged, rounded & edematous
  - Behavioral changes:
    - . **Start: bitch sexually attractive to, but rejects males** (growling & biting), may occur before swelling of vulva
  - Endocrine profile:
    - . **Estrogen**: gradual ↑ in plasma (17-ß-estradiol [17-ß-E]) secreted by developing ovarian follicles until 1-2 days before LH surge, then decreases rapidly
      - .. Cause proliferation & maturation (cornification) of vaginal epithelium
      - .. Other target tissues: growth of mammary ducts & tubules; proliferation of oviductal fimbria; elongation of uterine horns; thickening of oviduct & uterine lining; diapedesis of RBC through endometrium; enlargement of cervix; elongation & edema of the vagina
    - . **Progesterone (P4)**: low early (baseline), begins to rise at end of proestrus **(initial rise > 2 ng/ml)** (P4 from granulosa cells (preovulatory luteinization)
      - .. Behavioral estrus depends on a proper ratio of P4 & 17-ß-E
      - .. Unlike other domestic species, signs of estrus occur when P4 rising
  - **Vaginal cytology:**
    - . Early proestrus: > 80% noncornified cells
    - . Late proestrus: > 70% cornified cells
    - . RBCs throughout proestrus
    - . WBCs decrease in number
    - . ± Extracellular bacteria throughout proestrus & estrus

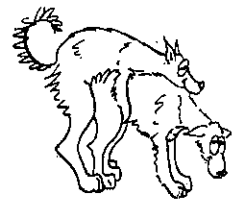


- **Estrus**: acceptance of male
  - Duration: 9 days (3-21 days)
  - Physical changes: Vulvar swelling, decreased vaginal discharge; straw color (reduced diapedesis/RBCs)
  - Behavioral changes:
    - . **Start: acceptance of male; End: refusal**
    - . **Standing heat** (stand firmly with hindquarters & vulva in a lordosis-like position)
    - . **"Flagging"** (deviate tail to the side) to help intromission
  - Endocrine profile:
    - . LH surge usually at onset of behavioral estrus
    - . **Ovulation 2 days** (1-3 days) after LH surge
    - . **P4 continues rise** started at end of proestrus
  - **Vaginal cytology:**
    - . **90% Cornified cells** (superficial & anuclear squamous cells)
    - . No neutrophils (PMNs) & clear background
    - . ± RBCs & bacteria (normal)

- **Metestrus/diestrus: refuses mate**
  - Duration 75 days (60-90 days)
  - Physical changes: none to mark start
  - Behavioral changes: none, except:
    - . **1st day female stops accepting male**
    - . If pregnancy or pseudopregnancy occur, behavioral changes in time
  - Endocrine Profile:
    - . Early metestrus: serum P4 increases to about day 25 then gradually declines over the next 5-6 weeks, end baseline level < 2 mg/ml
      - .. P4 similar for mated & unmated bitches
  - Vaginal cytology:
    - . **Diestral shift - 1st day: sudden marked decline in cornified cells** & return of small intermediates, parabasal & WBC cells (parabasal & intermediate cells outnumber cornified cells)
      - .. **Record: retrospective indicator time of LH peak & ovulation & when will whelp** (7-9 days after the LH peak, 5-7 days after ovulation)
      - .. Bred at right time if between 8 & 4 days before 1st day of diestrus
    - . Reappearance of PMNs & background debris, RBCs & bacteria disappear
  - End of diestrus: parturition or false pregnancy

- **Anestrus: period of sexual quiescence**, follows diestrus & stops w/ next proestrus (bleeding & swelling)
  - Endometrium sloughs, repair takes 120 days after nonpregnant cycles & 150 days after pregnant cycle
  - Duration: average 4.5 months - variable
  - Physical & behavioral changes: not apparent
  - Endocrine profile:
    - . P4: basal concentrations
    - . E17B levels fluctuate with waves of follicular development
  - Mechanisms for termination of the anestrus phase & initiating a new follicular phase is unknown





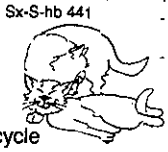
Hormones - estrus cycle
- Estrogen: gradual rise in proestrus
- Progesterone: low early, rises at end of proestrus
- LH surge within 24 hr of P4 rise (above 1 ng/ml)
- Ovulation in 24-48 hr of LH surge
- P4 increases to about day 25 of diestrus

ESTROUS CYCLE - BITCH

Stage	Duration	Physical changes	Behavioral changes	Endocrine profile	Vaginal cytology
Proestrus:	9 d (3-17)	Vulva swelling **Bleeding**	**Attracting males** Refuses copulation	Estrogen: gradually increasing Progesterone (P4): baseline, **initial rises at end (> 2 ng/ml)**	Early: > 80% intermediate & parabasal Late: > 70% cornified cells RBCs, decreasing WBCs, ± Bacteria
Estrus	9 d (3-21d)	Vulvar swelling, softer Straw-colored discharge	**Acceptance of male** Standing heat, Flagging	LH surge on first day of estrus P4: steady rise E17B - declining to baseline	**90% cornified cells** No PMNs & clear background ± RBCs
Diestrus metestrus	75 d (60-90 d)	Vulva decreases & mammary glands enlarge	**Again refuses male**	Early: P4 increases to day 25 then declines for 5-6 weeks	**Sudden drop in cornified cells** Return of WBCs
Anestrus:		Not apparent	None	P4 & testosterone - basal levels Serum FSH increased ± LH sporadic increases	Parabasal & small intermediate cells ± RBCs

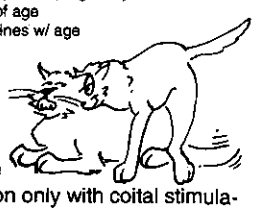
Queen - Estrous cycle

E-hb 628; I2M 842; IM 636; E 1690; F 303; Cat 1855, 1847; F-N 458; R-R 698, 411; R-M 795; E&R 741; Endo 320; DDx 381; Sx-S-hb 441



- **Seasonally polyestrous**
  - United States: Jan-Oct = cycling
    . Nov & Dec = anestrous period
  - Cycle controlled by photoperiod
    - 12 -14 hours of daylight needed to cycle
    - < 12 hours of light causes anestrus
  - Artificial light (50 ft-c) can result in year round cycling
- Puberty: first estrus: 7 (5-12) months of age
  - Factors effecting start of puberty:
    . Delayed if during anestrus season (Oct-Dec)
    . Earlier in free roaming cats, than in confined
    . Breed: later in Himalayans & Persians (long haired) than Siamese & Burmese (short haired)
    . Poor nutritional status delays start
    . Speeds up: exposure to intact, sexually active cats

  - Signs of first estrus usually mild & brief
  - Once cycling established, it occurs at regular intervals until interrupted by seasonal effects, pregnancy or pseudopregnancy
  - Breed no sooner than 12 months of age
  - Sexually active to age 14, but declines w/ age

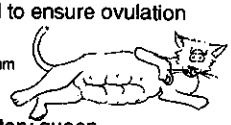


Estrus cycle/ovarian cycle

- **Induced ovulator**: ovulation only with coital stimulation (bitch is spontaneous ovulator)
- Duration & course of cycle depend on mating
  - Ovulation follows, conception results, pregnancy & lactation
- Cycles: anovulatory & ovulatory in the queen
  - Anovulatory cycle: every 2 - 3 weeks (aver. 18 days); interestrus interval: 9 -13 days (no luteal phase occurs)

- Proestrus: lasts for 0.5 - 3 days
  - Usually not observed, short & no obvious swelling or bleeding as in bitch.
  - Starts to show estrus behavior, but won't breed
  . ↑ Affection, rubbing, vocalization, restlessness, rolling, treading in place

- **Estrus**: period of maximum sexual receptivity
  - Duration: varies: 1-10 days
    . 1-4 days if male is present
    . 7-10 days if male not present & recurs again every 2-3 weeks
    . Influenced by breed, mating & season of the year (longer in the spring)
  - Few physical changes seen (vulva may be slightly swollen with a mucoid discharge)
  - Behavioral:
    . Vocalization (deep cries), restlessness, rolling, treading in place
    . Estral crouch (lordosis, treading, & lateral deviation of the tail)
    . Behavior intensifies when dorsal lumbar region rubbed, vulva massaged, or in presence of a Tom
    . Anorexia & urine spraying can occur during estrus
    . ± Bloody vaginal discharge if excessive mating following ovulation
    . Breeding behavior may persist for 1-2 days if ovulation fails to occur & follicles regress
  - Ovulation: coitus causes LH release & if sufficient ovulation in 48 hours
    . < 50% ovulate with 1 breeding
    . > 90% ovulate if bred 3 x/day for 3 days
    . Multiple breedings needed to ensure ovulation



- Diestrus/metestrus: corpus luteum forming (metestrus), actively secreting progesterone (diestrus)
  - Does not occur in nonovulatory queen
  - Ovulation w/o fertilization (spontaneous rare, sham copulation, or sterile mating): 45 (35-70) days
  - Ovulation + fertilization: 63-66 days until birth
  - 10% of pregnant cats will show estrus behavior & mate during 3rd & 6th weeks or gestation
    . This may result in superfetation
- Anestrus: sexual quiescence:
  - Seasonal: when light < 12 hours/day - Nov-Dec
  - Lactational (6-8 wk): rarely cycle while nursing, estrus usually 2-3 weeks after weaning
    . Postpartum estrus shorter & less fertile than others

Vaginal cytology: generally not used in the queen

- Behavioral changes proceed changes in vaginal cytology so it is not a reliable predictor of estrus in the cat

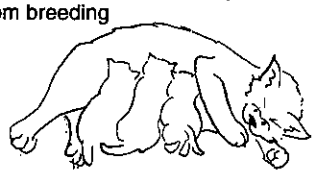
Can induce ovulation by physical / hormonal stimulation

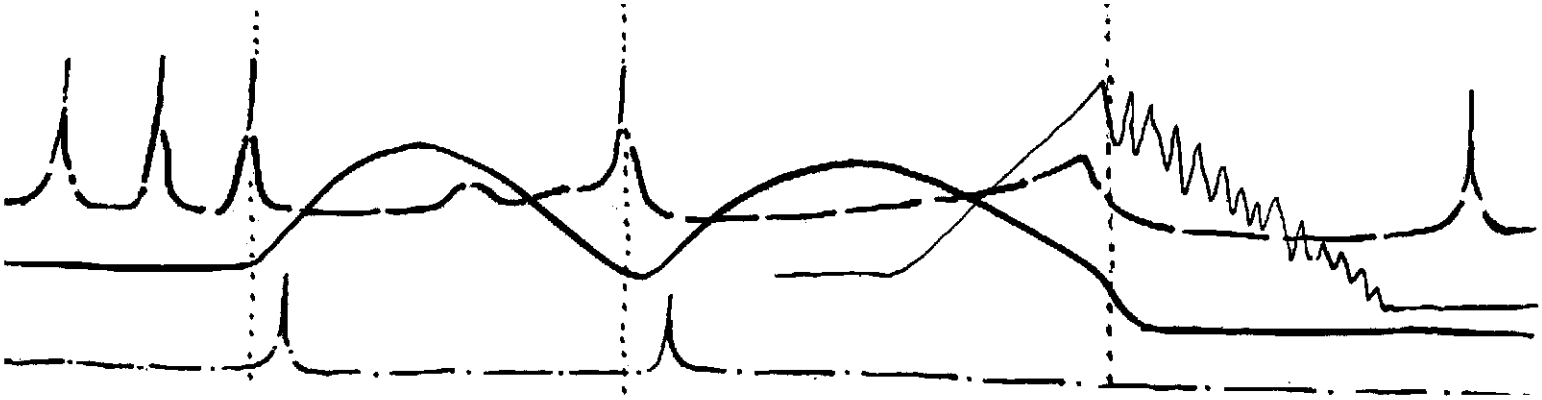
Reproductive hormones:

- Luteinizing hormone (LH): mating necessary for release
- Progesterone (P4)
  - Cycling queen: basal concentrations
  - Pregnant queen: increases 3-4 days after breeding & peaks at day 21 of gestation, then gradually decreases during gestation
    . 4 - 5 times basal levels just prior to parturition
  - Pseudopregnant queen: persists for 30-50 days; levels parallel pregnant queen & drop to near basal concentration by day 50 post breeding
- Estradiol (E): elevated during estrus

Litter size: 2-5 kittens is normal

- Optimum, reproductive age: 1-5 years old
- Reproduction performance declines after 6 years
- Retire most cats from breeding after 8 years of age

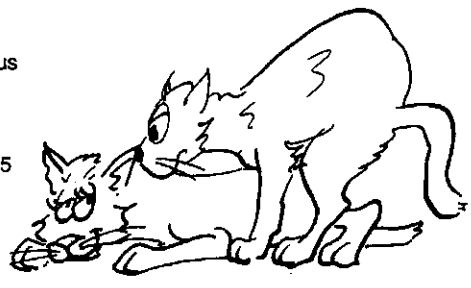




ESTROUS CYCLE - QUEEN

Stage	Duration	Physical changes	Behavioral changes	Endocrine profile
Proestrus:	0.5-3 d	Very little	**Affection, rubbing, treading** Refuses copulation	Estrogen: gradually increases Progesterone (P4): baseline
Estrus	9 d (3-21)	Very little	**Vocalization** Estrual posturing Breeding	LH surge on first day of estrus P4: steady rise
Metestrus diestrus	75 d (60-90)		**Again refuses male**	Early: P4 increases to day 25 then declines for 5-6 weeks
Anestrus:			None	

Vaginal cytology: generally not used in cat



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Estrous/Reproductive cycle - Bitch

E-hb 605; IM 633; E 1604; SAP 932; H2B 637; I2M 838; R-M 453, 463; R-R 676, 411; Endo 320; DDx 377; Sx-S-hb 440; Sx-S 1294; NB 19.5, 19.6

- **Bitch: monestrous: 1-3 cycles per year**
  - . Independent of season of the year in most breeds
  - . Basenji: 1 season annually, in the spring (m/b sled-dogs also)
  - . German Shepherd will cycle every five to six months
- **Interestrus interval**: time betw. 2 consecutive estrous cycles **7 months** (4-13), variable within bitch (can't predict next interval); smaller breeds - shorter cycles than large breeds

- Sequence of estrous cycle: bitch
  - Proestrus (swelling & bleeding)
  - Estrus (accepts male)
  - Metestrus/Diestrus (abrupt loss of cornified cells)
  - Anestrus (low progesterone levels)
- **"Heat"** or **"season"**: proestrus & estrus (follicular phase of cycle, sexual activity) (breeders use term "heat" for period of sexual receptivity [estrus] only)
  - . Body size has no influence on length of time in "heat"

Parts of estrous cycle

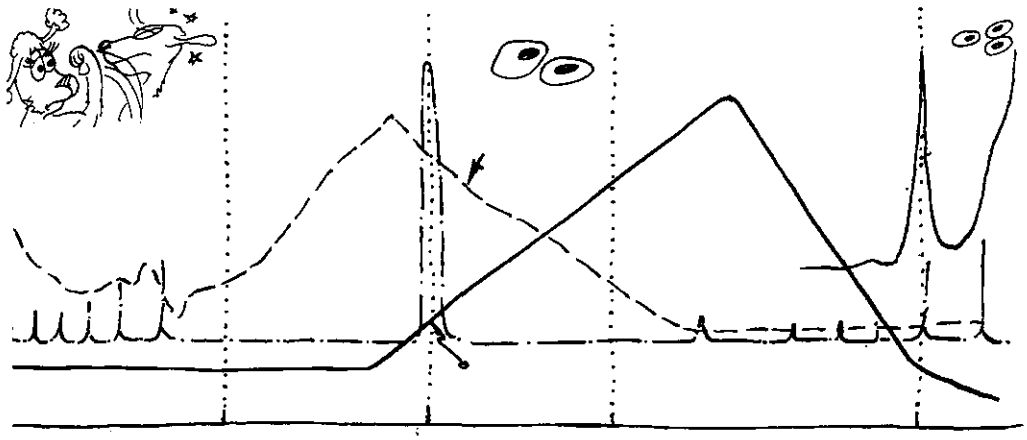
- **Proestrus**: begins when vulvular swelling & bleeding 1st noted, ends when bitch is receptive to male
  - Duration: 9 days (3-17 days)
  - Physical changes:
    - . **Vulvular swelling, bleeding** (sanguineous discharge)
    - . Vaginoscopy: vaginal folds enlarged, rounded & edematous
  - Behavioral changes:
    - . **Start: bitch sexually attractive to, but rejects males** (growling & biting), may occur before swelling of vulva
  - Endocrine profile:
    - . **Estrogen**: gradual ↑ in plasma (17-β-estradiol [17-β-E]) secreted by developing ovarian follicles until 1-2 days before LH surge, then decreases rapidly
      - .. Cause proliferation & maturation (cornification) of vaginal epithelium
      - .. Other target tissues: growth of mammary ducts & tubules; proliferation of oviductal fimbria; elongation of uterine horns; thickening of oviduct & uterine lining; diapedesis of RBC through endometrium; enlargement of cervix; elongation & edema of the vagina
    - . **Progesterone (P4)**: low early (baseline), begins to rise at end of proestrus **(initial rise > 2 ng/ml)** (P4 from granulosa cells (preovulatory luteinization)
      - .. Behavioral estrus depends on a proper ratio of P4 & 17-β-E
      - .. Unlike other domestic species, signs of estrus occur when P4 rising
  - **Vaginal cytology:**
    - . Early proestrus: > 80% noncornified cells
    - . Late proestrus: > 70% cornified cells
    - . RBCs throughout proestrus
    - . WBCs decrease in number
    - . ± Extracellular bacteria throughout proestrus & estrus

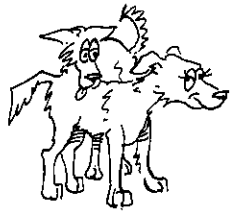
- **Estrus**: acceptance of male
  - Duration: 9 days (3-21 days)
  - Physical changes: Vulvar swelling, decreased vaginal discharge: straw color (reduced diapedesis/RBCs)
  - Behavioral changes:
    - . **Start: acceptance of male; End: refusal**
    - . **Standing heat** (stand firmly with hindquarters & vulva in a lordosis-like position)
    - . **"Flagging"** (deviate tail to the side) to help intromission

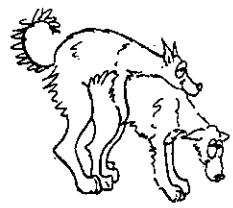
  - Endocrine profile:
    - . LH surge usually at onset of behavioral estrus
    - . **Ovulation 2 days** (1-3 days) after LH surge
    - . **P4 continues rise** started at end of proestrus
  - **Vaginal cytology:**
    - . **90% Cornified cells** (superficial & anuclear squamous cells)
    - . No neutrophils (PMNs) & clear background
    - . ± RBCs & bacteria (normal)

- **Metestrus/diestrus: refuses mate**
  - Duration 75 days (60-90 days)
  - Physical changes: none to mark start
  - Behavioral changes: none, except:
    - . **1st day female stops accepting male**
    - . If pregnancy or pseudopregnancy occur, behavioral changes in time
  - Endocrine Profile:
    - . Early metestrus: serum P4 increases to about day 25 then gradually declines over the next 5-6 weeks, end baseline level < 2 mg/ml
      - .. P4 similar for mated & unmated bitches
  - Vaginal cytology:
    - . **Diestral shift - 1st day: sudden marked decline in cornified cells** & return of small intermediates, parabasal & WBC cells (parabasal & intermediate cells outnumber cornified cells)
      - .. **Record: retrospective indicator time of LH peak & ovulation & when will whelp** (7-9 days after the LH peak, 5-7 days after ovulation)
      - .. Bred at right time if between 8 & 4 days before 1st day of diestrus
    - . Reappearance of PMNs & background debris, RBCs & bacteria disappear
  - End of diestrus: parturition or false pregnancy

- **Anestrus: period of sexual quiescence**, follows diestrus & stops w/ next proestrus (bleeding & swelling)
  - Endometrium sloughs, repair takes 120 days after nonpregnant cycles & 150 days after pregnant cycle
  - Duration: average 4.5 months - variable
  - Physical & behavioral changes: not apparent
  - Endocrine profile:
    - . P4: basal concentrations
    - . E17B levels fluctuate with waves of follicular development
  - Mechanisms for termination of the anestrus phase & initiating a new follicular phase is unknown







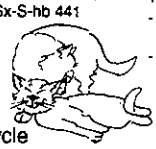
Hormones - estrus cycle
- Estrogen: gradual rise in proestrus
- Progesterone: low early, rises at end of proestrus
- LH surge within 24 hr of P4 rise (above 1 ng/ml)
- Ovulation in 24-48 hr of LH surge
- P4 increases to about day 25 of diestrus

ESTROUS CYCLE - BITCH

Stage	Duration	Physical changes	Behavioral changes	Endocrine profile	Vaginal cytology
Proestrus:	9 d (3-17)	Vulva swelling **Bleeding**	**Attracting males** Refuses copulation	Estrogen: gradually increasing Progesterone (P4): baseline, **initial rises at end (> 2 ng/ml)**	Early: > 80% intermediate & parabasal Late: > 70% cornified cells RBCs, decreasing WBCs, ± Bacteria
Estrus	9 d (3-21d)	Vulvar swelling, softer Straw-colored discharge	**Acceptance of male** Standing heat, Flagging	LH surge on first day of estrus P4: steady rise E17B - declining to baseline	**90% cornified cells** No PMNs & clear background ± RBCs
Diestrus metestrus	75 d (60-90 d)	Vulva decreases & mammary glands enlarge	**Again refuses male**	Early: P4 increases to day 25 then declines for 5-6 weeks	**Sudden drop in cornified cells** Return of WBCs
Anestrus:		Not apparent	None	P4 & testosterone - basal levels Serum FSH increased ± LH sporadic increases	Parabasal & small intermediate cells ± RBCs

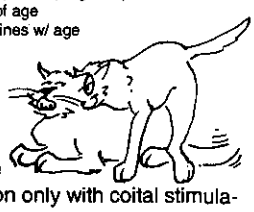
Queen - Estrous cycle

E-hb 628; I2M 842; IM 636; E 1690; F 303; Cat 1855, 1847; F-N 458; R-R 698, 411; R-M 795; E&R 741; Endo 320; DDx 381; Sx-S-hb 441



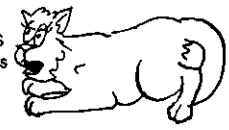
- **Seasonally polyestrous**
  - United States: Jan-Oct = cycling
    . Nov & Dec = anestrous period
  - Cycle controlled by photoperiod
    - 12 -14 hours of daylight needed to cycle
    - < 12 hours of light causes anestrous
  - Artificial light (50 ft-c) can result in year round cycling
- Puberty: first estrus: 7 (5-12) months of age

  - Factors effecting start of puberty:
    . Delayed if during anestrus season (Oct-Dec)
    . Earlier in free roaming cats, than in confined
    . Breed: later in Himalayans & Persians (long haired) than Siamese & Burmese (short haired)
    . Poor nutritional status delays start
    . Speeds up: exposure to intact, sexually active cats
  - Signs of first estrus usually mild & brief
  - Once cycling established, it occurs at regular intervals until interrupted by seasonal effects, pregnancy or pseudopregnancy
  - Breed no sooner than 12 months of age
  - Sexually active to age 14, but declines w/ age

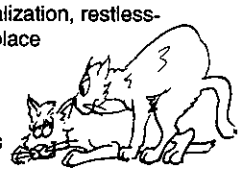


Estrus cycle/ovarian cycle

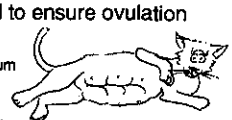
- **Induced ovulator**: ovulation only with coital stimulation (bitch is spontaneous ovulator)
- Duration & course of cycle depend on mating
  - Ovulation follows, conception results, pregnancy & lactation
- Cycles: anovulatory & ovulatory in the queen
  - Anovulatory cycle: every 2 - 3 weeks (aver. 18 days); interestrus interval: 9 -13 days (no luteal phase occurs)



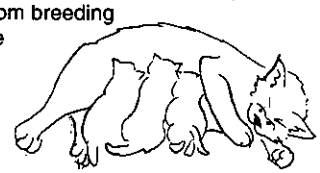
- Proestrus: lasts for 0.5 - 3 days
  - Usually not observed, short & no obvious swelling or bleeding as in bitch.
  - Starts to show estrus behavior, but won't breed
  . ↑ Affection, rubbing, vocalization, restlessness, rolling, treading in place



- **Estrus**: period of maximum sexual receptivity
  - Duration: varies: 1-10 days
    . 1-4 days if male is present
    . 7-10 days if male not present & recurs again every 2-3 weeks
    . Influenced by breed, mating & season of the year (longer in the spring)
  - Few physical changes seen (vulva may be slightly swollen with a mucoid discharge)
  - Behavioral:
    . Vocalization (deep cries), restlessness, rolling, treading in place
    . Estral crouch (lordosis, treading, & lateral deviation of the tail)
    . Behavior intensifies when dorsal lumbar region rubbed, vulva massaged, or in presence of a Tom
    . Anorexia & urine spraying can occur during estrus
    . ± Bloody vaginal discharge if excessive mating following ovulation
    . Breeding behavior may persist for 1-2 days if ovulation fails to occur & follicles regress
  - Ovulation: coitus causes LH release & if sufficient ovulation in 48 hours
    . < 50% ovulate with 1 breeding
    . > 90% ovulate if bred 3 x/day for 3 days
    . Multiple breedings needed to ensure ovulation



- Diestrus/metestrus: corpus luteum forming (metestrus), actively secreting progesterone (diestrus)
  - Does not occur in nonovulatory queen
  - Ovulation w/o fertilization (spontaneous rare, sham copulation, or sterile mating): 45 (35-70) days
  - Ovulation + fertilization: 63-66 days until birth
  - 10% of pregnant cats will show estrus behavior & mate during 3rd & 6th weeks or gestation
    . This may result in superfetation



- Anestrus: sexual quiescence:
  - Seasonal: when light < 12 hours/day - Nov-Dec
  - Lactational (6-8 wk): rarely cycle while nursing, estrus usually 2-3 weeks after weaning
    . Postpartum estrus shorter & less fertile than others

Vaginal cytology: generally not used in the queen

- Behavioral changes proceed changes in vaginal cytology so it is not a reliable predictor of estrus in the cat

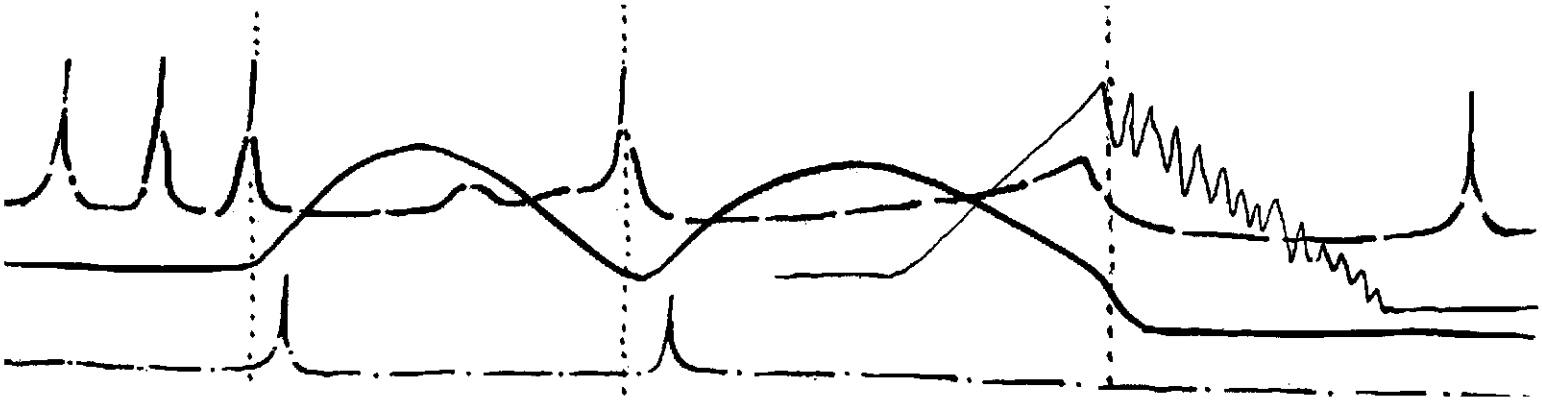
Can induce ovulation by physical / hormonal stimulation

Reproductive hormones:

- Luteinizing hormone (LH): mating necessary for release
- Progesterone (P4)
  - Cycling queen: basal concentrations
  - Pregnant queen: increases 3-4 days after breeding & peaks at day 21 of gestation, then gradually decreases during gestation
    . 4 - 5 times basal levels just prior to parturition
  - Pseudopregnant queen: persists for 30-50 days; levels parallel pregnant queen & drop to near basal concentration by day 50 post breeding
- Estradiol (E): elevated during estrus

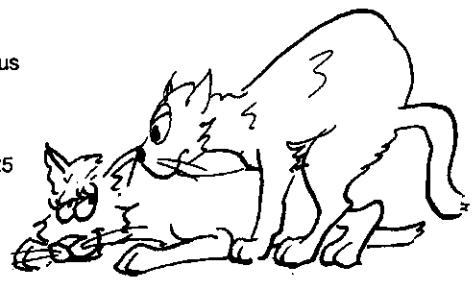
Litter size: 2-5 kittens is normal

- Optimum, reproductive age: 1-5 years old
- Reproduction performance declines after 6 years
- Retire most cats from breeding after 8 years of age



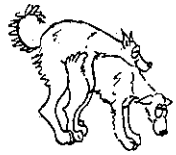
ESTROUS CYCLE - QUEEN

Stage	Duration	Physical changes	Behavioral changes	Endocrine profile	Vaginal cytology: generally not used in cat
Proestrus:	0.5-3 d	Very little	**Affection, rubbing, treading** Refuses copulation	Estrogen: gradually increases Progesterone (P4): baseline	
Estrus	9 d (3-21)	Very little	**Vocalization** Estrual posturing Breeding	LH surge on first day of estrus P4: steady rise	
Metestrus diestrus	75 d (60-90)		**Again refuses male**	Early: P4 increases to day 25 then declines for 5-6 weeks	
Anestrus:			None		



Mating - dogs

E-hb 605; I2M 840; IM 633; IM-WW 417; SAP 932; H2B 639t; 5min 24; E 1605; R-M 461, 465; E&R 544, 547; C12T 1043; Sx-S-hb 440; Sx-S 1294; NB 19.5



Memory aid for estrus detection & breeding:
"Breed when will until won't"

- **1st day to breed - 1st day of estrus**
  - -1st day of standing heat (#1 -when female will breed)
  - Day of LH surge
  - Initial progesterone rise
  - Day ≥ 90% cells cornified
  - Roughly 10 days after start of proestrus (proestrus starts with swelling, bleeding [show color] & attract males)

- **Management failure to breed animals at right time #1 cause of infertility (failure to become pregnant)**
  - Often breed on a predetermined day after vagina shows color (start of proestrus) often 10th day; not by using behavior or cytological or assay
    . This is a problem if bitch has short proestrus
- Behavior: let animals tell when estrus starts
  - **Start of proestrus: bleeding & swelling of bitch,** attracts males, but bitch refuses copulation
  - Bring pair together every other day starting at day 5 of proestrus & let breed when will & every other day or every 3rd to 4th day until they won't breed (breeding every other day is a common practice & possibly excessive, but dogs generally don't mind!
  - **"Flagging"**: stroke bitch near tailhead & she will "flag" (elevate tail to one side) if she is receptive - get her to male

This is simplest & cheapest for client. Cytology & hormonal assays can help, but don't let them make you miss standing estrus - animals usually know best

If there is a infertility problem or artificial insemination is practiced other estrus detection methods become more important

- Minimum breeding to insure pregnancy:
  - Breed on 1st day of estrus & 3 days later to insure live sperm & oocyte, easier to remember **"breed every other day when will until won't"**

Conception:
- Insemination during proestrus & diestrus rarely fertile
- Maternal age effects conception rate & litter size
  - Beagles: greatest between 2-3.5 years of age; decreases after 5 years

Vaginal exfoliative cytology:

Cytological changes to guide breeding
- Proestrus noted (bleeding & swelling & attraction)
- Vaginal smear day 5 of proestrus & every other day
  - Bring pair of dogs together when 60% of cells cornified, allow to breed
  - 1st day of estrus = 90% of cells cornified (expect to breed)

"Breed when will until won't"

- **1st day of diestrus (diestral shift)** = abrupt drop in % of cornified cells = **infertile** (at least 20% drop) & concommitant ↑ in parabasal cells (signals end of estrus & onset of diestrus (even if bitch receptive - unlikely to be fertile). Used for retrospective evaluation of timing of breeding practice if infertility problems & to predict whelping day
  - LH peak 6-10 days prior to diestral shift
  - Ovulation 5-7 days prior to diestral shift
  . Insemination must have occurred 3-10 days prior to diestral shift
  - Whelping 57 days after diestral shift

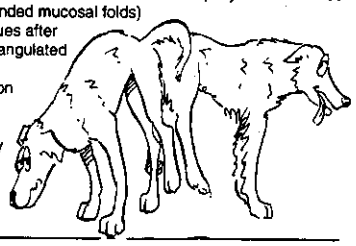
Serum progesterone ELISA kit to predict ovulation & time to breed & if pregnancy can be maintained

HB 638; C11T 943; NB 19.8
- ELISA kits (Icagen TARGET®, EstruChek®)
- Run assay every other day starting at day 5 of proestrus (bleeding, swelling & attraction)
- Change from < 1 to 2-5 ng/ml (initial rise) the day of preovulatory LH peak: breed as soon as female will allow once rise (ovulation in 2 days)
- "Breed every other day until won't" (or just once in 3 days)
- Progesterone at baseline level of < 1 ng/ml until end of proestrus. Initial rise reaches 2 ng/ml at time of LH surge. Ovulation expected in 2 days & maturation in 4 days; sperm live for 5 days. Must have at least one reading < 1 ng/ml; if first reading at 2-5 ng/ml then don't know whether in estrus or diestrus.

Urine LH assay to predict ovulation & time to breed
- OvUpeak®: rapid, semiquantitative enzyme-immunoassay
  - Detects LH fragments in urine on day of preovulatory LH peak (fragments only present for 1 day usually)
  - Free catch morning urine sample beginning no later than day 5 of proestrus & assay for LH
    . When LH appears in urine do a serum progesterone determination (> 1 ng/ml confirms preovulatory LH peak)
    ."Breed every other day until won't"
    . If testing started too late (after LH peak, thus LH fragments in 1st test) it is useless

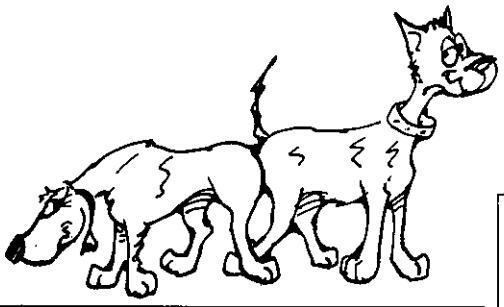
Appearance or vaginal mucosa & stage of estrus

(due to estrogen levels)
- Anestrus: flat & smooth
- Proestrus: edematous: rounded distended vaginal folds obliterating vaginal lumen
- Preovulatory peak ± 24 hours: initial crenulation (very subtle wrinkled appearance to rounded mucosal folds)
- Crenulation continues after LH peak: mucosa angulated w/ sharp profile
- Maximum angulation occurs at oocyte maturation
- Diestrus: irregularly flattened & blotchy red & white



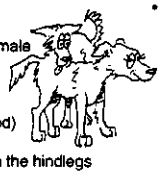
Breeding

- LH surge (near day 1 of estrus) - Ovulates 1-2 days later
- Maturation of oocyte 2-3 d after ovulation or 4-6 days after the LH surge, viable for another 2-3 days
  - Canine spermatozoa: viable for 3-4 days
  - Maximum conception rate: breed up to 2 days before LH surge (in other words when female will first allows breeding)



Mating:

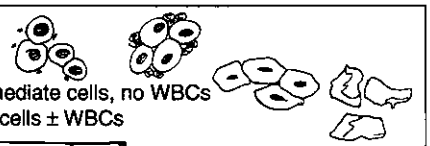
- Better in male's territory: bring bitch to male
- Nonslippery flooring (mounting, intromission & ejaculation)
- Pheromones secreted in the vaginal discharge stimulates male
  - Male sniffs & licks the vulvar & perineal regions
  - Bitch in estrus will permit these investigations
- Erection of the penis (two phases)
  - Partial initial erection (filling of cavernous tissue with blood)
    . Male mounts bitch while she holds the tail to one side
    . During thrusting, male makes paddling movements with the hindlegs
    . First fraction of semen ejaculated
  - Complete erection after intromission & ejaculation of the sperm rich (2nd) fraction occurs
    . **"Tie"** usually occurs (a lock between the vulva & penis)
      .. Not essential for fertilization to occur
      .. Dismounts & steps over bitch so facing opposite directions usually shortly after the ejaculation of the 2nd fraction
      .. "Tie" may last 5 to 30 minutes or longer & during this stage, the prostatic (3rd) fraction of semen is ejaculated
    . Do not try to separate animals



Puberty: IM 633; NB 19.5

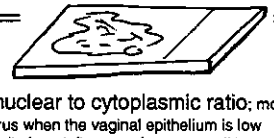
- 9 -10 months of age (range 6 -24)
  - Usually coincides with attainment of adult body weight
    . Small breeds reach puberty sooner than large breed
  - Breeding on the 1st estrus not recommended
    . Maximal reproductive potential not achieved
    . Pubertal bitches may display "split heats"
    . 2nd estrus usually matured reproductively
  - Once matures
    . Estrous cycle fairly constant in duration, but varies enough that it can't be used to predict next cycle
    . Interestrus interval from 4-12 months (average 7)
    . Interestrus interval may lengthen with age
    . Interestrus interval not influenced by pregnancy or photoperiod (length of daylight), except in Basenji

Anestrus	Parabasal cells, occasional WBCs
Proestrus	RBCs, Parabasal & intermediate cells
Estrus	Cornified cells, occasional RBCs & intermediate cells, no WBCs
Diestrus (day 1)	Abrupt shift: ≥ 20% decrease in cornified cells ± WBCs

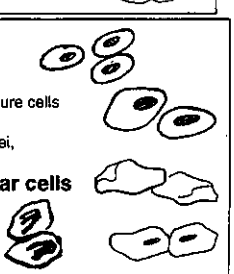


Vaginal exfoliative cytology technique
- Collection of cells: several methods
  - Swab technique: open lips of vulva, insert saline moistened cotton tip swab into vagina. Direct upward & then cranial, twist once & withdraw. Avoid obtaining cells from the vulva, by utilizing a small speculum (e.g. otoscope attachment)
  - Bulb pipette technique: draw saline solution into bulb pipette, insert pipette into vulva, squeeze & release bulb repeatedly ending with a release drawing fluid into the pipette & withdraw
- Slide Preparation:
  - Direct impression: allow to dry
  - Swab technique: Roll cotton swab onto slide lightly, 2-3 times
  - Bulb Pipette technique: Drop a small amount of fluid onto slide & allow to dry
- Staining:
  - Diff Quik: slides must be dry before staining
  - New Methylene Blue: slides may still be wet; drop small amount of stain onto slide, cover with a cover slip

Interpretation of cytology



- Epithelial cells: range of maturation
  - **Parabasal cells**: small cells with a large nuclear to cytoplasmic ratio; mostly immature cells typically seen during anestrus, early proestrus & metestrus when the vaginal epithelium is low
  - Intermediate cells (small or large): maturing parabasal cells from influence of estrogens (Nonpyknotic nuclei, small intermediates: rounded, mature intermediates: angulated)
  - **Cornified cells: here used to denote superficial (pyknotic nuclei) & anuclear cells** (superficial cells, for the purest, are not cornified because they have a nucleus). Most common cells when uterus has reached maximum cornification to protect female from penis trauma: proestrus & estrus
- WBCs (Leukocytes)
  - Maybe see in anestrus, early proestrus & again in metestrus
  - WBC in metestrus don't indicate infection unless they have toxic changes. These characteristically reappear 7-9 d after the LH surge
- Bacteria: normally in the vagina. If present along with toxic neutrophils, suspect infection
- RBCs: characteristically during proestrus, but may be during estrus & metestrus. Caution must be used when evaluating the presence of RBCs

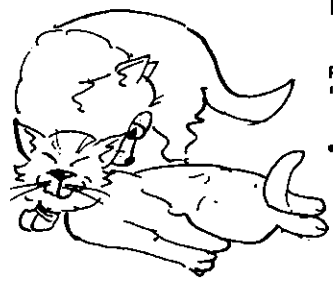


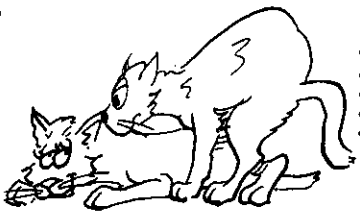
Breeding - Cat

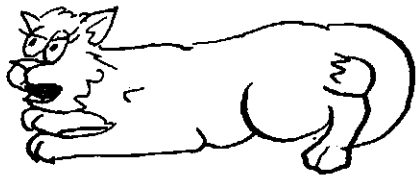
E-hb 628; IM 636; 5min 24; E 1290; F 303; Cat 1849; R-R 703; R-M 812; DDx 381

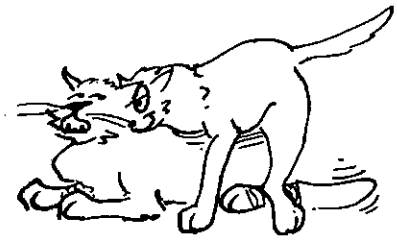
Mating - cats

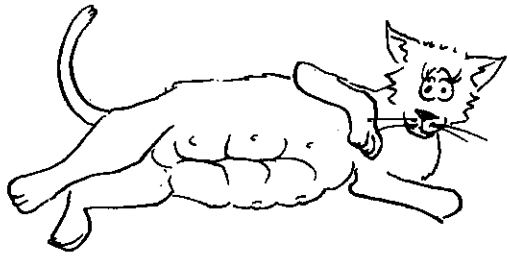
- **Cats are induced ovulators so timing not as critical as in dogs**
  - Proestrus queen may become aggressive to the Tom or to the handler if mounting attempted
  - Estrus: Queen "call" to the Tom, rub on objects, roll on floor & assume lordosis position in presence of a Tom
- **Multiple matings**: mating takes 0.5 - 5 minutes
  - May be repeated up to 30 times in 24 hours
  - Tom firmly bites neck of queen, grasps the lateral thorax w/ his front legs & treads w/ back legs
    . Penis introduced w/ a thrusting motion & ejaculation occurs immediately
  - Queen patiently holds lordosis position, tread w/ her hind legs, deviate her tail laterally
    . **"Copulatory cry"**: as penis withdrawn, good indication of adequate stimulation for conception
  - Experienced Tom then sit back & waits
  - Postcoital reaction: female's pupils dilate, she rolls around, splay forelimbs w/ nails exposed & kneading (orgasm?). She will licks her vulva & resist Tom for a variable period.
  - **Queen allows another mating within 5-15 minutes**
    . Mating frequency: 5 copulation/hours for first 2 hours then <1/hr for 3 days











Breeding Practices

Rule for breeding

"Multiple breedings when will, until won't"

- **Queen brought to Tom's territory**, best to transport female several weeks before to allow adaptation. Different breeding methods below:
  - 1. Place pair together for short periods & observe
    . Separate if fight
    . See if queen in heat
    . Witness mating (this is labor intensive)
  - 2. House queen & tom together - allow mating ad libitum w/ o observation
  - 3. Large breeding colonies: harem breeding
    . 1 or 2 Toms housed w/ many queens
    . 1 Tom for each 4 - 5 queens best, up to 15 queens/tom maximum
- **Multiple matings 3 - 5 x day until the end of estrus**
- Mature tom can be used 3 x times a week, or daily for 4 - 5 days in a row
- Over use of the tom may cause ↓ vigor, semen quality & conception rate
- Vaginal swabs can be taken to document mating if mating not observed (sperm)
- Vaginal cytology not used much in cat

Pregnancy - cat

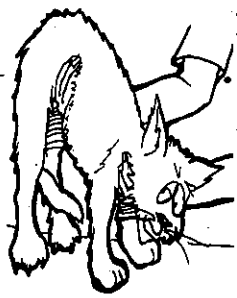
Mk 640; F 313; IM 672; SAP 901; H2B 697; Cat 1856, F-N 463; C12T 1043; R-R 32, 686, 705; R-M 813; E&R 752; Sx-S-hb 448; Sx-S 1317; NB 19.10

- **Length of Pregnancy/gestation:**
  - 66 days (64-69) of fertile mating in cat
  - 63 days from ovulation
  - Parturition prior to 60 days is considered premature
  - Prolonged if queen stressed
  - Shortened with large litters
- Litter sizes vary (2-7 kittens)

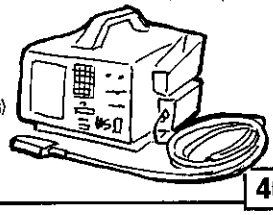
Endocrine Profile of Pregnancy:

- Progesterone from corpora lutea required for only 50 days of gestation, placenta then can maintain (not in dog)
  . If nonfertile induction of ovulation CLs persist for 30-50 days
  - If fertile induction of ovulation CLs last beyond 30 days
  . Progesterone concentration increases after ovulation whether pregnancy or not (dog & cat)

Diagnosis of Pregnancy



- Increased body weight, appetite, mammary development or milk production not diagnostic as these can occur in the normal or pseudopregnant bitch
- **Abdominal palpation**: about 3 weeks postbreeding
  - Cheap, quick
  - Earliest 14-21 day
  - Vesicles 1 inch (2.0-2.5 cm) at 28 day
  - Difficult to detect past 5 week
- **Ultrasound: 28 days (heart beat)**
  - Uterine sacculations, heartbeat & fetal structures
  - Differentiate pregnancy from pathologic conditions (pyometra)
  - Don't predict number of feti w/ ultrasound
- Radiography: confirm after 40 days in cat
- Behavioral & physical signs of pregnancy
  - Cessation of estrus (but may cycle 18-24 d & 40-45d after breeding)
  - Last 2 weeks or gestation
    . Fetal activity obvious
    . Obvious mammary development
- Pregnancy tests: none worth running with availability of ultrasound

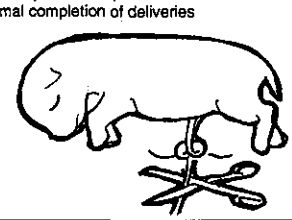


Impending parturition

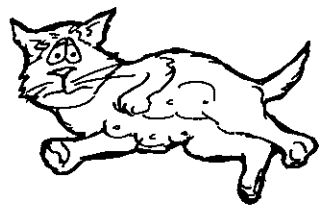
Cat 1857; F-N 463; R-M 815; E&R 749, 753

- Many queens (not all) refuse to eat 24-48 hours before parturition, **no reliable temperature drop (<12 hours before)** or progesterone drops to predict parturition
- Last week, slows down & investigates quiet places: put out a parturition box (put her in it often, she may still pick her own spot)

- Stage 1: uterine contractions w/o abdominal compression
  - Decreased activity, ± more attentive to humans
  - Abdominal wall drops
  - Fetal movements
  - Marked vulvar enlargement
  - ± Mucoid vulvar discharge
  - Queen may seclude herself in the last 24 hours
  - Perineal ligaments very flaccid
  - Mammary glands contains colostrum
  - Rectal temperature may be decreased
  - Straining, visiting litter box frequently
  - Rearrange queening box
  - Stage ends with entrance of first kitten in birth canal
- Stage 2: delivery of kittens, beginning:
  1st kitten into pelvic canal
  - ± Panting
  - Abdominal contractions obvious; may assume many positions
  - Amnion visible as she pushes
  - Amnion ruptures & kitten delivered in short order
  - Birthing of 1st kitten up to 1 hour
  - May be followed quickly by the birth of a second
  - Entire litter usually w/in 2-6 hours
  - Interrupted parturition: occurs normally in some queens for 12-24 hours, resumptions results in normal completion of deliveries

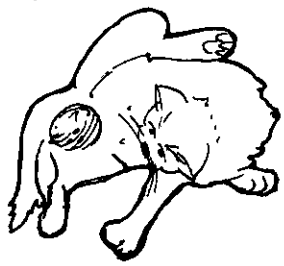


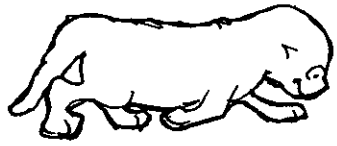
If the queen not actively straining, is eating, nursing kittens & content, let her go for up to 24 hr before getting concerned



- Stage 3: Placental delivery & uterine involution
  - Placenta usually delivered soon after individual kittens although when 2 kittens born close together, placentae may follow after birth of both kittens
  - Involution occurs within days

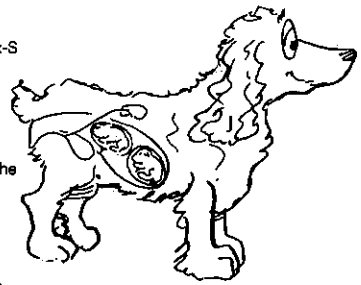
Nursing: within 1-2 hours of birth, some queens may allow suckling between births others won't until last birth



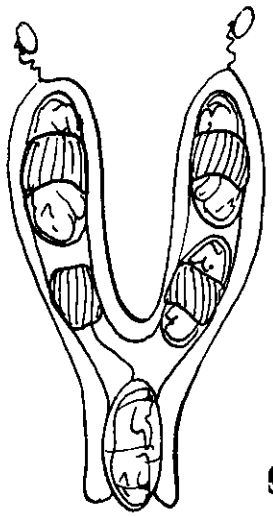


Pregnancy - Bitch

SAP 901; I2M 881; IM 672; H2B 697, 10t; R-M 491; Sx-S-hb 447; Sx-S 1316; NB 19.10



- **Uterine changes:**
  - Implantation occurs 17-22 days after ovulation
    - Almost equal distribution of fetuses in the 2 horns
    - Zonary placentation occurs (endotheliochorial)
  - 21 days: liquid filled fetal membranes form distinct oval swellings of the uterus (1/2" / 1.2 1.5 cm)
  - 28 days: round swellings (1"/2.5 cm)
  - 35 days: the uterus uniform in size
- **Length of Pregnancy/gestation:**
  - Cat: 66 days (64-69) from fertile mating
  - Dog
    - 63 days from ovulation
    - 65 days from LH surge
    - 63 ± 7 days from first breeding
    - **57 days from diestral cytology shift**

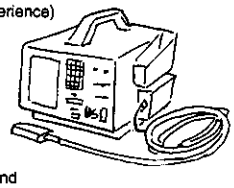


- **Physical changes in the bitch:**
  - Marked abdominal distention by day 50-55
    - Fetal movement may be detected
  - Behavior usually normal until the last part of gestation
    - End of gestation: abdominal pain or discomfort
    - Appetite increases during gestation
  - Mammary growth: 2nd half of gestation
    - Late: +/- serous secretion from the nipples
    - Multiparous bitches:
      - No mammary enlargement until the last 3-4 days of pregnancy
      - Lactation occurs right away
    - Primiparous bitch:
      - Glands are more obvious sooner
      - Lactation does not usually occur until 24 hours prior to whelping
- Hematologic & biochemical changes of pregnancy:
  - PCV: ↓ after day 21 of gestation to a low of 30% in late pregnancy - anemia
  - WBC: ↑ after day 21 until day 49 (~ 30,000/ul) then declines
  - Platelets: ↑ during the 3rd or 4th week
  - Coagulation factors: VII, VIII, IX & XI ↑ during the 4th to 6th week then normalize
  - Fibrinogen: ↑ 2-3 fold

Diagnosis of pregnancy

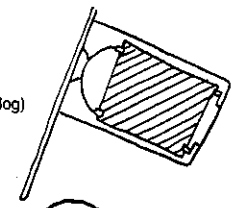
SAP 933; I2M 881; IM 671; H3B 581; R-M 494; R-R 32, 104, 683; Sx-S-hb 441; Sx-S 1295; NB 19.10

- Increased body weight, appetite, mammary development or milk production not diagnostic as these can occur in the normal or pseudopregnant bitch
- **Abdominal palpation: 26-35 days**: cheap, quick around 80% accurate
  - 21-28 days: individual fetus of 1 cm in diameter
  - 30 days: uterine swellings or 1 inch (3 cm), uterus enlarged & fallen ventral & forward
  - 35 days: difficult to palpate for diagnosis
  - 56th day: often possible to palpate fetuses & movement
- **Ultrasound: 99% accurate at 28 days - bitch**
  - Early diagnosis: before radiography (day 21 possible w/ experience)
  - Uterine sacculations, heartbeat & fetal structures
  - Differentiate pregnancy from pathologic conditions (pyometra)
  - Don't predict number of feti w/ ultrasound



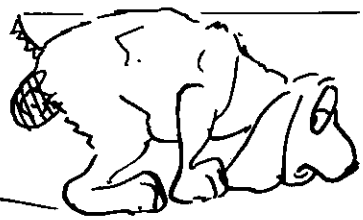
- Radiography: confirm after **day 45** in bitches, after 40 days in cat
  - Determine number & size of fetuses late in gestation in problem whelpers
- Pregnancy tests: none worth running with availability of ultrasound

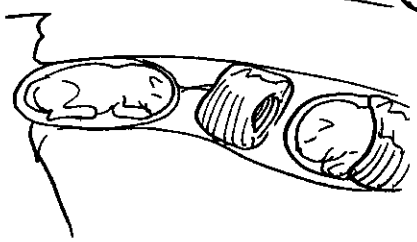
- **Impending parturition**
  - **Within 24 hours of transient temperature drop (monitor bid) in bitch, not cat**
  - 10-14 hours after serum progesterone drops below 2 ng/ml (dog)
  - 12-24 hours: nesting behavior
  - Several days: restlessness, seeks seclusion, may not eat
  - 1-2 weeks: ± mammary turgidity & secretion of milk

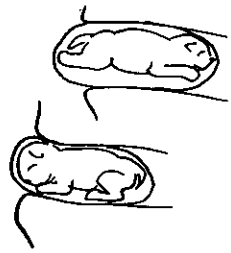


Stages of parturition - bitch

HB 697; I2M 882; IM 672; IM-WW 417; SAP 901; 5min 58; R-M 496, 498, 500; Sx-S-hb 448; Sx-S 1317; NB 19.10

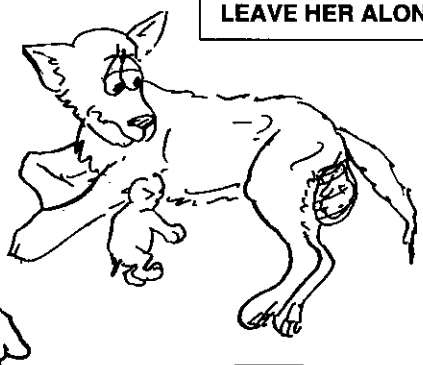


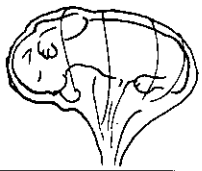




- Similar to other species
- **Stage 1: cervical dilation**, uterine contractions (not visible externally) without voluntary abdominal compression
  - Nesting behavior, anxiety, restlessness, panting, trembling, ± vomiting
  - Onset within 24 hours of rectal temperature drop <100 F° (monitor temperature bid the last 7 days of gestation)
    - Preceded by drop of progesterone < 2 ng/ml
    - **Lasts 6-12 hours**, longer in the maiden bitch
- **Stage 2: Delivery of fetus**
  - Begins as 1st pup enters the pelvic canal & ends w/ birth of last pup
  - Visible contraction - obvious straining
  - 1st pup within 4 hours of onset of stage 2
    - Entire litter - up to 24 hours to be delivered
    - Resting phases between pups up to 4 hours (normally 1/2 to 1 hours between deliveries)
    - Constant, unrelenting straining is abnormal
    - Bitch break or licks off the fetal membranes & licks the puppy to stimulate breathing
    - Bitch may eat the membranes
    - 50% of pups are born breach
  - Cat: occasionally 12-24 hours passes between births of normal kittens, not in dog
- **Stage 3: Delivery of placenta**
  - Alternates w/ stage 2
  - Should occur with pup or within 15 minutes (5-15) of each delivery
  - Bitch may pass a small amount of blood & a green

If bitch is happy, tending to the litter & not straining for greater than 2 hours between pups, LEAVE HER ALONE!

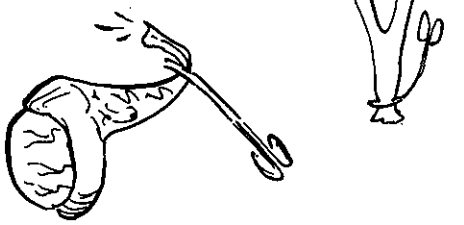




Birth control, Contraception, Estrus suppression, Population control

C12T 1074, 1037; E-hb 612; H2B 701; I2M 858; IM 650; IM-WW 429; E 1630; F-N 461; Sx-WW 174; Sx4B 489; R-M 528, 563, 810(f); R-R 687; E&R 601, 766(f)

- **Ovariohysterectomy & castration**
  most popular forms of birth control (inexpensive, invasive & permanent)
  No need to allow even 1 cycle in the bitch
  (↓ mammary tumors dramatically)



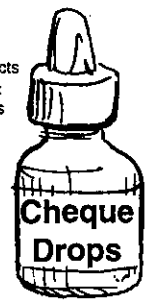
- Vasectomy & tubal ligation: don't affect behavior such as territory marking & continuous estrus cycles and thus are not used much in veterinary medicine

- **Ovulation induction in Queen**: sham mating or use a vasectomized male - all cause LH surge
  - Sham mating: sufficient vaginal stimulation (probing the vagina w/ a thermometer or cotton swab 4-8 times at 5-20 minute intervals) or
    .. Use of vasectomized Tom
  - Petting & stroking by owner can cause ovulation in some cats
  - Some may ovulate spontaneously
    .hCG or GnRH (Cystorelin®) IM on 1st 20 days of estrus
  - Delays onset of next cycle, doesn't shorten present estrus
  - Pseudopregnancy occurs if queen not bred
  - **Estrus usually resumes 45 days** (35-70) after induction

- **Estrus suppression: bitch & queen**
  - **1. Ovaban® (megestrol acetate)**: a progestin to suppress estrus

  . **More effective if given during anestrus than proestrus** (vaginal swelling)
  . **Don't suppress more than 2 cycles in a row** (may cause CEH)
  . **Only give to postpuberal bitches & queens**
  . **Proestrus treatment: high dose for 8 days**
  .. Started in proestrus to prevent continuation of proestrus & estrus
  .. Start in first 3 days of proestrus when start bleeding & swelling of vulva
  .. Verify proestrus w/ cytology in bitch (majority of cells not cornified)
  .. Suppression of proestrus in 3-8 days
  .. **Return to proestrus in 2-9 months**
  .. If started to late in proestrus can stimulate ovulation & fertility
  . **Anestrus treatment: low dose for 30 days**
  .. Start Tx in anestrus at least 1-2 weeks before expected proestrus (based on previous interestrus interval of that bitch)
  . **Contraindications**: any diz of reproductive organs, pregnancy, diabetics, or liver, uterine or mammary gland diz
  . Side effects (see Toxicology pg 732)
  .. Polyphagia, lethargy & weight gain
  .. Uterine: cystic endometrial hyperplasia & infertility, **pyometra**
  .. ↑ Mammary gland hyperplasia & tumors in bitches
  .. ± False pregnancy signs when Tx stopped
  .. Diabetes mellitus
  .. Liver enlargement
  .. Acromegaly
  .. Adrenocortical suppression in cats
  .. Injection site: alopecia, thinning of skin, discoloration of hair
  . **Not recommend for bitches intended for future breeding** because of effects on reproduction tract

  - **2. Mibolerone (Cheque®)**
  . **Androgen approved for estrus suppression.**
  . **Daily oral dose at least 30 days prior to next expected estrus, can prescribe for 24 consecutive months in bitches**
  . Mechanism: negative feedback inhibition of release of pituitary gonadotropins
  - May be indicated for infertility in bitches due to short estrus cycles (<4.5 month) to delay estrus for endometrial recovery.
  - **Return to estrus in 7 days to 7 months when Tx stopped**
  . **Toxicity see Tox pg 732:** Side effects can be significant, usually reversible once Tx stopped, but may persist for months to years
  .. Clitoral hypertrophy ± ossification
  .. Mucopurulent vulvular discharge
  .. Vaginitis
  .. Masculinization of female fetuses, ± teratogenic
  .. ↑ Muscle mass & aggressiveness
  .. Premature epiphyseal closure in young



  - **Not recommended for bitches intended for future breeding**
  - **Not during pregnancy**
  - **Don't breed if have estrus during treatment** (break through estrus)
  - **Not prior to puberty (open physes)**
  - **Do not use in cats!** (hypertrophy of the glans clitoris & hepatotoxic effects)

- 3. Testosterone injections including mibolerone: not approved, used in greyhounds to prevent estrus, may enhance racing performance which is not considered an acceptable reason to use by veterinarians.

- 4. Depot injectable progestins: MPA (DepoProvera®) do not use in dogs

Pregnancy termination, Induced abortion, Mismating

C12T 1075, 1074; E-hb 613; SAP 899; H2B 702; IM 677; IM-WW 430; 5min 6; E 1632, 1075, 1079; Cat 1871; F-N 460, 463; R-M 530, 811 (F); R-R 691, 707, 715; E&R 592

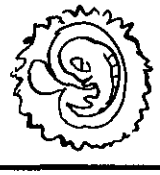
- **Unwanted pregnancy**: common problem (unacceptable male, immature bitch)
- CS: Unwanted pregnancies; mismating
- Dx: Hx (mismated: **saw "tie"**); cytology of a vaginal smear (sperm - 24 hours post breeding in 65%; lack of sperm doesn't rule out, presence of sperm confirms; assessment of stage of cycle [if in proestrus or diestrus {low # of cornified cells} conception is unlikely])

- **1. Ovariohysterectomy TOC (Tx of choice)** in nonbreeding bitches (safest), diagnose pregnancy in 3-4 weeks after mating by palpation or ultrasound. Queens in 1st 3 weeks

- **2. Allow to carry pregnancy to term** may be safer than medical managements

- **3. Medical methods**: occasionally request for pharmacological means to terminate pregnancy. None consistently effective & most associated w/ significant side effects - advise client

3a. Estrogens (ECP/Estradiol cyplonate [Depo-Estradiol®] or Diethylstilbestrol (DES®):
. Commonly done but not recommended due to side effects
. ECP IM given once in estrus to prevent pregnancy
.. Never during diestrus (vaginal cytology - decline in cornified cells)
.. Never exceed 1 mg
.. Never repeat dose
. Toxicity see Tox pg 733 - Side effects:
.. Fatal irreversible aplastic anemia & blood dyscrasias (pale mucous membranes, petechial hemorrhages, dark stools, hypothermia
.. Cystic hyperplasia-pyometra complex (25% -most common cause of **pyometra** in young bitches)
.. Prolonged behavioral estrus
.. Cystic follicles
.. ± Future infertility



3b. Prostaglandins F2a (Lutalyse®): IM shots a month after mating
- **If mating suspected** (isolate to prevent other matings)
- **Ultrasound in 30 days for pregnancy** (60% won't be),
  . If pregnant: IM Lutalyse BID until abortion (vaginal discharge after abortion, check w/ ultrasound, can abort all or only some of litter). Keep in clinic until aborts. Discontinue shots if hasn't aborted after 10 days
  . Dog: 75% successful if given after **30 days** of gestation
  . Cat: 50% if given after **40 days** of gestation
- **Day 6-10 of Diestrus Tx**: may be less offensive than mid gestation abortion (5min pg 6)
  . SQ on day 6 for 5 days
  . Ultrasound for pregnancy at day 30
  . If pregnant repeat regimen on day 31-35
- May be best option to veterinarian even though not approved for use
- Contraindicated if preexisting cardiovascular or respiratory problem, use only in young healthy bitches
  .. Mechanism: cause luteolysis of CL so prostaglandin level drops & can't maintain pregnancy. Resistant to effect until after day 25 of gestation in dog & 40 days in cat
  .. Shortens interestrous interval from normal 4-10 months to as short as 40 days
  .. Results have been impossible to reproduce without concurrent SQ ACTH for 2 days.
  .. Prostaglandins analogs: fluprostenol (Equimate®) & cloprostenol (Estrumate®) not tested enough to recommend yet
  .. **Toxicity see Tox pg 733**: vomition, urination, tachypnea, trembling & salivation after injection
  ... Often well tolerated & usually becomes less severe as therapy progresses
  ... Return to normal reproductive cycle after Tx

3d. Bromocriptine (Parlodel®): dopamine antagonist & prolactin suppression. GI side effects can occur & efficacy questionable. Given at day 31-35 of diestrus PO.

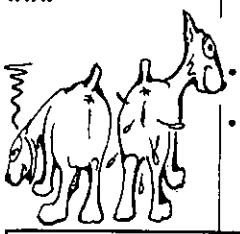
. 3e: Bromocriptine + prostaglandin F2 alpha: excellent results on day 6-10 of diestrus

3c. Glucocorticoid may cause termination (abortion), but not justified. Do not give during pregnancy you don't want terminated.

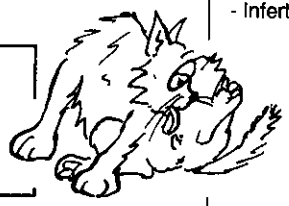
3e. Epostane: steroid synthesis inhibitor: **orally** shown to terminate pregnancy (decline in progesterone), not commercially available in USA because controversy about use in other species (Humans?)

3f: Mifepristone (RU 486): antiprogestin which works but is not being developed for vet medicine, perhaps due to controversy over use in humans.

Condition	Facts & Cause	Presentation/CS	Diagnosis
CEH, Cystic endometrial hyperplasia/ **Endometritis/ Pyometra complex, Diestral endometritis** M8k 1038; Mk 656; SAP 893, 931; E-hb 614, 22t; H3B 595; H2B 655; I2M 870; IM 661; IM-WW 422, 427; C12T 1081; C11T 919(f); 5min 1000; E 1636; R-M 484, 483; R-R 734, 712; E&R 544, 605, 627; Sx-WW 172; Sx-S-hb 442; NB 19.14; Emrg 422 ***	• **A complex**: cystic endometrial hyperplasia (CEH) leads to endometritis which can lead to pyometra - Each can occur alone • Incidence: - Older cycling bitches & queen > 3 -4 years old - Young bitches: mismate shot (estrogens potentiates progesterone effect) - Dogs >> cats (queens are induced ovulators) - ALL intact bitches are at risk - Most experienced estrus 2 months previously • Cause: CEH + bacterial infection = pyometra - **CEH: exaggerated response of endometrium to progesterone** . **Mismate shots of progestins or estrogen ↑ risk: dog**; Nonbred queens due to intermittent exposure of ovarian estrogens - Endometritis: inflammation of endometrium - **Pyometra: infection of uterus, pus filled uterus,** open or closed cervix affects severity, prognosis & Tx • 30% of dogs have concurrent urinary tract infections • Some bitches more sensitive to progesterone for unknown reason	• CEH: - May be vague - + Blood tinged vaginal discharge • Pyometra: - **Open cervix**: usually less severe than closed . Vaginal discharge: bloody to purulent 4-8 wks postestrus . Depression, anorexia, lethargy . ± Fever (20%) . Vomiting & diarrhea esp. if closed . PD/PU - **Closed cervix: septicemia** . Abdominal enlargement . Very ill: dehydration, azotemia, depression, anorexia, lethargy . PU/PD . Vomition (toxemia & altered renal function) . Diarrhea . **No discharge** (so don't note as soon) . Shock, collapse & coma - death • Cat: less conspicuous signs, asymptomatic except for distended abdomen • Sequela: - Ruptured uterus = peritonitis & sepsis - Infertility	• Hx (aged bitch in diestrus, young w/ mismate shot, estrus 2 months earlier), CS (nonspecific illness in intact female) **- Consider in any ill diestral bitch or queen** • PE: distended abdomen, enlarged uterus, dehydration - Careful of uterine rupture, especially in cats • Hematology - Inflammation: ± ↑ PMNs w/ left shift . Sepsis: toxic PMNs & degenerative left shift . ± ↑ WBC usually > 15,000, up to 100-200,000/µl **- May be normal if open pyometra** - Mild nonregenerative anemia (PCV 25-35%), 50% of cats • Chemistries: - Hyperproteinemia, hyperglobulinemia **- Prerenal azotemia** (25%: dog, 12%: cat) - ↑ Alkaline phosphatase, acidosis • Urinalysis (UA): +/- isosthenuria 33% of dogs (↓ concentrating ability) (low specific gravity due to endotoxin effect on renal tubules, causing an acquired nephrogenic diabetes insipidus) - Proteinuria 33% dogs - ± Pyuria, bacteruria • Radiology: PYO - identical to early pregnancy - R/O pregnancy after 40-45 days of gestation - Enlarged uterus (negative doesn't R/O - opened pyo) . (Normal nongravid uterus not seen) - +/- peritonitis/rupture • Ultrasound: DDx pyo. from pregnancy anytime • Vaginal cytology & culture: not definitive, sensitivity for ABs • Biopsy of a bitch with possible CEH • Endoscopy if open to differentiate uterine from vaginal discharge • Exploratory for stump pyometra

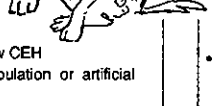


Normal progesterone to CEH to pyometra
CS: ± Discharge, Sick, PU/PD
Dx: Hx, CS in diestrus, PE, Rads
Tx: OVH (TOC), Med: PgF

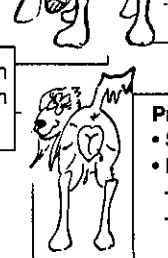


DDx:
- **Pregnancy**
- Caudal abdomen neoplasia
- Vaginitis
- Muco- or hydrometra
- Other causes of PU/PD
- Stump pyometra

Pathophysiology: CEH + bacterial infection = pyometra
• **Cystic endometrial hyperplasia** (CEH): 1st step
- Proliferative & degenerative changes associated w/ aging
- Exaggerated response of endometrium to progesterone
. Following ovulation, progesterone elevated for 8-10 weeks to prepare uterus for implantation (diestrus - luteal phase/progesterone)
.. Glandular hypertrophy = cystic endematous, thickening endometrium & ↑ uterine secretions (perfect media for bacteria)
.. Progesterone also inhibits WBCs
. Mismate shots of progestins or estrogen ↑ risk
.. Exogenous progestins (i.e., megestrol acetate [Ovaban®])
.. Estrogens potentiates progesterone - younger animals
. Pseudopregnancy



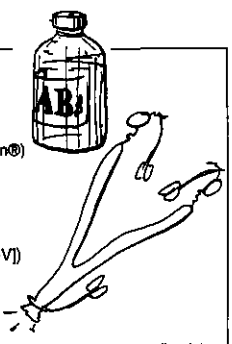
• **Endometritis**: inflammation w/ or w/o bacterial invasion, may follow CEH
- Cause: spontaneous cause: sequela to CEH, 2° to breeding events, either copulation or artificial insemination; postpartum due to retained placentas or fetuses, dystocia, or abortion
• **Pyometra: pus filled uterus**, may follow CEH &/or endometritis
- Bacterial infection - ascends through cervix
. *E. coli* #1 (also Staph., Strep., Pseudomonas, Proteus & others (secretions ideal for bacteria)), a few sterile especially in cats
- Open or closed cervix affects severity, prognosis & Tx
- **Cat: Progesterone dysfunction from retained or cystic corpus luteum**, mechanism not understood because can happen in (as expected) sterile bred cats (so CL can form/induced ovulation) & unbred cats (petting may cause ovulation in come cats)
• Mucometra: seen occasionally in advanced CEH
- Atrophy of uterine wall & viscid mucus w/in uterine lumen
• Hydrometra: atrophy w/ watery fluid in uterus



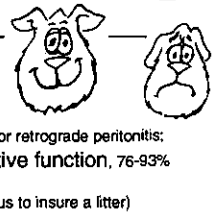
"Mismate shots" high concentration of estrogen shots increases risk

Stump Pyometra
• Uncommonly in the spayed female
• Remnant of the uterus from ovariohysterectomy (OVH)
- Later can progress through the complex. This occurs if aberrant ovarian tissue remains in the abdomen or if hormone treatment is used

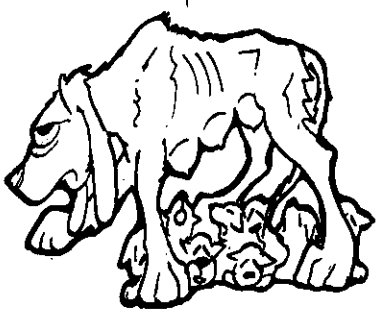
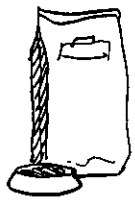
Treatment:
• Prompt & aggressive Tx necessary
• **Fluids**
• **ABs** (antibiotics) immediately (trimethoprim-sulfa (Tribrissen®) ampicillin or clavulanate-amoxicillin - 2-3 weeks - E coli
• Glucocorticoid (large doses IV if shock - may repeat once)
• **OVH** (ovariohysterectomy) (TOC/Tx of choice), esp. if closed cervix, toxic bitch or not breeding animal
- Fluid & IV ABs (cephalothin [Keflin®] & amikacin [Amiglyde-V]) before, during & after surgery
- OVH: triple-clamp method w/ ligation of uterine arteries
- If peritonitis: open abdominal drainage
- Healthy patient excellent surgical risk
- Severely ill patient requires intensive Tx of IV fluids & brd. spectrum antibiotics (immediately)
- Further tests to evaluate condition m/b (acid base, kidney function, cardiac rhythm. However, surgery should not be delayed more than a few hours
• **±Medical management if stable breeding animal**
- **Initial treatment: Fluid therapy support, Broad spectrum ABs**
- **Prostaglandin (PgF2a/ Lutalyse®)** to evacuate uterus
. Open or closed, closed guarded prognosis
. 3-5 days sid
- 48 hrs to see clinical improvements so don't use in severely sick (sepsis) do an OVH
• Abdominal radiographs 1st to rule out pregnancy & vaginitis, as PgF2a causes abortions
• Trimethoprim-sulfonamide (broad spectrum) 7-10 days
. Recheck in 2 weeks, if vaginal discharge do OVH or maybe give 2nd PgF series
. Cause uterine contractions & cervix opening (evacuation) & increase blood flow to the uterus
. Side effects w/in 20 min of injection: discomfort, vomiting, diarrhea; retrograde movement of uterine contents- Walk to minimize
- **Complication of medical Tx: sepsis & peritonitis**
- Breed on next estrus recommended (if recover, most will be fertile, but reoccurrence common)

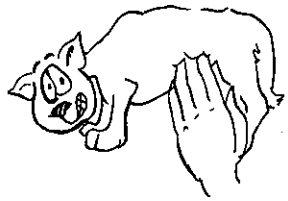


Prognosis:
• Surgery: Good if no peritonitis (mortality 10%)
• Medical:
- Closed: poor (25-40%) low response rate & rupture or retrograde peritonitis;
- Open: good for short term return to reproductive function, 76-93% success, 1/3 need 2nd series of injections
- Recurrence as high as 75% long term (so breed at next estrus to insure a litter)
- 40-75% of successfully treated bitches whelp at least 1 litter



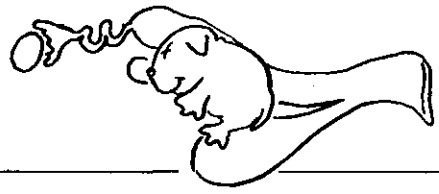
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Malnutrition pregnancy & lactation H2B 1291; C11T 971; F-N 562 **	• **Poor nutrition during pregnancy & lactation** - Deleterious effect on fetal development, size of litter, parturition & milk production • Cause: - Insufficient nutrients - Not ↑ amount in late pregnancy & lactation - Unbalanced diet - Maintenance diet - Cereal based **dog** food to queen • Pathophysiology: pregnancy & lactation ↑ nutrient requirements	• **Weight loss & emaciation** • Uncontrollable diarrhea during lactation • **"Fading puppy" or "fading kitten" syndrome** - ± Normal appearance at birth - Fading & ± dieing variable time after birth - Fail to gain weight - Ineffectual nursers • Inadequate milk production - Crying puppies	• Hx (diet), Clinical signs • Physical exam of neonates, dam • Lab: - Hematocrit < 37%, hemoglobin < 12 g/dl, total plasma protein < 5.5 g/dl	• **Nutritional balanced diet** - Canine reproduction or growth diet . Throughout pregnancy but especially last 3-4 weeks & during lactation - Feline reproduction & growth diet . Throughout pregnancy, especially last 3 weeks & during lactation • No supplements (meat, milk, calcium, phosphorus or vitamins) • **Feeding regimes:** - First 5-6 weeks or pregnancy: same amount as normal - Gradually ↑ towards end of gestation so eating 15-25% more calories at birth . Free choice or BID - Lactation feed free choice or TID to maintain optimum weight . 1.5 x maintenance 1st wk . 2 x maintenance 2nd wk . 3 x maintenance 3rd wk to weaning - Start weaning at 3-4 weeks, gradual change over • Monitor success of feeding: expect maintenance of optimum weight & steady weight gain in neonates Prognosis: **Excellent**

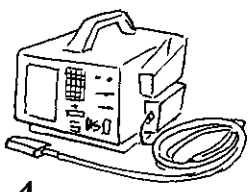
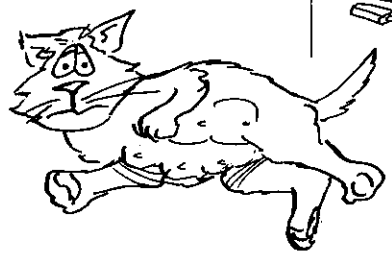
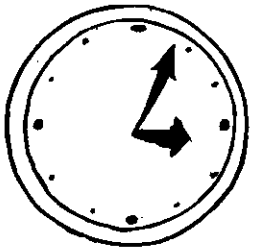


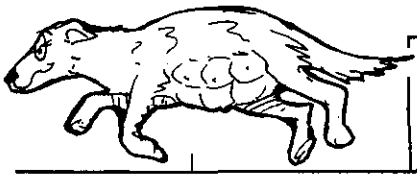
Poor nutrition during pregnancy & lactation
CS: Dam: Emaciation, Diarrhea; "Fading puppy" or "kitten"
Dx: Hx, CS, PE
Tx: Prevent: ↑ Nutrients toward end of gestation & during lactation

Ectopic * pregnancy, Extrauterine pregnancies E-hb 609; R-R 141; R-M 814; Cat 1860	• **Rare in cat, but more common than in other species**; Pregnancy other than in uterus • True extrauterine pregnancy: fetus w/ nutritive connection w/ tissues other than endometrium - Humans: ovarian & tubal pregnancies may occur, true abdominal pregnancies rare - No authentic cases or true extrauterine pregnancies reported in domestic species • Secondary extrauterine pregnancies: escape of recognizable fetus from uterus to abdominal cavity or vagina • CS: Asymptomatic as apposed to in humans, unless rupture of uterus due to trauma • Dx: Usually incidental finding, mummies • Tx: Surgical removal, ± Spay	



Pseudopregnancy, False pregnancy, Pseudocyesis M8k 1036; Mk 678; E-hb 607; H3B 630; H2B 690, 1258; I2M 880; IM 669; 5min 590; E 1609; R-R 682, 703, 715; R-M 490, f 814; F 307; C-N 461; C12T 1083; E&R 747, 765; Sx-S-hb 441; NB 19.13 **	• **Uncommon in bitch, rare in queen** • Physical & behavioral simulation of pregnancy in nonpregnant animal, including lactation - All nonpregnant bitches in late diestrus are pseudopregnant, either overt of covert • Physiology: Bitch - Normal phenomenon in intact nonpregnant . Progesterone stays high for 2-3 months in pregnant & nonpregnant bitches . ↓ P4 & ↑ prolactin at end of diestrus may cause false pregnancy . Usually seen 2 months after the last estrus - Also if OVH during metestrus/diestrus (steep decline in P4) - Upon withdrawal of progestin therapy (Ovaban®) - Not all bitches show the clinical signs of pseudopregnancy • Physiology: queen - Causes: sterile mating, sham copulation, spontaneous ovulation, embryonic death, hormonal therapy • Note: can be seen clinically in queens shortly following OVH • Pathophysiology: require sterile mating to cause ovulation & corpora lutea formation; CL persists only 30 days - Therefore signs rarely seen 45 days after copulation	• **Bitch** - **Restlessness** - **Anorexia** - **Nesting** - Mammary development w/ or w/out milk production - Some bitches act as if parturition has occurred . "Mothering": nesting inanimate objects . Refusing to eat . Aggressively behavior, lethargy • Cat: usually only mild sign - Rarely: mammary development w/ or w/ out milk production - "Mothering" - nesting inanimate objects • Sequela: Mastitis	• Hx, CS • **R/O** (rule out pregnancy: palpation, rads, ultrasound) **DDx:** • True pregnancy • Mammary gland disorders (mastitis, neoplasia) • Hypothyroidism	• **Best to do nothing: self limiting in 1-3 weeks** • Stop lactation: - Hold off food for 24 hours then gradually bring back (decreases lactation) - Low-dose Lasix® (furosemide) bid for 7 days, of deprive bitch of water overnight - Stop stimulation of mammary glands (licking, hot compresses) - Progesterone, estrogen, testosterone or dopamine antagonist not recommended - Cheque® (mibolerone) an androgen if wild behavior changes - Bromocriptine inhibits prolactin release (not approved in USA) • Mild tranquilization if significant behavioral changes (not phenothiazines [stimulate prolactin]) • **Consider OVH** if repeated bouts - prevents recurrence Prognosis: **Good** • Recurrence common in subsequent estrous cycles in bitches • No ↓ in fertility



Bitch: Uncommon (term); Queen: Rare (45 d)
CS: Bitch: Acts pregnant: mammary, nesting; Cat: < 45 d
Dx: Hx, CS, R/O Pregnancy
Tx: Nothing - Self limiting in 411 1-3 weeks • Px: Good

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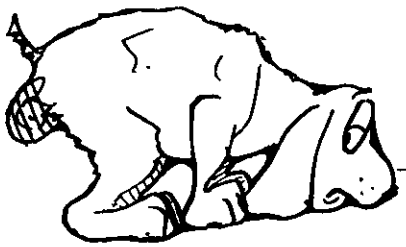
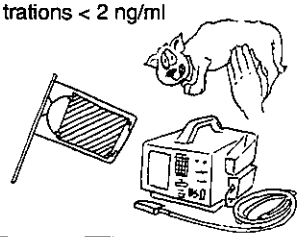
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Dystocia, Abnormal parturition M8k 1036; Mk 67 7; E-hb 609, 629; SAP 901; H3B 637, 649(f); H2B 697; I2M 883; IM 673; IM-WW 422; 5min 58; E 1617; R-R 285, 277; R-M 500; E&R 578; Sx-WW 173; Sx-S-hb 448; Sx-S 1318; Sx-G 284; NB 19.11; Emrg 420 ***	• **Difficult birth/parturition** • **Rare in cat** • Predisposing factors present: brachiocephalic breeds, acetabular fxs • History of previous dystocia **Causes/DDx: Dystocias** • Fetal dystocia: - Large neonate - oversized - Monster pups/kitten - Nonviable fetus - Abnormal position/presentation/ posture (usually not a problem in cats because limbs are so short (breech normal in cat, 40-50%) - Cat: 2 kittens wedged in canal, monsters - Malposition usually not a problem • Maternal Dystocia: - Narrow or obstructed birth canal . Congenital: brachycephalic breeds & terriers (flattened dorsoventral diameter of pelvis (Scottish terriers, Sealyhams) . Old pelvic fractures . Vaginal mass - neoplasia . Developmental abnormalities: vaginal stenosis, vulvar hypoplasia, persistent hymen, persistent Mullerian duct - Uterine torsion (cat > dog) - 2° uterine inertia - Primary uterine inertia - Metabolic disturbances . Hypoglycemia . Hypocalcemia	• **Prolonged gestation > 70 days** • > 24 hours since prepartum drop in temperature • Constant unproductive straining **> 1 hour** • Pup stuck in birth canal for > 2 hours	• Hx (**gestation length**), CS - **Gestation > 70 days** - **Stage 1 > 24 hours** - > 24 hours since rectal temperature drops in full-term bitch - > 1 hr between birth w/ constant straining • **Physical examination:** - General physical examination - Rectal temperature - Careful palpation of abdomen - Digital vaginal exam (aseptic) for fetus in canal & tone - Mammary gland for colostrum • Abdominal radiographs: - Number, size & viability of pups (intrafetal gas patterns, overlapping skull bones = death) • Ultrasound for fetal viability • +/- Serum calcium/magnesium concentrations • Plasma progesterone concentrations < 2 ng/ml	• **Pup lodged in birth canal** - Digital manipulation/extraction - Lubricate w/ KY Jelly • Healthy animal - **Digitally feather dorsal vagina** - Tranquilization: for nervous 1st litter bitch (acepromazine) • Medical: bitch with normal sized pups & no obstruction - **Oxytocin** IM, repeated at 30 min (max 3 x) - **Digitally feather dorsal vagina** . Careful w/ oxytocin because of possibility of premature placental separation . ± 10% calcium gluconate or 50% dextrose before oxytocin injection (no evidence of benefit) hypoglycemia or hypocalcemia rarely exists - Failure to deliver w/in 1 hour: do a cesarean • **Cesarean section**: indicated: - 1° or 2° uterine inertia unresponsive to medication (if pups are term) - Bitch with oversized fetus - Obstructive dystocia not correctable by manipulation - Fetal death w/ putrefaction Prognosis: Depends on cause



Dog, Rare in cat
CS: > 70 days, > 1 hr between, Stuck pup
Dx: Hx, CS, PE
Tx: Feather vagina, Oxytocin, Cesarean

DDx:
• Uterine inertia
• Hypoglycemia
• Hypocalcemia



•••If healthy bitch is content, nursing her pups & hasn't delivered another pup she may be done or if not, is probably just fine & can be checked during regular hours•••

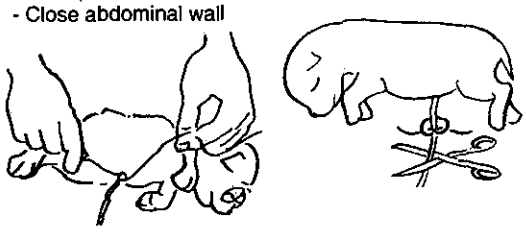
Uterine dystocia/ inertia See above **	• **1° inertia: total absence or partial absence of contractions between deliveries** • Cause: unknown, insufficient stimulation of contraction due to small litter, overstretching of uterus due to large litter, stress & anxiety of 1st litter bitch, hypocalcemia, hypoglycemia sepsis, prevalence in large breeds w/ large litters . uterine inertia (older queens, obesity), young queen: 6-7 months old, • **2°: stage 2 labor stops**: prolonged efforts to deliver fetuses (myometrial exhaustion & subclinical hypocalcemia/hypoglycemia)	• **Prolonged gestation > 70 days** • > 24 hours since prepartum drop in temperature • **1° uterine inertia**: Bitch normal unless fetal death & putrefaction occur • **2° uterine inertia** - Constant unproductive straining > 1 hour - Pup stuck in birth canal for > 2 hours - Nonattentive bitch to pups already delivered - Labor appears to stop before entire litter delivered	• Owner complains of prolonged gestation • **Hx (stage 2 stops), CS** • Physical examination: - General physical examination - Digital vaginal examination (aseptic) for fetus in canal & tone - No response to oxytocin or pressure per vaginum (lack of Ferguson reflex) • Abdominal radiographs: - Number, size & viability of pups (intrafetal gas patterns, overlapping skull bones) - Ultrasound for fetal viability	• Medical: bitch with normal sized pups & no obstruction - **Oxytocin** IM, repeated at 30 min (max 3 x) - Digitally feather dorsal vagina . ± 10% calcium gluconate or 50% dextrose before oxytocin injection (no evidence of benefit) hypoglycemia or hypocalcemia rarely exists • **Cesarean section** indicated if no response to oxytocin in 1-4 hours Prevention: in problem bitches, have owners monitor rectal temperature, If longer then 24 hours after temperature drop do C-section Prognosis: **Guarded**
Fetal dystocia **	**Large Pups - oversized** - Large head & narrow shoulders (Scottish terriers, Boston terriers, English bulldogs, Sealyham terriers & Pekingese) - Large sire, single fetus or small liters, 1st born of a litter or prolonged gestation • Malformed pups (cannot fit through the pelvic canal) • Nonviable fetus (fetal edema, hydrocephalus, chondrodystrophy) • Abnormal position/presentation/ posture - Presentation: cranial & caudal normal, transverse abnormal - Position: dorsal position normal - Posture: relationship of pups head & limbs to body: normal - extended & flexed postures are both normal	• **Dystocia** • **Fetus in birth canal** • Prolonged gestation > 70 days • Stage 1 > 24 hours • Stage 2 > 4 hour w/o birth • > 1 hours between births w/ active straining • Pain or depression as/w/ labor Normal presentations	• Hx, CS • Digital palpation **Nervous dystocia** NB 19.17 • More common in toy breeds • Tx: place in quiet environment • Tranquilization (Acepromazine)	• **Gently feather dorsal vagina** • **Manual repositioning of fetus** - Digital manipulation preferred over instruments - Bitch in standing position, adequate lubrication & sterile gloves - Correct malposition w/ repulsion & repositioning - Gentle traction in caudoventral direction (gentle side to side rotation) no traction of fetal extremities - Instruments only when necessary • **Cesarean section** Prognosis: • Good - early • Guarded - late

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Uterine torsion Cat 1860; F 341; H3B 597; H2B 658, 709, 698; E-hb 609; SAP 897; IM-WW 422, 423; R-M 814; R-R 93, 741; Emrg 424 *	• **Rare cat > dog,** frequent in cow - 5 cases reported in cat between 1985-1992 • Serious condition especially if in late pregnancy or parturition • Cause: - Occurs during end of gestation usually - pendulous uterus, results in dystocia - Multiparous dams more at risk - Uterine pathology: uterine tumor; pyo-, muco- or hemometra	• **Dystocia:** prolonged unproductive labor • ± Asymptomatic for weeks if only 180° torsion • Abdominal distention • **Abdominal pain** • Shock (collapse, pale mucous membranes • Anorexia, depression, lethargy • Vomiting • Hemorrhagic vaginal discharge • Sequela: - Uterine rupture **DDx:** • Pregnancy w/ dystocia • Pyo-, muco-, or hematoma • Caudal abdominal tumor	Hx (pregnant), CS • Palpation of caudal abdominal mass, pain - **Dehydration** • **Radiographs:** Gravid or fluid filled uterus - If fetal death: fetal or intrauterine gas, collapse of cranial bones, decomposition • Ultrasound (US): of uterus & fetal viability • Exploratory surgery - definitive	• Emergency: exploratory • Supportive Tx: fluid • **Spay** (ovariohysterectomy) (ischemic uterine tissue usually devitalized) • ABs if fetal death, purulent discharge or fever Prognosis: Good if surgery successful; Grave if shock
Uterine tear or rupture * F 340; H2B 709; R-R 198, 357, 737, 743; R-M 820 (f)	• **Rare** • Tear: lesion through endometrium & part of myometrium but not through serosa • Uterine rupture: tear through all layers of uterus including serosa • Cause: Severe trauma of gravid uterus, Uterine torsion, Parturition, Necrotizing metritis, Pyometra, Cesarean section	• **Dystocia** • Hemorrhagic discharge > several minutes may indicate uterine tear - Hypovolemic shock if prolonged bleeding • **Sick:** abdominal pain & depression: uterine torsion, tear of rupture • Sequela: Shock	• **Hx, CS, PE** • Abdominal radiographs - For size, number & position of remaining fetuses - Uterine rupture - fetus in abdominal cavity • Ultrasound: for fetal viability • Exploratory laparotomy	• **OVH** (ovariohysterectomy) after stabilization • Treat peritonitis: rinse w/ warm saline or lactated Ringer's solution & ABs • Penrose drainage: ventral drainage • Broad spectrum antibiotics 2 weeks Prognosis: **Guarded**
Uterine prolapse/neoplasia see pg 442				
Postpartum hemorrhage F 322; H2B 699; R-R 353; E&R 585, 754 (F), 755 (F); Emrg 422 **	• Uncommon in dogs & cats • Normal: slight in cat - Last only 3-5 days • May follow dystocia	• Normal sign for 3-5 days postpartum • Uterine tear: frank blood **Cause: Postpartum hemorrhage** • Normal • Abnormal hemorrhage rare - Uterine tear/torsion - Inherited coagulopathy (von Willebrand's diz) - Rodenticide - Immune-mediated diz (thrombocytopenia) - DIC - Placental site problems	• Hx, CS • Physical exam • Lab: Normal PCV = 30% at parturition	• Treat with **Oxytocin,** 5-10 IU IM • If no relief, OVH may be indicated Prognosis: **Guarded**

Cesarean section

SAP 908; R-R 321; R-M 502, 819 (F); Cat 1902; C12T 1085; Sx4B 496; Sx3B 404; Sx-S-hb 450, 762; Sx-S 1322, 1325, 2300; NB 19.12

- Indications:
  - . **Dystocia not correctable by medical treatment**
  - . **Systemic ill full term bitch**
  - . **Dead puppies**
- Breeds predisposed to dystocia: Chihuahua, English bulldog
- Inform owner that OVH may be necessary if uterus nonviable
- Correct any abnormalities of extended labor
  - Physical exhaustion, dehydration, acid-base balance, hypotension, hypocalcemia or hypoglycemia
  - IV fluids (balanced electrolyte solution w/ dextrose if indicated - minimum of 10 ml/kg/hr)
  - ± Corticosteroids
  - Antibiotics - cefazolin (Ancef®, Kefzol®®) recommended
  - ± Calcium gluconate
- Anesthesia: dog
  - General anesthesia: complete analgesia & immobilization
    - . Oxymorphone for sedation
    - . Thiopental (short acting barbiturate added if resist intubation
    - . Methoxyflurane & N2O (agents of choice), halothane & N2O
    - . Disadvantages: depression of fetuses & dam
  - Epidural (safest) Bupivicaine (1 ml/3.5 kg) slowly into the L7-S1 intervertebral space (spinal needle)
    - . Oxymorphone, IV if tranquilization necessary
- Cats: Ketamine & local anesthesia
  - Inhalation anesthesia after neonates removed
- Surgical technique:
  - Open abdomen: dorsal recumbency, incise skin, SQ, linea alba on ventral midline, avoid mammary tissue
  - Exteriorize uterus & isolate from abdomen
  - Nick nonvascular dorsal or ventral midline of uterine body w/ scalpel; extend incision w/ Metzenbaum scissors
  - Gently squeeze feti to incisions & remove
    - . Break anionic sac
    - . Clamp & transect umbilical vessels - 1 inch long
    - . Pass neonate to assistant
    - . Remove placental if easily separates, otherwise leave in place
    - . Extract all fetuses - check entire uterus
  - Close uterus
    - . Uterus contracts rapidly after fetal removal & oxytocin rarely required
    - . 2-0 or 3-0 chromic catgut of absorbable suture
    - . 1 or 2 layer inverting suture pattern (Cushing or Lambert
  - Rinse uterus w/ warmed physiological saline & return to abdomen
  - Lavage abdominal cavity w/ warm physiological saline if contamination suspected
  - Close abdominal wall

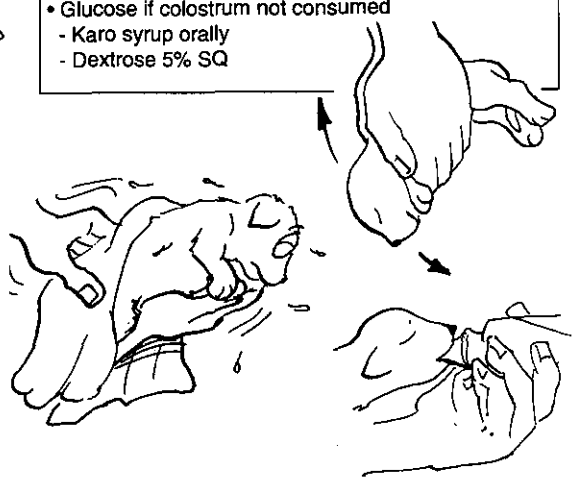


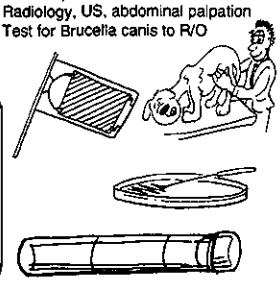
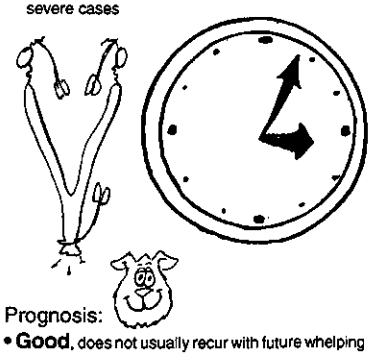
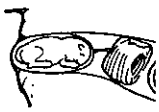
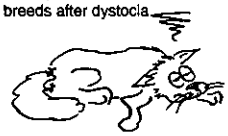
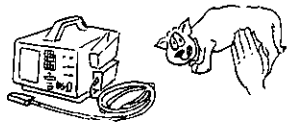
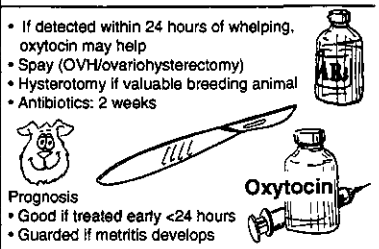
- Care of neonate:
  - 1-2 drops of naloxone (Narcan®) or doxapram (Dopram®) onto tongue or into umbilical vein to reverses effects of narcotic or barbiturate anesthesia
  - ± Sodium bicarbonate if prolonged asphyxiation (>5 min) via umbilical vein
  - Prolonged bradycardia: Epinephrine IV; Atropine IM or IV
  - Normal resuscitation immediately
  - introduce dam & neonate on recovery from anesthesia so colostrum passed
    - . ± Oxytocin to stimulate milk letdown
- Complications: hemorrhage, hypovolemia, hypotension, peritonitis (uterine fluids contamination), wound dehiscence, agalactia
  - OVH (ovariohysterectomy) if uterine viability questionable (w/ owner approval) concurrently w/ cesarean section
    - . Will not effect mothers instincts or ability to nurse young

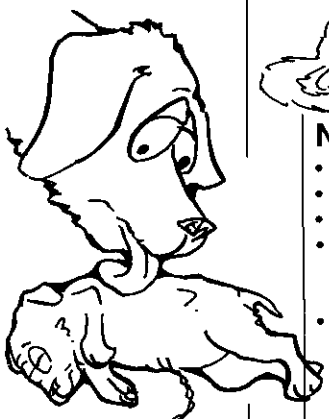
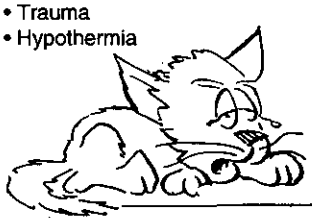
Resuscitate neonates

E-hb 611; E 1623?; SAP 909; Sx-S-hb 450; Sx-S 1324

- **Establish airway** w/in 1-3 min of birth
  - Remove placental membranes, meconium, suction or swab oral cavity & trachea
  - Swing pup head first downward path while supporting rest of head & body repeatedly to clear airway
- Stimulate breathing: briskly massage thorax & face w/ warm towel
- O_2 by mask if cyanosis persists
- Monitor heartbeat (thoracic palpation/auscultation)
  - External cardiac massage if none detected
- Completely dry & keep warm
- Encourage immediate sucking (calories, colostrum & glucose)
- Glucose if colostrum not consumed
  - Karo syrup orally
  - Dextrose 5% SQ

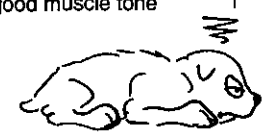


Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Lochia E-hb 610; E 1618	• **Normal:** greenish, brick red, brownish, then serosanguinous vaginal discharge which has no odor & decreases in amount & diminishes after 4-6 weeks			
Subinvolution of placental sites, SIPS, Persistent decidual reaction E-hb 610; SAP 896; H3B 641; H2B 701; I2M 887; IM 676; IM-WW 424; 5min 1090; E 1618; R-M 513; R-R 742, 354; E&R 586, 756(f); Sx-S-hb 443; NB 19.13 ** 	• **Failure of involution** > 12-16 weeks - Normally complete by 12 weeks . Normal lochia: hemorrhagic vaginal discharge during subinvolution • Persistent pospartum hemorrhage 7-12 weeks - Blood loss rarely severe • <3 years old, not reported in cats • Cause: unknown - Fetal trophoblast cells invade endometrium & myometrium & may prevent involution - Lack of thrombosis in endometrial blood vessels results in bleeding	• **Bloody** (serosanguinous) **vaginal discharge** > 6 weeks postpartum • Healthy bitch • Sequela: infrequent - Life threatening if allowed to continue - Uterine rupture - Ascending metritis - Anemia **DDx: Postpartum hemorrhage** • Injuries during whelping • Bleeding disorders/Coagulopathies • Vaginal masses • Placental necrosis • Metritis • Retained fetal or placental tissues • Trauma/neoplasia to genital tract • Chronic vaginitis • Normal lochia	• **Hx, CS** (bloody discharge > 6 wks in healthy bitch) • Palpation: ± discrete, firm, spherical enlargements of uterine horns • Blood values & urinalysis usually normal - Rarely anemic (PCV normally declines in pregnancy) • Vaginal cytology : ± trophoblast (highly suggestive of SIPS) • +/- Histopath to confirm • Radiology, US, abdominal palpation • Test for Brucella canis to R/O 	• **Tx usually not needed, recovery usually spontaneous & infertility unaffected** • Ergonovine once may be attempted • OVH is curative (TOC in nonbreeding bitches) - Laparotomy & curettage could be performed in severe cases  Prognosis: • **Good**, does not usually recur with future whelping
Retained placenta F 324; IM 676; H2B 700; 5min 1026; R-R 384; F-N 465; E&R 587, 756(f) * 	• Common in cow, **rare in dog & cat** • Normally passed after each fetus or 2 passed after 2 kittens/puppies born • If not passed normally suckling usually causes expulsion w/in few hours • Toy breeds after dystocia 	• Rarely asymptomatic • Postpartum discharge • Fever • Anorexia • Depressed • Lactation stops • Sequelae: - Metritis & death in 5 days if not treated - Infertility	• Abdominal palpation: segmental swelling of the uterus • US (ultrasound) • Radiographs: uterine enlargements - ± Contrast studies if cervix still opened 	• If detected within 24 hours of whelping, oxytocin may help • Spay (OVH/ovariohysterectomy) • Hysterotomy if valuable breeding animal • Antibiotics: 2 weeks  Oxytocin Prognosis • Good if treated early <24 hours • Guarded if metritis develops

Neonatal problems IM 681 *** 	• Hypoglycemia • Infection • Trauma • Hypothermia 	• **Persistent crying** (>20 min) • ↓ Activity - ↓ Nursing • Failure to gain weight • Dry, rough hair coat • ↓ Muscle tone • Puppies piled on each other = cold • Widely separated/ panting = warm hot **DDx - Crying** • Cold • Hungry • Ill • Neglected	• Hx (neonates) • Presentation/CS • Physical exam - Dehydration - Pale mucous membranes - Cyanosis	• **Treat problem** • Support: warmth, fluids, nutrition • Supplemental tube feeding • Foster mother Prognosis: • Poor if loss of 10% of birth weight • Grave if ↓ muscle tone • Worse than similar signs in adult because of rapid progression in neonates

Normal neonate IM 681

- Should have pink mucous membranes, be round & sleek w/ good muscle tone
- Respiratory rates: 15-35 breaths/min
- Heart rate: over 200 beats/min for 2 weeks
- Temperature: 96-97° F (35.6-36.1° C) at birth
  - 100° F (27.8° C) by 1 week old
  - Neonates unable to regulate temperature for 2 weeks
- Normal birth weight: Kitten: 100 ± 10 g Puppy: 100-750 g
  - Weight gain: Kitten: 7-10 g/day Puppy: 5-10% of birth weight/day
  - Kitten weight at 6 weeks = 1 lb (500 g)
  - Puppy at 10-12 days should weigh twice birth weight



Hypothermia - neonate IM 681; E-hb 17; 5min 80; E 26 *** 	• **Common cause of neonatal death** • **Neonates can't regulate body temperature for 2 weeks** • Cause: - Low environmental temperature - Damp, drafty environment - Inadequate maternal care	• **Persistent crying followed by ↓ activity** • Culling of cold puppies by mom 	• Hx, CS • Physical exam: - **Rectal temperature < 97° F (36.1° C)** 	• **Warm neonate** slowly over 1-3 hours to 97-98° F (36.1-36.7° C) Prevention: • Adequate environmental temperature • Adequate maternal care • Clip ventrum of long haired dams to encourage cuddling Prognosis: • Good if responds in 3 hours (increased activity, & dam accepting it again) • Grave: if doesn't respond in 3 hours

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Hypoglycemia, Malnutrition - neonate E-hb 611; IM 681; H2B 1273, 1291; 5min 146, 20, 164 ***	• **Common cause of neonatal death** • Neonates: fewer gluconate precursors & less ability to use other energy sources than adults • Higher glucose requirement than adults • Nutritional requirements usually met by dam for 3-4 weeks • Problem at weaning - need to supplement w/ solid food at 3-4 weeks after parturition	• **Hypoglycemia** - Persistent crying - Weakness - ↓ Activity - ↓ Nursing - Respiratory distress - Convulsions - Coma • Orphan - weaning - Constant crying - Weight loss of > 10% - ↓ Body tone & strength	• Hx (**failure to suckle**), CS • Physical exam - Bradycardia - Weight gain	• **Hypoglycemia: oral glucose** sol. while cause is discovered - Equal mixtures of Ringer's sol. & 5% D/W at 3.5-4.0 ml/100 g SQ IV or intraosseously - 10% glucose solution PO, IV or intraosseous at 30 min intervals until rectal temperature ≥ 90° F • Correct hypothermia gradually over 1-3 hours in environment of 85-90° F • **Tube feeding** - Syringe w/ 8 French, 12" human infant rubber feeding tube - Mark tube for distance to stomach (last rib to nose) - Inject correct amount over 2 minutes - For first 3 weeks or life: Burp neonate . Swab genital area w/ moist cotton to stimulate defecation & urination • Orphan neonates: - Milk replacer + glucose to meet caloric needs . Homemade formulas (HB 1274) . Commercial products: Esbilac®, Unilact®, Havolac®, Veta-Lac® - Feed 3-4 timers /day . 13 ml/100 g body weight (BW) for 1st wk . 17 ml/100 g BW for 2nd wk . 20 ml/100 g BW for 3rd wk . 22 ml/100 g BW for 4th wk - Warm feed to body temperature • Supplemental feeding in preparation for weaning - Smear gruel (water & solid food) on lips . 1:3 parts dry puppy/kitten food to water . 2:1 parts canned dry puppy/kitten food to water - Puppy licks off lips - Slowly transfer to eating from a bowl - Decrease amount of water gradually until only solid food - tid

Causes/DDx Hypoglycemia
- Lactation dysfunction
  . Metritis, mastitis, or undeveloped mammae
- Hypothermia (decreased digestion)
- Septicemia
- Weak or sick neonates that can't suckle
- Congenital defects affecting intake
- Death of bitch or queen
- Rejection by dam
- Litter to large to care for

Common cause of neonatal death
CS: Crying, Weakness, Coma
Dx: Hx, CS, PE
Tx: Oral glucose, Warm slowly, Tube feeding

Prevention:
- Make sure neonate nurses in first 12 hours for colostrum
- Supplement weaning at 3-4 weeks of age
- Adequate diet for lactating dam

Neonatal infections

IM 682; H2B 1187; E-hb 608; E 1614; I 20, 69, 3; Cat 1877, R-M 821

***

- Source usually dam or other adults even if asymptomatic
- **Environmental hygiene**
- More common in weanling than neonatal puppies & kittens
- Bacterial can cause neonatal septicemia
- Canine & feline herpesvirus can cause high mortality in 9-14 day-olds

- **Persistent crying**
- ↓ Activity
- ↓ Nursing
- **Failure to gain weight**
- Dry, rough hair coat
- ↓ Muscle tone
- Signs of specific dizs

- Hx, CS
- PE
- Thorough post mortem
  - Hemorrhagic & necrotizing renal lesions - herpes virus
  - Adult parasites
  - Samples of liver, spleen, lung & GI tract for histopath, bacterial culture, & virus isolation
- Brucella testing of colony

- **Fluids** - maintain hydration
- **Antibiotics** for bacterial or 2° bacteria
- Force feeding

Failure of passive transfer

E-hb 611; Mk 1519; R-R 45, 46, 213
- Acquired immunodeficiency
- Failure to nurse w/in 12-24 hours of parturition
  - 5% of immunoglobulins occur between maternal & fetal blood
  - Not as emphasized as much as in ruminants & equine medicine

Prognosis:
- Canine herpes virus: grave

Infectious - neonatal death
- Virus
  - Parvo virus
  - Feline leukemia virus
  - Herpes virus
  - Canine adenovirus 1
  - Canine distemper virus
  - Corona & rotavirus viruses?
- Bacterial
  - E coli
  - Hemolytic & nonhemolytic strep
  - Staph
  - Bordetella
  - Pasteurella
  - Salmonella
  - Brucella
  - Campylobacter
- Parasitic
  - Toxocara
  - Ancyclostoma
  - Giardia
  - Coccidia
  - Crytosporidium

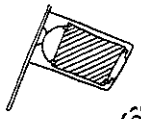
Queen - Hysterical mother

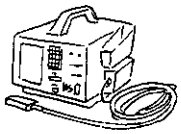
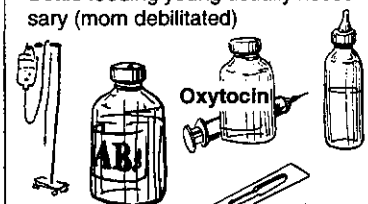
E-hb 610; F 323

*

- **Postpartum rejection of part or all of litter**, not always due to recognition of congenital defect
- Environmental insecurity: moves kittens to a more secure area (under bed, closet)
  - Common 35 days after queening, ↑ Protective behavior, aggression, fear
- Treatment: **Quiet environment, tranquilize, remove kittens**
- Prognosis: **Guarded**

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Metritis, Postpartum endometritis M8k 1035; Mk 677; SAP 895, 931; E-hb 610; H3B 640; H2B 700; I2M 886; IM 676; IM-WW 424; 5min 828; R-M 505; R-R 384; E&R 586, 756(f); Sx-S-hb 444; NB 19.13; Emrg 421 **	• **Severe postpartum bacterial infection of uterus** • Cause: - #1: Infection postpartum (ascending) . Retained placenta . Dystocia trauma . Obstetric manipulation . Normal parturition . Post insemination . Post breeding . Post abortion • *E. coli* & Staphylococcus organisms seen most commonly	• **Acute w/in 1 wk of birth** (w/in 48 hrs in cats) • **Copious purulent vaginal discharge** (foul), Normal lochia: red-dish brown & persists for 2-6 weeks • **Systemic illness** - Fever - Depression, lethargy - Anorexia - Loss of maternal instinct (cold, crying neonates clue) - Vomiting - Poor milk production • PD/PU • Infertility • Sequelae: - Dehydration - Sepsis & toxemia (rapid progression possible) - Chronic metritis - infertility - Pyometra - Rupture of uterus (cats) - Mastitis	• Hx (**postpartum**), CS (vaginal discharge postpartum) • Physical exam: fever or hypothermia, dehydration • Palpation: **doughy uterus** • Laboratory: - Severe bacterial infection (PMNs w/ a left shift) or septic (leukopenia w/ degenerative left shift, toxic neutrophils) - +/- Prerenal azotemia with a low urine SG • Radiology/ US (ultrasound) - Enlarged uterus - Check for retained fetus or placenta • Cytology & culture (guarded cranial vaginal culture) - Vaginal discharge (septic: PMNs, bacteria, ±endometrial cells) . Not diagnostic but guide for ABs • Vaginoscopy for location of discharge	• **IV fluids** (stabilize, may require shock doses) • **IV ABs** immediately - Cephalosporin while wait for culture - Amikacin + cephalothin or amikacin + penicillin if sepsis suspected (rehydrate 1st) - Continue orally for 1-2 weeks (Pen derivatives or Trimethoprim sulfadiazine) - Not tetracycline or chloramphenicol (toxic to neonates in milk) • **OVH recommended** if not breeding bitch/ queen or to save the bitch's/queen's life - OVH if uterine rupture - OVH if placenta or fetal tissue remain in uterus • Evacuation of uterus - **Oxytocin** IM sid or bid for several days - Prostaglandin PgF2 alpha: SQ sid or bid for 2 days • Uterine infusion: if cervix can be cannulated - 2% Betadine® (povidone-iodine) or sterile saline. Caution: uterine rupture • Bottle feeding young usually necessary (mom debilitated)



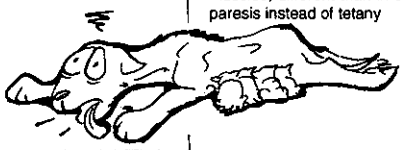
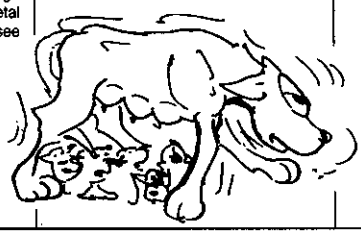



DDx:
- Retained placenta
- Retained fetuses
- Normal lochia & slight fever
- Hemorrhage
- Systemic diz
- Mastitis

Prognosis:
- **Guarded** because of progression to toxemia & sepsis
- Chronic metritis may cause infertility
- Guarded for future fertility even w/ successful evacuation

Postpartum
CS: Sick mom, Vaginal discharge, Crying kittens
Dx: Hx, CS, PE
Tx: ABs, Fluids, OVH or Med? • Px: Guarded

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Hypocalcemia, Puerperal tetany, Eclampsia, Hypocalcemic tetany, Periparturient hypocalcemia Mk 457; E-hb 610; SAP 234; H3B 639; H2B 699; Cat 710; I2M 885; IM 675; IM-WW 423; 5min 535; E 1618; R-M 511, 821 (F); R-R 372; E&R 587; NB 19.13; Emrg 421 ***	• **Life threatening** • Bitch > queen (rare) • **Toy breeds**, 1st 4 wks postpartum • **Small, hyperexcitable primiparous bitches**, rare in larger dogs & cats • Cause: - Excessive calcium loss in the milk 1-4 weeks postpartum most commonly - 20 days prepartum to 45 days postpartum (weaning) • Predisposing factors: - Unbalanced diet - Inappropriate dietary supplementation - Reduced appetite - Stress of lactation - Calcium supplementation during gestation - Ca+ loss in milk - Alkalosis • Rare if nutritious, well balanced diet • Hypomagnesemia may be present & if not corrected, calcium therapy will not work • Pathophysiology: Hypocalcemia alters membrane potentials - spontaneous discharge of nerve fibers & tonic contraction of skeletal muscles, different than in cow where we see paresis instead of tetany	• **Nursing bitch** • Initial signs: - **Restlessness** - **Panting, whimpering** - **Salivation**, facial pruritus - 15 min to 12 hours • Advanced: - **Muscle fasciculation/ spasms** - Stiff, ataxic gait - **Hyperthermia** - **Tetany**: tremors & relaxation periods - Seizures: opisthotonus • Sequelae: - ± Hyperthermia - ± Flaccid paralysis - ± Cerebellar edema - Shock & death if untreated	• Hx (**lactating**), CS • PE: 108 F° temperature • Laboratory: - **Hypocalcemia < 7 mg/dl** (normal > 8.5 mg/dl) - Severity related to degree of hypocalcemia - Treat before get results back - Normophosphatemia - ± Hypomagnesemia (If not corrected, calcium therapy will not work - ± Hypoglycemia • **Response to Tx** **↓ Ca+**	• **Delivery of fetuses ultimate cure** • **Slow IV Ca+** (calcium gluconate 10%) immediately - Monitor heart (ventricular fibrillation & cardiac arrest/bradycardia), stop until normalize - Follow w/ IM, SQ or PO Calcium - Calcium oral supplementation after initial Tx (Ca gluconate, Ca carbonate [Titralac®, Camalox®]], Dicalcium phosphate) for duration of lactation • Correct any hypomagnesemia or calcium therapy will not work - Heart rate should be monitored • Correct any hypoglycemia also • Steroids contraindicated • +/- Anticonvulsant as additional therapy - IV sodium pentobarbital or diazepam (Valium®) • +/- IV 20% dextrose to those that don't respond to Ca • Wean neonates if recurs during same lactation • Balanced lactation diet w/ additional oral calcium

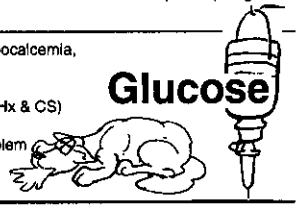
DDx:
- Hypoglycemia
- Toxicities
- Epilepsy
- Irritability & hyperthermia
  - Metritis
  - Mastitis

Prevention:
- Make sure mom eats during lactation

Prognosis: **Good**: response to Tx usually rapid & complete
- Tend to recur in subsequent pregnancies

Nursing bitch w/ fever & CNS signs, Ca

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Gestational hypoglycemia & ketonemia E-hb 608; H2B 1292 *	• **Extremely rare**; Bitches on carbohydrate-deficient diets during advanced pregnancy; 7x dead puppies at birth, High mortality among puppies w/ hypocalcemia, Result in failure to respond to calcium Tx • CS: ↓ food intake & activity, vomiting, rapid respiration, abdominal straining, prostration, acetone breath, weakness, depression, seizure, coma • Dx: Hx (last gestation), CS, acetone breath, ketonuria, serum glucose levels < 7 mg/dl, response to Tx, check for concurrent hypocalcemia (similar Hx & CS) • DDx: Hypocalcemia • Tx: **IV glucose** in normal saline solution (respond immediately & not affected again), frequent feeding, parturition or cesarean section alleviates problem • Prevention: proper nutrition throughout gestation, monitor glucose periodically until puppies weaned			



Condition	Facts/Cause	Presentation/CS	Diagnosis

Abortion, Fetal resorption, Stillbirth complex

SAP 898, 932; H3B 628; H2B 688, 706; I2M 890; IM 678; E-hb 608; C11T 925; 5min 2, 4; R-M 834; R-R 206, 210; E&R 574, 628, F 757; DDx 375; NB 19.12

Facts/Cause

- **Incidence ?**: difficult to assess because no reliable method of confirming pregnancy early in gestation
  - Death early in gestation = resorption
  - Death later in gestation results in abortion
- Queen: abortion generally occurs between 50-58 days of gestation

Presentation/CS

- Vary: cause & time of gestation

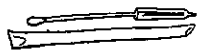
- **Early abortion**
  - **No CS**
  - Infertility (failure to conceive)
  - Bitch continue to appear pregnant (mammary gland development & weight gain)
  - Queens: appearance of pregnancy subsides gradually
    . Queens likely to resume cycling
  - ± Vaginal discharge, ± malaise, fever, anorexia

- Late abortion:
  - **Vulvar discharge**
    . Fetal material (live or dead)
    . Restlessness & abdominal contractions associated w/ impending abortion
- **Systemic illness** (anorexia, lethargy, diarrhea, vomiting) during pregnancy
  - May indicate recent of pending abortion
- Herpes virus: vesicular or follicular lesion of vaginal mucosa
- Loss of premature fetuses does not mean the entire litter will be aborted
- Queens rarely show listlessness or anorexia
- Sequela: **infertility**

Diagnosis

- **Hx** (vaccinations, environmental changes, drugs, dietary supplementation, new animals in colony), CS
- Physical exam:
  - Digital vaginal exam
  - If systemically ill do CBC, chemistries & urinalysis
  - Consider pyometra

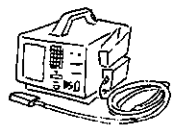
- **Difficult unless fetal tissue found**
- **Fetal tissue = diagnosis**
- Submit fetal tissue, placenta & vaginal swabs from bitch

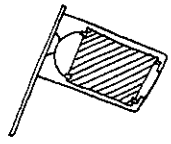


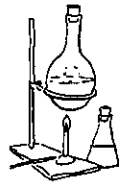
- **Ultrasound:** diagnose pregnancy after 16 days & also to confirm viability of fetuses, or retained fetus
- Radiographs: for death or nonviability
  - After 45 days: collapse or decalcification of skeleton, intrafetal gas, or abnormal fetal position
- **Brucella serology in all bitches**

  - Slide agglutination Test (RSAT): screening for positives (negative almost certainly free from infection)
  - Retest positives w/ TAT, remove positives

- FeLV, FIV & FIP serology
- Fetal/placental tissue for bacteriology & virology
- ± Karyotyping fetus if no maternal evidence (rarely done)
- ± Toxoplasma paired titer
- ± Thyroid stimulating hormone (TSH) test
- ± Low plasma progesterone (<2 ng/ml) indicate hypoluteoidism, monitor next pregnancy if no diagnosis







Incidence ?
CS: Infertility, ± Vaginal discharge
Dx: Hx, CS, PE, Fetal tissue, Rads, US, Brucella, FeLV, FIV & FIP serology
Tx: Supportive, OVH, Oxytocin, ABs, Tx cause • Px: Good

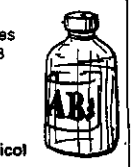
Abortion: determination of exact cause is difficult

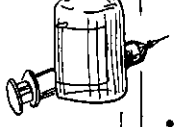
- **Canine:**
  - Fetal defects:
    . Chromosomal abnormalities
    . Anatomical abnormalities

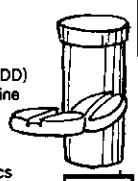
  - Maternal factors:
    . **Systemically ill**
    . **Uterine diz** (chronic endometritis, cystic endometrial hyperplasia, uterine adhesions)
    . Exogenous glucocorticoid therapy
    .Infectious agents: Brucella, E. coli, streptococcus, herpesvirus, leptospirosis, canine parvovirus, canine distemper virus, mycoplasma, Campylobacter sp.
    .. **Canine herpesvirus infection (CHV) & brucellosis**: important because of impact on breeding programs
    . Toxoplasmosis (dog not cat)
    . **Hypothyroidism**
    . Hypoluteoidism (ovarian failure)
    . Immune-mediated hemolytic anemia
    . Immune-mediated thrombocytopenia
    . Bleeding disorders
    . Hernia or torsion of uterus
    . Chloramphenicol
    . Trauma: unlikely but can occur
- **Queen:**
  - Defective zygote - chromosome -anatomic
  - Infections/structural changes in genital tract
  - Environmental stress
  - **Viral Infections** 60% of cases
    . Feline viral rhinotracheitis (FVR) herpes virus: >
    . Panleukopenia virus
    . FeLV: 40% of losses, #1 (feline leukemia virus)
    . FIP (feline infectious peritonitis)
  - Toxoplasmosis: not usually in cats
  - Bacterial infections: strep, staph, E. coli, salmonella
  - Bacterial metritis
  - Chlamydial agents, Coxiella burnetti (Q Fever)
  - Inadequate progesterone secretion rare in cat
  - Nutritional: Vitamin A deficiency, Iodine deficiency, Malnutrition, Taurine deficiency ?
    . Inadequate progesterone - rare

Drugs - risk of abortion

- Antibiotics
  - Aminoglycosides
  - Amphotericin-B
  - Ciprofloxacin
  - Enrofloxacin
  - Griseofulvin
  - Tetracycline
  - **Chloramphenicol**
  - Metronidazole
  - Doxycycline
  - Oxytetracycline
- Nonsteroidal antiinflammatories
- Hormones
  - **Androgens**
  - Bromocriptine
  - **Estrogen**
  - Excessive thyroid
  - **Glucocorticoids**
  - Prostaglandin
- Anesthetics
  - Barbiturates
  - Halothane
  - Methoxyflurane
  - Diazepam
- Anticonvulsants
- Anticancer drugs
- Antiparasitic drugs
  - Levamisole
  - Thiacetarsamide
  - Trichlorfon
  - Amitraz
- Miscellaneous
  - Captopril
  - Dantrolene
  - Dimethyl sulfoxide (DMSO)
  - Diphenoxylate
  - Isoproterenol
  - Loperamide
  - Methocarbamol
  - Mitotane (o,p'-DDD)
  - Methoscopalamine
  - Nitroglycerine
  - Nitroprusside
  - Propranolol
  - Thiazide diuretics
  - Vitamin overdose







Treatment:

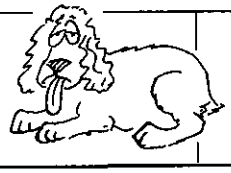
- **Supportive & symptomatic Tx of mom**
  - If viable fetuses remain, allow pregnancy to continue
  - If no viable fetuses
    . **OVH**
    . **Oxytocin** or prostaglandin PgF2 (Lutalyse®) to promote uterine evacuation
  - **Antibiotics**
- Attempts to preventing impending abortion/resorption usually ineffective
- **Treat underlying cause if possible**
  - Incidental bacterial infection: antibiotics from culture & sensitivity
    . Pyometra best treated w/ ovariohysterectomy, but may be managed medically in some w/o severe illness
  - Brucellosis: no effective cure: cull positive animals
    .Transiently elimination somewhat effective w/ ABs, but recurrence can occur
    . Prevention: no vaccine so identify (serology) & elimination of infected animals
  - Primary hypoleoidism: exogenous progesterone w/ caution
  - Treat: toxoplasmosis, distemper, feline infectious peritonitis, FeLV & HV
- **Repeat aborter**
  - Changing studs or
  - Invasive reproductive evaluation (biopsy)
  - Thyroid status assessed
- Retained dead fetuses: medical or surgical removal of fetal material
- Queens w/ late-term hemorrhage> rest

Lutalyse

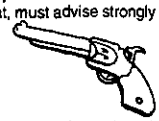
Oxytocin

Prognosis:

- **Good** (many isolated event & subsequent breedings uneventful)



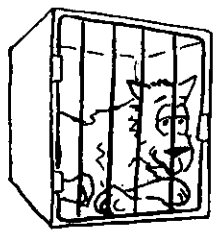
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Canine brucellosis M8k 1043; SAP 129t, 130, 879, 898, 926; E-hb 608, 621, 185, 106; H2B 1203; I2M 928; IM 713; 5min 408; E 37; C12T 1094; C11T 925; R-M 467, 470, 544; R-R 728; E&R 664, 626, 683; DDx 375	• **Devastates on breeding program** - Highly contagious, no vaccine & no effective treatment - **#1 bacterial cause of abortion in bitch** • Cause: ***Brucella canis*** (gram negative coccobacillus) - Localizes in lymphoid & mononuclear system, prostate & testes, gravid uterus (infertility, abortion), rarely in eye, kidney or intervertebral discs • Transmission: penetrates any mucous membrane from infected material (aborted fetus) - Oronasal, conjunctival or venereal routs (semen) - Intrauterine (abortion) - Milk & urine - Between same sex housed together does not easily occur - Time from exposure to bacteremia 21 days & can last up to 4 years - Abortion at 45-55 days • **Intracellular bacteria**	• **Asymptomatic**, usually - Mild lymphadenopathy, splenomegaly - Fever & systemic illness rare, death never in adult • **Abortion**: between 45-55 of gestation: autolyzed fetuses - Healthy bitch - Followed by brown to greenish gray vaginal discharge - May whelp near term pups (live or dead). Surviving will be bacteremic - May lose 2 or 3 successive litters • **Infertility**: usually conception occurs but resorption or embryonic death • Male, inapparent infections - **Infertility #1** (abnormal sperm) - Testicular atrophy & enlargement (orchitis) - Epididymitis & preputial discharge - Scrotal dermatitis • ± Diskospondylitis - back pain, paresis or paralysis • ± Anterior uveitis	• **Hx, CS** • **Rapid slide agglutination test (RSAT)**: good screening test because few false negative (negative RSAT almost certainly free from infection), quick, easy & sensitive - Many false positive (up to 50%) so retest positives w/ TAT - False negatives in dogs on antibiotic therapy (1%) • **Tube Agglutination Test (TAT)**: used to confirm RSAT positives - More specific, low incidence of false positives • AGID (agar gel diffusion) for retesting positive TAT • **Culture**: definitive diagnosis - blood, milk, urine, vaginal discharges, semen, lymph nodes, or bone marrow. Blood culturing most practical (gold standard) - Difficult to isolate & time consuming	• **Euthanize all positive animals recommended** • **No effective cure**: none guaranteed - Intracellular location of Brucella makes AB Tx difficult & all infected animal considered potential carriers for life • Advise not to breed & neuter all infected dogs before ABs • Transiently elimination somewhat effective w/ ABs, but recurrence can occur - High levels of minocycline + streptomycin) for 14 days weeks may eliminate the bacteremia phase, very expensive - Tetracycline: 2 courses reculture & retreat if + - These animals should not be used for breeding => retire or destroy • If owners choose to treat, must advise strongly of public health risk Prevention: • **No vaccine**, so identify (serology) & elimination of infected animals - Brucella free kennel . Isolate all new animals until brucellosis-negative on 2 tube agglutination test at least 1 month apart . RSAT screening in prebreeding exam - Do not breed any Brucella + animals because: . Likelihood of spread of diz . Pups born to positive bitch likely to be stillborn or bacteremic - Remove infected dogs from breeding kennels Prognosis: • **Poor** for positive animals, relapses often occur, diz spreads & devastating results on breeding program

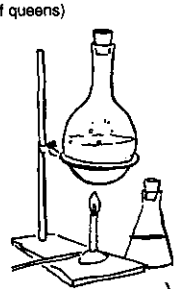


• **Public health**: rare (low level of risk)
- Most cases of human brucella are in laboratory personnel or kennel attendants, suggesting repeated, massive exposure to the organism (aborted fetuses, placenta of infected dogs)
- CS: Fever, headache & myalgia (muscle pain)
- Prevention: neuter all positive dogs

Devastates breeding, Contagious, No vaccine & No Tx
CS: Asymptomatic, Abortion, Infertility
Dx: RSAT, TAT, Tests, Culture
Tx: Euthanize all + No cure, No vaccine • Px: poor for +
Public Health: Rare

Herpesvirus infection, Canine herpesvirus infection CHV, Feline herpesvirus M8k 550, 336; SAP 898, 932; H2B 1190; I2M 226; IM 640, 711, 743; IM-WW 304, 421, 561; E-hb 608, 201, 208; 5min 673, 474; E 408; C11T 927; R-M 467, 475, 516; 835; E&R 576	• **Similar syndrome in dogs & cats** - Cat: feline herpesvirus type 1 (FHV-1, rhinotracheitis) • Prevalence - CHV: 15% in house pets, up to 85% in kennels • Once infected - infected for life • Transmission: venereal, transplacental, via contact by the neonate during birth, or through respiratory tract	• **Neonates: < 2 weeks old** - **Acute fatal infection** . **Generalized focal necrosis & hemorrhage** . Weak, don't nurse, shiver, bright yellow, fluid stool, crying, nasal discharge, death in 1-2 days . Persistent neurologic deficits in recovered pups/kits (ataxia, blindness, cerebellar signs) • Older pups/kits: 3-5 weeks old - Mild, transient respiratory signs • **Adult:** - **Respiratory**: mild conjunctivitis, ocular & nasal discharges - Genital form: asymptomatic usually . Vaginal/vestibular/vulvar lesions: vesicular early, then pox-like, Genital lesions disappear & reappear with the onset of proestrus • **Infertility, fetal resorption, mummification**: small litter size, Abortion (day 44 - 51 when infected on day 30), Premature birth - weak pups, Some pups in a litter may be unaffected	• Hx (**acute neonatal death, adults - vesicular lesion of mucosa of genitalia**), CS • Intranuclear inclusions in tissue sections, histopath on fetus • Serology • Virus isolation (difficult) - diagnostic (organs, ling, liver, kidney, & spleen (chilled not frozen) - Nasal swabs of queens, genital swabs for bitch • Fetal placental lesions include congestion, grayish white foci & underdevelopment • Postmortem - neonates: multifocal, diffuse hemorrhage & gray parenchymal organs (especially kidney, liver & lungs - Microscope: multifocal, necrotizing lesions - intranuclear inclusions (uterus, placenta & aborted fetus of queens)	• **Neonates - unrewarding - fatal** - Hyperimmune serum - Elevate body temperature? - Vidarabine **None** • **Adults: Isolate until heal** - Consider culling in kennel situation - because constant source of infection Prevention • **No CHV vaccine** • FHV feline rhinotracheitis vaccine • Hygiene & isolation in kennels • Isolate pregnant females & neonates from rest of kennel Prognosis: • **Neonates: grave** • Adult: recrudescence w/ stress





Dogs & cats, Infected for life
CS: Neonates: Fatal; Older: Mild, Respiratory signs; Infertility
Dx: Hx, CS, Intranuclear inclusions, Serology
Tx: Neonates: Fatal; Adults: Isolate until heal, Cull
Prevention: No CHV vaccine, FHV feline rhinotracheitis vaccine

DDx:
• Neonatal bacterial septicemia
• Canine brucellosis

Hypoluteoidism, Ovarian failure, Luteal insufficiency

SAP 898; H2B 644; E-hb 607; C12T 1072; C11T 928; C-N 472, R-M 830(f); E&R 628, 632, 764 (f)

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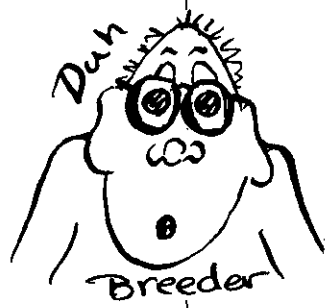
• 1° luteal failure (undocumented), Ovarian failure (CL doesn't secrete adequate progesterone to maintain pregnancy); Cause: ovarian dizs; 1° hypoleoidism in bitch & queen. Not well understood
• CS: Infertility (recurrent fetal resorption)
• Dx: Recurrent fetal resorption; Low plasma progesterone (<5 ng/ml) & no pregnancy w/ preceding diagnosis of pregnancy w/ ultrasound
• Tx: 1° hypoleoidism; **exogenous progesterone** w/ caution because predisposes to pyometra, low progesterone levels may be a complication of another disorder
• Px: Good if Dx early & supplementation

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
"Fading kitten" FeLV, Feline leukemia virus infection, Feline lymphosarcoma, Feline leukemia Mk 39; F-N 470; E-hb 204; H2B 1197; SAP 82; IM 876, 954; C12T 30; E&R 758 ***	• See Systemic dizs • FeLV causes spontaneous neoplasia & suppresses bone marrow & the immune system • **#1 neoplastic diz of cats** • #1 cause of illness & death in cats • Retrovirus like FIV • Diseases: nonneoplastic & neoplastic (lymphoma #1) • Fetal resorption or abortion: 80% in infected cats & transplacental & transmammary transmission in at least 20% of surviving kittens form infected queens • Most young cats become persistently viremic	• **Unaffected/asymptomatic** • **Immunodeficiency: 2° infections** • **Wasting diz** • **Lymphoma**: anterior mediastinal; GI form, Kidney, Liver (anemia, jaundice, weight loss, vomiting) • Bone marrow myeloproliferative diz • Eye, CNS, Cutaneous dizs • **Reproduction system** - Inappetence & listlessness - **"Fading kittens"** - Infertility - Stillbirths & abortions	• Hx, CS • Physical exam: marked enlargement of lymph nodes • Vaginoscopy: for vaginal discharge or vesicles • Laboratory: Anemia, Chemistries • **FeLV: ELISA** (Probe-Combo ELISA test (tests for FeLV & FIV) • Necropsy of any stillborn or aborted fetuses: infectious agents	• **FeLV dizs** no safe & effective antiviral agents - Retest - If persistently infected: client counselling Management of FeLV + cats • Keep indoors to protect from contact • Keep other vaccines current • Monitor for onset of systemic diz Prevention: • Vaccines available: efficacy <100% - MLVs recommended for cats at risk of exposure (outdoor/indoor cats, multicat households) 2 initial doses & annual boosters • Eradicate test & removal from cattery Prognosis: **Poor**
Feline viral rhinotracheitis, FVR, Feline herpesvirus infection M8k 1115; Mk 760; F-N 471; E-hb 208; SAP 100; H2B 1216; IM 163; 5min 474; E 208; R-M 835; INF 119 ***	• Common cause of feline upper respiratory infections • > 40% of viral losses during pregnancy	• **URI** (**sneezing, naso-ocular discharge**, fever) • Other CS - Inappetence & listlessness - Ulcerative keratitis - Pregnant queens (FVR): . **Abortions** . **Fetal infections**: born w/ generalized infection (fatal encephalitis or focal necrotizing hepatitis) or asymptomatic & develop CS shortly after birth	• History • Physical & reproductive examination: systemic diz • Vaginoscopy: for vaginal discharge or vesicles • Lab: CBC, chemistries • Urinalysis • FeLV test & FIV • Necropsy of any stillborn or aborted fetuses - infectious agents	• **URI: self-limiting in 5-7 d usually** **Prevention:** • **Vaccination** for FHV & calicivirus routinely - Intranasal vaccine in outbreak situation • Minimize exposure (see Resp) Prognosis: **Good**
Toxoplasmosis F-N 472; R-M 837 *	• Protozoan. Cat only definitive host, not documented to cause abortions			

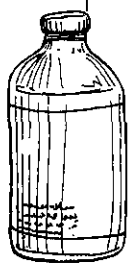
FPV, Feline panleukopenia abortion, F-N 471; IM 336; SAP 114, 700; E-hb 149, 467; 5min 592; E 314; H2B 1194; R-M 836; R-R 66, 211; INF 1; E&R 759 **	• **See Systemic pg 690** • Contagious **viral gastroenteritis** • Parvovirus: relatively rare now because of vaccinations, occasionally seen in unvaccinated kittens • **Destroys rapidly dividing cells** - Transplacental: abortion, teratologic . Cerebellar hypoplasia in utero up to 9 d-old	• **Adults - subclinical** • **Perinatal infection - neonate** - Normal or weak - **Cerebellar damage** at 3 wks of age . Hypermetria, intention tremors, symmetrical incoordination, rolling & tumbling, ataxia persist for life - **dancing kitten** - Fading kitten syndrome . Invasion of thymus, thymic atrophy & early neonatal mortality - Retinal dysplasia if invades retina • Severe: older kits, like parvo in dogs • **In utero infections** - Early embryonic resorption (infertility) - Fetal death/mummification - Abortion & stillbirth - Early neonatal deaths - Inappetence & listlessness in dam	• Hx (**unvaccinated**), CS • Previous vac. doesn't R/O • Lab: **Transient leukopenia** • Necropsy of any stillborn or aborted fetuses - infectious agents	• **Emergency: #1 aggressive fluids, ABs; NPO** ; Antiemetics • Isolate for 2-4 wks, dispose feces • Vaccinate other cats in household • Chlorox (1:32) environment CLOROX **Vaccinations:** • **Active immunization** - **MLV vac** (not for pregnant or cats < 4 weeks old) • **Inactivated vaccine**: for pregnant cats & kittens <4 wks-old or debilitated kittens Prognosis: **Guarded to grave**: young kittens (mortality 50-90%) • Cerebellar hypoplasia persists for life, can live
Bacterial infections - abortions R-M 835; E&R 758 ***	• E coli, Strep, Staph, salmonella, Chlamydial agents, mycobacterium • Dog > cat	• **Mild anorexia & depression** • Advanced - ± **Vaginal discharge** (open pyometra) • ± Febrile - ± Abdomen may be distended - PD/PU - Dehydration - Infertility only usually - Pyometra - discharge	• History • Physical exam: systemic diz - Abdominal palpation - Vaginal digital palpation, not recommended in queen • Vaginoscopy: vaginal discharge or vesicles • Hematology (left shift w/ a leukocytosis) - Serum biochemistry (azotemia) • Cytology & culture of vaginal discharge • Urinalysis • FeLV test & FIV • Thyroxin in older queens >6 year old • Ultrasound (US): enlarged, nongravid uterus if CEH, confirm pregnancy, fetal viability • Exploratory: uterine biopsy & cultures (CEH), ovarian cysts • Radiography	• **ABs** (antibiotics) • Evacuate uterus Prognosis: • **Guarded**

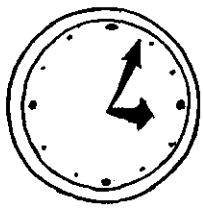
Condition	Facts/Cause	Presentation/CS	Diagnosis
Infertility - queen- Breeding disorders E-hb 630; H3B 645; H2B 705; IM 644; 5min 88; E 1695; C11T 947; Cat 1864; F3IM581; R-M829; R-R 709; E&R 762; DDx 381 ***	• Failure to breed, conceive or produce young • **Common** • Classification - Failure to breed - Normal estrous cycle - Abnormal estrous cycle	• **Abnormal estrus cycles** - Ovarian degeneration: weight loss & rough thin hair coat - Persistent anestrus: poor weight gain, poor coat, failure to socialize, failure to thrive (low on social order) • **Silent heat** - not detected • **Ovulation failure** - Continues to cycle w/o luteal phase • Cystic endometrial hyperplasia - Infertility only usually - Pyometra - discharge • **Resorption & abortion** - FeLV - Asymptomatic - resorption - infertility - Sanguineous vaginal discharge - Expulsion of fetus - abortion - Inappetence & listlessness	• History - Interestral interval 45-50 d - pseudopregnancy - Breeding management - History of infectious dizs in cattery - Medical problems - Housing & nutrition - Vaccinations - Breeding record of queen, litters etc. - Male fertility • Physical & reproductive exam: systemic diz - Vaginal palpation not recommended in queen, visualization of vulva • Vaginal cytology to see if cycling - estrogen cornification of cells • Vaginoscopy: for vaginal discharge or vesicles • Hormonal assay: - Serum estrogen: DDx anestrus for silent heat . Estrus : E >20 pg/ml; Anestrus & interestrus < 20 pg/ml (expensive) - Serum progesterone: DDx pseudopregnancy form anestrus . Pseudopregnancy & pregnancy > 2 ng/ml . Anestrus <1 ng/ml • Lab data base: CBC, chemistries • Urinalysis (cystocentesis) • FeLV test & FIV • Thyroxin in older queens >6 year old • Ultrasound (US): enlarged , nongravid uterus if CEH - Confirm pregnancy - Fetal viability • Exploratory: uterine biopsy & cultures (CEH), ovarian cysts • Necropsy of any stillborn or aborted fetuses - infectious agents • Karyotyping in suspected animals

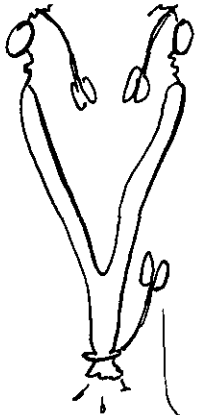


Failure to breed, conceive or produce young; Common
Dx: Hx, CS, PE, Lab, UA, FeLV & FIV
Tx: Treat cause

DDx - Infertility - queen - no estrus
- Normal winter anestrus
- OVH (ovariohysterectomy)
- Hermaphroditism
- Delayed puberty
- Silent heat
- Progesterone medication
- Megestrol acetate
- Debility
- Ovarian dysfunction
  - Ovarian dysgenesis
  - Prolonged anestrus
  - Ovarian neoplasia
- Cystic endometrial hyperplasia
- Pyometra complex
- Short photoperiod
- Lack of exposure to male cats



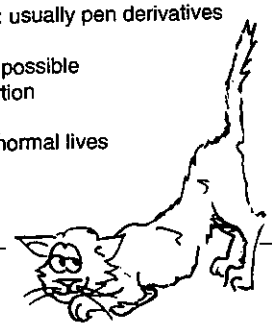




Infertility - cycle but don't conceive
- **Poor breeding management #1**
- Stress
- Cystic ovaries
- Ovulation failure
- Prolonged proestrus or estrus
- Cystic endometrial hyperplasia
- Early embryonic death
- Pseudopregnancy
- Infertility of the male
- Refusal to mate
- OVH w/ ovarian remnant
- Feline panleukopenia
- Pregnancy failure/FeLV
  - Early embryonic loss/FeLV
  - Abortions

Prevention:
- Prevent infectious dizs
  - Vaccination
  - Husbandry
  - Isolate new cats & those coming back from shows

Treatment:
- Persistent seasonal estrus
  - Allow breeding on a daily basis
- Persistent nonseasonal estrus
  - No specific treatment
  - ± OVH in older queens
- Silent heat:
  - Change photoperiod to 14 hours of light
  - Estrus induction: FSH
- Ovulation failure:
  - Allow repeated breeding starting no later than 4th day of behavioral estrus
  - Start at first day of estrus & daily until won't breed
  - Induce ovulation: vaginal stimulation with thermometer or metal or glass probe
    . Success indicated by copulatory cry
    . HCG or GnRH injection
- Cystic endometrial hyperplasia:
  - OVH: treatment of choice
  - Prostaglandins: may work 0.5 mg/kg SC
  - PgF2 side effects: restlessness, GI signs, respiratory distress, muscle tremors.
  - Antibiotic therapy is indicated: usually pen derivatives
- Resorption & abortion:
  - Treat underlying cause when possible
  - Can't prevent impending abortion
- Intersex:
  - No treatment, OVH, can live normal lives
- Pseudopregnancy:
  - None
  - Consider OVH



Condition	Facts/Cause	Presentation/CS	Diagnosis

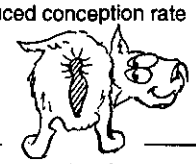
Infertility - bitch
- breeding disorders

E-hb 615; SAP 925; H3B 627; H2B 687; I2M 850; IM 644, 649; 5min 88; E 1640; C11T 954; R-M 466; R-R 709; E&R 619, 544, 553; DDx 377

Failure to produce young; Common
Dx: Hx, CS, PE, R/O Brucellosis
Tx: Treat cause

- **Temporary or permanent reduced ability to breed, conceive or produce a normal number of viable offspring**
- Common
- Classification:
  - Normal estrous cycle
  - Abnormal estrous cycle

- **Unsuccessful breeding**
  - Mating w/o pregnancy or whelping
  - Refusal to breed
  - Not coming in to estrus by 24 months of age
  - Prolong estrus (>10 months in adult)
  - Abnormal cycle behavior (prolonged estrus, split heats, short interestrus interval & anestus)
  - Abortion or fetal resorption
  - Physical anomalies (enlarged clitoris)
  - Vulvar discharge
  - Mass protruding from vulva
  - Small litter size & reduced conception rate
- Genitourinary tract Diz



- Complete medical & reproductive history
- Physical exam: general & reproductive
- Laboratory (blood values & urinalysis for underlying diz)
- **1st check breeding management practices**
- **Rule out brucellosis**
- Thyroid function test
- Vaginal cytology/culture
  - Vaginal cytology: management, neoplasia
  - Cranial vagina culture: infection
- Radiology
- Ultrasound
- Progesterone assay (breeding dates)
- Canine herpesvirus culture (if fetal resorption)
- ± Mycoplasma/ureaplasma cultures
- ± Toxoplasma serology
- Karyotyping in suspected animals
- Exploratory laparotomy

Prognosis:
- Depends on cause

Causes/DDx: Infertility - bitch

1. Normal estrus cycle/low conception

- **Management error (timing) #1**
- Vaginal abnormalities that prevent copulation (neoplasia, vaginal edema)
- ↓ Libido (dominant bitch, prior breeding trauma)
- Abnormal conformation (bulldog)
- Refusal to breed
  - . Psychological/territorial
  - . Vulvar/vaginal strictures
  - . Vaginal hyperplasia/prolapse
  - . Musculoskeletal
  - . Occlusive lesions: inflammation, tumor
- Cystic endometrial hyperplasia
- Abortion/fetal resorption
  - . Maternal infectious diz: B. canis, herpes, toxoplasma, mycoplasma/ureaplasma, Parvovirus, Distemper, iatrogenic
  - . Defects of fetus
  - . Progesterone insufficiency (hypoleoidism)
- Stud dog infertility
- Occult illness
  - . Hyper- or hypoadrenocorticism
  - . Diabetes mellitus
  - . Hypothyroidism
  - . Occult neoplasia
- Infectious:
  - . *Brucella canis*
  - . Canine herpes virus
  - . Uteritis, Mycoplasma, Ureaplasma? others
- Immunological causes (uncommon)
- Inherited infertility
- Old age

2. Abnormal estrus cycle

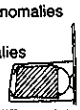
- Prolonged estrus (nymphomania)
  - . Cystic ovaries
  - . Estrogen Tx
  - . Granulosa cell tumor
- Short interestrus interval
  - . Cystic ovaries
  - . "Split" estrous
  - . Premature luteal regression
- Long interestrus interval/
  - . No estrous cycles/Anestrus
  - . Pregnancy
  - . Pseudopregnancy
  - . Endocrine diz
  - . Ovarian dysfunction
  - . Intersex
    - . OVH (spay)
    - . Young (delayed puberty)
    - . Old bitches
    - . Drug Tx
    - . "Silent" estrus
    - . Systemic dizs
    - . Steroid Tx
    - . Ovarian pathology

Diagnosis of infertility expanded

- **History**: to narrow problem list
  - General past history (vaccination, etc.)
  - Detailed history: cycles, breeding, pregnancies, pregnancy terminations, failure of neonates to survive, kennel history & pedigree
  - Allows breeding or not?
  - Evaluate breeding management #1 cause
  - Brucella testing, history: eliminated or euthanized positive animals
  - Hormone & other drug treatment
- Physical Exam:
  - General physical for systemic diz
  - Reproductive system, inclusive of mammary gland
    - . Vulvar discharge & swelling
    - . Rectal exam
    - . Vaginal digital exam: for stricture, adhesions, foreign bodies, masses
    - . If vaginal culture or cytology done, do prior to digital examination
    - . Mammary gland abnormalities (swellings, discharge)
    - . Vaginoscopic examination for congenital abnormalities
- **1st check breeding management practices**: method used to determine when to breed, cytology, observation for estrus
  - How is when to breed determined?
    - . Often a predetermined day after show color (start of proestrus) often 10th day; not by using behavior, cytological or assay. This is a problem if bitch has short proestrus
  - Let animals behavior tell when estrus starts
    - . Note start of proestrus (swelling or bleeding)
    - . Bring pair together every other day starting at day 5 of proestrus & let breed when will & every other day until won't
- Laboratory for underlying diz
  - Blood values & urinalysis
- Rule out brucellosis:

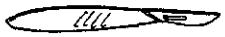
  - RSAT test to screen
  - Retest w/ TAT for RSAT positive - recommend euthanize positives
  - Screen bitches prior to each breeding
  - Screen studs every 6 months & bred only to tested bitches
  - Routinely test animals every 6 months
  - Recommend to remove positives form breeding population

- Thyroid function test: always if infertility
- Vaginal cytology/culture: determine management problems, infection or neoplasia, done prior to digital vaginal exam
  - Vaginal cytology: for stage of cycle & normal progression. Take every other day in proestrus until diestrus - record. Helps determine when pair will allow breeding.
    - . Let breed when will after > 60% cornified
    - . Day 1 of diestrus - to late (abrupt drop in cornified cells) too late to breed successfully
      - .. Can be used to figure when LH surge, ovulation & optimum time to breed was & expected day or parturition (57 d)
    - . Degenerative muscle fibers: retained fetus
    - . Spermatozoa indicate mating (+ in 65% of cytologies after 24 hrs)
    - . Cells suggesting neoplasia
  - Cranial vagina culture: infection
    - . Bacteria: +/- in normal bitches, interpret w/ caution & correlate to other information
      - .. Intracellular & extracellular bacterial + degenerative PMNs indicates vaginitis, UTD, or uterine infection or inflammation
      - .. Heavy, pure culture + inflammation signs: vaginitis
      - .. Light, mixed culture w/o inflammation: contamination
  - Vaginoscopy for stage of estrus:
    - . Proestrus: enlargement & edema of vaginal fold
    - . Estrus: loss of edema (↑ wrinkling of mucosa) w/ decreasing estrogen & rising progesterone levels
      - .. Maximum wrinkling 1-2 days after ovulation
    - . End of estrus into anestrus: flattened thin surface
- Radiology: pyometra, vaginal lesions & congenital anomalies
  - Size, shape & nature of contents of uterus, pyometra
  - Contrast to outline vaginal lesions & congenital anomalies



- Ultrasound:
  - Ovaries (follicles, corpora lutea, cysts)
  - Detect pregnancy 20-23 days after last breeding to differentiate conception failure from fetal absorption
  - Differentiates pregnancy from pyometra
  - Neoplasia

- Progesterone assay:
  - Diestrus >2 ng/ml indicates ovulation & functional CL
  - Gestation: progesterone <2 ng/ml inadequate to support pregnancy
  - Progesterone assay: day 1 of estrus = day changes form baseline to > 2 ng/ml ovulation expected in 2 days (need 2 assays minimum)
    - . Tease bitch w/ male on 1st day of rise: let breed when will (as above), will usually breed that day
- Canine herpesvirus culture (if fetal resorption)
  - Samples (10% formalin - liver, kidney, spleen & placenta)
    - . Histo & serum neutralizing antibodies & viral culture
  - Suspected carriers: vagina/preputial & nasal conjunctival swabs + serum neutralizing antibody levels
    - . Any positive titer considered significant
- ± Mycoplasma/ureaplasma cultures
- ± Toxoplasma serology
- Karyotyping in suspected intersex conditions
- Exploratory laparotomy

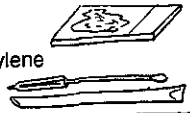


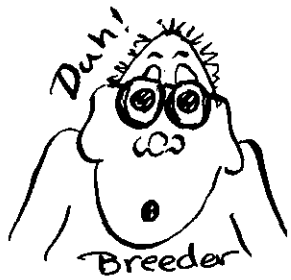
Prevent infertility:

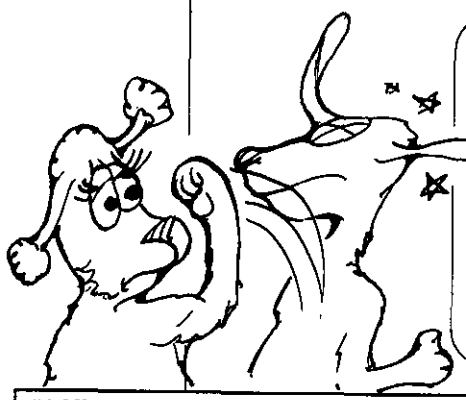
- Breed young (2-6 years): maximum fertility
- Screen all for B canis w/ RSAT every 6 months
  - Check positives w/ TAT: eliminate positives
- Remove all canine herpes virus animals
- Perform breeding soundness on all potential sires, use only fertile males
- Concentrate on estrus detection:
  - #1 let animals tell you when ready to breed & breed
  - Not start of proestrus
  - Vaginal cytology during proestrus & estrus
  - Progesterone & LH hormone assay
- Routine health maintenance (deworming, vaccinations, regular physical exams)
- Avoid hormonal treatments
- Adequate maintenance of bitch during pregnancy, whelping & neonatal period = maximum neonatal survival
- OVH recommended for all nonbreeding bitches

Vaginal cytology technique:

- Clean & clip perineal area
- Pass sterile cotton swab in cranial vagina & roll
  - Moisten w/ bacteriostatic sterile saline first
- Roll swab on glass slide
  - Fix w/ alcohol
  - Stain (Diff-Quik, new methylene blue or Wright's stain

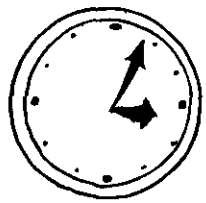


Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Female - Refusal to breed, Failure to permit breeding E-hb 629; SAP 930; H3B 627; H2B 687; I2M 850; IM 648; 5min 88; R-M 468; E&R 647, 765 (F) ***	• **Females refuse to allow mating** 	• **Complaint of difficulty breeding** • **Chronic vaginitis** • Sequela: - Problem breeder: even if the disorder is corrected - memory: "it" was unpleasant - Chronic vaginitis . Occurs because of urinary retention & bacterial overgrowth .. Excessive licking or attraction of males	• Hx (young), CS • Physical exam: musculoskeletal • Cytology: to see if in estrus while attempting breeding - If not in estrus will normally refuse male • Digital examination (gloved & lubricated index finger in all but the most miniature of dogs) during estrus to determine presence of strictures or other defects - Vaginoscopy • Observe attempted breeding • Thyroid tests (T3 & T4 or TSH stimulation) • Ultrasound: defects • Laparotomy/laparoscopy	• **Wait until in estrus** • Physiological - Make sure breeding pair compatible - Breed on males territory - Try more dominant male • Artificial insemination if refuse to breed or physically incapable of breeding • Obstructive: supervise parturition, may not be able to pass fetus around stricture • ± Surgical correction in bitches with severe defects

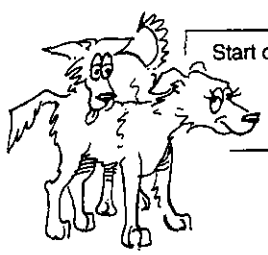
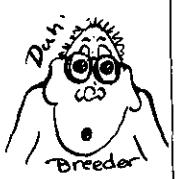
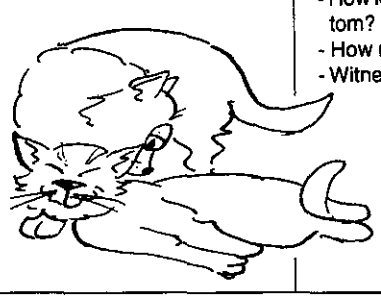


Causes/DDx: Refusal to breed - female

- **Mismanagement #1**
  - Bitch not in heat
- Psychological/behavior:
  - She doesn't like him
  - Territorial (better on males territory)
  - .Queen: adaptation time needed
  - Prior traumatic breeding
  - Timid, inexperienced bitches/queen
- Musculoskeletal
  - Hip dysplasia
  - Arthritis
  - Neural - painful conditions
- Vagina or vulva abnormalities
  - Strictures
  - Narrowing of vestibule/vagina
  - Double vagina
- Abnormal stature
  - Eng. bulldogs
  - Long bodies queen or short bodied tom
- Vaginal obstructions:
  - Tumors (older bitches)
  - Vaginal hyperplasia/prolapse
  - Hair over vulva (queen)
  - Vaginitis



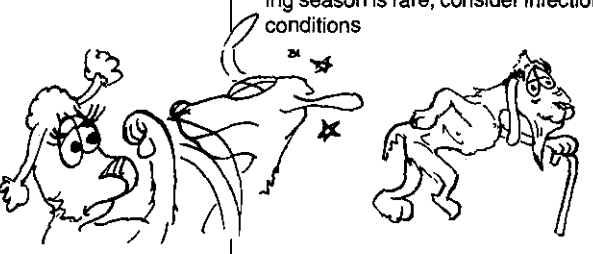
#1 Mismanagement
CS: Difficulty breeding, Sequela: Problem breeder
Dx: Hx, CS, PE, Cytology of estrus, Breeding, T3 & T4, US
Tx: Wait until in estrus, AI

Breeding management - infertility, SAP 932; H2B 687; H3B 627; I2M 850; IM 649; 5min 88; F-N 467; E&R 553, 623, 762(f) ***	• **#1 cause of infertility** • Faulty estrus detection: - Breeding at wrong time . Missing 1st day of estrus .. Breeding short proestrus female on pre-determined day (10 days after proestrus) - Breeding after start of diestrus (cytological change) - Breeding only once - Breeding several times in short period (2 days) - Making breeding unpleasant for animals - Kennel hygiene & overcrowding - Nutrition, vaccination & parasite control - Depending on science (cytology) instead of dogs natural ability & desire to breed at right time	• **Infertility** **"let breed when will & every other day until won't"**  Start of estrus = 1st day will breed = Progesterone rise = LH fragments in urine = roughly > 90% cornified cells	• Thorough Hx of breeding management - Evaluate fertility of male 1st - How is when to breed determined? . Often a predetermined day (often 10th day) after show color (start of proestrus); not by using behavior, cytological or assay . This is a problem if bitch has a short proestrus	• Nature know best • **Behavior:** 5 days after vulva swells, bring bitch to male every other day, breed when will every other day until won't • **Vaginal cytology:** cytology 5 days after vulva swells, when cornified cells >60-90% bring bitch to male every other day, breed when & will every other day until won't • **Progesterone** (ELISA): assay 5 days after vulva swells, when initial rise from < 1 to 2-5 ng/ml (initial rise) bring to male every other day, breed when will & every other day until won't • **Urine LH assay:** assay 5 days after vulva swells, when + bring bitch to male every other day, breed when will & every other day until won't • Examine bitch for pregnancy in 25-30 days: abdominal palpation or ultrasound - If not pregnant do progesterone assay to see if above 2 ng/ml
Queen - infertility Management **Ovulation failure** F-N 468; E-hb 628; IM 636, 649; 5min 88; E 1290; F 303; DDx 381 *** 	• **Mismanagement:** - Failure to identify estrus ("call") . Queen may need tom to show estrus - Not enough time for adjustment to Tom's territory - Inexperienced Tom - Only 1 breeding (needs multiple) - Miss timing • **Frequency of mating more important determinant of ovulation in queen than day of cycle on which mating occurred**	• **Infertility**  **"Multiple breeding when will until won't"**	• **Breeding management history** - How long has female been housed w/ tom? - How many matings allowed? - Witness mating? Ad libitum? Harem?	• **Queen to Tom's territory**, several weeks before to allow adaptation -1. Place pair together for short periods & observe. Separate if fight, See if queen in heat. Witness mating (labor intensive) - 2. House queen & tom together - allow mating ad libitum w/o observation - 3. Large breeding colonies: harem breeding . 1 or 2 toms housed w/ many queens . 1 tom for each 4 - 5 queens best, up to 15 queens/tom maximum • **Multiple matings: at least 3/day x 3 day** • Mature tom can be used 3 x times a week, or daily for 4 - 5 days in a row with a rest in between

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Silent heat cycles, Delayed puberty E-hb 606; IM 645; IM-WW 420; H3B 628; H2B 688, F 705, 5min 88; R-M 468; R-R 713; E&R 553, 635 **	• **May escape heat detection** • **Winter will delay coming into estrus (photoperiod)** • Bitch: fastidious w/ minimal vaginal swelling or discharge & little behavioral changes (not detected . Common in 1st heat bitches - delayed puberty . Not pursued until 2 -3 yr of age, allowing time for maturity • Cat: onset of 1st estrus: 7-9 months usually, purebreds: may start later: 9-12 months • Causes (etiology): - Breed variations - Season - Poor nutritional status - Parasitism - Chronic diz - Poor housing or lighting - Absence of cycling females or mature Tom	• **Apparent anestrus** • Cat: failure to start cycling by 13 months **DDx:** • **Poor heat detection** • **Failure to cycle** - OVH (ovariohysterectomy) - Ovarian hypoplasia/aplasia - Ovarian neoplasia - Androgen/progestins therapy - Hypothyroidism - Cushing's diz, steroid Tx - Intersex - Inadequate daylight - cats	• **Wait until mature** (2 years: dog) before pursuing • History (age) • Physical exam: intersex characteristics • Can be difficult to detect silent heat - Bitch: owner check vulva closely 2 x weekly for swelling or bleeding & present bitch to a male once weekly - Endocrine test if can't wait 2 years . Progesterone > 2 ng/ml indicates cycled in last 60-90 days in bitches, & estrus & mating in cat in last 40-50 days - Vaginal cytology weekly for 6 months	• **Bitch: wait until 2 years old** & if still not cycling check for persistent anestrus • Expose cats to proper photoperiod for 2 months before retesting - Improved husbandry - Diagnosis & treatment of diz conditions - Introduction to a cycling queen & a Tom
Split heat cycles, **False heat** E-hb 606; SAP 892; IM 647; IM-WW 420; H2B 688; 5min 88; E1609; C11T965; R-M 468; R-R 713; E&R 553, 632 **	• **Pubertal bitches** (young), can happen in any bitch on any heat - Estrus starts but ovulation or development of CLs fails - Returns to standing heat 2 -12 weeks later & hormonal events are normal - Not shortened interestrous intervals - Final or true heat is fertile - Rarely repeated in same bitch	• **Bitch: signs of proestrus: vulvar swelling, vaginal bleeding, attract males** - **Usually no breeding** (no estrus) - Proestrus returns in 2-10 weeks may or may not proceed to estrus • Sequela: bitch - CEH from repeated diestral progesterone influence	• Hx (**young bitch**) • CS: signs of heat w/o breeding • Vaginal cytology, breeding behavior, hormone evaluation • P4 assays: low level indicate no ovulation or CL formation	• **Breed on the true heat** (allow breeding when will breed!) Prognosis: **Excellent**

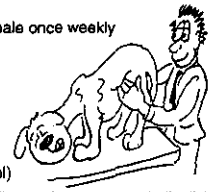
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Ovulation failure - queen Cat 1866, 1873; E-hb 631; H3B 645; H2B 705, 689; IM 649, 652; IM-WW 420; F 306; F-N 460; F3IM 582; C12T 1072; R-M 808; R-R 694, 705; E&R 751 **	• Cause of ovulation failure: - **Inadequate coital stimulation, too few breedings** - **Copulation to late in follicular cycle** (follicular regression) • Physiology: - At least 3 matings w/in 4 hours to ensure LH release - LH release required for ovulation . Only 50% ovulate after 1 mating • **Frequency of mating** more important to ovulation than day of cycle mating occurs in queens **< Than 3 matings • Tx: Vaginal stimulation**	• **Failure to ovulate** • Continues to cycle w/o luteal phase	• History: breeding management • Physical & reproductive examination • Vaginal cytology to see if cycling • Vaginoscopy: for vaginal discharge or vesicles • **Serum progesterone:** DDx pseudopregnancy & pregnancy form anestrus - Pseudo- & pregnancy > 2 ng/ml - Anestrus < 1 ng/ml • Lab data base: CBC, chemistries • Urinalysis	• **Allow multiple mating no later than 4th day of estrus or** - Start on 1st day of estrus & daily until won't breed • **Induce ovulation**: queens are induced ovulators - Vaginal stimulation w/ thermometer or metal/glass probe 4-8 times at 5-20 minute intervals . Success indicated by copulatory cry - Use of vasectomized Tom - Petting & stroking by owner can cause ovulation in some cats - HCG or GnRH (Cystorelin®) IM on 1st 20 days of estrus • Delays onset of next cycle, doesn't shorten present estrus • Pseudopregnancy occurs if queen not bred • Estrus usually resumes 45 days (35-70) after induction
Ovulation failure - bitch HB 687; IM 649; E&R 553, 632 *	• **Rare in bitch**; Cause: Ovarian pathology in bitches • CS: infertility, **coitus happens but animal doesn't become pregnant** • Dx: Hx, PE; Vaginal cytology to see if cycling; vaginoscopy; pregnancy diagnosis at 25-30 days by palpation or ultrasound; Hormonal assay if not pregnant to see if ovulated (serum progesterone: pseudopregnancy & pregnancy > 2 ng/ml, anestrus <1 ng/ml [didn't ovulate]) • Tx: **Induce ovulation**: hCG or GnRH IM on 1st day of estrus, success if serum progesterone > 5 ng/ml in early diestrus			
Short estrus I2M 855; IM 649; Cat 1866 *	• **Estrus shorter than 3 days: bitch, < 1 day: queen**; Invariably an error in observation; Causes: Poor heat detection, Split estrus, Age & erratic estrus cycles, Normal individual variation • CS: infertility, perceived short estrus, failure to get pregnant • Dx: Hx, CS; behavior, vaginal cytology, progesterone or LH assay • Tx: Correct estrus detection (teasing w/ male, behavior, cytology, progesterone assay) • Px: **Good**			Prognosis: **Guarded**
Silent heat, Unexpressed estrus F-N 467; R-M 832; H3B 645; H2B 705; E&R 764 **	• Don't show estrus cycle, but are cycling • "**Nerd queens**" in colony low on social ladder • Some queens require presence of a Tom to show estrus	• **Not seen to come into heat**	• **History ("Nerd queen")** • Physical & reproductive exams • Vaginal cytology to see if cycling - estrogen cornification of cells • Serum estrogen: DDx anestrus from silent heat (expensive) - Estrus: > 20 pg/ml - Anestrus & interestrus < 20 pg/ml • Lab data base: CBC, chemistries	• **Change housing** - **House "nerd queen" alone** or w/ either another cycling queen or an intact male Px: **Good**

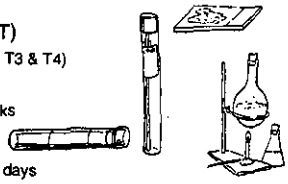
Condition	Facts/Cause	Presentation/CS	Diagnosis
Failure to Cycle, Persistent anestrus, Silent heat, Prolonged anestrus, Prolonged interestrous intervals E-hb 606; SAP 928, 892; I2M 854; IM 645; IM-WW 420; H3B 628, 645; H2B 688; C11T 963; E&R 632-3; E 1609; Cat 1865; R-M 468; R-R 712 ***	• **Prolonged anestrus** (PA) - > 10-12 months in young bitches - > 1 month in cycling queens - **Rule out previous spay 1st** • **Dog: don't not pursued until bitch is** 2 -3 yr of age, allowing time for maturity - 1° vs 2° failure to cycle: 1°: bitch that has never cycled; 2°: bitch that has cycled but now is not - Basenji, dingo & wolf breeds cycle only once a year - Hypothyroidism (bitches): most commonly associated with PA • **Cats don't cycle in winter** (Nov-Dec when days are short <12 hours of daylight) - Indoor cats with inadequate light may also not cycle - Pathologic anestrus during the breeding season is rare, consider infectious conditions	•**Doesn't appear to cycle/come into heat** • Long time between heats (estrus) • Cat: "Nerd": poor weight gain, poor coat, failure to socialize, failure to thrive	• **Wait until mature** (2 years) before pursuing • History: - Hormones to suppress estrus or steroid Tx - Cat: "Nerds" low on social order in cattery • Check heat detection • **R/O OVH** (look for scars), Note: Serum LH concentrations are persistently high in OVH bitches • **Difficult to detect silent heats** - Check vulva closely 2 x weekly & present bitch to a male once weekly - Progesterone levels see below • Physical exam: for systemic diz - Health & underlying diz - Intersex characteristics - Signs of endocrine disorders (hypothyroidism, hyperadrenocorticism, pituitary dwarfism) • Steroid excess (endogenous & exogenous cortisol) • Laboratory: CBC, Chem, & urinalysis if indicated (suspect metabolic diz) • Vaginal cytology weekly for 6 months (monitor for estrus, metritis, pyometra or vaginitis) • Screen for B. canis (RSAT & TAT) • Thyroid tests (TSH stimulation or basal T3 & T4) • Endocrine test - Progesterone assay every 1-2 weeks . > 2 ng/ml indicates functioning CL .. Bitch: ovulatory in last 60-90 days .. Queen = estrus & mating in last 40-50 days - LH concentration >30 ng/ml in 3 successive samples 20 minutes apart = ovariectomy or ovarian hypoplasia/aplasia • HCG stimulation for testosterone from testicular tissue • Karyotyping if abnormal external genitalia, or never cycled • US (ultrasound): uterine enlargement or masses, ovarian cyst • Induction of estrus attempted if all else fails • Laparoscopy/laparotomy as last resort to evaluate reproductive organs • Premature Ovarian Failure - Assay of FSH or LH may be helpful, as these concentrations would be very high with ovarian failure



DDx:
• Short interosseous interval

No heat
Dx: Wait 2 yrs, Hx; R/O OVH; PE, Lab, Cytology, B. canis, T3 & T4, Progesterone, Karyotyping
Tx: OVH, Estrus induction





Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Short interestrus intervals, **Recurrent estrus** E-hb 607; SAP 930; I2M 854; IM 647; H3B 628; H2B 688; C12T 1074; C11T 966; R-M 468; R-R 713; E&R 629 **	• **Dog** • **Interestrus interval < 4 months** • Usually associated w/ infertility - Insufficient time for endometrium to recover (requires 120-150 days) - Inability of implantation • Cause: usually unknown - Gonadotropin or estrogen therapy can shorten interval	• **Infertility** • **Short interval between estruses** < 4 months • Sequela: CEH from repeated diestral progesterone influence	• Hx, CS • Vaginal cytology, breeding behavior, hormone evaluation • P4 assays easily confirm this diagnosis **DDx:** • Split heat	• **Mibolerone** (Cheque®, Check Drops® [androgen]) for 3-4 months to delay estrus (make sure not pregnant 1st) - Suppress estrus for 6-9 months to allow endometrium to recover - Breed on next estrus because short interval frequently resumes (estrus can begin immediately or up to 9 months after Tx stopped) • Megestrol acetate (Ovaban®) not recommended because of progestin effects on endometrium - pyometra • **Ovariohysterectomy** if nonbreeding Prognosis: **Guarded**: bitches usually remain subfertile even when estrus delayed
Dog: **Prolonged heat,** **Prolonged proestrus/ estrus, Nymphomania** E-hb 606; SAP 929; I2M 855; IM 648; H3B 628; E 1609; Cat 1865; F-N 468; C12T 1073; C11T 963; R-M 468, 830 (f); R-R 714; E&R 63 *	• **Estrus > 35 days in bitch** • **> 16 days in queen** • Pathophysiology: - Proestrus & estrus: 21 days - Hyperestrogen causes signs of heat	• **Estrus > 35 days in bitch** - Mounting & riding males - Won't allow copulation usually - Bitch - nervous ill tempered, psychotic - Swollen, bleeding vulva - Sterile • **> 16 days in queen** • Sequelae: - CEH (cystic endometrial hyperplasia) - Cystic mammary hyperplasia - Genital fibroleiomyomas or fibroids **Causes - estrogen secretion** - Follicular cystic ovarian diz (#1) . Usually bitches < 3 years old - Secretory ovarian neoplasia - Administration of estrogens - OVH w/ ovarian remnant	• **Hx** (signs or estrus observed by owner) • **R/O** (rule out) estrogenic treatment • **Physical exam** - general - Swollen vulva & vulvar discharge - Abdominal masses (ovarian tumor) • Vaginal cytology: cornified cells confirm estrogen presence • Endocrine tests: estrogen >15 pg/ml suggested of proestrus or estrus • **Ultrasound**: enlarged ovaries (cyst or neoplasia - granulosa cell tumor • **Radiology**: ovarian mass • Exploratory	• **None if young**, healthy bitches - Resolves spontaneously • Attempt to induce ovulation - hCG (human chronic gonadotropin) or GnRH or LH, variable results - If ovulation successful then signs of estrus resolve in 5-7 days • Androgen Tx (Cheque®) for 3-4 months & then breed on subsequent estrus • OVH (ovariohysterectomy) for nonbreeding animals • Celiotomy & manual rupture of cyst • Surgically remove tumor (rare) Prognosis: **Guarded**
Cat **Prolonged proestrus or estrus,** **Persistent estrus** Cat 1865; F-N 468; E-hb 630; E 342; H2B 705; IM 648; IM-WW 420; E 1695?; SAP 929; R-R 714; R-M 830; E&R 765 *	• **Estrus lasting longer than 16 days** • Receptivity up to 45 days • Physiology: - Normal ovarian cycle: repeated estrus (follicular) phases of 7 day duration . Intervening interestrus phase - If follicles form in overlapping cycles - estrus may be continuous • Persistent nonseasonal estrus - Cause: cystic follicular degeneration of ovaries - Old, nulliparous queens	• **Receptivity up to 45 days** - Nymphomania (uncommon?) - Aggressive, vicious - If bred rarely conceive • Cystic follicular degeneration - Persistent estrus during seasonal anestrus period - ± Weight loss, rough, thin hair coat **Causes/DDx: Persistent estrus** • Waves of follicles lasting 7-10 days • Hormonal treatments (DES) • Infections (tom attracted to queen but she is not in estrus) • Nymphomania (may be due to cystic follicles) • Granulosa cell tumor (uncommon) • Behavioral rather physiologic cause	• History; CS • Physical & reproductive exam • Vaginal cytology to see if cycling - Periods of cornification of cells indicates estrogen presence - Separated by interestrus periods (noncornified cells) • Vaginoscopy: for vaginal discharge or vesicles • Hormonal assay: - Serum estrogen: DDx anestrus from silent heat . Estrus: E >20 pg/ml • Lab data base: CBC, chemistries • Urinalysis **DDx:** • Normal multiple cycles	• **If due to waves of follicles: nothing** - Most cats will show regular cycles during next season • If due to previous estrogen therapy, wait; may last 2 - 3 weeks • If due to persistent follicles: - Spay (ovariohysterectomy) - Induce ovulation . Breed . Sham copulation . HCG (50 250 IU) IM • Granulosa cell tumor: Spay • Persistent nonseasonal estrus - Spay considered in older queen Prognosis: Depends on cause
Estrus > 16 days **CS: Vicious > Nymphomania, Rarely conceive** **Dx: Hx, CS, PE, Vaginal cytology, Serum estrogen** **Tx: Wait or Spay**				

Superfecundation F 310 *

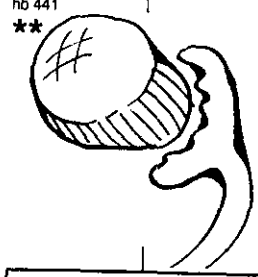
- Fertilization of separate ova by sperm from different males
- Common in cat
  - Initial copulation causes ovulation
  - Ova not fertilized can be during subsequent matings
  - Queen may allow several toms have their way with her

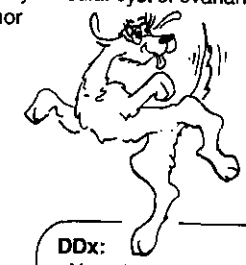
Superovulation, Superfetation *

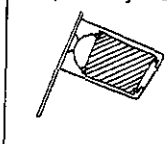
F 310; F-N 462

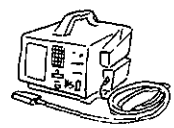
- 2 or more fetuses of different ages due to separate matings during different estrus periods
- More common in cats than other species
- Estrus & mating during pregnancy

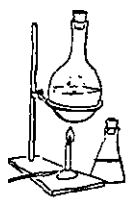
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Ovarian cysts, **Cystic ovarian diz, Nymphomania, Persistent anestrus/ estrus** M8k 1037; E-hb 607; SAP 892; H3B 583; H2B 643; F 342; F-H 520; C12T 1072; C11T 963; R-M 830 (F); R-R 712; E&R 544, 633, 765 (F); Sx-S-hb 441 **	• **Fluid-filled structure in or around ovary** - Normal structures (vesicular follicles or cavities in forming CL) - Abnormal structures . Follicular cysts . Luteinized cysts . Cystic remnants of incomplete spay (ovariectomy) • Dogs > cats • 10% of bitches: unilateral ovarian cyst • < 5% of bitches had evidence of CEH	• **Most clinically silent** • Follicular cysts: - Prolonged proestrus w/o following estrus - Nymphomania • Persistent anestrus (effect of cystic mass) - ↑ Interestrous interval • Persistent estrus (> 21 days, normal 5-9 days) nymphomania - Least recognized but widely discussed - Persistent, hemorrhagic vaginal discharge - Continuous secretion of estrogen by follicular cyst or ovarian tumor	• **Incidental finding during spay in most** • Hx (estrus > 21 d) CS • Vaginal cytology: cornified cells in nymphomania due to estrogen • Estrogen assay: high or normal levels > 10 pg/ml • Ultrasound: cystic structure, can't differentiate normal form abnormal • Abdominal radiographs • Exploratory: definitive	• **Ovariohysterectomy** (TOC/Tx of choice) in nonbreeding animals. Curative • Most spontaneously disappear w/o Tx • Attempt to luteinize cyst - Bitch -Gonadotropin-releasing hormone (GnRH [Factrel®]) once IM - hCG (human chorionic gonadotropin [Follutein®]) once IM - Response expected in 2-3 weeks (change in vaginal cytology from cornified to noncornified cells) monitor for 80 days after Tx for pyometra - Cat:: induce ovulation . Vaginal stimulation w/ thermometer or metal/ glass probe 4-8 times at 5-20 minute intervals .. Success indicated by copulatory cry . HCG or GnRH (Cystorelin®?) IM

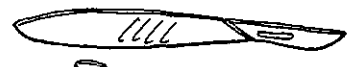


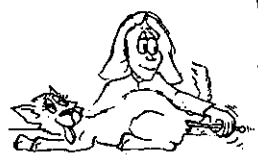












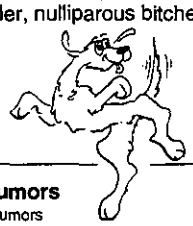
DDx:
- Nymphomania & split estrus
- Polycystic kidneys
- Neoplasia or adrenal & kidneys
- Ovarian neoplasia
- Other midabdominal masses
- Persistent estrus in cats

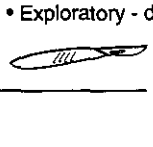
Fluid-filled structure, Dogs > Cats
CS: Clinically silent
Dx: Incidental finding during spay
Tx: OVH, Spontaneously disappear • Px: Good

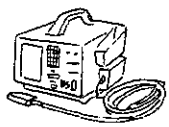
Ovaritis & lesions of oviduct: rare in dog & cat

Prognosis:
- **Good w/ OVH** - curative
- Guarded w/ medical: poor response & reoccurrence possible

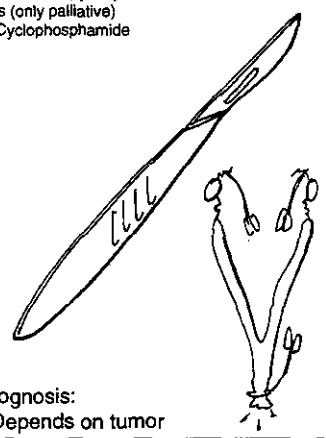
Ovarian tumors, **Neoplasia** E-hb 632; SAP 892; H3B 585; H2B 645; IM-WW 429; 5min 898; E 1700; F 344; R-M 523, 833(f); R-R 722; E&R 633, 640; Sx-S-hb 441 **	• **Uncommon** in bitch & queen, more common in older, nulliparous bitches	• **Many asymptomatic** • Effusion papillary adenocarcinoma in peritoneal cavity • Persistent estrus (granulosa cell tumors) • +\- Abdominal distention (granulosa cell tumors & teratomas)	• Many incidental finding on necropsy or surgery • CS • US (ultrasound), radiology • Exploratory - definitive	• **Ovariohysterectomy** (TOC) - Avoid rupture of neoplasia on removal • Chemotherapy may be added to OVH for metastasis (only palliative) - Cyclophosphamide







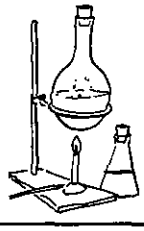
Ovarian tumors
- Epithelial tumors
  . Papillary adenoma: benign
  . Papillary adenocarcinoma: malignant, metastasize to peritoneal cavity (peritoneal effusion), lymphatics & distant sites
  . Cystadenoma: less common benign (cysts)
- Sex-cord stromal tumors
  . **Granulosa cell tumors**: #1-cat, frequent in bitch
  .. Large, unilateral, often palpable; ± Hyperestrogenism - persistent estrus
  .. Usually: malignant in cat, benign in dog; only 10-25% metastasize
  . Sertoli-Leydig cell tumors - thecomas & luteomas, rare
- Germ cell tumors:
  . Dysgerminomas: uncommon, large unilateral, 10-20% metastasize
  . Teratomas: multiple tissue types, large benign unilateral tumors, m/b palpable & abdominal distention

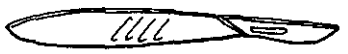


Prognosis:
- Depends on tumor

Ovarian remnant syndrome H3B 585; H2B 645; F 343; C11T 966; 5min 2; E&R 640; Sx4B 445 *	• **Presence of functional ovarian tissue in spayed bitch or queen** • Cause: failure to remove all ovarian tissue (more common in flank incision than ventral), Iatrogenicl - Signs may develop months to years after spay	• **Bitch** - Signs or proestrus & estrus . Vulvar swelling . Bloody vaginal discharge . Flagging or standing heat . Attraction of males - Pseudopregnancy w/ or w/o signs of estrus • **Queen** - Vocalization, rolling, treading or lordosis - Attract &/or accept tom - ± Alopecia	• Hx (**spayed**), CS • Vaginal cytology: cornification of cells: estrogen secretion from follicle • **Progesterone> 2 mg/ml** confirm presence of functioning corpus lutea (CL) - Queen induced ovulator so progesterone alone not enough • hCG or GnRH stimulation: progesterone level rise above >2 mg/ml in 2-3 weeks • Exploratory	• **Exploratory laparotomy & excision of remnant tissue** - Remanent easier to find if animal in estrus, look caudal to kidney

DDx:
- Vaginal neoplasia
- Vaginitis
- Uterine stump pyometra
- Trauma





Prognosis:
- **Good** if remnant found

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Uterine prolapse M8k 1032; Mk 700; SAP 897, 911; E-hb 610; H3B 598; H2B 658; IM-WW 422, 423; Cat 1903; R-M 510, 820 (F); R-R 361; E&R 661, 756 (F); Sx-S-hb 444; Emrg 422 *	• **Rare in queens** > bitches of any age, most common in cow & ewe • Protrusion of uterine body &/or horns through the cervix • +/- Hx of dystocia • Occurs when cervix open usually - During prolonged labor, usually right after delivery of last neonate, up to 48 hours after parturition . Straining form metritis, forced fetal extraction, excessive traction on retained placenta . Normal parturition (cat) - After abortion	• **Partial prolapse** (not through vulva, just cervix) - Vaginal discharge - Abdominal pain - Straining, restlessness - Abnormal posture • Uterus through vulva - Mutilation - ± Ischemic or necrotic • Sequela - Hemorrhagic shock form rupture of ovarian or uterine artery **DDx:** • Vaginal prolapse • Neoplasia (TVT, SCC, leiomyoma)	• Prolapse of uterus - Partial - digital Digital exam of entire vagina impossible in bitch due to length	• **Ovariohysterectomy** TOC (especially if not a breeding animal or necrotic) • Manual reduction if uterus viable - Requires epidural or general anesthesia - Laparotomy reduction - Oxytocin after reduction for involution • Systemic ABs for metritis • Amputation if necrotic& can't be reduced, stump then reduced • ABs pre- & postoperatively Prognosis: • Cat: pregnancy reported after correction • Dog: future pregnancies questionable
Congenital * abnormalities of uterus Sx-S 442; R-R 720	• Agenesis of 1 uterine horn, may accompany unilateral renal agenesis • Hypoplasia • Agenesis • Atresia • Segmental aplasia • Septae uterine body • Double cervix • Cornual fusion			
Uterine * neoplasia E-hb 633; SAP 897, 931; H3B 599; H2B 659; IM-WW 429; F 342; R-M 525, 833 (F); Sx-S-hb 444, 709	• **Very rare** in dogs & cats • Leiomyomas #1 tumor - benign • Leiomyosarcoma #1 malignancy in bitch, • Endometrial adenocarcinoma #1 malignancy in cat • Other tumors: fibrosarcoma, fibroma, lipoma, adenoma	• Many asymptomatic • Abdominal distention • Tenesmus • Dysuria • ± Hemorrhagic vaginal discharge	• Hx, CS • Palpation • Radiographs or ultrasound • Exploratory exploration • Vaginal cytology rarely helpful	• Ovariohysterectomy usually curative if no metastasis Prognosis: Depends on metastasis

Uterine torsion see pg 414

Uterine tear/rupture see pg 414

DDx Vulvar discharge

I2M 865; IM 654; IM-WW 417; H3B 603; 5min 174, 1142; Dx-L 357

***

- **Normal & abnormal discharges**
- **Normal discharge**
  - Proestrus & estrus
  - During parturition
  - Postpartum up to 6 weeks - lochia
    . Less noticeable in queens
- Classify by predominant cytologic characteristics
  - Cornified epithelial cells
    . Normal - proestrus & estrus
    . Abnormal: estrogen, cysts, ovarian tumor
  - RBCs normal or abnormal
    . Normal: proestrus or estrus where predominant cytology of discharge is cornified cells
    . If RBC predominate = abnormal
  - Pus - PMNs:
    . Considered septic if accompanied by bacteria
    . Normal PMNs w/o signs or degeneration for first few days of diestrus
  - Mucus: predominate component of normal lochia (postpartum discharge)
  - Cellular debris:
    . Uteroverdin (dark green heme pigment of placenta) normal postpartum (< 12 hours)
    . Abortion, metritis, retained placenta

- **Vulvar discharge:**
  - Licking
  - Pollakiuria
- Not systemically ill:
  - Indicates disorder of vulva, vestibule, vagina or
  - Normal
- **Systemically ill**: indicates uterine disorder
  - Malaise
  - Weight loss
  - Vomiting
  - PU/PD
  - Fever, dehydration
  - Indicates uterine disorder

- **Determine origin of discharge: uterus vs vagina & cause**
- Hx, CS
- Physical exam
- Vaginal cytology: predominant component
  - Cornified epithelial cells
  - RBCs
  - Pus/PMNs
  - Mucus
  - Cellular debris
- Vaginoscopy: where coming form - vagina vs uterus
- If uterine disorder suspected
  - Radiographs, ultrasound
- Other tests depending on findings

- **Tx cause**

DDx: Vaginal discharge - predominant cytology

- Cornified epithelial cells
  - Normal proestrus-estrus
  - Abnormal source of estrogen
    . Exogenous estrogen
    . Ovarian cyst
    . Ovarian neoplasia
- RBC (peripheral blood)
  - Normal - proestrus
  - Subinvolution of placental sites
  - Uterine or vaginal neoplasia
  - Trauma to repro tract
  - Uterine torsion (rare)
  - Coagulopathies (rare)
- Mucus
  - Normal late diestrus or late pregnancy
  - Normal lochia
  - Mucometra
  - Androgenic stimulation
- Cellular debris
  - Normal lochia (up to 6 wks postpartum)
  - Abortion
  - Retained placenta/metritis
- Purulent (PMNs)
  - Nonseptic (no bacteria seen)
    . Normal 1st day of diestrus
    . Vaginitis
    . Metritis or pyometra possible
  - Septic (organisms seen)
    . Vaginitis
    . Metritis
    . Pyometra
    . Abortion

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Vaginal edema, Vaginal hyperplasia, Vaginal prolapse, Vaginal fold prolapse M8k 1040; Mk 681; E-hb 617; SAP 914, 921; H3B 603; H2B 663; I2M 869; IM 659; IM-WW 427; 5min 1140; R-M 478; R-R 721; E&R 653; Sx-WW 173; Sx4B 503; Sx-G 282; Sx-S-hb 446; Sx-S 1316 **	• Excessive vaginal tissue from estrogenic stimulation of estrus (type 1-3 from slight eversion to vaginal prolapse) • Common cause of obstruction • Younger, large-breed bitches, brachycephalic dogs - During proestrus or estrus - Rarely m/b associated w/ parturition (slight estrogen secreted) • Exaggerated response to estrogen = excessive edema & enlargement of mucosal folds of vagina - Estrogen normally causes some swelling & edema of vulvar & vaginal tissue - Enlargement diminishes when estradiol concentrations decline - Begins in proestrus, continues thorough estrus & subsides in diestrus - Breeds: **boxers**, Eng. bulldogs, mastiffs, Germ shepherds, St Bernards, Labs, Chesapeake bay retrievers, Airedale terriers, weimaraners	• **Can't breed, usually** **- Painful mating** • ± Protruding fleshy red mass through vulva - Prolapse during proestrus & estrus, regress during metestrus only to recur at next heat • Dysuria, stranguria • Excessive licking of vulva • Sequela: Drying, fissures & ulcers if protrudes for a time **DDx:** • Vaginal neoplasia • Benign vaginal polyps • Vaginal &/or uterus prolapse	• Hx (proestrus or estrus), CS • Digital palpation of mass just distal to urethral tubercle •± Vaginal cytology to confirm stage of estrus • Biopsy to DDx from neoplasia in confusing cases Prognosis: • Excellent w/ OVH • Tends to recur each estrus w/o OVH - 66%	• **Resolves w/ end of follicular phase of cycle** •**Ovariohysterectomy** (TOC) in nonbreeding animals; Hastens resolution • Medical: for breeding animals - Topical AB ointment (bacitracin-neomycin-polymyxin) - Artificial insemination can be performed if refuse intermission - Keep protruding mass clean & moist (K-Y jelly) - ± Elizabethan collar (rarely necessary) - Gonadotrophin-releasing hormone (GnRH) (Cystoreline?®) or Megestrol acetate in early proestrus to attempt to prevent in predisposed bitches by hastening ovulation & stopping estrogen release • Surgical excision of exposed tissue for only extremely valuable animals profuse bleeding, doesn't preventing recurrence)
"Vaginal prolapse" * E-hb 617; SAP 915, 921, 918; IM 659; IM-WW 427; 5min 1140; R-M 479; R-R 721; E&R 563; Sx4B 505; SX-S-hb 446; Sx-S 1316	• **Severe vaginal hyperplasia** (donut shaped mass protruding from vulva) - W/o hyperplasia - rare: dystocia, tenesmus, forced separation during mating . Most commonly in cow	• **"Donut" shaped mass** protruding from vulva (see above)	• Hx, CS	• **Vaginal hyperplasia: see above:** • Prolapse w/o hyperplasia - Manual reduction & temporary retention suture in vulva
Vulvar stenosis SAP 912; R-R 721; Cat 1903; Sx-S 1314 *	• Abnormal fusion during development; Usually at vestibulolabial junction - narrowing of canal • CS: Pain on mating; Dystocia if pregnancy • Hx, CS, PE • Tx: Pregnancy: Episiotomy for birth, Permanent vulvar canal enlargement (episiotomy) if breeding animal			
Clitoral hypertrophy * SAP 912; E&R 661; Sx-S 1315	• Enlargement of clitoris associated w// intersex abnormalities or hyperadrenocorticism or anabolic steroid use • CS/Dx: Asymptomatic; Clitoral protrusion through vulva, vaginitis due to irritation (licking, vaginal discharge) • Tx: Treat cause (withdraw steroids or Tx hyperadrenocorticism); clitoral resection in hermaphrodites & pseudohermaphrodites if CS or os clitoris; Make sure doesn't contain urethra (phallus), if does spare when removing clitoris			

Vaginitis - adult M8k 1140; Mk 681; E-hb 617; SAP 916; H3B 603; H2B 664; I2M 867; IM 658; 5min 1142; E 1645; E&R 661; R-R 741 ***	• **Inflammation of vagina** • Common in bitch, rare in queen • Causes: - Bacterial vaginitis: rarely 1° . 2° to abnormalities in 70% of bitches . Congenital: vaginal stenosis, persistent hymen (urine pooling), vulvular hyperplasia . Acquired: clitoral hypertrophy, vaginal or vestibular foreign bodies, vaginal neoplasia, vaginal trauma . Uterine stump granulomas . Urinary tract diz (26%) - Canine herpes virus infections . Transient, recur - Idiopathic - 30% - Immunological • Bacteria: E coli, Staph, Strep, proteus, Pasteurella, Corynebacterium, Bacillus spp; Brucella canis (rare), Mycoplasma, Ureoplasma spp., Herpesvirus infection	• **Vaginal discharge** • **Vulvar licking** (10%), scooting • Erythema of the vaginal mucosa • Bitches may attract males • Pollakiuria • Herpes: diffuse multifocal, raised vesicular lesions of vaginal mucosa • Sequela: - Infertility - Urinary tract infections/cystitis - Chronic vaginitis **DDx:** • Proestral discharge • Diestral discharge • Postpartum discharge • Vaginal neoplasia • Vaginal hyperplasia • Subinvolution of placental sites • Acute metritis, Open pyometra • Brucellosis	• Hx, CS • Digital exam: stricture • Vaginal cytology: PMNs (various stages of degeneration) +/- bacteria, w/o blood • Vaginal culture: bacteria in 60% of normal bitches, may help w/ choosing ABs (cranial culture, pure culture usually considered pathologic) • Hemogram normal • Urinalysis for 2° urinary infections • Vaginoscopy: stricture, hyperemia, abnormalities, neoplasia & lesions • Contrast radiographs • Persistent cases: culture cranial vagina • Biopsy if chronic - Plasmacytic/lymphocytic infiltrate - immunological	• **Correct underlying cause**, if possible - Recovery directly related to correction of underlying disorder • **Bacterial vaginitis** - **Systemic Antibiotics** (Tribrissen/trimethoprim sulfa) 2-4 weeks . Monitor for keratoconjunctivitis sicca - Vaginal douches, bid-tid x 2-3 weeks: Betadine Douche® (povidone iodine) benefit questioned • Herpes: isolate, do not use for breeding • OVH (ovariohysterectomy) has no apparent affect on therapeutic outcome • Chronic vaginitis often frustrating, poorly responsive to medical managements - Repeat culture, biopsy - Plasmacytic/lymphocytic infiltrate) - trial therapy w/ steroids - Chronic antibiotic Tx to control rather than cure Prognosis: • Good if correct underlying cause • Idiopathic: good most recover spontaneously but may take years
Puppy vaginitis, Juvenile vaginitis Mk 681; E-hb 617; SAP 916; IM 658; 5min 174; E 1645; R-R 741 **	• Uncommon • Common in female < 1 year old • Cause:? • **Spontaneously resolves** w/ first estrus	• Vaginal discharge w/o blood • Vulvar licking	• Hx (< 1 year-old) • CS (vulvar discharge w/o blood • Cytology: usually nonseptic, no blood • If above 3 no further diagnostics or treatment needed	• **Resolves usually before 1st heat or w/ 1st estrus**, therefore postpone neutering until after 1st estrus • Young bitches w/ more than just vulvar discharge w/o blood treat as adult - Systemic ABs - Topical douches Prognosis: • **Excellent:** 90% recover w/ or w/o treatment

Bitch, 2° to abnormalities
CS: Vulvar licking, scooting
Tx: Bacterial: ABs; Herpes: isolate; Chronic: frustrating
Dx: Hx, CS, vaginal cytology: PMNs ; UA

Vulva

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Vaginal stenosis, Persistent hymen, Vaginal congenital abnormalities E-hb 617; SAP 913, 920; H2B 661; IM 656; IM-WW 426; 5min 1058; R-M 476; R-R 721; Sx-S-hb 446 **	• **Congenital vagina disorders: common in bitch**, rare in cat - Result from abnormal development of paramesonephric ducts (Mullerian ducts) or urogenital sinus • Hymen & vaginal stenosis - Both at junction of vagina & vestibule near external urethral orifice - Incomplete perforation = annular stricture or vertical septum or band - Hymen normally disappears before birth • Vertical vaginal septum may split vagina into double vagina • Segmental aplasia or hypoplasia	• **Asymptomatic** • **Breeding difficulties** - Dyspareunia/pain on copulation • Chronic vaginitis - Licking - Vaginal discharge • Intermittent positional dribbling of urine (urine pooling) • Dystocia if pregnant	• Hx (young), CS • Digital palpation • Vaginoscopy • Culture for 2° vaginitis	• **No Tx** for asymptomatic nonbreeding females • Persistent hymen or stenosis - Digital dilation attempted - Surgical removal of band or annular stricture Prognosis: • Excellent
Vulvar hypoplasia, Infantile vulvas, Atresia of vulva SAP 912, 919; E-hb 617; IM-WW 866; R-M 480; R-M 480; Sx-S-hb 1315 **	• Small vulva • Cause: - Prepuberal bitches, small & inverted, usually self corrected after first estrus - Spaying before reaching sexual maturity • Some recessed, causing urine pooling especially in fat animals	• Asymptomatic • Urine pooling & perivulvar dermatitis - Excessive licking & smell - 2° vaginitis • Sequela: - Ascending urinary tract infections - Recurrent cystitis	• Hx • Physical exam of vulva	• **Prepuberal: allow to have 1st estrus, usually corrects** • Adults: episioplasty: removal of excessive perivulvar skin & elevate recessed vulva - Weight reduction - diet
Vulvar enlargement SAP 913; R-M 480	• Normal response to estrogen during proestrus • If longer than 14 days suspect estrogen secreting ovarian neoplasia or cystic ovarian diz			
Anovulvar cleft, Vulvovestibular cleft R-M 480; Sx-S 1314 *	• Incomplete fusion of skin from anus to dorsal vulvar commissure; Failure of fusion of urogenital fold • CS: Inflammation of vestibule & clitoris (environmental exposure & fecal contamination) • Tx: Surgical closure • Prognosis: Good w/ surgery			

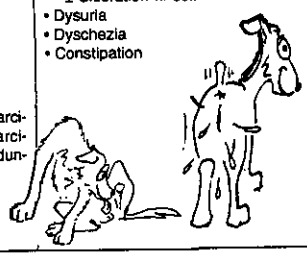
Vaginal & vulvar neoplasia, Vaginal polyps

E-hb 633; SAP 915, 918; H3B 605; H2B 665; IM-WW 172; E 1701; R-R 723; R-M 525, R-R 720; E&R 661; Sx-WW 172; Sx4B 505

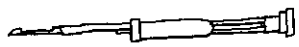
*

- 3% of all canine tumors
- **Most benign** (70-80%)
  - Polyps/Leiomyomas #1 (often pedunculated)
    - Small smooth firm masses
    - Aging bitches
    - Rarely cause clinical problems
  - Fibroma, lipomas
- Malignant tumors
  - Leiomyosarcoma #1, squamous cell carcinoma, hemanglosarcoma, adenocarcinoma & mast cell tumor (less often pedunculated)
- Transmissible venereal tumors

- **Vaginal discharge or bleeding**
- **Excessive licking of vulva**
- Protrusion of mass through vulva
  - ± Ulceration w/ self trauma
- Dysuria
- Dyschezia
- Constipation

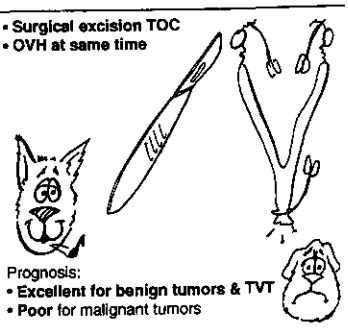


- Hx, CS
- **Visual or digital exam (rectal & vaginal)**
- Vaginoscopy for cranial tumors
- Vaginal cytology not usually helpful (don't shed cells)
- Excisional biopsy



DDx::
- 1° vaginitis/vestibulitis
- Vaginal trauma, laceration
- Tumors of distal urethra (squamous cell, transitional cell carcinoma)
- Vaginal edema & prolapse

- **Surgical excision TOC**
- **OVH at same time**



Prognosis:
- **Excellent for benign tumors & TVT**
- **Poor** for malignant tumors

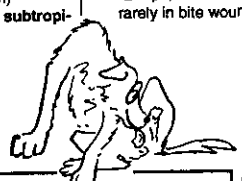
Canine **Transmissible venereal tumor**, TVT, Infectious sarcoma, Contagious venereal tumor, Venereal granuloma, Canine condyloma, Transmissible lymphosarcoma, Transmissible reticulum cell tumor, Histiocytoma, Sticker tumor

M8k 1048; E-hb 633; SAP 887, 915; H3B 612; H2B 672; I2M 931; IM 715; IM-WW 427; 5min 1118; E 1701; R-R 724, 799; R-M 526; Derm 1089

*

- **Contagious diz** of dog affecting external genitalia & mucous membranes
- Not in cats
- **Young - 4 years old, roaming, sexually active males & female**
- Transmission: coitus or close contact (licking, biting & scratching)
  - Low metastatic potential (regional lymph nodes, scrotum, perineal area, rarely to orbit, abdomen, lungs, CNS)
- Cause: naturally occurring allograft (round cell tumor of mesenchymal origin)
- **Temperate climates-tropical & subtropical** - worldwide

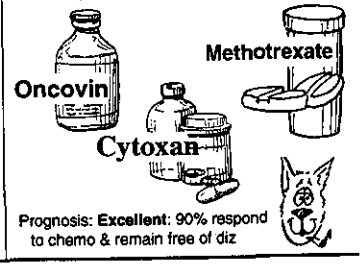
- Vaginal or preputial discharge
- Licking
- Foul odor
- **Friable, ulcerative, cauliflower masses** on external genitalia (starts as small raised hyperemic areas) may be pedunculated or papillary
  - ± Hemorrhagic & necrosis
  - Male: prepuce, penis, base of penis
  - Female: vulva, vestibule, vagina, vestibulovaginal junction
  - ± Lips, oral cavity, nasal cavity, skin rarely in bite wounds



- **Hx, CS, PE** (physical examination): presumptive diagnosis
- Impression smear & aspiration cytology: Diff-Quick®
  - **Homogenous round to ovoid cell w/ round nuclei & numerous mitotic figures**
- Karyotyping: 59 ± 5 chromosomes; normal 78 (rarely needed)

DDx::
- Mast cell tumor
- Histiocytoma
- Lymphoma
- Squamous cell carcinoma
- Nonneoplastic granulomatous lesions
- Serosanguinous discharge before tumor masses
  - Estrus
  - Urethritis/cystitis
  - Prostatitis

- Spontaneous regression does occur, most don't
  - If complete regression, immune except to large volume challenges with tumor cells
- **Cytotoxic chemotherapy** (TOC/Tx of choice)
  - Vincristine (Oncovin®) 4-6 weeks (2 Txs past disappearance of tumor, regression w/in 2 weeks)
  - Combo: vincristine, cyclophosphamide (Cytoxan®) & methotrexate - has more side effects
  - If recurrence do chemo again
  - If 2nd reoccurrence, doxorubicin
  - Evaluation of inguinal lymph nodes &chest radiographs should be done first
- Radiation curative if chemo not possible (100%)
- Surgical excision poor choice because of recurrence (50%), electrosurgery
- Limit exposure to other dogs until regression



Prognosis: **Excellent**: 90% respond to chemo & remain free of diz

Temperate climates, Coitus
CS: Friable, ulcerative, cauliflower masses
Dx: Hx, CS, PE, Diff-Quick smear
Tx: Cytotoxic hemotherapy

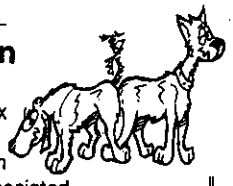
Male dog - Breeding soundness exam

SAP 934; H2B 692; 5min 90; R-M 539; R-R 836, 869; E&R 673; NB 19.2

Clinical evaluation of reproduction in normal dog

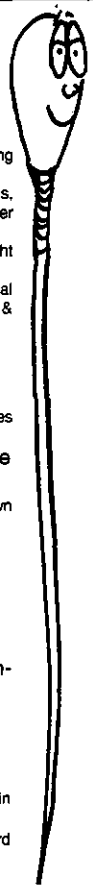
- Only done on Brucella negative dogs
  - Nigel Perkins recommends all brucella positive dogs be euthanized because of public health risk & poor success of treatment
- History:
  - General health
  - Management: estrus detection (ovulation timing technique)
  - Past breeding performance
    . Libido/Breeding behavior/Mating ability
    . Recently sired litters, litter size?
    . Previous semen evaluation?
  - Breeding history of bitches failing to settle
  - Infertility in related dogs
  - Infertility in other dogs & bitches in kennel?
  - Previous dizs & medications
- Physical examination:
  - General physical exam 1st
  - Scrotum: normally, sparsely covered with hair, uniform in thickness, freely movable over the testes
  - Testes: palpate for equal size, oval shape & firm consistency; cryptorchid
  - Epididymis, ductus deferens & spermatic cord: palpated for defects or pain
  - Penis & prepuce:
    . Prepuce completely encloses normal penis
    . Mild balanoposthitis (preputial discharge) normal
    . Penis: freely movable within sheath & easily exposed by pulling the prepuce over the bulbous glandis
    . Penile mucosa: pinkish white, smooth & nonpainful to touch
    . Os penis: palpate for fracture or abnormal shape
    . Evaluate erect penis & prepuce at semen collection
  - Rectal palpation:
    . Prostate gland: only accessory sex gland in dog, surrounds neck of the bladder
    .. Located at cranial rim of the pelvis (may slip into the caudal abdomen if bladder distended), elevating the chest & using free hand under abdomen to lift prostate facilitates exam
    .. Palpable median septum separates the prostate into 2 lobes (dorsal aspect) in all but the very large dogs
    .. Normal: symmetrical, smooth & firm consistency
    .. Size & weight of the normal prostate gland varies with size & breed of dog & whether or not he is intact
    . Pelvic urethra
    . Pelvis
  - Semen analysis included in evaluation (see below)
- Laboratory evaluation: if indicated
  - CBC, chemistries & urinalysis: for underlying systemic diz & specific diz affecting tract
- **Brucella canis testing yearly**: eliminate all positives form breeding program if not from this earth
- Thyroid function test: for all dogs presented for infertility

Libido & copulation



- **Dog**: normally can ejaculate 2-3 x week for 2 weeks or 1 x week for 6 week w/o decrease in number of sperm
  - Frequency of copulation associated with diminished libido
- **Cat**: can copulate 3 x day for 4-5 days, or 5 x hour for first 2 hours of exposure to an estrual queen
  - Frequency of copulation not associated with ↓ libido as in dog

Semen collection & evaluation

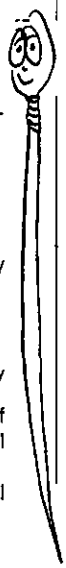


E-hb 618; SAP 935; H3B 635; H2B 694; I2M 899; IM 687; E 1649; C12T 1060; C11T 938; R-M 539; R-R 836; E&R 674

- Indication: artificial insemination, routine part of breeding soundness exam, evaluate male infertility
- Equipment: AV, graduated centrifuge tubes, pipettes, slides, cover slips, gloves, microscope, cell counter, stains, teaser bitch
  - Daily sperm production: correlated with testicular weight (large dogs produce more than small)
  - Semen collection in cat - not usually done in clinical practice because usually requires general anesthesia & electroejaculation
- Procedures:
  - Minimum 4 day rest
    1) Daily collection for 7 days or
    2) A single collection & comparison with standard tables (R-M 536)
  - Quiet area on nonslip surface w/ patience & a teaser bitch present
    . Nervous stud may need to be evaluated in his own environment
  - Three fractions in collection:
  - 1st fraction: pre-sperm (few drops to 2 ml)
  - 2nd fraction: sperm-rich (0.5-5 ml)
  - 3rd fraction: prostatic fluid: secreted over several minutes if constant pressure applied
  - First 2 fractions collected in first 1-2 minutes, collect 3rd fraction in separate tube
- Semen evaluation: immediately after collection
  - Record volume to calculate numbers
  - Motility:
    . ≥ 70 progressive linear motility (move in forward direction)
    . Abnormal movements: side to side, or circles w/o forward progression
  - Morphology: stained semen slide smear - oil immersion - count 100-200 cells
    . Abnormal morphology: 1° defects of head, midpiece, & tail; 2° defects: detached heads, retained cytoplasmic droplets, bent tails
    . Normal: < 20% abnormal sperm
  - Sperm count (Unopette system, hemocytometer, spectrophotometer or Coulter counter):
    . > 200 million in ejaculate to be fertile
    . Trauma to seminiferous tubules cause drop in number for weeks to months
  - Color: normally white to opalescent & opaque
    . Green tint: infection (w/ or w/o clumps, clots or flakes
    . Red: hemorrhage
  - Infertility diagnosed only if several samples over 6 months abnormal
    . Below numbers, progressive motility & morphology
  - Third fraction: normally clear & colorless, ph 6.0-7.2, WBC & RBC rare
  - Seminal alkaline phosphatase: comes form the epididymis. Low levels indicate incomplete ejaculation or obstruction distal to epididymis

- Collection of semen:
  - Warm (37° C) sterile latex or plastic cone connected to a sterile semen collection vessel
  - Manual technique: gently slide prepuce back & forth over penis until dog relaxes & starts to erect the penis
  - Teaser bitch: allow stud to mount teaser bitch & as he starts to thrust slide prepuce back
  - Place collection cone over penis including bulbous glandis . Ensure bulbous glandis is exteriorized before full erection or else pain may occur
  - Hand holding cone maintains constant pressure over the b.g. while the other hand massages the prepuce back & forth over penis caudal to bulbous glandis

Artificial insemination, AI



E-hb 619; H3B 580; I2M 933; IM 717; E 1652; R-R 869, 923; NB 19.8; E&R 549, 734

- Indications:
  - 1° when natural breeding not possible (behavior, partner preference, vaginal prolapse)
  - Breeder preference (trauma or infectious contact less likely)
  - Transport of semen easier than live animal
- Factors influencing success of AI
  1. Reproductive health of male & female
  2. Timing of AI is critical
     - Day 0 = day progesterone abruptly ↑ (>2 ng/ml) = day of LH peak
       - Ovulation expected on day 2
       - Maturation of egg between day 2 & 4
     - Minimum of 2 "matings": day 3 & 5 or 4 & 6 (only 2 matings are often included in stud fee)
     - Unlimited: 1st insemination on first day of standing estrus, then every other day until diestrus (sharp change in vaginal cytology)
     .. 1st day of estrus = 1st day progesterone level rises above 2 ng/ml (color change kit)
     = 1st day of behavioral/standing heat
     = Vaginal cytology > 90% + standing heat
  3. AI technique:
     - Collection: don't collect prostatic portion (3rd fraction) of ejaculate
     . Protect form spermicidal agents (water, lubricants, some plastics, some rubbers) latex rubber usually used
     . Protect for temperature changes
     .. Work at room temperature & inseminate right after collecting
     .. Chilled & frozen semen: add a protectant "semen extender" & follow cooling, freezing & thawing rates
  4. Insemination (same for fresh, chilled or frozen semen)
     - First examine (thawed) sample microscopically on a warmed slide for quality & number of motile sperm
     - Mix sample & aspirate into insemination pipette
     - Pass insemination pipette into the cranial vagina as close to cervix as possible (cervix to hard to catheterize)
     - Gently inject sperm through it, followed by air to clear all semen out of pipette
     - Remove pipette & elevate rear quarters

- Fresh semen: most often used
  . Conception about same as natural breeding
- Frozen semen: can save semen indefinitely
  . Poor conception rates in dogs - 0-25% intravaginal & 45-78%
  . Intrauterine insemination preferred but requires surgical approach usually
- Chilled semen: stored at & for 24-48 hours
  . Better conception rate than frozen - 70-80%

AI in Cat

I2M 937; Cat 1848; F-N 466; F 350; C11T 929; R-M 805; R-R 870, 925; E&R 751

- AI rarely performed in clinical practice; collection usually requires anesthesia & electroejaculate.
  - AI possible because some cats can be taught to ejaculate into a artificial vagina
  - Tomcats can be ejaculated 2-3 x/week without lowering sperm count

Infertility in dog - male

E-hb 619; SAP 933; H2B 690; H3B 631; I2M 905, 909; IM 692; 5min 90; E 1654; R-R 752; R-M 544; E&R 619, 718; DDx 383

***

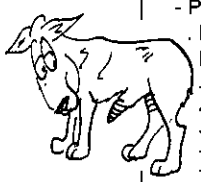
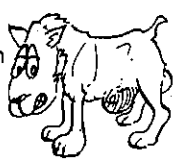
- **Unable to breed or produce pregnancy when bred to fertile bitch**
- Classified as:
  - Never been fertile (1° infertility)
  - Previously fertile but not now (acquired infertility)
  - Subfertile: poor conception rate owing to substandard spermatozoa in ejaculate (oligozoospermic) or ↓ motility & ↑ abnormal spermatozoa)

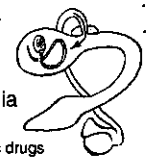
Presentation/clinical signs

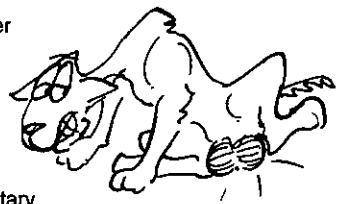
- Lack of interest in estral bitches
- Reluctance or refusal to breed
- Failure of conception (normal breeding)
- Small litters
- Abortions
- Congenital defects in offspring
- Abnormal ejaculate
- Preputial discharge
- Underdeveloped external genitalia
- Cryptorchidism
- Feminization ?
- Enlarged, hot or painful scrotum
- Abdominal mass or pain
- Painful urination of defecation

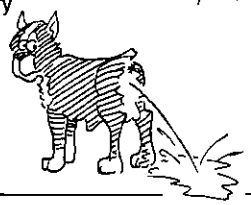
DDx - Male infertility

- Failure to breed
  - Breeding management error
    - . **Poor estrus detection**
    - . Sexual overuse
    - . Inexperienced dogs
    - . Bitch not in heat
    - . Behavioral problems (submissive, aggressive)
  - Inability to mount
    - . Defects of penis
      - .. Paraphimosis
      - .. Persistent frenulum
    - . Vulva or vaginal disorders
    - . Erection failure
  - Poor libido
    - . Behavioral problem
    - Hypotestosteronism
      - .. Hypopituitarism
      - .. **Hypothyroidism**
      - .. Hyperestrogenism
      - .. Hyperadrenocorticism
      - .. Drugs
- Azoospermia or aspermia
  - Incomplete ejaculation
    - . Pain or anticipated pain
    - . Stress or fright
    - . Semen collection w/o teaser bitch
  - Retrograde ejaculation
  - Congenital disorders
    - . XXY syndrome
    - . XX male syndrome
    - . Testicular hypoplasia
  - Acquired azoospermia
    - . Drugs
      - .. Antineoplastic, cytotoxic drugs
      - .. Methyltestosterone
      - .. Estradiol
      - .. Diethylstilbestrol
      - .. Tamoxifen (Nolvadex®) citrate
      - .. Glucocorticoids
      - .. Anabolic steroids
      - .. Anti-gonadotropin releasing hormone analogues
      - .. Spironolactone
      - .. Ketoconazole
      - .. Cimetidine
      - .. Cyclophosphamide
      - .. Vinblastine
      - .. Amphotericin B
    - . Environmental toxins
    - . Radiation
    - . Heat
    - .. inflammation
    - .. Hernia
    - .. Environmental
    - .. Systemic dizs - prolonged fever
    - .. Orchitis, orchiepididymitis
      - ... **Brucellosis**
      - ... Immune mediated
    - ..Scrotal dermatitis
    - . Duct occlusion/epididymitis
    - . Testicular tumors
    - . Tumors of hypothalamus or pituitary
    - . Hormonal disturbances
      - . Endocrine dysfunction (pituitary dwarfism)
    - . Ischemia (testicular torsion)
    - . Age - senile atrophy
    - . Debilitating systemic diz
      - .. Distemper (prolonged fever)
      - .. Renal failure
      - .. Liver cirrhosis
      - .. Diabetes mellitus
      - ..Metastatic neoplasia
      - .. Hypoadrenocorticism (testicular atrophy - 60%)
      - .. Hypothyroidism
    - . Sexual overuse
  - Infertility w/ sperm in ejaculate
    - Oligozoospermia
    - Teratozoospermia
    - Asthenozoospermia



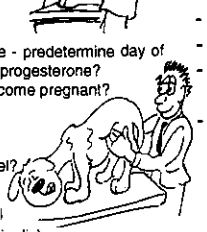




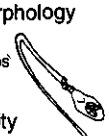
No breeding or offspring
Dx: Hx, PE, *B. canis* , T3 & T4 , Semen
CS: No libido, No conception, Cryptorchidism, etc.
Tx: Tx cause, Monitor semen •Px: Varies w/ cause

Diagnosis - infertility:

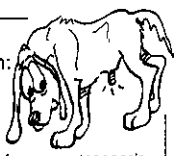
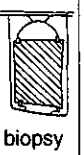
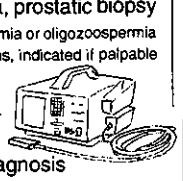
- History: general health, management & breeding practices, past breeding performance, previous dizs, drug administration
  - Systemic diz in last 6 months
  - Exogenous drugs (current & previous)?
  - Trauma, stress?
  - Breeding practices: mating management thoroughly established before subjecting a stud to rigorous & expensive medical workup
    - . Past breeding performance
      - .. Libido/Breeding behavior/Mating ability
      - .. Recently sired litters, litter size?
      - .. Previous semen evaluation?
    - . Mating protocol
      - .. Ovulation & breeding timing technique - predetermine day of season?, behavior? vaginal cytology? progesterone?
    - . Breeding history of bitches that don't become pregnant?
    - . Facilities, housing?
    - . Overuse of stud?
    - . Infertility in related dogs?
    - . Infertility in other dogs & bitches in kennel?
- Physical exam:
  - General exam: thorough & include all body systems (e.g., hip dysplasia, systemic diz)
  - Scrotum: dermatitis, adhesions, tumors
    - . Measure scrotal width compare to body weight (E table 127-1)
  - Testis: check for 2, size, symmetry & consistency
    - . Cryptorchid, orchitis, tumor, degeneration
  - Palpate epididymis, vas deferens & spermatic cord for abnormalities - shouldn't be painful
  - Penis & prepuce: nonerect & erect: freely movable, pinkish, smooth, nonpainful mucosa, mild discharge normal
    - . Persistent frenulum, foreign bodies, trauma, neoplasia, folliculitis, phimosis, discharge
  - Os penis: palpate for fracture, congenital deformity
  - Rectal palpation & abdominal
    - . Prostate gland: normal: symmetrical, smooth & firm, nonpainful
    - . Pelvic urethra
    - . Pelvis



- CBC, chemistry, urinalysis: for underlying systemic dizs & specific repro dizs
- ***B. canis*** screening for All dogs (male & female) presented for reproductive problems
  - Rapid plate agglutination test - accurate for negatives
  - Retest positives - TAT
  - Eliminate all positives form breeding program if not from this earth
- Thyroid function (T3 & T4 levels or TSH stimulation)
- **Semen collection**: number, motility, morphology
  - Normally milky white
    - . Green tint: infection (w/ or w/o clumps, clots or flakes
    - . Red: hemorrhage
  - Volume (for total sperm # calculation)
  - **Motility: >70%** progressive linear motility
  - Morphology: >80% normal for fertility
  - **Numbers: > 200 million** in ejaculate to be fertile
  - Infertility diagnosed only if **several** samples over 6 months abnormal for motility, morphology or number
  - Other tests on ejaculate:
    - . Cytology for epithelial or inflammatory cells
      - .. Elevated toxic WBC - suggest inflammation
      - .. Abnormal epithelial cells - prostatic neoplasia
    - . Aerobic bacterial culture & sensitivity (>10,000 suggest genital infection < 10,000 suggests urethral contamination), not diagnostic for infection
      - .. Culture of sperm rich fraction of ejaculate - for organisms originating in testes or prostrate: normally < 100 bacteria /ml
      - .. Culture of prostatic fraction more specific for prostatic organisms: normally < 100 bacteria /ml
    - . ± Virus isolation for canine herpes virus maybe
    - . ± Mycoplasma/Ureoplasma cultures
    - . Semen pH - normally 6.3-7.0 , for antibodies (basic AB for acidic prostatic fluid)
- **Seminal alkaline phosphatase concentration**: marker for completeness of ejaculation
  - Normally 5-40,000 units/l, if <5,000 may not have completely ejaculated or obstruction distal to epididymis
- +/- Scanning electron microscopy: ultrastructure sperm defects



- Hormone assay
  - Serum testosterone concentration: to differentiate from castration & cryptorchid
    - Scrotal testes: >1,000 pg/ml
    - Cryptorchidism: 200-1,000 pg/ml
    - Bilateral castration: 25 pg/ml
  - **FSH** (follicular stimulating hormone) indicator for spermatogenesis, pituitary-gonadal function; assays not readily available
    - . Normal = 20-130 ng/ml
    - . Active acute testicular degeneration = 130-250 ng/ml
    - . Severe testicular damage = >250 ng/ml
  - **LH** (luteinizing hormone) rises w/ testicular dysfunction, take multiple samples 20 minutes apart
- Radiography: for prostatic enlargement
- Ultrasound: for testicular neoplasia, prostatic biopsy
- Testicular biopsy: if persistent azoospermia or oligozoospermia
- ± Epididymal aspiration: for obstructive lesions, indicated if palpable abnormality of epididymides
  - Weigh against possible sperm granuloma

Treatment:

- Base treatment on specific diagnosis
- Treat specific dizs
- Consider:
  - Surgical corrections (hernias, torsion)
  - Thyroid supplementation
- Empirical hormonal regimens often unhelpful or deleterious, use only as a last resort after complete diagnostic evaluation
- Monitor semen every 2-3 months
  - Spermatogenesis requires 62 days
  - Epididymal transit - 15 days
  - Requires abnormal sperm for 6 months to diagnose as infertile

Prognosis: varies w/ cause

- Potentially reversible: drugs & toxins, high temperature, infections
- Many poor to guarded despite appropriate treatment

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Infertility in tom Cat 1852; F-N 467; F 349; H3B 647; H2B 708; SAP 933; IM 692; R-M 829; DDx 385	• **Unable to breed or produce pregnancy when bred to fertile queen** • Classified as: - Never been fertile (1° infertility) - Previously fertile but not now (acquired infertility) ıbfertile	• Lack of interest in estral queens • Reluctance or refusal to breed • Failure of conception (normal breeding) • Small litters • Congenital defects in offspring • Preputial discharge • Underdeveloped external genitalia • Cryptorchidism	• History: - Systemic diz in last 6 months - Exogenous drugs (current & previous)? - Trauma, stress? - Breeding practices: check breeding management before rigorous & expensive medical workup . Past breeding performance .. Libido & breeding behavior .. Mating ability .. Recently sired litters .. Number of kittens? . Mating protocol . Queen's fertile . Facilities, housing . Infertility in related cats . Infertility in other toms or queens in kennel? • Physical exam - General exam: thorough & include all body systems - Testis: check for 2, size, symmetry & consistency - Penis: hair at base of penis, priapism, discharge • CBC, chemistry, urinalysis: for underlying systemic dizs & specific repro dizs • FeLV & FIV • Thyroid function (T3 & T4 or TSH stimulation) in older toms • Semen collection: rarely done in cats - refer - electroejaculation can be done or Tom can be trained to ejaculate into a artificial vagina (takes 3 weeks) . > 60% of sperm motile . >70% normal morphology . Normal number of sperm > 10 million - Other tests on ejaculate . Cytology for epithelial or inflammatory cells	• **Base Tx on specific diagnosis** • Treat specific dizs • Consider: - Unilateral castration? -Thyroid supplementation • Poor libido: - Change housing . House males separately . Bring queen & tom together only during breeding . Artificial insemination considered - Testosterone supplementation not recommended: doesn't increase libido, can decrease spermatogenesis by negative feedback • Cryptorchid: bilaterally castrate

DDx - Tom infertility
- Failure to breed
  - Breeding management error
    . Sexual overuse
    . Inexperienced
    . Queen not in heat
    . Behavioral problems (submissive, aggressive)
    . Stress
    . Caged tomcat
  - Inability to mount & achieve intromission
    . Hair rings at base of penis
    . Vulva or vaginal disorders
  - Poor libido
    . Behavioral problem (incompatibility, dominant queen)
    . Hair rings at base of penis
    . Frequent copulation doesn't decrease libido in cat
    . Chronic illness
- Abnormal sperm
  - Age - senile atrophy: >12 hears old
  - Intersex: tortoiseshell male cats
  - ↓ Sperm quality or quantity not extensively studied in cat
- Reproductive tract infections (uncommon)
  - Orchitis
  - Effusive FIP infection of scrotum
- Cryptorchidism
- Endocrine diz not common
- Hypothyroidism (infrequent)
- Estrogen administration
- Nutritional
  - Malnutrition, obesity
  - Hypervitaminosis A
  - High liver intake
- Congenital defects
  - Testicular hypoplasia
  - Segmental aplasia of epididymis

DDx:
- Infertility in queen
- Poor breeding management - timing

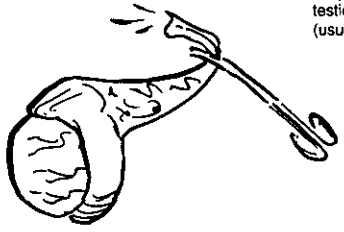
Prognosis: Depends on cause

Surgeries & Procedures

Castration, Orchidectomy in dog

SAP 883; C12T 1037; Sx-G 294; Sx-WW 178; Sx4B 58; Sx3B 416; Sx-S-hb 452

- Equipment: standard general surgical pack & suture
- Procedure:
  - Dorsal recumbency, aseptic prep prescrotal area
    . Avoid clipping or scrubbing scrotum (irritation)
  - Incise prescrotal skin on midline as push 1 testis toward incision
  - Incise SQ & spermatic fascia to expose parietal vaginal tunic
  - Exteriorize tunic covered testes & cut scrotal ligament/ligament. of tail of epididymis
  - Reflect fascia & fat up spermatic cord w/ gauze sponge
  - **Closed technique**:
    . Double-ligate intact spermatic cord & vaginal tunics w/ a transfixing absorbable suture (don't cut parietal vaginal tunic
    . Transect spermatic cord & cremaster muscle distal to ligature (thus never opening vaginal/peritoneal cavity:
  - **Open technique:**
    . Incise parietal vaginal tunic (thus opening the vaginal cavity which connect to peritoneal cavity)
    . Double ligate spermatic cord w/ transfixing absorbable suture
    . Ligate parietal vaginal tunic & cremaster muscle w/ an encircling ligature
    . Transect spermatic cord, parietal vaginal tunic & cremaster muscle
  - Routinely close SQ tissue (simple interrupted/absorbable) & skin (simple continuous subcuticular pattern/absorbable or routine skin closure/monofilament)



Prepuberal gonadectomy

Sx4B 496, 511

Early age neutering before sexual maturity

Orchidectomy for abdominal ectopic testis

SAP 883

- Procedures:
  - Dorsal recumbency, aseptic prep
  - Incise skin & ventral abdominal wall from umbilicus to pubis, avoid prepuce
  - Locate ectopic testicle by tracing one of following:
    . Ductus deferens from prostate
    . Testicular vessels from aorta & caudal vena cava
  - Double ligate testicular vessels 7 ductus deferens & transect distally, remove testis
  - Routinely close ventral abdomen
  - Submit testis for biopsy

Extra-abdominal ectopic testis - orchidectomy

SAP 883

- Procedure:
  - Dorsal recumbency, aseptic prep of pubic region
  - Palpate testis under skin
  - Incise over testicle
  - Double ligate & transect spermatic cord, remove testis
  - Routinely close skin
- Postop care & complication
  - Scrotal inflammation or bruising:
  - Hemorrhage: may swell scrotum & require scrotal ablation
  - Scrotal infection
  - Elizabethan collar
- Prognosis: Good even if testicular neoplasia (usually benign)

Castration/Orchidectomy in cat

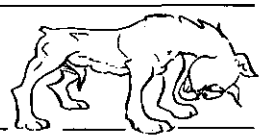
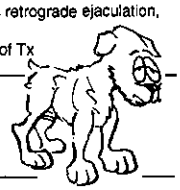
Cat 1894; SAP 884; Sx4B 521; Sx-G 38; Sx-S-hb 452; Sx3B 420

- Procedure:
  - Position in dorsal recumbency at end of a table, let tail hang down
  - Pluck hair of scrotum and aseptically prep perineum
  - Incise scrotum over each testes & expose testis
  - Incise parietal vaginal tunic (open) & excise it
  - Ligate spermatic cord
    1. Separate ductus deferens from rest of spermatic cord & tie 2 square knots with ductus deferens & rest of spermatic cord or
    2. Ligate spermatic cord w/ absorbable suture
  - Transect spermatic cord & ductus deferens distal to knots
  - Do not suture scrotal incision
  - Traction avulsion technique is used by many veterinarians because of its speed, if you wish not to do for your new boss become proficient & speedy at other techniques

Testicular biopsy

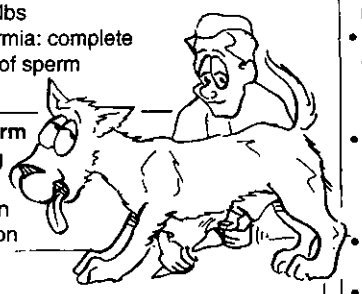
SAP 882, 935; E-hb 621; Cat 1898; E&R 687

- Procedure:
  - Dorsal recumbency - septic prep of prescrotal area
  - Incise skin just cranial to scrotum
  - Incise parietal vaginal tunic& tunica albuginea of testis
  - Excise bulging testicular tissue w/ razor blade
  - Close tunica albuginea (absorbable suture) routinely close skin (nonabsorbable suture)
  - Bouin's or Zenker's fluid fixation
- Postop complication: hemorrhage, infection, local hyperthermia, scaring, adhesions & atrophy
- Prognosis: good

Condition	Facts/Cause	Diagnosis	Treatment
Infertility **Breeding management, Normospermic infertility** SAP 933, 937; H2B 690; H3B 631; I2M 905, 909; IM 692; R-M 832(f); R-R 789 ***	 • **DDx: Breeding management** - Sexual overuse - Inexperienced dogs - Bitch not in heat (heat detection) - Ejaculation w/ normal sperm - Behavioral problems (submissive, aggressive) • Lack of interest in estral bitches • Reluctance or refusal to breed	• **History**: general health, management & breeding practices, past breeding performance, previous dizs, drug administration - Breeding practices: imperative mating management be thoroughly established before subjecting a stud dog to rigorous & expensive medical workup see preceding page) . Past breeding performance (Libido/breeding behavior/Mating ability) . Mating protocol: Ovulation & breeding timing technique . Breeding history of bitch? . Facilities, housing . Overuse of stud - Assess libido: . Maximum in own territory w/ less dominant female	• **Correct any management problems** • **Check heat detection** • **Switch partners** • **Patience in retraining nervous dogs** **Prognosis: Good**
Lack of libido ** I2M 905, 909; IM 693; Cat 1852; R-M 832(f); E&R 719	• **Cause/DDx: Lack of libido** - In foreign territory - Dominant female - No female in estrus in area - Shy (other animals in area) - Inexperience or frightened - Doesn't like partner - Prefer semen collection - Repeated ejaculation (not in toms) - Age - Pain, stress - Hypothyroidism - Steroids (endogenous or exogenous glucocorticoids)		
Failure of erection * SAP 936; E&R 694	• Causes: prior castration, May be to young - prepubertal, Timid inexperienced dog, Testicular atrophy or degeneration, Intersex condition, Congenital disorders (penile hypoplasia, hypospadias, persistent frenulum, preputial stenosis), Pain (orchitis, prostatitis, fractures of os penis) • CS: infertility - **failure to achieve an erection** • Hx (age, experience, timidity); Physical exam (check for castration, genitals, & other causes); Endocrine testing: testosterone concentration, Karyotyping if intersex suspected, Testicular biopsy for atrophy or degeneration • Tx: Ensure female in heat, Ensure male mature, Correct underlying causes; Management of breeding technique viewed so animals not intimidated		
Erection w/ failure to ejaculate * SAP 936	• Cause: **Pain** causing loss of erection & interest in sex, Analgesia, Os penis fracture, Retrograde ejaculation, Blockage of vas deferens • CS: Infertility, **Erection w/ failure to ejaculate** • Hx: pain causing loss of erection & interest in sex; Physical exam: R/O penile analgesia or os penis fracture; Examine urine after breeding (If spermatozoa indicates retrograde ejaculation, Elevated alkaline phosphatase suggest blockage of vas deferens; Testicular biopsy on azoospermic dogs for seminiferous tubule function assessment • Tx: Surgical correction of outflow obstruction; Retrograde ejaculation; Sympathomimetic agents (pseudoephedrine or phenylpropanolamine) Little data on success of Tx		
Congenital infertility * I2M 905, 909; IM 696	• **Never successful in siring a litter**; Causes: abnormalities in hypothalamic-pituitary-gonadal axis; Hypogonadotropic hypogonadism, Anatomic abnormalities of wolffian duct system - atresia; Intersex • CS: Infertility • Dx: Hx; CS; PE of external genitalia (intersex); Karyotyping; Gonadal biopsy; Ultasound: evaluation of internal genitalia; Laparotomy/laparoscopy • Tx: **None**		

Oligospermia or Azoospermia
I2M 907; IM 695; E-hb 620; H2B 691; R-M 552, 833 (F); R-R 873; E&R 722
***

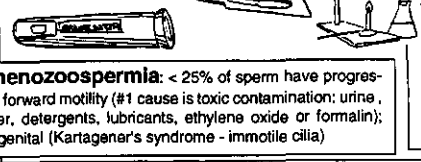
• **↓ Concentration of spermatozoa**
- Oligospermia: < 200 million sperm/ejaculate in dog ≥ 10 lbs
- Azoospermia: complete absence of sperm



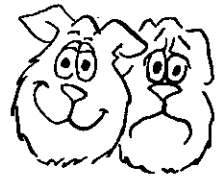
DDx - Low or no sperm
• Cause in normal dog
- Overuse
- Anxiety, stress, pain
- Incomplete collection
• Pathology:
- Anabolic steroids
- Spermatogenesis/testicular degeneration
. Heat (inflammation, fever, environmental temperature, cryptorchidism, scrotal dermatitis)
. Metabolic disorders/endocrinopathies
. Toxins & drugs (heavy metals, rare earth salts & androgens or estrogens)
. Orchitis (B. canis, E coli, Proteus)
. Miscellaneous (Cold, Radiation, Vascular ischemia, Zinc & Vit A defc., Neoplasia; Debilitating diz, Diabetes, spermatocele, varicocele)
- Testicular hypoplasia
- Testicular atrophy/fibrosis
- Bilateral obstruction of ductus deferens or epididymis
- Retrograde ejaculate
- Prostatic diz - obstruction

• **Diagnosis can be difficult/improbable?**
• Hx (drugs, metabolic disorders, fever, anabolic steroids [restoring body flesh after a debilitating diz])
• **Semen evaluation**: repeated collection to ensure complete collection
- Never deem a dog infertile based on a single evaluation
- Collect males in presence of owner, in his own surroundings
- Reevaluation at several weeks interval may be necessary

• **Physical exam for diz**
- Scrotal temperature
- Small testicles (hypoplasia)
- Rectal for prostatic enlargement/obstruction
• **Laboratory**: CBC, chemistries, urinalysis for metabolic, endocrinopathies or infections
• **Urinalysis** after ejaculate for retrograde ejaculation
• Seminal alkaline phosphatase: if low, may indicate incomplete ejaculation or obstruction distal to epididymis
• Testicular biopsy: Interpretation must be done by an expert
- Stem cells (spermatogonia) damaged in basal compartment of the testes, then permanent damage may have occurred
• Endocrinologic evaluation
• Epididymal aspirate



• Treatment depends on cause which often is not discovered
• **General: azoospermic males remain azoospermic**

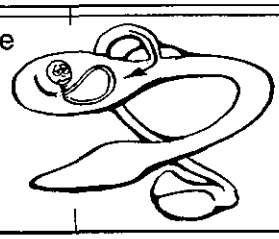


Prognosis:
• **Guarded**
• Reevaluate every 2 months for year since recovery form testicular insult takes 62 days
• Oligozoospermic males may be subfertile rather than infertile
- Breed judiciously, pregnancy possible w/ as few as 50-100 million sperm/ejaculate

Asthenozoospermia: < 25% of sperm have progressive forward motility (#1 cause is toxic contamination: urine, water, detergents, lubricants, ethylene oxide or formalin); congenital (Kartagener's syndrome - immotile cilia)

Teratozoospermia: > 50% of sperm abnormal, count & motility may be normal
• Primary abnormalities (Orchitis, Toxins, Chemotherapy, Heat)
• Secondary abnormalities (Prolonged storage, Epididymal diz, Damage at collection/handling)
• Abnormal motility often associated with defects of midpiece/tail

Retrograde ejaculate
IM 696; E&R 732
*



• **Ejaculation of semen in urinary bladder** rather than out the urethra
• Cause: ? neurogenic, inadequate pressure in the internal urethral sphincter of the neck of bladder

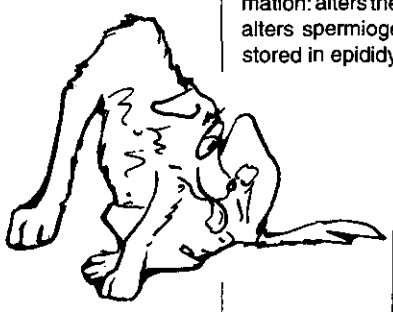
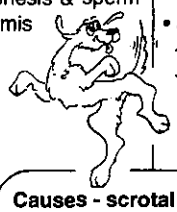
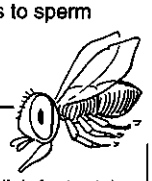
• Hx, CS (infertility)
• Semen evaluation: **Low number of sperm**
• **Urinalysis: excessive sperm** in urinary bladder after ejaculation
- Cystocentesis better?

• **Pseudoephedrine (Sudafed®)**: alph-adrenergic drugs recommended PO

Sudafed

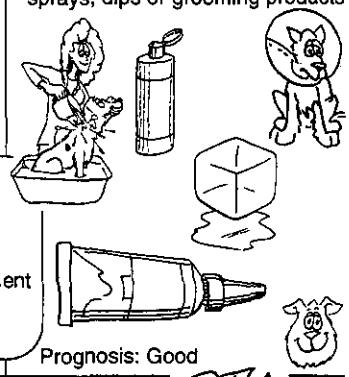
Prognosis: To little experience to give prognosis

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Scrotal dermatitis SAP 877; H3B 612; E&R 710; Sx-S-hb 456; DDx 369, 370 **	• **Uncommon** • **Don't castrate dogs through the scrotum**, remove testes through skin incision just cranial to scrotum • Chronic or severe scrotal inflammation: alters thermoregulation - alters spermiogenesis & sperm stored in epididymis	• **Most asymptomatic** • **Pain** • **Swelling** • **Licking of scrotum** • +/- Anorexia, listlessness, reluctance to walk, fever, stiff or stilted gait • Sequelae: - Orchitis if reaches testes - Deleterious to sperm	• History, CS (**licking**) • Physical exam: general exam - Scrotum: normal: uniform in thickness, freely movable over the testes . Dermatitis (Brucellosis?) • Laboratory: ± CBC, chemistry, urinalysis: for underlying systemic dizs & specific repro dizs • ± Brucellosis canis screening • Semen collection - Motility: >70% progressive linear motility - Morphology - Numbers: > 200 million • Impression smears for fungus, neoplastic cells or other infiltrates	• **Superficial scrotal lesions** - Topical therapy: Panalog® - Elizabethan collar • **Cold water or ice**: if scrotal swelling & inflammation to reduce quickly to minimize damage to testicles • Dilute & rinse after using soaps, detergents & disinfectants • Avoid scrotal use of insecticide sprays, dips or grooming products

Causes - scrotal dermatitis
- Local irritation
  . Chemicals (soaps, dips or disinfectants), very sensitive
  . Insect bites (fly strike)
- Acute orchitis = excessive licking (B. canis)
- Trauma (abrasions, surgery)
- Any generalized dermatitis

DDx - Scrotal swelling
- B. canis because of public health
- Diffuse thickening of scrotum
- Edema or local inflammation
- Testicular or epididymal enlargement
- Inguinoscrotal hernia
- Systemic edematous conditions



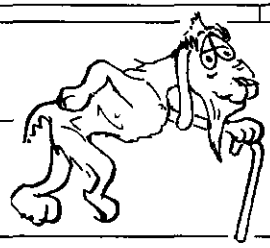
Prognosis: Good

Scrotum sensitive in dog
CS: Asymptomatic, Licking
Dx: Hx, CS, PE, Semen
Tx: Panalog, Cold water

Chronic hyperplasia of scrotum **

SAP 878; Sx-S-hb 456

• Common in older dogs, **scrotum becomes wrinkled, thickened & heavily pigmented**; Usually not clinically significant unless becomes infected

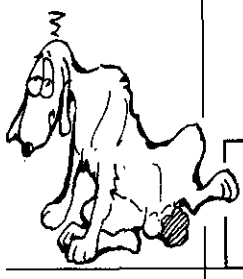
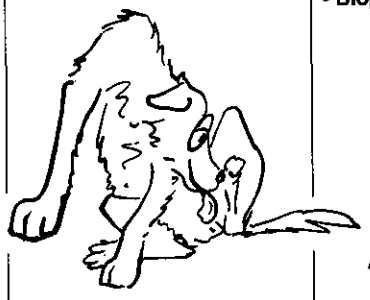
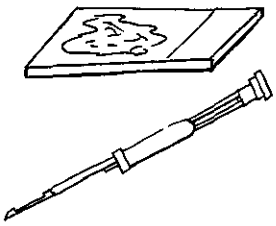


Varicosities of scrotal blood vessels

Sx-S-hb 456

- Varicose dilation of scrotal veins in older dogs
- Trauma may lead to ulceration
- CS: repeated profuse bleeding
- Tx: Stimulate thrombosis w/ styptics or surgical removing involved scrotal skin & blood vessels

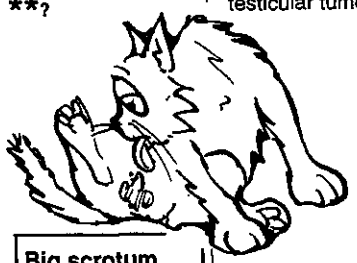
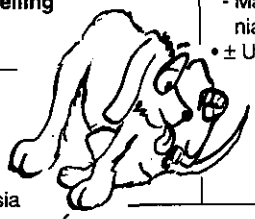
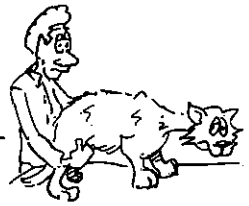
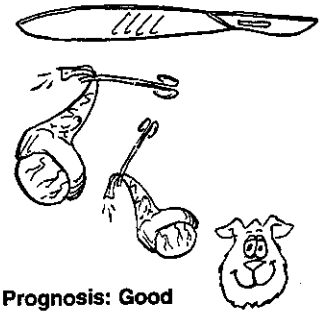
Scrotal neoplasia SAP 878; E-hb 632; E 1700; Sx-S-hb 456, 452; R-M 563; E&R 710; DDx 370 *- **	• Types - Mast cell tumor - Melanomas - Squamous cell carcinomas • **Highly malignant** • **Uncommon** in dog, rare in cat	• Mass • Ulceration	• **Hx, CS** • **Impression smear of ulcerated skin** • **Aspiration of nodule** • **Biopsy**	• **Surgical excision** (TOC), scrotal ablation • Postop: - Elizabethan collar - Complication, bleeding, infection, dehiscence

Prognosis: **Guarded**

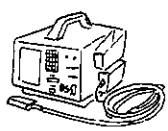
Highly malignant
CS: Mass, Ulceration
Dx: Impression, Biopsy
Tx: Surgical excision

Scrotal/ inguinal hernia SAP 877; E&R 709; Sx-S-hb 171; Emrg 425 **?	• **See GI 105** • **Herniation of abdominal organs or omentum through the inguinal canal** • Congenital or traumatic • ↑ Incidence of testicular tumors	• **Enlarged spermatic cord & scrotal contents** • **Pain, swelling**	• **Physical exam of scrotum & spermatic cord** - Manually try to reduce & feel hernial ring, often unable to reduce • ± Ultrasound	• **Sx correction immediately to avoid strangulation,** Transfixing ligation of hernial sac • **Bilateral castration** recommended to prevent recurrence

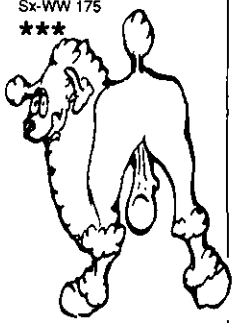
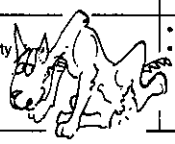
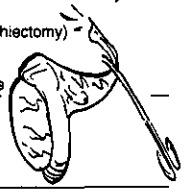
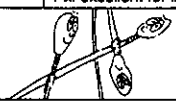
DDx - ↑ Scrotal size
SAP 937
- Inguinal hernia
- Testicular torsion
- Testicular neoplasia
- Orchitis
- periorchitis
- Epididymitis
- Sperm granuloma
- Hydrocele
- Hematocele
- Scrotal abscess

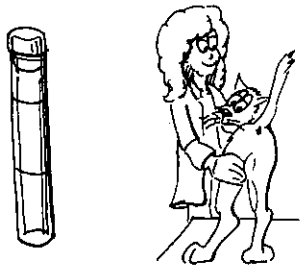
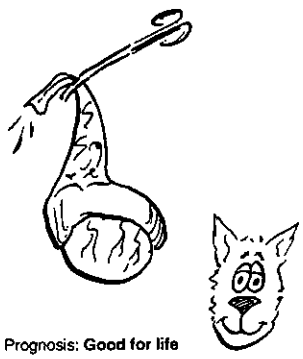
DDx: ↓ Scrotal size
- Cryptorchidism
- Testicular hypoplasia
- Testicular degeneration
- Intersex conditions



Prognosis: **Good**

Big scrotum
Tx: Sx & Neuter

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Cryptorchidism, Hidden testicle M8k 986; E-hb 628; SAP 877, 880; H2B 649; H3B 588; I2M 915; IM 702; 5min 490; Cat 1851, 1896; R-M 541, 831 (F); R-R 821; Sx4B 522; Sx3B 421; Sx-WW 175 *** 	• **Common**: incidence 1-2%, #1 congenital testicular defect • **Failure of 1 or both testicles to descend into scrotum** - Normally they descend: . Dog: by 6-8 weeks old (m/b as late as 6 months). Usually not palpable until 2 weeks old . Cat: prenatal - 2:1 - right:left ratio • Unilateral (usually fertile) > bilateral (infertile) • Location of nondescended testicle - **Abdomen** - **Inguinal canal** - **Lateral to penis** • Sex linked inherited trait (bitches can be homozygous/heterozygous carriers), simple autosomal recessive • Sertoli cell tumors & torsion	• **Testicle not in scrotum at 6 months old** • Sequela: - **Testicular neoplasia in dog** (14 x more likely - Sertoli cell, seminoma), not in cat . Feminization . Blood dyscrasias (excess estrogen) - Torsion of testicle 	• **Palpation, periodically until 6 months old** • Locate retained testicle - Palpation if external to superficial inguinal ring - Exploratory celiotomy if abdominal • Agenesis testis very rare • Purebreds predisposed: Yorkshire terrier, Pomeranian, miniature & toy poodles, smaller breeds, boxers, Pekingese, Maltese, Shetland& sheepdog, cairn terrier & Persian cats	• **Castration**: retained & scrotal testicles • Inguinal testicle: GnRH & HCG may aid descent • Discourage breeding: genetic factor - Orchiopexy not condoned Prognosis: **Good**
Common; Abdomen, inguinal canal or lateral to penis **CS: Empty scrotum at 6 mo., Sequela: testicular tumors** **Dx: PE: palpate** **Tx: Castration, don't breed; Px: excellent**				
Testicular hypoplasia * SAP 877; H2B 691; R-R 815; Sx-S-hb 451, DDx 371	• Abnormal development of seminiferous tubular germinal epithelium - Reduced sperm number & infertility	• Small: 1 or both testicle at puberty • Infertility 	• CS (small testicles) • PE (small testicle) 	• Nothing (dogs aren't concerned by size of their testicles!) • Neuter (spay/orchiectomy) Px: excellent for life 
Testicular aplasia of duct system SAP 877 *	• Results in impaired transport of sperm to urethra; Accumulation of sperm proximal to obstruction; Unilateral • CS: Sperm granuloma, Testicular degeneration • Tx: Neuter (spay/orchiectomy)			

Intersexuality, Intersex E-hb 627; SAP 939; H3B 607; H2B 667; R-M 567, 831 (f); R-R 709, 820 * 	• **Intersex: animals w/ abnormalities in chromosomal, gonadal or phenotypic sex** • Causes... - Idiopathic - Inherited - Abnormal sex chromosome constitution - Fetal exposure to androgenic or progestational hormones 	• **Abnormal external genitalia** • **Phenotypic females**: - Infertility, irregular cyclicity, failure of conception, small litters, complete failure to cycle, abortions • **Phenotypic males**: - Azoospermia, oligozoospermia, high percentage of abnormal nonmotile sperm - Testicular hypoplasia - Cryptorchidism - Low libido - ± Intermittent hematuria & pyometra	• Hx (administration of exogenous androgens or progestins during pregnancy) • CS: presented for abnormal external genitalia • **Physical exam**: - External genitalia & rectal for prostate - Cat: note coat color calico or tortoiseshell males? • Exploratory • Histology of gonads • Karyotyping: blood sample to lab for lymphocyte culture & chromosome analysis • Other lab tests: - Male histocompatibility (H-Y) antigen assay - Androgen receptor assays 	• **No curative treatment** • Intersex disorders can lead normal lives • Medical: ointment for urine scalding, antibiotics for urinary tract infections • Surgical: for minor defects causing urine scalding; clitoridectomy • **Neuter** to minimize risk of tumors & pyometra & abnormal behavior  Prognosis: **Good for life**

Abnormalities of phenotypic sex, * Pseudohermaphrodite

XXY

E-hb 627; SAP 877; H2B 667; R-R 820

- Chromosomal & gonadal sex agree but genitalia are ambiguous, 1 type of gonad w/ 1 or more characteristics of opposite sex in external genitalia
- **Female pseudohermaphrodite**
  - Masculinized internal & external genitalia
    . From mild clitoral enlargement to nearly normal male external genitalia w/ prostate internally
  - More than a single X chromosome, often XXY karyotype
  - Cause: androgen or progesterone administration during gestation or androgen administration to racing greyhounds
- **Male pseudohermaphrodite**
  - XY chromosomes + testicles but feminization of external or internal genitalia, penile hypoplasia
    . Testicular hyperplasia, cryptorchidism or abnormal development of penis, prepuce or scrotum, hypospadias

XY

Chromosomal defects *

E-hb 627; SAP 939; H2B 667; R-R 820

XXY

- XXY syndrome: Klenefelter's syndrome: cats may be of any color but usually tricolored (calico/tortoiseshell) males - sterile?

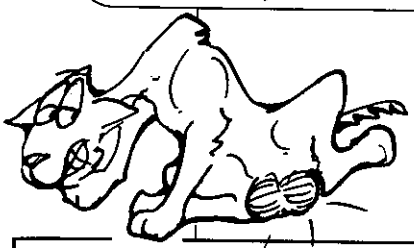
XO

- XO syndrome/Turner's syndrome: normal female phenotype but hasn't cycled by 24 months of age, small body, infantile reproductive tract
- XXX syndrome: abnormalities of estrous cycle & infertility frequent findings
- True hermaphrodites: Chimeras & Mosaics: have both ovaries & testicles, external genitalia usually appear female w/ enlarged clitoris & ± os clitoris; rare, history of failure to cycle
- **Mass**
- **Ulceration of scrotum**

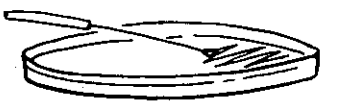
XXX

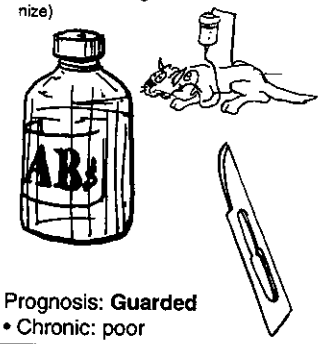
XX

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Orchitis/ epididymitis, Orchiepididymitis M8k 1041; SAP 877; H3B 589; H2B 650; E-hb 630; I2M 914; IM 702; 5min 557; R-M 841; R-M 545, 551; R-R 841; SX-S-hb 451; DDx 371 **	• **Inflammation of testes & epididymis respectively** - Inflammation of 1 often results in involvement of other • **Dog** > cats • Causes: ***B. canis***, *E coli*, Canine distemper virus **Causes: Orchitis** • **Brucella canis** • **Direct trauma** (puncture wounds, licking) #1 for acute • Bacterial septicemia (rare, by lymphatics) • Bacterial prostatitis (descend the ductus deferens) • Bacterial cystitis (descend ductus deferens) • Canine distemper virus, FIP, canine ehrlichiosis, Mycoplasma, • Fungus: blastomycosis, coccidioidomycosis	• Acute: - **Pain, heat** - **Swelling** - **Licking of scrotum** - ± Anorexia, listlessness, reluctance to walk, fever, stiff or stilted gait • Chronic granulomatous orchitis: - Enlarged, firm, nonpainful testicle - Slow, progressive, low-grade, nonsuppurative inflammation w/ fibrosis • Sequelae: - Infertility - Self mutilation - Chronicity: atrophy, fibrosis & irregular testicle, adhesions to scrotum **DDx:** • Testicular trauma • Testicular neoplasia • Immune mediated orchitis • Testicular torsion • Urethritis • Prostatitis	• **Hx, CS** systemic illness • **Physical exam** - General: systemic diz - Testes: palpate . Compare size . Irregular surface, nodule or adhesions: chronic inflammation, infection or neoplasia . Firm hard testicle: neoplasia or acute orchitis . Pain: acute orchitis or testicular torsion • **Seamen evaluation** - Motility: normal >70% progressive motility - Numbers: > 200 million in ejaculate to be fertile . Numbers drop on trauma to seminiferous tubules for weeks to months . Infertility diagnosed if several samples over 6 months abnormal • **Bacterial cultures:** - Wounds - Sperm rich fraction of ejaculate - for organism originating in testes or prostate - ***B. canis*** test all males w/ reproductive failure, chronic scrotal dermatitis or orchitis, often negative . Serum agglutination test for screening, confirm w/ agar gel immunodiffusion test • CBC • **Urinalysis (UA)** • ± Biochemistries • ± Fungal cultures • Cytology: fine needle aspiration - Differentiate purulent from granulomatous inflammation • ± Castration & histopath	• **Nonbreeding animals** - **IV fluids** - **ABs** (broad spectrum) (C&S) 2 wks . Trimethoprim-sulfadiazine or aminoglycosides . Cephalosporin or oxacillin for staph resistant . Ampicillin, amoxicillin, clavunate-amoxicillin, chloramphenicol - **Castrate** (ovariectomy) once stable • Breeding animals - IV fluids, ABs - Cold compresses - Anti-inflammatory agent (corticosteroids, aspirin) - ± Unilateral orchiectomy to save unaffected testis • Castration: - Brucella-positive dogs - Severe testicular abscesses &/or necrosis - Nonbreeding animals • Remove positive *B. canis* male from breeding herd (neuter or euthanize) Prognosis: **Guarded** • Chronic: poor

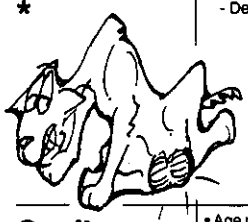


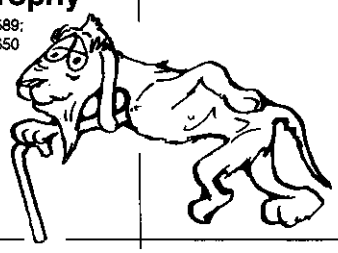
Dog > cats, #1 *B. canis*
CS: Pain, Heat, Swelling, Licking of scrotum
Dx: Hx, CS, PE, Semen, Cultures
Tx: ABs, Castrate • Px: Guarded

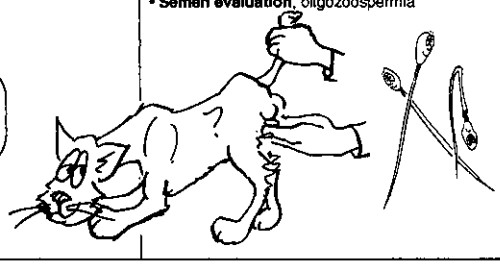


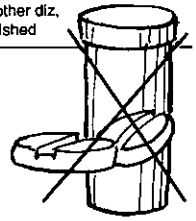


Immune mediated orchitis, Autoimmune orchitis SAP 878; H3B 590; H2B 651; E-hb 630 *	• **Infiltration of lymphocytes & plasma cells** • Cause: - Traumatic - Infectious dizs • Breeds: beagle, Scottish terriers • Pathophysiology: - Blood-testes barrier separates sperm form immune system - Exposed spermatozoal antigens to immune system - Infiltration of lymphocytes & plasma cells - Deterioration of seminiferous epithelium	• No acute inflammation usually • **Infertility & azoospermia** • Chronic testicular diz - Changes in testicular size & consistency - Changes in semen quality **DDx:** • Chronic orchitis (Brucellosis) • Other causes of male infertility • Testicular atrophy	• Hx (breeding) • Physical exam - Palpate: size, shape & consistency - Compare size - Firm hard testicle: neoplasia or acute orchitis • Culture for B canis all males presented for reproductive failure, chronic scrotal dermatitis or orchitis - Serum agglutination test for screening, confirm w/ agar gel immunodiffusion test • Seamen evaluation • Cytology: fine needle aspiration • **Biopsy/histopath: rete testis** - **Plasmacytic/lymphocytic infiltrate**	• **Castration** • No curative treatment available • Immunosuppressive steroids lead to infertility - Prednisolone, Cytoxan, Imuran • Evaluate related dogs for hereditary Prognosis: Poor for fertility
Senile atrophy H3B 589; H2B 650 *?	• Age related change in testicles due to cessation of sperm production • Cause: unknown	• **Infertility** **DDx:** • Trauma or infectious atrophy • Hypothyroidism • Hyperadrenocorticism	• Hx • PE (physical exam): small, soft testicles • **Semen evaluation**, oligozoospermia	• **NO effective Tx** **None** Prognosis: Good: doesn't predispose to other diz, fertility is diminished









Testicles - Adverse drug reactions

SAP 877
*

- Damage to seminiferous epithelium: Amphotericin B, Anticancer drugs, Cimetidine, Toxins (lead), Irradiation
- CS: Deterioration of semen quality; **Infertility**
- Dx: Hx (exposure), **Semen exam**
- Tx: **Withdraw drugs** to prevent permanent damage
- Px: **Good** if no permanent damage

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Trauma to testicle SAP 877; H2B 650; IM 702; H2B 667; R-R 826; Cat 1898; Sx-S-hb 452; DDx 372 ***	• **Trauma**: abrasions, contusions, hematoma, laceration, edema, constant licking (scrotal pyoderma), bite wound in cats, malicious rubber bands • May lead to chronic orchiepididymitis	• **Pain, swelling** • **Licking of scrotum** • Sequela: Acute or **chronic orchiepididymitis**	• Hx (**trauma**), CS • Physical exam • Culture & sensitivity	• **Treat promptly** to prevent orchiepididymitis - Topical ABs - ± Elizabethan collar - ± Neuter
Endocrine diz - testicles SAP 878 *	• Alter metabolism or gonadal hormones & gradually cause deterioration of seminiferous tubules **Endocrine diz & testicles** • Hypothyroidism • Diabetes mellitus • Hi or low glucocorticoids (hyperadrenocorticism, hypoadrenocorticism) • Low or high androgen, estrogen, gonadotropin	• **Infertility** • **Skin disorders**	• **Hx: endocrinopathy** • Physical exam: for endocrinopathy • Seamen evaluation • Thyroid hormone: if poor libido or lethargy • Cortisol levels • Estradiol increase: Sertoli cell tumor & seminoma	• Remove causative agent if possible • Discontinue all drugs if not life requiring • Treat any endocrinopathy: takes several months to see improvement in semen quality Prognosis: Poor
Testicular torsion SAP 878; H3B 591; H2B 651; I2M 917; R-R 822; R-M 869; E&R 705; DDx 371; Emrg 425 *	• **Enlarged, neoplastic abdominal (cryptorchid) testis most often** • Rare: torsion of scrotal testicle, due to trauma & breaking of scrotal ligament • Occlusion of venous & lymphatics - Infarction • Age 5 months to 10 years	• **Acute torsion of abdominal testicle** - +/- acute abdominal pain - Anorexia, fever, vomiting • Acute torsion - scrotal testes - ± Testicular & spermatic cord engorgement - Mild fever, severe vomiting, unwillingness to move • Chronic partial torsion - ± Clinical signs **DDx:** • Scrotal torsion: acute orchitis, blunt trauma, necrosis of neoplasia • Abdominal torsion: other cause of abdominal pain • Partial or chronic torsion: testicular neoplasia	• Hx, CS • Physical exam (cryptorchid, painful testicle) • Surgery	• **Abdominal torsion** - **Stabilize - fluids** - **Immediately neuter** (spay/orchiectomy) • Intrascrotal torsion: castration Prognosis: **Good** w/ surgery

Testicular tumors

E-hb 632; SAP 878; H3B 592; H2B 652; I2M 917; IM 703; E 1699; F-N 473; R-M 546, 551, 561, 833 (F); E&R 699; Derm 682; D-CT 295; D-Sy 107, 151, 194; D-Mi 278; Sx-WW 177; Sx-S-hb 452; Sx-S 1328?; DDx 371

* - ***

- **Common - old dog**, rare in cat
  - 2nd to skin in dog for neoplasia, 5-15% of all tumors
- Types:
  - **Sertoli cell tumor** (25%)
  - **Interstitial (Leydig) cell** (40%)
  - **Seminoma** (from spermatogonia) (35%)
  - Combo of types (25%)
- Location in the descended testes:
  - 100% interstitial cell
  - 75% seminomas
  - 40% Sertoli cell
  - Most benign, especially if in scrotum
  - ± Malignant if in abdomen (Sertoli & seminomas)
  - All can metastasize to lymph nodes, liver, lungs, spleen, kidneys, pancreas
- Pathophysiology:
  - Compress seminiferous tubules
  - Sertoli cell: ↑ estrogen
  - Interstitial cells: ↑ testosterone
- Breeds: boxers, Chihuahua, Pomeranian, poodle, min. schnauzer, Shetland, husky, Yorkie, weimaraners, shepherd
- Mean age 10 years old
- **Cryptorchids: 14 x risk to develop tumors** especially Sertoli cell or seminomas, inguinal hernia also increases risk

- Asymptomatic
- ± Tenderness
- **Feminization**: excess estrogen secretion, most common in Sertoli
  - Penile & contralateral testicular atrophy
  - **Gynecomastia**, lactation
  - Pendulous prepuce
  - ↓ Libido, infertility
  - Attract other males 25%
  - Prostatic enlargement (metaplasia see pg 471)
  - Squatting to urinate
  - ± Bone marrow depression
- **Skin:**
  - **Bilateral symmetrical, non-pruritic alopecia** (perineum & genital area progressing cranially to ventrum & neck; ± flank)
    - Frizzy, dull, dry coat
    - ± Hyperpigmentation
  - Seborrhea
  - Ceruminous otitis externa
  - ± Linear preputial dermatitis, melanotic macule
- Estrogen toxicity:
  - Infection, septicemia: leukopenia, pancytopenia
  - Bleeding diathesis: thrombocytopenia
  - Anemia, usually aplastic
- Sequelae:
  - Torsion of spermatic cord & testicle
  - Scrotal swelling (lymphatic obstruction)
  - **Metastasis unusual**

- Hx (**old, cryptorchid males**)
- CS: **feminization**
- Physical exam: palpation of mass in testes, diffuse or discrete nodule
- **Ultrasound** of testes if not palpable
- ± Bone marrow depression: Myelotoxicosis (10-15%) anemia (erythroid hypoplasia), hemorrhage (thrombocytopenia) & infection (granulocytic hypoplasia)
- Cytologic aspiration (rarely done)
- Stained preputial swab: epithelial cell influenced by estrogen - cornification
- **Castration**: excised testicle: appearance of tumor. Histopath: definitive
- Chest & abdomen radiographs for **metastasis**
- ± ↑ Serum levels or estradiol, progesterone or testosterone
- CBC for blood dyscrasias: anemia, thrombocytopenia

- **Castration/orchiectomy** unilateral or bilateral:
  - Usually complete response in 3 months
  - May not reverse myelosuppression of bone marrow
- Cases of metastasize are unusual
  - Cytotoxic chemo: vinblastine, cyclophosphamide & metotrexate weekly - 50% tumor reduction - at least several months of improved life
- Monitor for hematological changes (CBC) & metastasize at 3, 6 & 12 months

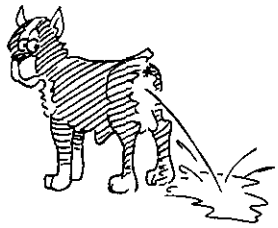
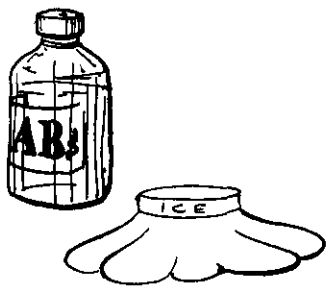
Prognosis:
- **Good** for reversal of feminization
- Poor for bone marrow changes - 30% recover
- Metastasis: grave

Interstitial (Leydig) cell tumor (ICT)
- Small, 1-2 cm within the testes substance
- Clinically insignificant, Rarely metastasize
- Yellow to orange on cut surface

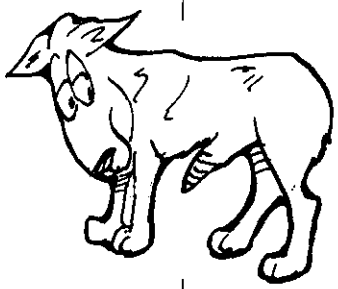
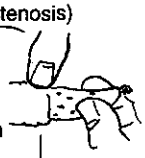
Sertoli Cell Tumor (T)
- 1 - 5 cm, Slow developing; 40% in scrotal testicle, 60% in abdominal testicle, May be malignant if abdominal
- Fine or coarse spongy texture & brown to white in color
- **10-20% metastasize to lumbar & iliac lymph nodes, m/b kidney**

Seminomas
- Rarely metastasize 5-10% to regional lymph nodes & abdominal viscera; Location: 75% in scrotal testicle, 25% in abdominal testicle

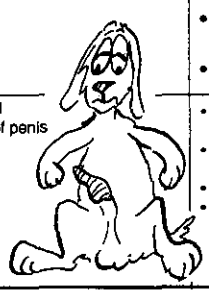
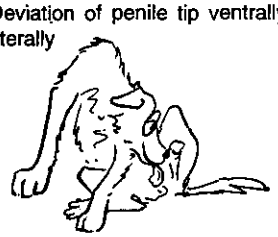
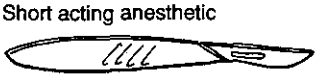
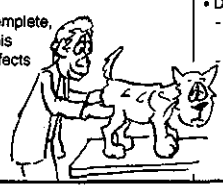
Old dog, # 2 tumors; Most benign, Cryptorchids
- Sertoli, Interstitial, Seminoma
CS: Asymptomatic, Feminization, Skin: Alopecia
Dx: Hx, CS, PE, CBC, Rads, Castration
Tx: Castration

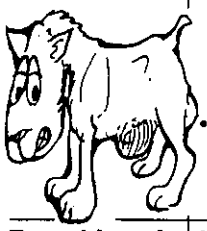
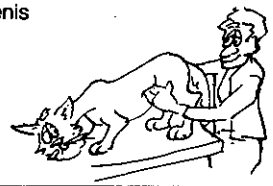
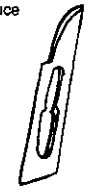
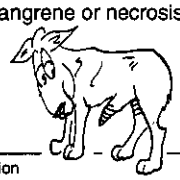
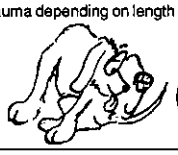
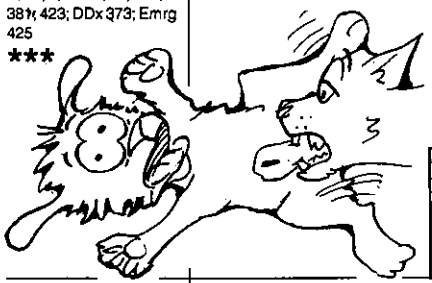
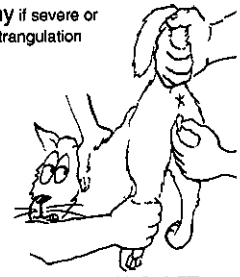
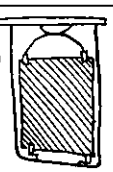
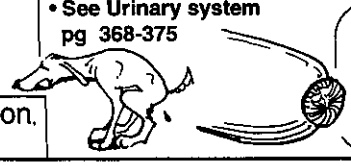
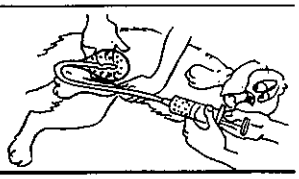
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Penis & prepuce SAP 886; E-hb 628; H2B 669; IM 700; R-R 807; R-M 549; E&R 691; Sx-S-hb 453; Sx3B 426; DDx 372 ***	• **Several dizs** exist of the penis & prepuce many of which are congenital 	• **Many asymptomatic** despite diz • **Purulent preputial discharge** (balanoposthitis, urine pooling in prepuce, foreign bodies, tumors) • **Hemorrhagic discharge** (trauma, tumors, bleeding of urinary tract) • Urinary incontinence &/or urine scalding (hypospadias & penile hypoplasia) • Urination in wrong direction (persistent frenulum) • **Copulatory problems** (persistent frenulum, deformity of penis, preputial stenosis)	• **Hx**: systemic diz, trauma, bleeding problems • **Physical exam** (PE): complete - Normal finding on inspection of penis, prepuce & urethra orifice . **Normal small amount of green preputial discharge** . Free prepuce, easily exteriorized penis . Penile mucosa: pinkish white, smooth & nonpainful . 1 orifice at end of penis . Hyperplasia or lymphoid follicles (bulbous glandis) normal in many dogs - Palpate penis & os penis - Rectal exam to R/O (rule out) prostatic & urethra diz • Radiology: os penis defects • Laboratory: - Cytology of preputial discharge & masses . Normal: epithelial cells, inflammatory cells (PMNs) & bacteria . Balanoposthitis: toxic PMNs & extracellular bacteria . TVT: large round cells w/ numerous mitotic figures • Culture & sensitivity of perpetual discharge • Karyotyping for female pseudohermaphrodite	• **Eliminate or prevent infection** • Prevent formation of adhesions • Reduce inflammation • Treat cause - Hypospadias: Surgery - Penile hypoplasia: none usually needed - Persistent penile frenulum: surgery - Os penis deformity: none or break & set - Priapism: Tx cause, protect - Paraphimosis: replace - Phimosis: enlarge preputial opening - Trauma: Tx & prevent adhesions - Penile lymphoid hyperplasia: scarification - Neoplasms: surgery - Balanoposthitis: ABs - Urethral prolapse: surgery - Fracture of the os penis: none or set 

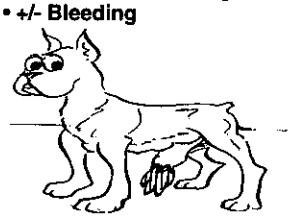
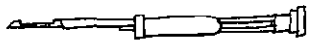
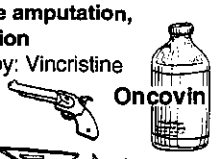
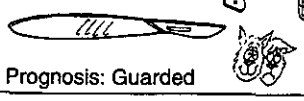
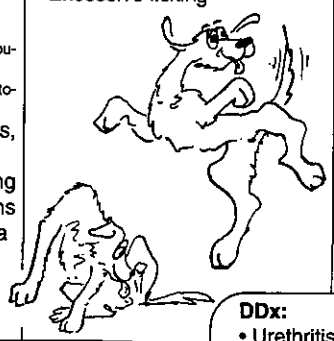
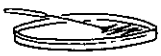
Penile & prepuce dizs
- Hypospadias
- Penile hypoplasia
- Persistent penile frenulum
- Os penis deformity
- Priapism
- Paraphimosis
- Phimosis
- Trauma
- Penile lymphoid hyperplasia
- Neoplasms
- Balanoposthitis
- Urethral prolapse
- Fracture of the os penis

Many congenital
CS: Asymptomatic; Discharge, Incontinence; ± Copulation
Dx: Hx, CS, PE, Rads, Lab, C&S; Karyotyping
Tx: Infection, Prevent adhesions

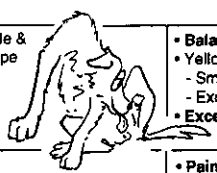
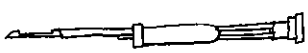
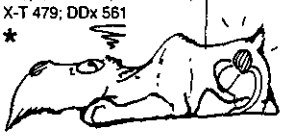
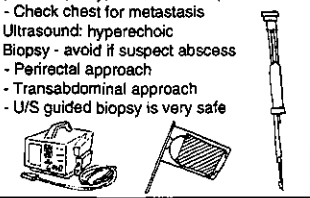
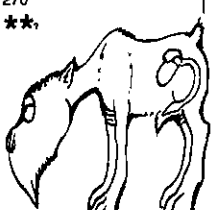
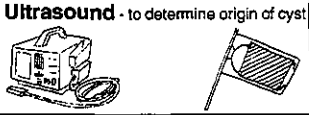
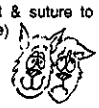
Hypospadias SAP 886; E-hb 628; H3B 609; H2B 669; IM 700; 5min 1058, 718; R-M 549; E&R 691; Sx-S-hb 453; Sx4B 529; Sx3B 426; DDx 372 *	• **Rare** congenital defect, but #1 external genitalia anomaly • Developmental failure of genital fold to fuse • Cause: exogenous progesterone or estrogens during pregnancy, inadequate androgenic stimulation during fetal development • **Boston terrier** 	• **Urethral opening ventral & caudal to normal position** - M/b found in perineal region • Asymptomatic m/b • Underdeveloped penis • Incomplete prepuce ventrally • Urinary incontinence &/or urinary scalding of abdomen & perineum	• **Hx (young)** • Physical exam (PE): incomplete prepuce ventrally • ± Catheterization of penis • **Associated defects** - Cryptorchidism - Incomplete scrotum & prepuce (ventral) - Persistent Mullerian structures - Unilateral renal agenesis	• Mild glandular hypospadias - **surgical reconstruction of urethra** • Severe deformities: urethrostomy & castration w/ excision of rudimentary penis, prepuce & scrotum Prognosis: Good **Diphalia** IM 700; E&R 692 • Duplication of penis • Reported in 2 dogs
Penile hypoplasia SAP 886; H2B 669; IM 700; R-M 549; E&R 691 *	• **Rare** in dogs & cats • Breeds: Great Dane, collie, cocker spaniel, Doby • Normally associated w/ female pseudohermaphrodites - 78- chromosome individual w/ XX karyotype	• **Penis shorter than prepuce** • **Asymptomatic** • +/- Urine pooling in prepuce - Irritation & infection of prepuce • Urinary incontinence &/or urinary scalding of abdomen & perineum • Dysuria, hematuria • Bilateral cryptorchidism	• **Hx (young)** • Physical exam (PE): of penis, testes • ± Karyotype • ± Histopathology of gonadal tissue • Serum H-Y assay (not generally available yet)	• **None needed if no clinical signs** • Surgical enlargement of preputial orifice if urine pooling **None needed** Prognosis: **Good** (dog not concerned about size)
Persistent penile frenulum SAP 886, 891; H3B 609; H2B 669; I2M 912; IM 700; R-M 549; R-R 795; Sx-S-hb 454; Sx4B 533; E&R 691; DDx 373 **	• **Uncommon** congenital defect • Band of connective tissue from ventral tip of penis to prepuce - Normal ruptures by puberty • Breeds: cocker spaniels, miniature poodles, mixed breed dogs, Pekingese 	• **± Asymptomatic** • **Hindered extrusion of penis** • Deviation of penile tip ventrally or laterally • Unwillingness or inability to copulate (pain of erection) • Inability to extend penis • Urine pooling in prepuce • Pain on urination • Urination on medial aspect of hindlimb - scalding • Excessive licking of prepuce	• Hx (young) • Physical exam (PE) - Hindered extrusion of penis - Deviation of penile tip ventrally or laterally 	• **Surgical correction** - Cut w/ scissor - Control bleeding w/ pressure - Short acting anesthetic  Prognosis: **Good** for natural copulation
Os penis deformity SAP 886; R-R 807; E&R 692 *	• **Congenital** • Deviation of penis	• Paraphimosis +/- ability to retract penis into prepuce (deviation) • Shortened os penis: flaccid penile tip, impaired copulation • Pain of erection - won't or can't mate • Inability to extend penis	• Hx (young) • Physical exam (PE): complete, palpate penis & os penis • Radiology: os penis defects 	• Depends on severity - None if non-breeder & doesn't cause paraphimosis or dysuria - Severe: fracture & straighten

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Phimosis (can't protrude) M8k 1042; Mk 683; SAP 886, H3B 610; HB 671; I2M 913; IM 700; 5min 989; R-M 549; R-R 793; E&R 692, 767 (F); Sx-S-hb 455; Sx4B 531; Sx3B 428; Sx-G 304; DDx 372				
** 	• **Uncommon** in dogs & cats • **Penis trapped in prepuce/inability to extrude penis** - **Small preputial opening** - Acquired - trauma - Matted preputial hair in cats • Breeds: G. shepherd, golden retriever **Penis trapped inside**	• **Asymptomatic** if opening large enough for urination • **Urine dribbling**: if interference w/ urine flow, urine retention • Unwillingness or inability to copulate (pain of erection) • Inability to extend penis • Sequela: ± Septicemia in neonates & death at 10 days old	• Hx (**young**) • Physical exam (PE): small preputial opening, difficult to extrude penis 	• **Enlargement of preputial orifice** - Multiple attempts may be necessary - Wedge shaped excision of skin, SQ tissue & preputial mucosa on dorsal prepuce -Appose preputial mucosa & skin • Elizabethan collar m/b • Clip hair if cause in cat  Prognosis: Good
Paraphimosis (can't retract) M8k 1042; Mk 683; SAP 888, 890; H3B 610; H2B 670; I2M 913; IM 701; 5min 989; R-M 550; R-R 802; E&R 692, 767 (F); Sx-S-hb 455; Sx4B 531; Sx3B 428; Sx-G 306; DDx 372; Emrg 425	• **Can't retract penis into prepuce**, commonly occurs after copulation or semen collection • Causes: - Preputial orifice "sticking" to glands as erection subsides - Congenital deformity of penis - Preputial stenosis - Inflammation & swelling of prepuce - Preputial hair restricting penis - Strangulation of penis w/ rubber band, string etc. - Chronic balanoposthitis	• **Can't retract penis into prepuce** • Pain of erection: won't or can't mate • Licking of exposed penis • Drying or necrosis of exposed penis • Stranguria, hematuria & anuria • Sequela: Gangrene or necrosis 	• Hx (**young**), CS • Physical exam (PE): visualize - Palpate penis & os penis • Radiology: os penis defects **DDx:** • Priapism • Phimosis • Abnormally short prepuce • Hematoma of penis	• **Treat promptly** (minimize trauma) • Sedate or anesthetize • **Clean, lubricate & replace penis** - Retract prepuce so more glans is exposed until prepuce unfolds - Cool water soaks or dextrose solution to reduce edema - Remove any preputial hair restricting penis - Daily extrusion to prevent adhesions • ± Enlarge preputial orifice if penis can't be returned • Amputation if severe necrosis Prognosis: recurrence common
**				
Priapism, * Persistent erection H3B 611; H2B 671; I2M 902; R-M 550; E&R 693	• Persistent penile erection **not** associated w/ sexual excitement • Cause: - Nerve injury to penis - Amphetamine administration for narcolepsy - thromboembolism of cavernous venous supply at base of penis	• Persistent erection • variable penile trauma depending on length of time • Licking of penis • Neurologic signs 	• Observation of persistent erection • Can't replace in prepuce as you can w/ paraphimosis **DDx:** • Paraphimosis	• **Treat underlying cause if can** • Spontaneous remission may occur • Supportive care if persistent - Keep exposed penis clean & lubricated - prevent licking & self trauma (Elizabethan collar) Prognosis: Guarded
Trauma to penis & prepuce SAP 886, 887; H3B 614; H2B 673; I2M 911; IM 699; Cat 1852, 1892; R-M 550; H2B 667; R-R 775; E&R 695; Sx-G 310; Sx-S-hb 454, 455; Sx-S 1341; Sx4B 527; Sx3B 381, 423; DDx 373; Emrg 425	• Causes: - **Falls, fighting injuries, blows, hit by car, mating** - Strangulation (malicious rubber bands around penis, cat hair) - Foreign bodies: Grass awns • Contusion, laceration or puncture wounds • Fracture of os penis **(see below)**	• **Bleeding** • Swelling, hematoma, bruising • Dysuria, hematuria, stranguria, anuria • Systemic depression • Balanoposthitis: perpetual discharge • Paraphimosis (inability to retract penis into prepuce) rubber band - 2° urethral obstruction • **Excessive licking**	• Hx: **trauma**, bleeding problems • Physical exam (PE): palpate/visualize penis & os penis • Radiology: os penis fractures - Retrograde urethrography for urethral integrity • Laboratory: toxic PMNs & bacteria • Culture & sensitivity of perpetual discharge	• **Local pressure to control bleeding** • Clean, debride & suture lesions • Remove any foreign bodies • **Prevent formation of adhesions**: manually extrude penis daily & apply antibiotic ointments • Avoid sexual excitement • ± Suture arterial bleeding • ± Suture tunica albuginea for erectile tissue bleeding • ± Partial penile amputation & scrotal urethrostomy if severe or necrosis form strangulation
*** 				 Prognosis: **Guarded**
	Common **CS: Bleeding, Swelling, Dysuria, Paraphimosis** **Dx: Hx, CS: Licking, PE** **Tx: Stop bleeding, Clean, Suture, Prevent adhesions**			
Fracture of the os penis H2B 673; IM 699; R-M 550; Sx-S 1342; Sx3B 423 *	• Cause: **trauma**	• **Pain**, local swelling • Bloody discharge • Sequelae: - Urethral blockage - Anuria	• **Hx, CS** • Palpation: fracture, ± urinary bladder distention  • ± Uremia • Radiology • Urinary catheterization or retrograde urethrography for urethral involvement	• **No surgery if minimal displacement** - Local antiinflammatories etc. • **Stainless steel surgical wire of bone plate** -Emergency cystocentesis - Catheterization & lavage to prevent urethral stricture postoperatively; Antibiotics (ABs) • Consider urethrotomy or urethrostomy - temporary or permanently • Amputation if severe Prognosis: Guarded
Urethral problems	• **See Urinary system pg 368-375** 	**Urethral problems** • Urethritis 368 • Fistulas 369 • Hypospadia 369 • Urethral prolapse 369	• Neoplasia 370 • Stenosis or stricture 370 • Trauma 371 • Urolithiasis 372 • FUS 374	
Masturbation, Onanism R-R 776				

Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Neoplasia - penis & prepuce SAP 887; E-hb 632; R-M 562; R-R 799; E&R 695; Sx-S-hb 454, 456; Sx-S 1342 **	• **Uncommon** in dog, Rare in cat - Transmissible venereal tumors (contagious) - Papillomas - Carcinomas - Occasional tumors . Urethral neoplasms (transitional cell carcinoma, squamous cell carcinoma, & rhabdomyosarcoma) extension to penis	• **+/- Preputial discharge** • **+/- Bleeding** 	• Hx, CS • Physical exam (PE) • Biopsy: TVT: large round cells w/ numerous mitotic figures 	• **Small: surgical excision** • **Large: penile amputation, scrotal ablation** • Chemotherapy: Vincristine (Oncovin®) • Euthanasia   Prognosis: Guarded
Balanoposthitis, Inflammation of penis & prepuce M8k 1042; Mk 682; SAP 886; H3B 611; H2B 671; I2M 913; IM 700; R-M 550; R-R 803; E&R 694, 695; Sx-S-hb 454; Sx-S 1342? *** 	• **Inflammation of penile & preputial mucosa** • **Very common in dog,** rare in cat • **Mild cases so common considered normal** • Cause - #1 bacterial infection (normal preputial flora) - Also herpesvirus, fungi (Candida & Blastomycetes) - 2° to trauma, foreign bodies, penile lymphoid hyperplasia • Normally follows compromising of the local defense mechanisms of the penis & prepuce mucosa	• **Asymptomatic except for discharge** - Yellow-green preputial discharge • Excessive licking 	• Hx: systemic diz, trauma, bleeding problems • Physical exam (PE): complete - Small amount of green preputial discharge normal - Excessive: further investigation - Penile mucosa: pinkish white, smooth & nonpainful - Rectal exam to R/O (rule out) prostatic & urethra diz • Cytology of preputial discharge . Normal: epithelial cells, inflammatory cells (PMNs) & bacteria . Balanoposthitis: toxic PMNs & extracellular bacteria • Culture & sensitivity of perpetual discharge 	• **None if asymptomatic** • Remove any foreign body or debris • Local & systemic ABs (trimethoprim-sulfadiazine) • Preputial douche w/ 10% Betadine® (povidone-iodine) or 5% chlorhexidine solution • Antifungal agents for blastomycosis • Extrude penis daily to prevent adhesions • Castration usually diminishes discharge **±Tx** Prognosis: **Good:** tends to recur

Dog: Normal or Inflammation
CS: Asymptomatic, discharge, licking
Dx: Hx, CS, PE, C&S
Tx: ±

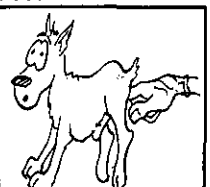
DDx:
- Urethritis
- Early penile or preputial neoplasia, TVT
- Preputial trauma
- Prostatitis

Penile lymphoid hyperplasia H2B 671; E&R 694 *	• Inflammation of penile & preputial mucosa, type of balanoposthitis 	• **Balanoposthitis** • Yellow-green preputial discharge - Small amount considered normal - Excessive: further investigation • **Excessive licking**	• Physical exam: lymphatic hyperplasia • **Histopathology - definitive** 	• **Scarification**, cauterization of lymphoid papules w/ 5% silver nitrate solution • AB/corticosteroid ointment daily • Protrude penis daily to prevent adhesions
Prostatic neoplasia M8k 1047; Mk 696; E-hb 626; SAP 865; H2B 631; I2M 922, 924; IM 709; IM-WW 357; 5min 329; Cat 1874; C12T 1106; R-R 852; R-M 559; Sx-WW 176; Sx-S 460; Sx4B 480; Sx3B 393; Sx-G 276; X-T 479; DDx 561 * 	• **Rare** - Adenocarcinomas & transitional cell carcinoma spreading from the bladder • **Old dogs** • **Castration doesn't protect** • Metastasis is common • Aggressive biological behavior 	• **Pain & fever** (arched back, stiff gait) • Tenesmus, dyschezia (difficult/painful evacuation of feces) • Constipation • Anorexia & weight loss • Urinary tract signs - ± Dysuria - urethral obstruction - Hematuria, pollakiuria • Advanced: vomiting, weight loss, lameness 	• Hx, CS • Physical exam - rectal: enlarged, asymmetric prostate, enlarged sublumbar lymph nodes • Cytology: malignant cells in urine sediment, prostatic wash, ejaculate or needle aspiration (usually only consistent w/ inflammation) • Radiography: prostatomegaly, sublumbar lymphadenopathy, calcification of prostate - Check chest for metastasis • Ultrasound: hyperechoic • Biopsy - avoid if suspect abscess - Perirectal approach - Transabdominal approach - U/S guided biopsy is very safe 	• **Treatment largely unsuccessful** - Stool softeners • Euthanize advanced cases • Prostatectomy: palliative, usually not an option, too far along, may extend life by several months • No response of PAC to castration as in man, but may help symptomatically • Megestrol acetate (Ovaban®) or may help • Radiation: some help Prognosis: • **Grave:** mean survival < 4 months
Prostatic or paraprostatic cysts M8k 1047; Mk 652; SAP 865; H2B 625; I2M 924; IM 709; IM-WW 349; 5min 972; R-M 557; Sx-WW 176; Sx-S-hb 459; Sx4B 481, 484; Sx-G 270 ** 	• Large cysts, in or associated w/ prostate • Congenital • ± Extension of cystic hyperplasia • Paraprostatic cysts m/b assoc w/ Mullerian ducts (uterinus masculinus) 	• Prostatic enlargement CS - **Tenesmus** - **Urine retention** - Abdominal. distention - Constipation - Dysuria - ± Push out on perineum	• Hx, CS • Prostatic fluid - usually sterile • **Rads - 2 bladders** - **Contrast** to tell bladder from cyst • **Ultrasound** - to determine origin of cyst 	• Low residue diet • Medical management unavailable • Estrogen contraindicated • **Surgical removal** or • Drainage by marsupialization (make permanent stoma [mouth] in cyst & suture to abdominal wall so drains to outside) • Castration  Prognosis: Guarded

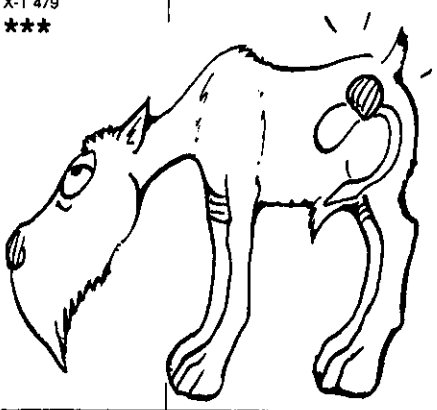
DDx:
- **Perineal hernia**

Large, Congenital
CS: Prostatic enlargement CS
Dx: Rads - 2 bladders, US
Tx: Surgical removal, drainage, castration

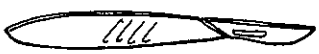
Prostatic massage:
- Pass a urethral catheter & remove all urine, collect specimen
- Flush bladder, retract catheter tip to prostate area
- Massage prostate for 1 min
- Flush fluid & collect specimen
- Compare premasssage & postmassage specimens



Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Prostatic dizs M8k 1045; Mk 695; E-hb 622; SAP 865; I2M 919; IM 706; IM-WW 345; H2B 625; 5min 160, 132; E1662; C12T 1103; C10T 1151; CM 521; Cat 1852; R-M 553; R-R 851; E&R 711; Pys-R 558; Sx-WW 176; Sx-S-hb 458; Sx-S 1353; Sx-G 269; X-T 479 ***	• **Common in middle-to-older aged dogs,** see preceding page also • Large breed dogs (dobies) more commonly affected • **Extremely rare in cats** for unknown reasons • Simultaneous multiple diz processes possible	• Vary w/ diz • **Asymptomatic** (possible in all but acute prostatitis) • **Enlarged prostate** - Fecal tenesmus - "Ribbon" stool - Constipation 2° to pain avoidance • **Dysuria** (urethral obstruction) • **Urethral discharge** (classic sign) • **Blood dripping from penis** independent of urination • Abdominal enlargement (paraprostatic cysts or abscess) • **Systemic signs** (bact./abscess) - Fever, Depression, Vomiting/Diarrhea, Anorexia • Sequelae: - Liver diz: Icterus - **Recurrent lower UTI** - Urinary incontinence - Peritonitis or metastasis . Caudal abdominal pain &/or lumbar pain &/or hindlimb stiffness - Hypertrophic osteopathy - Urethral obstruction - Infertility	• **Hx** (older intact dogs (rare in neutered males) - Severity, duration & progression? - Normal urination or defecation? - Lameness? Systemic signs? - Change in water intake or output? • **Rectal prostatic palpation: normal: symmetrical, smooth, movable & nonpainful** - Scottish terriers up to 4 x normal size for other dogs • **Urethral discharge:** microscopically - Culture: >100,000 bact/ ml significant if also isolated from cystocentesis-collected urine • CBC & chemistries: no consistent correlation, except neutrophilic leukocytosis & acute fulminating bact. prostatitis • **Urinalysis & culture:** bacterial cystitis & bact. prostatitis can occur independently - Culture not diagnostic, so do prostatic fluid analysis also • **Semen** (prostatic fluid = 3rd fraction) culture: - Normal: < 100 bacteria/ml, occasional WBC, pH 6.5-6.8 • **Prostatic massage:** pre- & post-massage - Normal: few RBCs & transitional epithelial cells • Urethral brush specimen: specific, but expensive • **Radiology:** size, location & contour **- Normal: smooth, symmetrical, near cranial rim of pelvis** - Retrograde urethrocystography: diameter of prostatic urethra 1.0-2.7 x midpelvic membranous urethra . Mild urethoprostatic reflux normal - Excretory urography - Prostatic calcification ± neoplasia - **Check chest, pelvic area for metastasis** • **Ultrasound:** prostate consistency & guide biopsy • Prostatic aspiration - cytology & culture: - Pass catheter to prostate (judge by rectal palpation) - Aspirate via syringe on catheter (usually only small sample collected) useful in very painful dogs who will not ejaculate • Needle aspiration: perirectal or transabdominal routes (not for abscesses) for periprostatic cysts • Prostatic biopsy: percutaneous (closed) prostatic biopsy - perirectally or transabdominally or during surgery	• Tx based on specific diz process • **Benign prostatic hyperplasia:** - Tx only if clinical signs present - Castration most effective Tx - Antiandrogens • **Paraprostatic cysts:** - Castration recommended - Surgical drainage with excision or marsupialization • **Bacterial prostatitis:** **- Acute prostatitis** . ABs 2–3 weeks . Supportive care . Castration recommended **- Chronic prostatitis:** . Eliminate any predisposing factors . ABs - must penetrate prostatic/blood barrier- 4 weeks .. 2 negative cultures . Castration for prevention of recurrence • **Prostatic abscessation:** - ABs, ± long-term suppressive AB Tx - Surgical drainage recommended • **Prostatic neoplasia:** - None effective - euthanasia **Prognosis:** • Benign hyperplasia: Good w/ Sx • Prostatitis: Guarded • Abscess: Guarded • Paraprostatic cyst: Guarded • Neoplasia: Grave



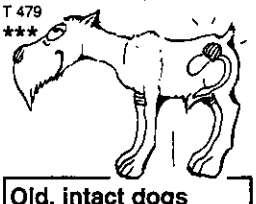
Common older dogs, Rare cat
CS: None, "Ribbon stool", Discharge, Blood, UTI
Dx: Hx, CS, PE, UA, Prostatic fluid, Rads, US
Tx: Depends on diz



Benign prostatic hyperplasia

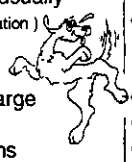
BPH,
Cystic hyperplasia
M8k 1046; MK 696; E-hb 635; SAP 865; H2B 626; I2M 921; IM 707; IM-WW 346; 5min 389; C12T 1033, 1103; R-M 556; R-R 851; E&R 711; Cm 422; DDx 560; Sx-WW 196; Sx-G 274; Sx-S-hb 459; Sx-S 1353; X-T 479
***

• **Common in old, intact male** dogs (requires testicles)
• Only in dogs & humans, not in cat
• Most common prostatic diz in dogs - 60% of dogs > 6 yrs
• Usually no CS
• Starts as glandular hyperplasia leading to cystic hyperplasia
• **Aging prostate**
- Associated with altered testosterone/estrogen ratio



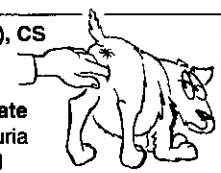
Old, intact dogs
CS: Asymptomatic
Dx: Hx, PE, Rads
Tx: None, Castration

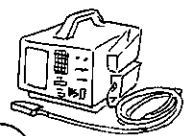
• **Asymptomatic** usually
• Tenesmus (defecation)
- Constipation
- "Ribbon" stool
• ± Urethral discharge
• ± Hematuria
• No systemic signs
- Healthy dog



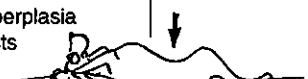
• Sequelae:
- Partial urinary obstruction (rare)
. Dysuria
- Perineal hernia (occasionally)

• **Hx (old, intact male), CS**
• **Rectal palpation:**
- Large, nonpainful, symmetrical prostate
• **Urinalysis:** ± hematuria
• CBC & chem: normal
• Radiology: **prostatomegaly** (dorsal displacement of colon, cranial displacement of bladder)
• **Ultrasound:** normal to diffuse hyperechoic (parenchymal cavities/cysts)
• Prostatic fluid: normal or hemorrhagic
• Biopsy: only definitive Dx (rarely necessary)

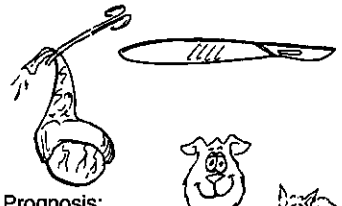




DDx:
• Chronic nephritis (both >6 yrs)
• Diarrhea
• Prostatic hyperplasia
• Prostatic cysts
• Cystitis



• **Tx only if CS,** advise owners about problems that may develop
• Empty distended bladder
• **Castration:** decreases size by 70% (usually long-term relief)
• Stool softeners, laxatives, enemas
• Alternate to castration (breeders): long-term studies lacking
- Megestrol acetate (Ovaban®, Megrace®) antiandrogen, interferes w/ testosterone
- Delmadione acetate (Tardak®) androgen inhibitor, not licensed in USA
- Estrogen (diethylstilbestrol (DES) contraindicated - may cause squamous metaplasia - cysts & infections see below
• Treat perineal hernia if present



Prognosis:
• **Good** w/ castration
• Hormone therapy: Guarded

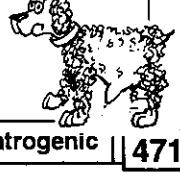
Squamous * metaplasia - prostate

E-hb 624; SAP 865; IM 708; H2B 626; IM-WW 347; R-R 852

• **Rare**
• Metaplasia of prostatic columnar epithelium
• **Cause: excess estrogen**
- Sertoli cell tumor, see pg 463
- Iatrogenic (exogenous estrogen to treat benign porstatic hyperplasia) see pg 733

Do NOT use estrogens in male dogs

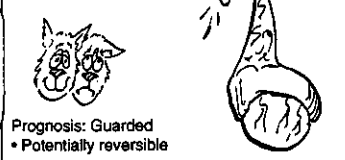
• Red-tinged urethral discharge
• **Hyperestrogenism signs**
- Alopecia
- Hyperpigmentation
- Gynecomastia
- Pendulous prepuce
• ± Cryptorchid



• Hx (estrogen), CS
• Nonpainful prostatomegaly
• ± Abnormal testes if Sertoli cell tumor
• Prostatic fluid: ± ↑ # if squamous epithelial cells
• **Presumptive dx: Hx, CS, histo of testes (if Sertoli)**
• Prostatic biopsy: definitive dx

DDx:
• Chronic nephritis
• Diarrhea
• Prostatic hyperplasia
• Prostatic cysts
• Cystitis
• Prostatitis

• **Remove source of estrogen**
- Castration TOC
- Discontinue estrogen Tx



Prognosis: Guarded
• Potentially reversible

Rare, Estrogen, Sertoli cell tumor, Iatrogenic

Bacterial Prostatitis

Condition	Facts/Causes	Presentation	Diagnosis	Treatment
Acute prostatitis M8k 1046; Mk 697; E-hb 625; SAP 865; H2B 627; I2M 923; IM 708; IM-WW 347; 5min 132, 974; C12T 1028, 1105; R-M 557; E&R 711; DDx 560; Sx-WW 176; Sx-S-hb 459; Sx-S 459; Gr 171, X-T 479; Emrg 424 ***	• **Sexually mature male dogs** • Bacteria: #1 ***E. coli***, Staphylococcus, Streptococcus, Pseudomonas, Proteus, Mycoplasma, *Brucella canis* • Reflux of bacteria from bladder or ascending from urethra • Acute < chronic prostatitis • Usually suppurative • Older dogs • Assoc w/ hyperplasia • Predisposing - Sertoli cell tumor or estrogen administration - 2° to UTI, septicemia - Prostatic hyperplasia - Squamous metaplasia - Neoplasia - Immunodeficiency • Complication - Rupture & peritonitis (palpation)	• **Acute systemic illness:** - Lethargy/Depression - Anorexia - Fever - Vomition from localized peritonitis • **Tenesmus** • **Constipation** • **Urine retention** • **Urethral discharge** • **Painful** caudal abdomen, arched back, reluctance to rise • Incontinence • ± Abnormal gait/stance (uncommon) • **Sequelae:** - Chronic prostatitis &/or recurrent urinary tract infections - Septicemia & endotoxemia	• Hx, CS • Rectal palpation: **painful prostate,** normal to mildly enlarged • **UA** (urinalysis) - Gross & microscopic **- Hematuria, bacteruria & WBCs** (pyuria) - Do cystocentesis to DDx from cystitis - culture • **↑ WBCs & PMNs +/– left shift** • **Radiology essential:** - Survey & cystourethrogram to eliminate cystitis - Cystourethrogram . Enlarged atonic bladder . ± Prostatic ducts & abscesses m/ fill w/ contrast • **Prostatic massage not recommended**	• **Life-threatening** • **ABs 21-28 days** (blood/prostate barrier breaks down, most ABs will work) culture & sensitivity - Reculture 3-7 days after ABs stopped, if + continue ABs **for 3 months** • Supportive care • Estrogen contraindicated • **Castrate** after resolution of infection, diminishes recurrence • **Large abscesses** - Surgical drainage (ventral drainage) + ABs (ABs alone, abscess will persist) • Concurrent septicemia or peritonitis - Culture & sensitivity of abdominal fluid or blood - Fluids & parenteral ABs - Monitor for hypoglycemia Prognosis: **Guarded**

Sexually mature males, *E. coli*, Ascending
CS: Ill, discharge, pain, tenesmus
Dx: Painful, UA, Rads, NO massage
Tx: ABs, Castration. Px: Guarded

Chronic * prostatitis** M8k 1046; Mk 697; E-hb 625; SAP 865; H2B 627; I2M 923; IM 708; IM-WW 347; Gr 171; C12T 1030, 1105; R-M 557; E&R 715; DDx 560; Sx-WW 176; Sx3B 393; X-T 479	• **Assume all males w/ UTI have prostatitis until proven otherwise, even w/o CS** • Cause: - Sequela to acute prostatitis, or - Develops insidiously - 2° to prostatic problems (cysts, neoplasia, squamous metaplasia, urolithiasis) **- UTI (assume prostatitis in intact male w/ UTI)** • May lead to abscessation • Granulomatous prostatitis - Associated w/ blastomycosis & cryptomycosis	• **Asymptomatic**, often no signs attributed to prostate • **Recurrent cystitis - UTI** **- Dysuria, stranguria** • ± **Urethral discharge** (constant or intermittent) • Constipation - ribbon stool • Sequela: **- Recurrent or chronic UTI** **- Prostatic abscess**	• **Hx (recurrent UTI)**, CS • Rectal exam - Prostate: variable size, **no pain** • CBC & chem.: usually normal • **UA: pyuria, bacteruria, hematuria - UTI** • **Prostatic fluid analysis** essential for diagnosis, but difficult to interpret **- Ejaculate or prostate massage** - Inflammatory cells & bacteria - Quantitative culture • Definitive: prostatic biopsy • Radiology: calcification m/b • Ultrasound - hyperechoic	• **Difficult because of blood-prostatic barrier** • **Long term ABs - 6 wks** minimum - Reculture urine & prostatic fluid 3-7 days & 1 month after Tx stopped - Gram +: erythromycin, clindamycin, oleandomycin, chloramphenicol or trimethoprim-sulfa - Gram -: chloramphenicol, trimethoprim-sulfa or carbenicillin - If fails: ABs for 3 months - trimethoprim-sulfa, or carbenicillin • **Castration** • Prostatectomy (difficult, ± postop incontinence) **Prognosis:** • **Guarded** for cure based on human medicine

Male UTI = prostatitis
CS: None, UTI
Dx: Hx (UTI), PE, UA, Fluid analysis
Tx: ABs - 6 wks, Castration

DDx:
- Chronic nephritis
- Diarrhea
- Prostatic hyperplasia
- Prostatic cysts
- Cystitis

Prostatic abscess M8k 1046; Mk 697; E-hb 625; SAP 865; H2B 627; I2M 923; IM 708; IM-WW 348; Gr 171; C12T 1028; R-M 559; Sx4B 481, 484; Sx-G 272; Sx3B 393; X-T 479; DDx 561; Sx-S-hb 459; Emrg 424 **	• **Severe form of chronic bacterial prostatitis** - Pockets of septic, purulent exudate within prostatic parenchyma - Obstruction of prostatic excretory duct • Pathogens primarily aerobic	• ± Asymptomatic • Acute prostatitis signs • Chronic prostatitis signs • **Usually UTI** signs **- Urethral discharge:** - Dysuria - Tenesmus • **Urethral discharge** purulent or hemorrhagic • Systemic signs may be present • Sequela: **- Rupture & peritonitis** **. Fever**, Pain, Vomiting **. Icterus**	• Hx, CS • **Palpation**: ± prostatic enlargement -± Asymmetrical w/ varying consistency (cobblestones), fluctuations - ± Pain (peritonitis more than abscess) - Palpation causes urethral discharge • Prostatic fluid: septic, purulent, bloody • CBC& chem: ± liver enzyme elevation - PMN leukocytosis ± left shift • Urinalysis: hematuria, pyuria, bacteriuria • Radiographs: - Prostatic enlargement ± irregular contour - Poor detail of caudal abdomen - peritonitis - Retrograde urethrography: ± prostatic reflux • Ultrasound: normal to diffusely hyperechoic with parenchymal cavities & asymmetric shape	• **Life-threatening: prompt & aggressive Tx** • **ABs (antibiotics)** - Parenteral administration initially if ill - ± Long term suppressive antibiotic therapy may be indicated • **Surgical drainage** recommended Prognosis: **Guarded**

DDx:
- Painful prostate
  - Acute prostatitis
  - Prostatic neoplasia
- UTI
  - Chronic prostatitis
  - 1° UTI

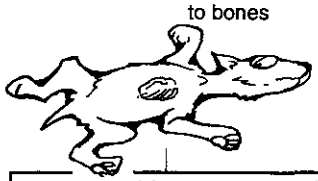
ABs + Sx drainage

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Mastitis M8k 1037; Mk 679; E-hb 611,630; H3B 615; H2B 675; I2M 875; IM 655; 5min 806; F-N 465; R-M 506, 820 (F); Cat 1494; E&R 589; INF 368 **	• **Bacterial infection of mammary gland** • Lactating bitches & queen • Usually caudal glands • Acute, gangrenous or chronic • Incidence or clinical significance unknown(?) • Cause: - Ascending infection via teat orifice - Hematogenous • Contributing factors - Hot, humid weather - Unsanitary conditions - Trauma of nursing - Postpartum w/ congested glands • *E coli, ß hemolytic strep, Staphylococci*	• **Acute mastitis** - ± Bitch/queen poor mothering (cold, noisy pups/kits) - **Swollen, warm, painful, reddened glands** (caudal glands more common) - Teat discharge (bloody, brownish or purulent) - ± Dam: toxemia: fever, anorexia, depression, discomfort, collapse - Neonates: cry, restless, bloated • Chronic/subclinical - Minimal physical changes - Neonate: poor weight gain, or septic illness • Sequela: - Abscessation & gangrene . Dark, cool &/or ulcerative - Neonate illness	• **Hx, CS** • **Physical exam**: inflammation of 1 or more mammary gland • Milk (↑ viscosity, yellow, pink or brown) - Cytology of milk: . Bacteria . WBCs > 3,000/µl (degenerative) . RBCs - Gram stain for ABs - Culture & sensitivity • Hemogram - Neutrophilic leukocytosis - +/- Toxemia	• **Wean pups or kittens** • **Systemic ABs** (culture & sensitivity) - Chloramphenicol (nonionized & therefore secreted into the milk) - 1st generation cephalosporin or beta-lactamase-resistant penicillins (?) • ± IV fluid • Warm compresses to reduce swelling & pain • Neonates & suckling: - If not frankly purulent allow suckling - Bandage to prevent suckling if purulent (milk out daily) - Severe of several glands affected - treat neonates as orphans & milk out glands • Surgical intervention may be necessary - Localized abscess: lance & drain . Local infusion of penicillin to prevent abscess formation - Necrosis: surgical debridement
Mammary congestion, Galactostasis H3B 616; H2B 676; I2M 875; IM 665; E-hb 611; R-M 508 ***	• **Accumulation of milk in mammary glands** • Causes: - Normal in advanced pregnancy & lactation - Weaning of pups - Pseudopregnancy - Mastitis • Heavy milking bitches on a high level of nutrition	• **Mammary glands engorged, hot & painful** • Bitch is not sick	• Hx (weaning or pseudopregnancy) , CS • Milk is not infected	• **Cold packs & massage** • Withhold feed for 24 hours, then ↓ caloric intake for a few days • Do not remove milk from the gland (stimulus to produce more) • Monitor for infection Prevent: • Gradually wean offspring w/ modest ↓ in food intake • Then gradually ↑ amount offered to pre-pregnancy level • Prognosis: Good

Infection of mammae
CS: Swollen, painful, reddened; Crying
Dx: Hx, CS, PE
Tx: Wean, ABs, Warm compresses

Agalactia E-hb 611; H3B 617; H2B 677; R-M 509, 820(f); E&R 590 **	• Lack of milk - Failure of milk production is rare - Failure of milk letdown more common • Occasionally, primiparous bitches have milk but will not let it down, nervous	• Lack of mammary development before whelping • Failure of milk let down **Causes Agalactia:** - Failure of milk letdown - Premature parturition - Physical exhaustion - Shock - Mastitis - Metritis - Systemic infection - Endocrine imbalance	• Hx, CS • Physical exam: mammary glands • Response to treatment	• **Tranquilizers** (diazepam, acetylpromazine) to calm animals so will nurse young • Prolactin 2 IU SID maintains milk flow • Oxytocin to cause milk letdown • Milk supplementation to neonates if milk letdown not achieved **Ace or Valium** **Oxytocin** Prognosis: Depends on cause
Galactorrhea H3B 617; H2B 677; I2M 875; IM 666; R-M 509, 820 (F) *	• **Lactation not associated w/ pregnancy & parturition** • Pathophysiology: - ↑ Prolactin release - TRH stimulates prolactin release, hypothyroid animals have increased TRH secretion because lack of negative feed back	• **Milk & no parturition or pregnancy** **Causes - galactorrhea** • #1 false pregnancy in bitch • OVH during diestrus • Cessation of progesterone Tx (megestrol acetate & methylprogesterone) • Hypothyroidism	• Hx (end of diestrus in nonpregnant female) • Physical exam	• **Self limiting**, usually doesn't require treatment • Avoid stimulating mammary glands • Withhold flood for 24 hours, follow w/ gradual return to diet • Bromocriptine (Parlodel®) inhibits prolactin secretion (not approved in USA) • ± Thyroid replacement Tx in hypothyroid animals Prognosis: Good
Mammary hypertrophy/ hyperplasia - cats, Fibroadenomatous hyperplasia, Juvenile mammary hypertrophy, Mammary fibroadenomatosis, Fibroglandular hypertrophy M8k 1037; Cat 1874; F-N 463; I2M 876; IM 666; H3B 618; H2B 678; INF 368; E&R 757 *	• **Rapid abnormal growth of mammary tissue** • Hormonal dependent, dysplastic change of mammary glands in cats - Fibroepithelial hyperplasia, fibroadenoma, fibroadenomatosis • Seen in: - Young pregnant intact **queens** most commonly - Intact & neutered males & female receiving **progesterone Tx** • Pathophysiology: - Response to **progesterone** . Pregnancy . Progesterone treatment ((megestrol acetate/Ovaban®, methylprogesterone) • Benign condition: differentiate from neoplasia	• **Pregnant queens** - Mammary enlargement in first 2 weeks or pregnancy (normally late pregnancy) • Nonpainful, firm swelling in 1 or more mammary glands • ± Profound enlargement & discomfort & inflammation • ± Ulceration of underlying skin • No systemic illness • ± Fluid-filled cysts	• Hx (time), CS • Physical exam • Biopsy if tumor suspected **DDx:** • Mammary neoplasia • Galactorrhea • Mastitis	• **Generally regresses w/o treatment** • **Remove progesterone** - Stop progesterone Tx - Delivery of kittens - Spay (ovariohysterectomy) • Testosterone sometimes effective • ± Surgical excision • Cool compresses, corticosteroids & diuretics Prognosis: Good

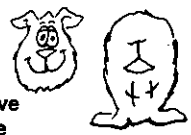
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Mammary neoplasia M8k 1043; E-hb 633; SAP 207; H3B 618; I2M 876; IM 666; E 1702, 1703; 5min800, 802; Cat 1904; C12T 1098; Cat 635; R-M 509, 521, 833 (F); Sx-S-hb 711; Sx-S 2185; Sx3B 454 ***	• **Old intact dogs & cats** (av. 10 years-old) or those spayed late in life • **Intact bitch: common** - **#1 tumor of bitch**, half of all tumors, #2 after skin tumors in either sex - **50/50 benign/malignant** . Benign: fibroadenomas . Malignant: adenocarcinomas - Rare if spayed at or near first estrus - Unspayed dogs 3-7x risk - Breeds: Sporting breeds (pointers, retrievers, Eng. setters, spaniels), poodles, Boston terriers, dachshunds • **Uncommon in cat: 90% malignant** - Siamese at increased risk - #3 to skin tumors & lymphoid tumors - 90% metastasis • Extremely rare in male cat or dog (aggressive) & young of both genders • Cause: unknown ?hormonal? • **Metastasis common to lungs**, <4% to bones	• **Nodular masses in mammae** - Dog: gland 4 & 5 - Cat: glands 1 & 2 - Multiple glands >50% - ± Attachment to outer skin - Rarely attached to body wall - ± Ulcerative skin (25% - cat) • **Bitch usually asymptomatic** unless metastasizes (lungs) • ± Hyperemia, edema & pruritus of surroundings tissue - indicates aggressive malignancy • ± Secretion from nipples • Sequelae: - **Metastasis to lungs**, dyspnea - **Cachexia**	• Hx (**old w/ nodule**), CS (masses) • Physical exam (can't differentiate benign form malignant) - Axillary & inguinal lymph nodes • **Biopsy - excisional** - Do not routinely do aspiration or biopsy of masses if surgical excision contemplated • **Radiograph**: chest for metastasis - 25-50% metastasize to lungs before surgery in dogs - Iliac lymph nodes if caudal glands involved • Ultrasound for iliac lymph nodes • If surgery contemplated - CBC, chemistries & urinalysis for concurrent diz - Aspirate thorax if pleural fluid on rads . Microscopic exam	• **Surgical excision recommended for all** except possibly inflammatory mammary carcinomas in dogs - **Type of Sx doesn't affect survival time in dog** - **En bloc dissection for cat** • **Spay** in dogs doesn't alter prognosis, do before mastectomy to avoid seeding of abdomen, not recommended in cat • **Histology**: send all excised tissue for exam because multiple tumor types possible • Medical therapy: - Cyclophosphamide & doxorubicin until remission or death . However cause severe anorexia & myelosuppression • Palliative therapy: - Antibiotics, hot packs, debridement of ulcerative lesions; Corticosteroids - Metastatic pulmonary diz: antitussive or bronchodilators



Old intact bitch, #1Tumor in bitch
CS: Mass, 50/50 benign/malignant
Dx: Biopsy, Rads
Tx: Excision
Prevention: Spay before 1st heat

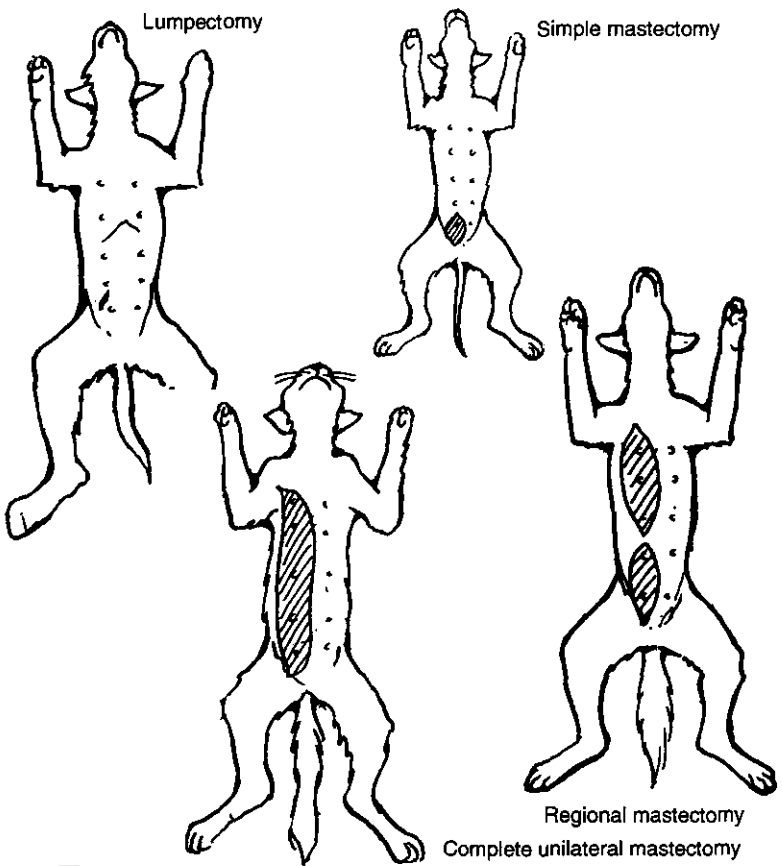
DDx:
- Glandular fibrosis
- Chronic inflammation
- Mastitis
- Mammary hypertrophy (cat)

Prevention:
- **Bitch: spay** (ovariohysterectomy) early is protective
  - Spay: at or near 1st estrus (0.5% incidence), after 1st estrous (8%), after 2nd but before 4th estrus (26%), > 2.5 yrs or 4th estrus no difference
- Queen: neutering ↓ risk



Prognosis:
- Benign: Excellent
- Metastasis to lungs: **Grave**
- Malignant: **Poor to grave**
  - Inflammatory carcinoma: **Grave**, die soon after Dx; Sarcoma: grave
- **Cat: Grave**; average survival of 8 months after Sx

Surgical excisions: recommended in all canine & feline mammary tumors except possibly inflammatory mammary carcinomas in dogs
- Dissect only normal tissue, do not disturb tumor
- **Dog: type of surgery doesn't effect survival time**, number of excised glands based on adequate resection margins of normal tissue
- **Cat: En block** removal of all glands on affected side decreases local recurrence over lumpectomy
  - However may not prolong survival
- Other recommendation:
  - Remove inguinal lymph node w/ gland 5
  - If SQ invaded remove ventral fascia of muscles also
  - If wall invaded: remove in bloc w/ glands
  - Axillary lymph nodes only removed w/ gland 1 if palpable or cytologically abnormal
- Surgical strategy:
  - **Lumpectomy**: remove tumor & 1 cm of normal tissue if tumor < 0.25" (5 mm)
  - **Simple mastectomy**: remove whole mammae, may be easier than lumpectomy (decreases milk & lymph leakage from wound)
  - **Regional mastectomy**: remove adjacent glands if incision into them required for normal tissue
  - **En bloc dissection or complete unilateral mastectomy**: complete removal of gland on same (ipsilateral) side, done if multiple glands involved or in cat
  - **Bilateral mastectomy**: if tumors in contralateral glands
    . Limiting factor: skin available to close ensuing defect
    . Complete bilateral mastectomy possible in flat chested dogs (Yorkshire terriers or Pekingese)
    . Deep chested dogs (Irish setter & pointers) not possible so staged bilateral mastectomy 2-4 weeks apart



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Neurological Problems

M8k 889; Mk 568; SAP 1110; I2M 942; IM 725; IM-WW 451; E-hb 228; E 578; NS-W 9; NS-O 7, 55; NS-L 365; NS-hb 4; NS-C 25; Sx-S 984; NB 12.2

- Challenging part of veterinary practice
- Nervous system is logically arranged

Objectives:

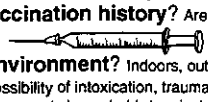
1. Neuro: confirm presence of neurological deficit
2. Localize: determine location & extent of the lesion
3. DDx: establish a differential diagnosis list
4. Dx: tentative diagnosis based on:
   - Signalment, history & anatomic localization
5. Dx/Tx: diagnostic &/or therapeutic plan
6. Px: determine prognosis

Approach: Develop a sequence & follow it every time
- Be logical, methodical & consistent
- Assume single lesion unless proven otherwise (occasionally multiple foci or diffuse disorder)

- **History: Questions:**
  - Signalment: (many dizs have different prevalence for each of the following)
    . Species: dog or cat?
    . Breed (see breed dispostions)
    . Sex: few neuro problems sex related
    .. Female: hypocalcemia associated w/ whelping, mammary adenocarcinoma w/ metastasis to nervous system
    .. Male: prostatic adenocarcinoma w/ metastasis to nervous system

  . **Age?**
    .. Young: more likely congenital & hereditary dizs, or infectious dizs
    .. Older: more likely to have degenerative or neoplastic dizs
    .. Any age: trauma, infection or toxicity, but young more likely (young less wise or immunocompetent)
  . Inherited/coat color: blue-eyed white cats, Dalmatians & English setters related to deafness
  - **Family history**? Littermates? Congenital or familial malformations?
    . Epilepsy ?

  - **Drug Hx**: Medication? Response to treatment? Chronic drug therapy?
  - **Previous surgeries**?
  - **Illnesses**? Past or present? Multiple-system?
    . Inflammation or metabolic disorders
    . General attitude? Fever? Appetite? Water consumption? Vomiting? Urination? Diarrhea? Constipation? Coughing? Sneezing? Weakness? Abnormal body discharges? Abortions?
  - **Vaccination history**? Are they protected?



  - **Environment**? Indoors, outdoors or both?
    . Possibility of intoxication, trauma?
    . Exposure to household chemicals, Antifreeze? Old batteries? Paints, lawn & tree sprays, parasite sprays & dips, deworming medications
    . Trauma? past, present or possibility (outdoor animal)?
  - **Diet**: Balanced? Nutrient supplements?
  - **Neoplasia?** Past?

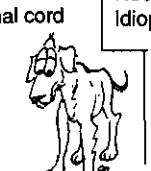
- **Primary complaint:** can give an initial opinion to the location of the problem (see box below)

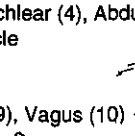
- **Client's neurologic evaluation**
  - Onset: acute or chronic?
  - Course: progressive, static or regressive?
    . Sign-time graph evaluates course of diz (see box)
    . Focal vs disseminated?
  - Duration?
  - Symmetry?

  - Changes in personality, sleeping, eating habits, water consumption, house training?
  - Cranial nerve signs? Vision (bumping into things)? Eye deviations, dilated pupils? Swallowing difficulties? Difficulty lapping water?
  - Head coordination & posture?
  - Limb incoordination, weakness or paralysis?
  - Urination or defecation problems?
  - Seizures?
    . Description? Preictal phase, aura, seizure/ictal, postictal phase
    . Length? Level of consciousness? Duration of recovery? Changes? Number? Frequency? Total number?
    . Age: over 1 or under 9 months of age

Primary complaint	Location of lesion
• Behavior & personality	Forebrain (cerebrum, thalamus)
• Seizures	Forebrain (cerebrum, thalamus)
• Altered consciousness, coma	Cerebrum, thalamus, brain stem
• Multiple cranial nerve deficits	Brainstem
• Single cranial nerve deficits	Individual cranial nerves (see below)
• Head tilt, circling, nystagmus	Vestibular system
- W/ weakness	Central vestibular
- W/o weakness	Peripheral vestibular
• Opisthotonus, tetany, tremors, myoclonus, muscle spasms	Multiple sites in CNS, PNS & muscles
• Incoordination of head & limbs	Cerebellum
• Paresis/paralysis/ataxia/weakness of all 4 limbs, episodic weakness	Brain stem, spinal cord, peripheral n., neuromuscular junction &/or muscle
• Weakness/paralysis/ataxia of rear limbs	Spinal cord behind T2
• Paresis/paralysis/ataxia of 1 limb	Peripheral nerve, unilateral spinal cord
• Dilated anus, atonic tail & distended bladder	Cauda equina, sacral cord
• Self mutilation	Multiple sites in CNS & PNS

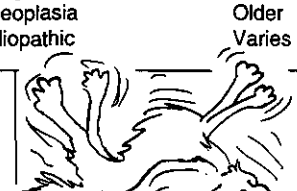
Cranial nerve (ANS, somatic) complaint	Location
• Visual dysfunction	Optic n. & visual pathways, cerebrum
• Anisocoria	Sympathetic, parasympathetic, oculomotor (3)
• Strabismus	Oculomotor (3), Trochlear (4), Abducent (6)
• Dropped jaw & head atrophy	Trigeminal (5), muscle
• ↓ Normofacial sensation	Trigeminal (5)
• Facial paralysis	Facial (7)
• Dysphagia	Glossopharyngeal (9), Vagus (10)
• Megaesophagus	Vagus (10)
• Laryngeal paralysis	Vagus (10)
• Paralysis/deviation of tongue	Hypoglossal (12)
• Deaf	Vestibulocochlear (8)





Sign-time graph evaluates course of diz

Congenital & familial	From birth (most)	Static
Trauma, vascular	Acute	Nonprogressive
Toxicity (1 exposure), metabolic, nutrition	Acute	Progressive
Inflammation	Acute or chronic	Progressive
Degeneration	Chronic	Progressive
Neoplasia	Older	Chronic progressive
Idiopathic	Varies	

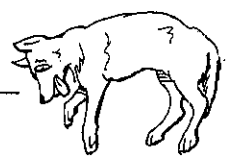


Symmetrical or asymmetric

Symmetric neurological dizs

Toxic
Metabolic
Nutritional
Inflammatory
Neoplastic
Traumatic
Vascular

Asymmetric (often, but can be symmetric)



Breeds - Neuro predisposition NS-C 29, NS-K 3; NS-W 254

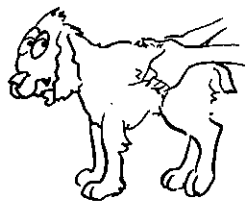
Afghan	**6-9 mo**	**Hereditary Afghan myelopathy**
Akita	< 6 mo	Idiopathic vestibular diz
Basset hound	adult	Intervertebral disc diz
Beagle	3-6 mo	Deafness, & idiopathic vestibular diz
	6-9 mos	Globoid leukodystrophy
	adult	True epilepsy
	adult	**Intervertebral disc diz**
Boston terrier	**birth**	**Hydrocephalus**
	young	**Hemivertebrae**
	adult	**Primary brain tumors**
Bouvier	**< 1 yr**	**Laryngeal hemiplegia**
Boxer	**6-12 wks**	**Dysmyelinogenesis/axonopathy**
	> 5 yrs	**Primary brain tumors**
	< 6 mo	Boxer neuropathy
	> 5 yr	**Degenerative myelopathy**
Brittany	6 wks	Brittany spaniel paralysis
	2-6 mo	Spinal muscular atrophy
	adult	Cerebellar degeneration
	?	Motor neuron diz
Cairn terrier	**3-9 mos**	**Globoid cell leukodystrophy**
Chihuahua	**< 1 yr**	**Hydrocephalus**
Chow Chow	**birth**	**Cerebellar hypoplasia**
	birth	**Myotonia**
	< 12 wks	**Dysmyelinogenesis**
	12-15 mos	Neuronal ceroid-lipofuscinosis
Collie	birth	Deafness
	3-6 mo	Dermatomyositis
Corgi	**adult**	**Intervertebral disc diz**
Dachshund	**adult**	**Intervertebral disc diz**
	adult	Neuronal ceroid-lipofuscinosis
	birth-4 wks	Sensory neuropathy (long hair)
Dalmatian	**birth**	**Deafness**
	3-6 mo	Dalmation leukodystrophy
Dobie	3-6 mos	Idiopathic vestibular diz
	2-9 mos	**Narcolepsy**
	adult	**Cervical vertebral malformation**
	> 5 yrs	Cervical disc diz
	adult	Myositis of head muscles
	adult	Dancing Doberman diz
Egyptian mau	**cat**	**Spongiform degeneration of CNS**
Eng. Bulldog	**birth**	**Sacrococcygeal malformation**
	< 6 mos	Hydrocephalus
	Variable	Hemivertebrae
English pointer	**< 6 mos**	**Sensory neuropathy**
	5 mo	**Neurogenic amyotrophy**
English Setter	**birth**	**Deafness**
	3-6 mos	**Neuronal ceroid lipofuscinosis**
Fox hound		**Hound ataxia**
Fox terrier	**3-6 mo**	**Hereditary ataxia**
(smooth)	**6-12 mo**	**Myasthenia gravis**
German shepherd	**1-6 mo**	**Idiopathic vestibular diz**
	3-6 mo	Megaesophagus
	15 mo	**Giant axonal neuropathy**
	adult	True epilepsy
	adult	Myositis of head muscles
	adult	Fibrocartilaginous infarct
	adult	Lumbar intervertebral disc diz
	> 5 yr	**Degenerative myelopathy**
Ger. shorthair pointer	**3-6 mo**	**Gangliosidosis**
Golden	8-10 wks	Myopathy
Gordon setter		Cerebellar cortical abiotrophy

Great Dane	3-6 mo	Megaesophagus
	6 mo-2 yrs	**Cervical vertebral malformation**
	adult	**Fibrocartilaginous infarcts**
	adult	Intervertebral disc diz
Harriers		**Hound ataxia**
Hounds	**adult**	**Acute polyradiculoneuritis**
Irish setter	birth	Quadriplegia & ambylopia
	1-3 yrs	True epilepsy
	Adult	**Degenerative myelopathy**
Irish terrier	8-10 wks	Myopathy
Jack Russell	**3-6 mo**	**Hereditary ataxia**
	6-12 mo	**Myasthenia gravis**
Kerry blue terrier	**6-12 mo**	**Cerebellar neuronal abiotrophy**
Lhasa apso	**Juvenile**	**Hydrocephalus**
Maltese	**Juvenile**	**Shaker dog diz**
Manx cat	**birth**	**Sacrococcygeal malformation**
Pekingese	**adult**	**Intervertebral disc diz**
Pomeranian	Juvenile	Hydrocephalus
Poodle	< 1 yr	Hypoglycemia
	< 1 yr	**Atlantoaxial subluxation**
	< 1 yr	Narcolepsy
	2-4 mo	**Demyelinating myelopathy**
	4-6 mo	Sphingomyelinosis
	6-9 mo	Globoid leukodystrophy
	adult	**True epilepsy**
	adult	**Intervertebral disc diz**
Pug	adult	Pug encephalitis
Rhodesian Ridgeback	juvenile	Meningocele. pileonidal cyst
Rottweiler	4-18 mo	Neuroaxonal dystrophy
	2-3 yr	Leukoencephalomyelopathy
	?	Spinal muscular atrophy
Sheepdog	birth	Sacrococcygeal malformation
	birth	**Deafness**
St. Bernard	1-3 yrs	True epilepsy
	adult	Fibrocartilaginous infarct
Schnauzer	6 mo-2 yr	Hyperlipidemia & seizures
	6 mo-2 yr	"Flybiting" & "stargazing" seizures
	adult	Fibrocartilaginous infarct (cervical)
Scottie	**6 mo- 3 yr**	**Scottie cramp**
Sheltie	juvenile	Dermatomyositis
Short haired pointer	**5 mo**	**Neurogenic amyotrophy**
Siamese cat	**birth**	**Congenital strabismus & nystagmus**
	6-8 wk	Mucopolysaccharidosis
	3-6 mo	**Gangliosidosis**
	4-6 mo	Sphingomyelinosis
	6-8 mo	Glucocerebrosidosis
Silky terrier	Birth	Dysmyelinogenesis
S. spaniel	5-7 wk	Hereditary neuronal abiotrophy
Swed. lapland	2-3 mo	Hypertrophic neuropathy
Tibetan mastiff	**4-18 mo**	**Neuroaxonal dystrophy**
Tri colored cats	**birth**	**Spinal dysraphia**
Weimaraner	**birth**	**Dysmyelinogenesis**
West Highland terrier	**3-6 mo**	**Globoid leukodystrophy**

General neuro physical examination: for all patients

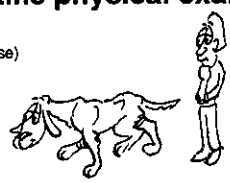
I2M 944; IM-WW 451; Cat 1507; NS-W 9; NS-C 41; NS3hb 8; NB 12.2

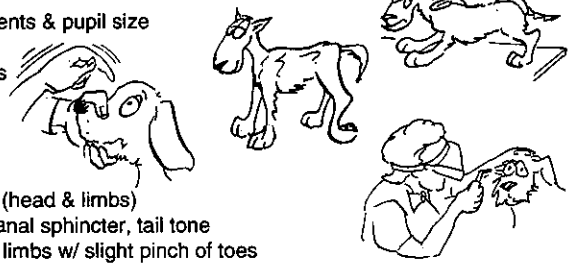
- **Check other systems for findings that may be pertinent to neurological disorders**
  - Some inflammation of CNS affects other systems
  - Musculoskeletal diz confused w/ CNS diz
  - Seizures: liver, kidney & metabolic dizs
  - Dizs of other systems - generalized weakness & collapse (hypoglycemia, cardiorespiratory, hypoadrenocorticism)
- System to check - associated neuro problems
  - **Eyes:**
    - . Conjunctivitis: distemper & rabies
    - . Corneal edema: canine adenovirus infections
    - . Corneal ulcers: facial nerve diz
    - . Anterior uveitis: feline infectious peritonitis (FIP) & feline leukemia (FeLV) viruses & toxoplasmosis, fungal infections, granulomatous meningoencephalitis
    - . Chorioretinitis: fungal, distemper, toxoplasmosis & granulomatous meningoencephalitis, FIP & FeLV
    - . Papilledema: ↑ cranial pressure or optic neuritis
  - **Respiratory system:**
    - . Nasal discharge: cryptococcosis, nasal tumors
    - . Laryngeal & pharyngeal exam: laryngeal hemiplegia, cricopharyngeal achalasia, swallowing problem
    - . Pneumonia & pleural effusions: distemper, FIP, toxoplasmosis, systemic fungi
    - . Neurogenic pulmonary edema: seizures
    - . Thoracic radiographs: metastasis from spinal cord or brain
  - Cardiovascular system
    - . Differentiate syncopal attacks from seizure
    - . Heart failure causes weakness & collapse due to hypoxia of nervous system
    - . Bacterial endocarditis: microabscesses to brain
    - . Thrombosis of caudal aorta: rear limb paralysis
  - **GI system:**
    - . Vomiting, diarrhea, weight loss: distemper, FIP, systemic fungi & lymphosarcoma
    - . Esophageal dilation & regurgitation: vagus or brain stem disorders
    - . Hepatic encephalitis
    - . Diabetes mellitus: coma, paralysis
    - . Pancreatic tumors, insulinoma: hypoglycemic seizures
  - **Hemolymphatic system:**
    - . Anemia: weakness
    - . Enlarged lymph nodes: lymphosarcoma or systemic infection
    - . Petechiae & ecchymoses: bleeding disorders
  - **Urinary system:**
    - . Uremia: encephalopathy, polyneuropathy
  - **Reproductive system:**
    - . Mammary & prostatic adenocarcinoma: metastasis to spinal cord & brain
    - . Pyometra: septicemia & brain emboli
  - **Integumentary system:**
    - . External ear canal & ear drum: middle &/or inner ear infection
    - . Skin changes: endocrinopathies:
    - . Laceration & bruising: trauma
    - . Tick or raccoon bites: tick paralysis, acute polyradiculoneuritis
  - **Skeletal system:**
    - . Palpate for fractures, masses
    - . Palpate joints for swelling & pain: polyarthritis

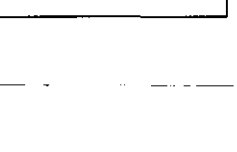


Screening - neurological - for routine physical exam

- **Observe**
  - **Mental status** (BAR [bright alert & responsive] or otherwise)
  - **Stance & head position**: head tilt, wide based stance; head tremor/bobbing
  - **Gait observation & strength**
- Testing
  - **Proprioceptive positioning (knuckling)**: rest paw on it's dorsum (or abduct limb or cross limbs)
  - **Head**
    - . Eyes: position, movements & pupil size
      - .. Menace response
      - .. Pupillary light reflexes
      - .. Fundic exam
    - . Jaw tone
    - . Swallowing, gagging
    - . Facial sensation
  - **Body: muscle atrophy** (head & limbs)
    - . Reflexes: patellar tap, anal sphincter, tail tone
    - . Withdrawal reflex: all 4 limbs w/ slight pinch of toes







Work up of a neuro problem

Mk 568; SAP 1110; IM 725; E-hb 267; E 578; NS-C 44; NS-L 367; NS-O 7; NS3hb 47; NB 12.3

A. Confirm existence of a suspected neurological problem:

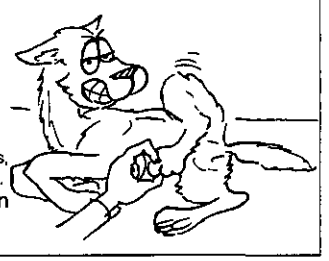
1. **General observations**: identify any neurological problem w/o specific localization (routine part of normal physical exam PE)
   - **Mental attitude/consciousness, behavior, seizures: cerebrum & brain stem**
   - Stance & head position: head tilt, wide based stance; head tremor/bobbing (cerebellum)
2. **Gait & strength observation** evaluates entire nervous system
   - **Gait observation**/Abnormalities: proprioceptive deficits, paresis/weakness, circling, ataxia /loss of coordination & dysmetria, scuffing, knuckling or atrophy
     - . Clinical entities: cerebrum, cerebellum, brain stem, spinal cord, peripheral nerves, or vestibular lesions
   - **Strength (push down on standing animal)**: weakness from cerebrum, brain stem or spinal cord injuries (UMN or LMN deficit)
3. **Postural reactions**: neuro screening tests: don't localize, but sensitive indicators of neurological disorders
   - **Proprioceptive positioning (knuckling)**: tests for conscious perception of location of limbs
   - **Hopping**: not routine part of PE, tests strength of the limb & integrity of the sensory & motor spinal tracts & cerebellar input
   - **Hemistands & hemiwalks**: not routine part of PE, tends to magnify a hemilateral deficiency
   - **Wheelbarrowing**: not routine part of PE, test as in hopping

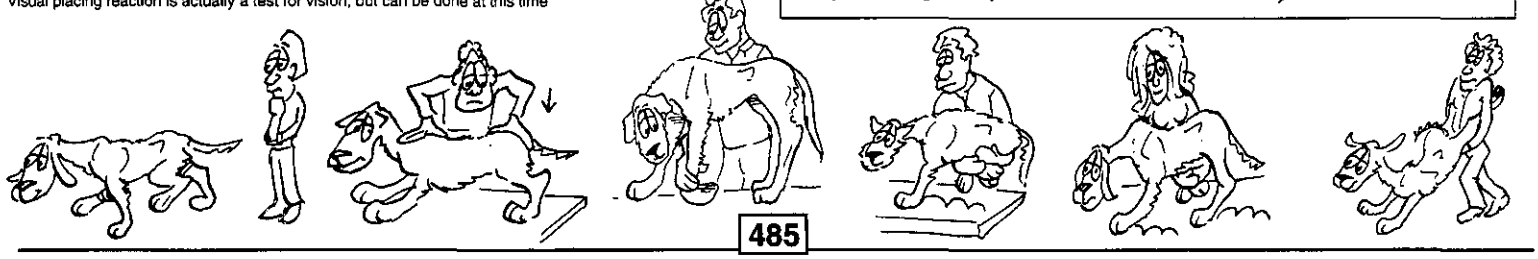
Other postural tests are less reliable than proprioception, hopping, hemistanding & wheelbarrowing: Righting reflex, Suspension righting, Tonic neck & eye reactions; Spinal sensory pathway tests: Tactile placing reaction, Extensor postural thrust

Visual placing reaction is actually a test for vision, but can be done at this time

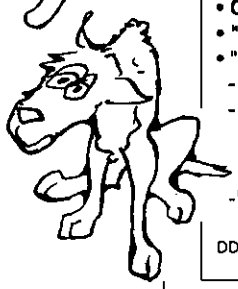
Neuro Exam - Problems - Summary

- **Identify that a neuro problem exists**
  - **General observations**
    - . Mental attitude, consciousness, behavior, seizures
    - . Stance & head position
  - **Gait & strength**
  - **Postural reactions** if still unsure
    - . Proprioceptive positioning reaction
    - . Hemistands & Hemiwalks
    - . Hopping
    - . Wheelbarrowing
- **Localize once identified**
- **Localize to brain**
  - **Cranial nerve exam**
    - . CrN 2 Menace reflex ± obstacle course
    - . CrN 3 Pupillary light reflex (also CrN1)
    - . ANS: Pupillary symmetry
    - . CrN 4 Eye position
    - . CrN 5 Palpebral reflex
    - . CrN 6 Eye position
    - . CrN 7 Menace, corneal & palpebral reflexes
    - . CrN 8 Loud noise
    - . CrN 8 Nystagmus, head tilt (unilateral)
      - .. DDx: Central vestibular: depression & weakness
    - . CrN 9,10: Gag Reflex, Cough Reflex
    - . CrN 12: Pull on tongue
  - **"Head signs"**: mentation, consciousness, seizures, behavior, head tilt, tremors, circling, cranial nerves, etc.
  - **"Head signs" + gait**: localize part of brain
  - **Specific signs of part of brain**
- **Localize in spinal cord** or brain
  - **UMN/LMN signs**
    - . **Spinal reflexes**
      - .. Patellar reflex
      - .. Withdrawal reflex of rear limb
      - .. Cutaneous trunci reflex
      - .. Withdrawal reflex of forelimb
      - .. Anal reflex
    - . **Muscle tone:** palpation
      - .. ↓Tone/flaccidity = LMN
      - .. Normal tone
      - .. ↑Tone: UMN
  - **Sensation:**
    - . Proprioception
    - . Superficial pain
    - . Deep pain
    - . Map superficial sensation: if LMN signs



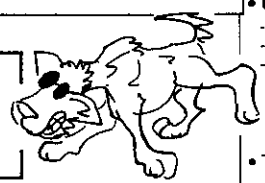


Condition	Facts/Cause	Presentation/CS	Diagnosis
Brain SAP 1128; E-hb 235; I2M 980; 5min 402; Cat 1517; NS-hb 55; NS-W 24, 112; NS-O 49, 91; NS3hb 55; Sx-WW 271, 279; X-T 66; Pys 82 **	• **Disorders of brain tend to fall into clear syndromes** • Lesion localization valuable because certain conditions affect specific areas • Functional division of brain - Forebrain (cerebrum & diencephalon) - Brainstem - Vestibular system - Cerebellum • Involvement of several parts of NS: multifocal signs - Usually caused by inflammatory dizs; neoplasia less common	• **Altered mental status/personality changes** • **Stance & head position**: head tilt, wide-based stance; head tremor/bobbing • **Cranial nerve deficits**, often partial • **Ataxia of gait & abnormal postural reactions** (vestibular, proprioception) • **Limb weakness**: UMN signs (↑ reflexes, rigidity) • **Vestibular signs**: head tilt, loss of balance, pathologic nystagmus & circling • **Abnormal consciousness** (depression, stupor or coma) • ± **Incoordination** (cerebrum) • ± Altered heart rate or respiratory patterns - uncommon, but life threatening	• History, CS • **Neurological exam for brain diz** - **Identify existence of a neurological problem 1st** **1. General observations**: mental attitude/consciousness, behavior; seizures; Stance & head position: head tilt, wide-based stance; head tremor/bobbing **2. Gait observation & strength**: proprioceptive deficits, paresis/weakness, circling, ataxia/loss of coordination & dysmetria **3. Postural reactions** (proprioceptive, hopping, wheelbarrowing) - **Localize neuro problem once identified to head** **4. Cranial nerves exam**: localize to cranial cavity C. Localize to part of brain - **"Head signs"**: changes in mental attitude, consciousness & behavior, seizures, head tremors, head tilt, circling - **"Head signs" ± gait ± weakness** . Little gait deficits: lesions rostral to midbrain (cerebrum & diencephalon) . Paralysis or weakness of all 4 limbs or 2 on same side: brain stem . Incoordination, no weakness: cerebellum D. Specific signs of parts of brain (see box) - Spinal reflexes preserved, but may be ↑ due to loss of UMN inhibition - Muscle tone: normal or ↑ (UMN sign) - Sensation: pain sensation usually normal in limbs or slightly decreased • CBC & chemistries: for metabolic abnormalities (cerebrum susceptible) • Radiography: - Plain skull for hydrocephalus, tumors, lesions of bone or cartilage, head trauma - Contrast radiographs: injection of ventricular or vascular system • Computerized tomography (CT) - for mass lesions • Electrodiagnostic tests: EEG (electroencephalography) - Electrical activity of cerebral cortex; for cerebral diz (epilepsy) • **CSF analysis** - Indications: abnormal neuro exam, recurring fever, epilepsy, chronic pain - Contraindications: recent CNS trauma, rapid declining level of consciousness - Interpretation . No change in CSF: degenerative, anomalies, metabolic, toxic & nutrition dizs . Neoplasia: usually increased protein, ± ↑ pressure, Cells usually normal . Inflammation: increased cell count & protein ± pressure elevation . Trauma: RBCs & protein elevation • Toxicological screening: for cerebral affects

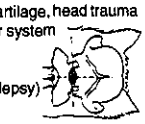


Clinical signs - Brain problems	Area of lesion
• **Cranial nerve deficits**	Head
• **"Head signs"**	**Brain**
• "Head signs" ± Gait ± weakness	Cerebrum, brain stem or cerebellum
- **"Head signs"** + little gait deficits	**Forebrain** (cerebrum & diencephalon)
- **"Head signs"** + paralysis or paresis of all 4 limbs or 2 on same side	**Brain stem**
. Contralateral gait deficits:	Unilateral - rostral midbrain
. Ipsilateral gait deficits:	Unilateral - caudal midbrain or lower
-**"Head signs"** + incoordination of gait or dysmetria w/o weakness/paresis	Cerebellum & connection to medulla

DDx: from gait deficits w/o "head signs" (focal cervical spinal cord, diffuse spinal cord, diffuse peripheral nerve, neuromuscular junction or diffuse muscular lesions)

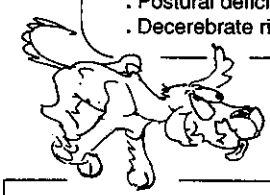


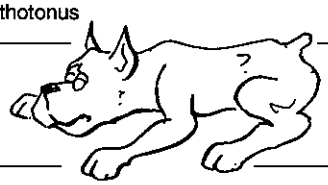
Different CS for different areas
CS: Mentation, Behavior, Cranial nerves, Tilt, Ataxia, Weakness
Dx: Neuro Exam, CSF, Lab, Rads
Tx: Depends (ABs, Steroids)



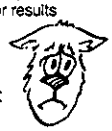
Specific signs for parts of brain

- **Forebrain** (cerebrum & diencephalon):
. Altered mental status/personality changes
. Epileptic seizures
. Cortical blindness
. Head pressing, compulsive walking
. Little gait deficits
. **Postural deficits,** mild paresis
. **Hypothalamus** (asymptomatic, endocrinopathies, behavioral abnormalities, temperature regulation problems, appetite & thirst disorders)
- **Brain stem:**
. Cranial nerve 3-12 deficits
. Ataxia, ± vestibular signs
. Unconsciousness
. Abnormal gait - UMN
. Weakness/paresis
. Postural deficits (proprioceptive)
. Decerebrate rigidity/opisthotonus
- **Vestibular system**
. Head tilt, circling, falling, rolling towards lesion
. Horizontal or rotary nystagmus
. Ataxia
. DDx peripheral from central vestibular diz
.. Central: depression, weakness, & postural deficits, horizontal, rotary or vertical nystagmus
- **Cerebellum:**
. Incoordination w/o weakness
. Head tremors/bobbing
. Dysmetria
. Base-wide stance
. Normal reflexes & posture
. Mental status normal - BAR





- **Specific Tx**: depending on diagnosis
- ABs (bacterial, protozoal & fungal)
- Immunosuppressive/antiinflammatory drugs
. Many diz idiopathic - immune-mediation suspected in some. Use in absence of infection
- Antineoplastic drugs
- Toxin removal: lead
- Nutritional Tx: Thiamine (B1) can cause neurological diz
• Nonspecific treatment
- Anti-edema: Furosemide (Lasix®), Mannitol
- Anti-inflammatory drugs: in absence of infection - to reverse inflammation & alleviate 2° processes: edema, vasculitis
- Pain control not usually needed in brain injuries
• Surgical therapy
- Uncommon because of difficulty of approach to brain
- Decompression #1 surgery - decompress or remove tumors, abscesses & hematomas - usually poor results



Prognosis:
• Anatomical location:
- **Brain stem: poor**
- **Cerebellum: guarded** - compensation possible
- Cerebral: better than brain stem, but worse than cerebellum
• Severity of injury: mild better than severe (duh!)
• Progression of diz important prognostically

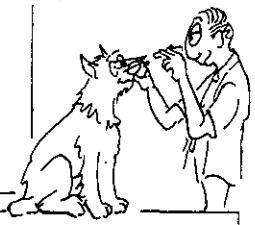
Localization - lesion of brain

	Mental status	Posture	Movement/gait	Postural reactions	Cranial nerves
Cerebrum & thalamus	**Abnormal behavior, depression seizures**	N	**Normal gait** Slight weakness	Deficits	Normal (± blindness) Thalamus - Cn2
Hypothalamus	Endocrine & ANS	N	N	N	N
Brain stem	**Depression, stupor, coma**	N	Weakness, ataxia	Deficits	**CrN 3-12**
Vestibular: central	**Depressed**	**Head tilt, falling**	**Weakness**, ataxia	Deficits	CrN ? ± CrN 5 & 7
Vestibular: peripheral	N	**Head tilt**	N to ataxia	**N (± awkward)**	CrN 8 ± CrN 7
Cerebellum	N	**Normal**	**Tremors, dysmetria, ataxia**	N to dysmetria	**N ± absent menace**

Cranial Nerve Exam

Localize neuro problem to head once identified

- Localize to head
  - **Cranial nerves exam**: to localize to cranial cavity/ above level of foramen magnum
    - . **Cn2** (optic): **menace reflex** - also CrN 7
      - . Obstacle course if blindness suspected after menace test
    - . **CrN 3** (oculomotor): **pupillary light reflex; also CrN2**
    - . **ANS** (sympathetic & CrN 3): **Pupillary symmetry**
    - . **Cn4** (trochlear): **eye position**
    - . **CrN 6** (abducens): **eye position** (strabismus); also CrN 3
    - . **CrN 5** (trigeminal): **palpebral reflex**; also CrN 7
    - . **CrN 7** (facial): assessed with menace, corneal & palpebral reflexes, observe ear drops, flaccid muscles of facial expression
    - . **CrN 8** (cochlear division): **loud noise**
    - . **CrN 8** (vestibular division):
      - . **Nystagmus at rest, head tilt (unilateral)**
      - . Central vestibular: + depression & weakness
    - . **CrN 9,10** (glossopharyngeal, vagus): **gag reflex, cough reflex**, observe of deglutition & vocalization
      - . CrN 11: goes to trapezius, little clinical significance
    - . **CrN 12** (hypoglossal): **pull on tongue** for strength, symmetry
  - Localize to part of brain
    - . **"Head signs"**: changes in mental attitude, mentation, consciousness & behavior; seizures, head tilt, head tremors, circling, cranial nerves, etc.
    - . **Gait + "head signs"**
      - .. Little gait deficits: lesions rostral to midbrain (cerebrum or diencephalon)
      - .. Paralysis or weakness of all 4 limbs or 2 on same side: lesions of brain stem
      - .. Incoordination of gait or dysmetria: cerebellum
    - . **Specific signs of parts of brain** (see boxes)



CRANIAL NERVE DYSFUNCTION

Findings	Cranial nerves
Blindness	CrN 2, brain, retina
Loss of menace	CrN 2, cerebellum
Loss of pupillary light	CrN 2, CrN 3
Pupils asymmetric	CrN 2, CrN 3, ANS
Eyes asymmetric	CrN 3, CrN 4, CrN 6
Loss of palpebral reflex	CrN 5, CrN 7
Masticatory muscle atrophy	CrN 5 (motor)
Dropped jaw	CrN 5 (motor)
Head tilt	CrN 8
Resting/positional nystagmus	CrN 8
Deafness	CrN 8
Loss of gag/cough reflexes	CrN 9 CrN 10
Laryngeal paralysis	CrN 9 CrN 10
Difficulty swallowing	CrN 9 CrN 10
Tongue: asymmetry, strength	CrN 12

Postural reactions screen: subtle unilateral lesion of the cerebral hemisphere, brain stem, spinal column & peripheral nerves

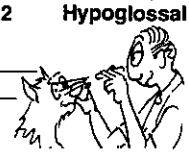
• Cerebral lesion	Postural deficits on opposite side of body (contralateral)
• Brain stem lesion	Postural deficits bilateral, but worse on same side (ipsilateral)
• Spinal cord & peripheral nn.	Postural deficits on same side of body
• Cerebellar lesion	No postural deficits, but incoordination
• Central vestibular lesions	Postural deficits, ipsilateral extensor weakness
• Peripheral vestibular injuries	No postural deficits, but falls, leans & falls to diseased side during postural maneuvers, ipsilateral extensor weakness

Postural reactions lost in all but cerebellar & peripheral vestibular injuries, at least partially due to loss of proprioceptive fibers

Cranial nerves - function

CrN 1	Olfactory	**Smell** - nasal mucous membrane
CrN 2	Optic nerve	**Vision**
CrN 3	Oculomotor	**Motor**: extrinsic eye muscles
		ANS - parasympathetic: constrictor to pupil
CrN 4	Trochlear	**Motor**: dorsal oblique extraocular muscles
CrN 5	Trigeminal	Major sensory to head & motor to masticatory muscles
	Ophthalmic	**Sensory**: eyeball, forehead area & medial canthus (eye)
	Maxillary	**Sensory**: lateral canthus, upper jaw area, upper teeth
	Mandibular	**Sensory**: ear, mandibular teeth, lower jaw area
		Motor: muscles of mastication
CrN 6	Abducens	**Motor**: lateral rectus & retractor bulbi
CrN 7	Facial nerve	**Motor**: muscles of facial expression
		ANS - parasympathetic: glands of head including lacrimal
		Taste: rostral tongue

CrN 8	Vestibulocochlear	
	Cochlear nerve	**Hearing** (organ of Corti)
	Vestibular	**Equilibrium** (semicircular canals, utricle & saccule)
CrN 9,10		**Motor**: pharynx & larynx (deglutition & phonation)
CrN 9	Glossopharyngeal	**Motor**: pharynx
		Sensory: pharynx
		ANS - para: buccal & parotid salivary glands
		Taste: caudal 1/3 of tongue
CrN 10	Vagus	**Motor**: pharynx & larynx
		Sensory: larynx, baro- & chemoreceptors
		ANS - parasympathetic: neck, thorax & abdomen
CrN 11	Accessory (spinal)	Motor: Trapezius m. & neck muscles
CrN 12	Hypoglossal	**Motor**: Muscles of the tongue

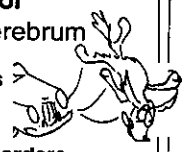


Cranial nerves exam (CrN 1 & 11 are usually ignored)

Nerve	Test	Checks	Procedure	Normal findings
CrN 2 (Optic)	**Menace response**	Cn2 & 7	Threaten each eye with the hand	Blinking of the eyelids (Cn7) or turning head away
CrN 3 (Oculomotor)	**Pupillary light reflex**	CrN 3 & 2	Bright focal light through the pupil	Constriction of both pupils, can move eyes
ANS	**Pupillary symmetry**	Symp, CrN 3	Check that pupils are same size	Same size
CrN 4 (trochlear)	**Eye position**	CrN 4,3 & 6	Check both eyes look in same direction	Substitute ophthalmic exam if suspect
CrN 5 (Trigeminal)	**Palpebral reflex**	CrN 5 CrN 7	Touch medial & lateral canthi	Closure of the eyelids
CrN 5/3 (Mandibular)	**Mandibular function**	CrN 5/3	Open mouth, check atrophy	Ability to eat, no atrophy
CrN 6 (Abducens)	**Eye position**	CrN 3,4, 6	Check eyes are in same direction	CrN 6 abnormal - deviation of eye towards nose CrN 3 abnormal - deviation down & out
CrN 7 (Facial)	**Facial symmetry**	CrN 7	Evaluate face for symmetry	Normal symmetry
CrN 8 (Cochlear)	**Unseen, loud noise**	CrN 8	Loud noise behind animal	React to sound
CrN 8 (Vestibular)	**Balance, nystagmus**	CrN 8	Check for balance, nystagmus & head tilt	No loss of balance & rolling, head tilt, nystagmus
CrN 98 CrN 10 (Glossopharyngeal, Vagus)	**Gag reflex**	CrN 9, 10	Finger in throat	Gagging
	Cough reflex	CrN 10 (9)	Irritate larynx	Coughing
CrN 12 (Hypoglossal)	**Tongue exam**	CrN 12	Observe, pull to test strength	Eating & retraction of tongue

DDx - Coma/stupor
- brainstem or cerebrum

NS-O 520

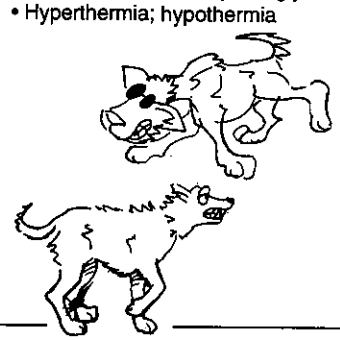


- **Brainstem disorders**
  - Trauma
  - Neoplasia
- **Cerebral cortical disorders**
  - **Anomalous conditions**
    - . Hydrocephalus
    - . Lissencephaly
  - Inflammatory diz
    - . Meningitis
    - . Encephalitis
  - 1° or 2° brain tumors
  - External trauma
  - Vascular disorders
    - . Feline ischemic encephalopathy
    - . Canine vascular accident

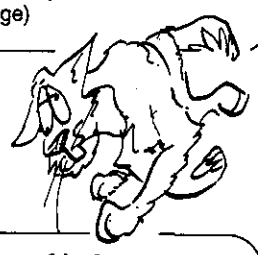
- **Metabolic encephalopathy**
  - Hepatic diz
  - Hypoglycemia
  - Severe uremia
  - Hyperosmolality of diabetes mellitus
  - Heat stroke
  - Hypoxia

- **Intoxication**
  - **Leads**
  - **Insecticides/rodenticides**
- Thiamine deficiency
- Epilepsy
- Narcolepsy/cataplexy

DDx: Encephalitis
- **Infectious**
  - Cats
    - FIP
    - Toxoplasmosis
    - Systemic fungus (cryptococcosis)
    - Rabies
    - Pseudorabies
    - Bacterial (rare)
  - Dog
    - Canine distemper
    - Infectious canine hepatitis
    - Granulomatous meningoencephalitis?
    - Systemic fungal diz
    - Toxoplasma, encephalitozoonosis, trypanosomiasis, babesiosis
    - *Neosporum caninum* encephalitis
    - Rabies
    - Pseudorabies
    - Protothecosis
    - Ehrlichiosis, salmon poisoning
    - Bacterial (rare)
- **Metabolic encephalomyopathies**
  - Energy depriving
    - . Hypoxia, ischemia - oxygen
    - . Hypoglycemia - glucose
  - Endogenous neurotoxins
    - . Uremia: renal failure, urinary obstruction
    - . Hepatic encephalitis, hyper-ammonia (portosystemic shunts, liver failure) - ammonia
  - Endocrine dysfunction
    - . Hyper- or hypoadrenocorticism
    - . Thyrotoxicosis or hypothyroidism
  - Biochemical imbalances
    - . Acid-base abnormalities: hypercapnia, acidosis or alkalosis Tx
    - . Osmolality changes: hyposmotic states (diuretic Tx, hyponatremia, fluid Tx) Hyperosmotic states: hypernatremia, hyperglycemia
    - . Electrolyte disturbances: hyper- or hypocalcemia
- Nutritional: thiamine deficiencies
- Toxins:
  - Exogenous neurotoxins
  - Toxins: molds, sedatives, salicylates anticholinergics, ethylene glycol
- Hyperthermia; hypothermia



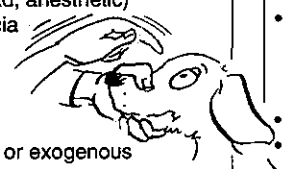
DDx - Protrusion of 3rd eyelid
NS-L 122
- Horner's's syndrome (constant)
- Tetanus (brief flashing protrusions)
- Cats w/ severe systemic diz
- Severe atrophy of muscles of mastication (myositis or CrN 5 nerve damage)



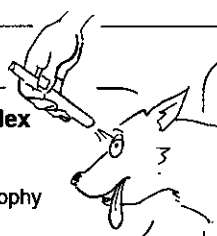
DDx - Loss of balance
- Peripheral vestibular diz
  - Otitis interna
  - Feline vestibular diz
  - Idiopathic vestibular syndrome (dog)
  - Trauma & hemorrhage in inner/middle ear
- Central vestibular (+ depression & weakness)
  - Distemper
  - Toxoplasmosis
  - Neoplasm
  - Brain stem trauma
  - ↑ Intracranial pressure - trauma

Differential Diagnosis - Cranial nerve tests

DDx - Absence of menace response
- Distemper encephalitis
- Space occupying (bone or frontal lobe tumors)
- Post orbital abscesses
- Pituitary hypothalamic (neoplasm, abscess)
- Optic radiation & visual cortex
  - Neoplasm, abscess
  - Trauma, scarring, etc.
  - Toxic & ischemia (lead, anesthetic)
  - Polioencephalomalacia
- Cerebrum
  - Concussion
  - Encephalitis
  - Neoplasia
  - Toxicities - metabolic or exogenous
  - Coma
- Facial nerve (can see, but can't blink)
- Cerebellar disorders (mechanism unknown)
- Very young & demented animals
- False due to air currents



DDx: Loss of pupillary light reflex
- Lesion of Cn2
- Lesion of CrN 3 or brain stem
- Posterior synechia or severe iris atrophy



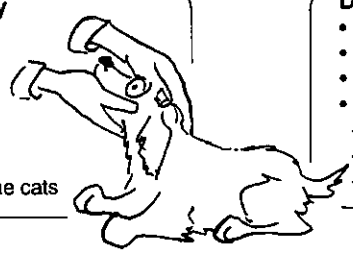
DDx - Abnormal eye position (ocular)
- Brain stem lesions - nuclei of CrN 3, 4, 6
  - Tumors, edema, ↑ intracranial pressure, hematomas & granulomas
- Tetanus
- Horner's syndrome

DDx - Loss of palpebral reflex
- Facial nerve problem
- Trigeminal nerve problems

DDx - Facial asymmetry
- Injury to cerebrum (opposite side)
- Brain stem injury (same side)
- Peripheral nerve (same side)
- Facial nerve palsy
- Hemifacial spasm
- Keratitis secondary to inability to blink
- Space-occupying lesions of cerebellar-medullary angle
- Otitis interna-media
- Bell's Palsy

DDx - Loss of gag & cough reflexes
- Dysphagia
  - Rabies
  - Pharyngitis
  - Brain stem lesions
  - Botulism
- Vomiting: vagal nerve branches
  - Otitis interna - tympanic nerve irritation
- Laryngeal paralysis ("Roarer"); recurrent laryngeal nerve paralysis

DDx - Pupillary asymmetry
- Abnormal CrN 3
- Abnormal sympathetic nerves
- Glaucoma
- Iritis
- Uveitis
- Synechia
- Normal mild anisocoria in some cats



DDx - Loss of mandibular reflex
- Dropped jaw syndromes
- Idiopathic trigeminal neuropathy
- Mandibular neuropraxia
- Bulbar or medullary lesions
  - Space- occupying lesions
  - Rabies
  - Old dog trigeminal palsy

DDx - Tongue weakness or displacement
- Hypoglossal n. paralysis
- Fractures stylohyoid bone
- Sublingual abscess or mass

Cerebrum & Thalamus

NEUROMUSCULAR SYSTEM

Condition	Facts/Cause	Presentation/CS	Diagnosis

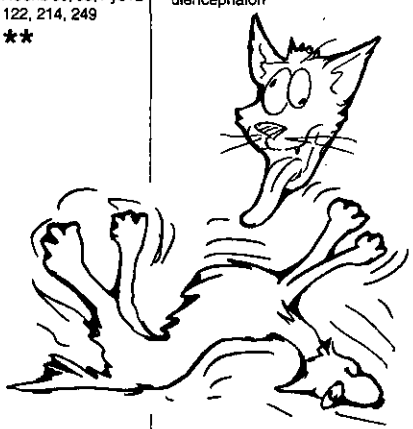
Cerebrum & Thalamus; Forebrain

Mk 579; IM 731, 747; H2B 237; SAP 1127, 1110; IM-WW 460; E-hb 273; E 146; Cat 1172; F-? 1517; DDx 429; Sx-S 1001; NS-C 133, 60; NS-W 25; NS-Pa 68; NS-hb 56, 60; NS-O 49; NS-L 377, 132, 318, 344; NS3hb 56, 63; Pys4B 122, 214, 249

**

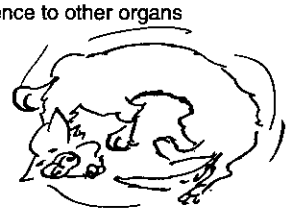
Facts/Cause

- **Cerebral hemispheres & basal nuclei** (telencephalon)
  - Voluntary motor control, behavior & mental status
  - Interprets vision & audition, proprioception & general sensations
- **Thalamus** of diencephalon: functionally closely related to the cerebrum to which it relays information
- Unilateral lesions = opposite side (contralateral) deficits
- Prosencephalon = 2 telencephalons & 1 diencephalon



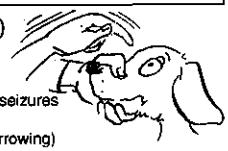
Presentation/CS

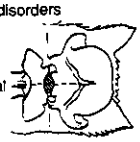
- **General forebrain signs**
  - **Altered mental status**
    - . Dementia (incorrect response to stimuli), delirious (dementia + agitation), lack of recognition of owner or environment, bewilderment, loss of trained habits
    - . Depression, stupor & coma from bilateral cerebral diz or brain stem diz
  - **Personality changes**: affection, irritable, hysteria, maniacal, aggression, changes in sleeping, eating, urinating & fecal habits
  - **Seizures**: usually from cerebral diz
  - **"Adversive" (turn to) syndrome**:
    - . Wide circling, head & eyes toward lesion if unilateral
  - ± Head pressing
- **Contralateral signs** if focal lesion
  - **Normal or nearly normal gait**
    - . Compulsive walking (continuous)
  - **Postural deficits** on side opposite lesion (contralateral) - weakness, falling or staggering, loss of proprioception & UMN
  - **Cortical blindness** w/ normal pupils & pupillary light reflexes, on side opposite lesion (contralateral)
- Extracranial origin: CS often reference to other organs



Diagnosis

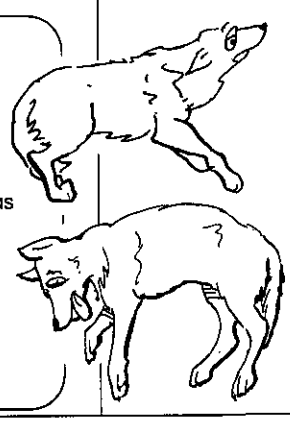
- History (Hx), CS (clinical signs), physical exam (PE)
- Neuro exam
  - **Identify existence of a neurological problem**
    1. General observations: mental attitude/consciousness, behavior; seizures
    2. Gait observation & strength: no appreciable
    3. Postural reactions (proprioceptive positioning, hopping, wheelbarrowing)
  - **Localize neuro problem once identified:**
    - **4. Cranial nerves exam**: to localize to cranial cavity/above level of foramen magnum
    - C. Localize to part of brain
      - "Head signs": changes in mental attitude, consciousness & behavior, seizures, circling
      - **Gait + "head signs"**: little gait deficits: lesions rostral to midbrain
    - D. Specific signs of cerebrum & thalamus:
      - . Altered mental status/personality changes (dementia to coma)
      - . Epileptic seizures
      - . Cortical blindness
      - . Head pressing, compulsive walking
      - . Postural deficits on side opposite lesion, mild weakness
    - **5. Spinal reflexes: preserved ±↑** due to loss of UMN inhibition
    - 6. Muscle tone: normal or ↑ (UMN sign)
    - 7. Abnormal sensation - opposite side, knows it hurts, but can't locate
      - . ± General hyperesthesia (uncommon)
- Extracranial origin cerebral diz
  - CBC & chemistries (cerebellum most susceptible to metabolic disorders)
  - Serology if infections suspected
  - Urinalysis
- Radiography: Plain skull for hydrocephalus, tumors, lesions of bone or cartilage, head trauma
  - Contrast into ventricular or vascular system: for hydrocephalus, tumors or vascular injury
- Computerized tomography (CT) - for mass lesions
- EEG (electroencephalography): electrical activity of cerebral cortex for cerebral diz (epilepsy), distinguish between intracranial & extracranial; interpretation difficult
- CSF analysis
  - Indications: abnormal neuro exam, recurring fever, epilepsy, chronic pain, brain disorders
  - Contraindications: recent CNS trauma, rapid declining level of consciousness
  - Interpretation
    - . No change in CSF: degenerative, anomalies, metabolic, toxic & nutrition dizs
    - . Neoplasia: usually increased protein, ± increased pressure, cells usually normal
    - . Inflammation: increased cell count & protein ± pressure elevation
    - . Trauma: RBCs & protein elevation
- Toxicological screening: for cerebral affects





Cerebral cortical disorders

- Anomalous conditions
  - Hydrocephalus
  - Lissencephaly
  - Lysosomal storage dizs
- Inflammatory diz
  - Meningitis
  - Encephalitis
- Tumors 1° or 2° brain
- Trauma
  - External
  - Infarcts (rare)
- Thiamine deficiency
- Vascular disorders
  - Feline ischemic encephalopathy
  - Canine vascular accident
- Metabolic encephalopathy
  - Hepatoencephalopathy
  - Hypoglycemia
  - Severe uremia
  - Hyperosmolality of diabetes mellitus
  - Heat stroke
  - Hypoxia
- Intoxication
  - Lead poisoning- Household toxins
  - Insecticides
  - Rodenticides
  - Drugs



Treatment

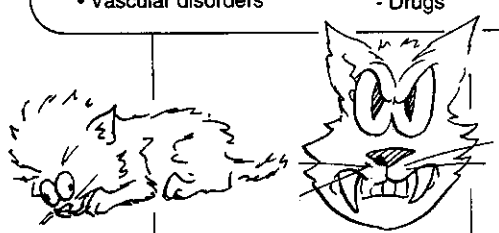
- **Specific Tx**: depending on diagnosis
  - Anticonvulsants: pentobarbital, diazepam
  - ABs (bacterial, protozoal & fungal)
  - Immunosuppressive/antiinflammatory drugs
    - . Many diz idiopathic: immune-mediation suspected in some. Use in absence of infection
  - Antineoplastic drugs
  - Toxin removal: lead
  - Nutritional Tx: Thiamine (B1) can cause neurological diz
- Nonspecific treatment
  - Anti-edema: Furosemide (Lasix®), Mannitol
  - Anti-inflammatory drugs: in absence of infection - to reverse inflammation & alleviate 2° processes: edema, vasculitis
  - Pain control not usually needed in brain injuries
- Surgical therapy
  - Uncommon because of difficulty of approach to brain
  - Decompression #1 surgery - decompress or remove tumors, abscesses & hematomas . Usually poor results

Prognosis:

- Cerebral: better than brain stem, but worse than cerebellum

Severity of injury: mild better than severe (duh!)

Progression of diz important prognostically



Frontal lobe: intellect, behavior, fine motor activity, some sensory information processing

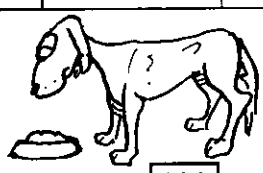
- Parietal lobe: processes some sensory information
- **Occipital lobe: processes visual information**
- Temporal lobe: behavior, processes auditory, taste & smell information

Higher Center - Intellect, Behavior
CS: Altered mentation, Behavior, Seizures, Blindness
Dx: CS, Neuro, CSF
Tx: Anticonvulsants +

Hypothalamus

IM 731; H2B 237; IM-WW 460; NS-hb 516; NS-O 51; NS-L 352, 377; NS3hb 56Sx-S 1001; Pys 243

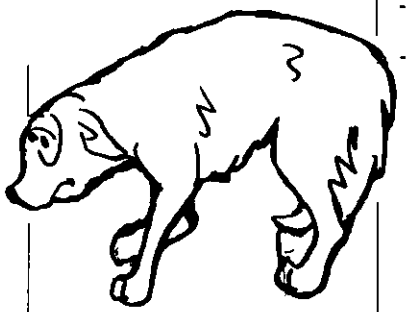
- Controls the autonomic nervous (ANS) & endocrine (pituitary gland) systems: body temperature, glucose metabolism, appetite control, autonomic nervous system (e.g., Horner's syndrome), water balance (e.g., diabetes insipidus), gonadal, thyroid & adrenal function
- Makes up the diencephalon w/ the thalamus

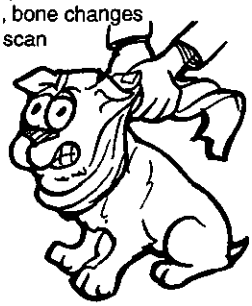


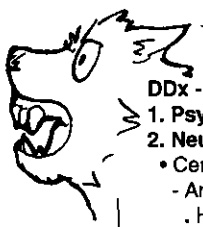
Clinical signs:

- **Asymptomatic**
- **Autonomic & endocrine abnormalities**
  - Polyuria/Polydipsia: diabetes insipidus & hyperadrenocorticism
  - Altered sleep/sexual patterns
  - Behavior alterations (rage [cat] to affectionate)
  - Abnormal drinking (thirst) & eating (hyperphagia/overeating) habits
  - Poor temperature regulation

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Behavior & personality disorders, Abnormal mentation IM 747; NS-C 133; NS-hb 360, 364; NS-W 119, 219, 90; NS3hb 366	• **Abnormal mental activity** - **Cerebral cortex lesions**: behavior, dementia, compulsive behavior - **Brainstem lesions**: depression, stupor, coma + cranial nerve & postural abnormalities • Behavior & personality changes - Usually due to lesion of cerebrum or diencephalon	• **Behavior & mentation changes** - Loss of recognition of owner - Dementia - Aggressiveness, irritability - Passiveness, hypersexuality - Compulsive pacing or circling - Sleepiness, semicoma, coma - Blind if occipital lobe affected • **Hypothalamus signs**: - Polyuria, polydipsia, aphagia (no eating), pica	• **Differentiate behavior from neuro problem** - Hx (owner): animals normal behavior, onset of signs? • Physical exam: - Identify a neuro problem: mentation changes + other neuro deficits . ± Seizures . **Gait & strength: little change if cerebral** . **+ Postural reactions deficits** (contralateral limbs if unilateral cerebral) . Blind: occipital lobe damaged - Differentiate from brain stem diz . Brain stem: also depression, stupor & coma .. Cranial nerve deficits .. Gait abnormalities + postural deficits • CBC: for infectious, metabolic or toxic diz • Ancillary test: - EEG may help differentiate from psychological problems - CSF: infectious or neoplasm - Radiography: skull fxs or neoplasms, bone changes - MRI or CT scan	• Treat cause

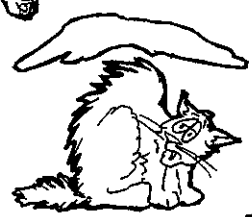




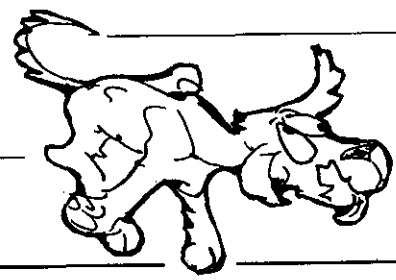


DDx - Abnormal mentation
1. Psychological problems
2. Neurological problems
- Cerebral cortical disorders
  - Anomalous conditions
    . Hydrocephalus
    . Lissencephaly
    . Lysosomal storage dizs
  - Inflammatory diz
    . Meningitis
    . Encephalitis
  - Tumors: 1° or 2° - brain
  - Trauma: external or infarcts (rare)
  - Thiamine deficiency
  - Vascular disorders
    . Feline ischemic encephalopathy
    . Canine vascular accident
- Metabolic encephalopathy
  - Hepatoencephalopathy
  - Hypoglycemia
  - Severe uremia
  - Hyperosmolality of diabetes mellitus
  - Heat stroke
  - Hypoxia
- Intoxication
  - Lead poisoning - household toxins
  - Insecticides
  - Rodenticides
  - Drugs
- Disorders of brainstem
  - Trauma
  - Neoplasia

DDx:
- **Cerebral/diencephalon**
- **Psychological problems**
- **Brain stem**



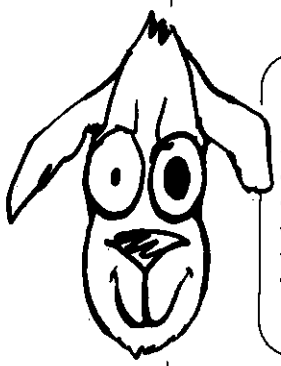
Behavior changes usually cerebrum
CS: Behavior & mentation changes
Dx: Behavior or neuro? Cerebrum or brainstem?
Tx: Treat cause

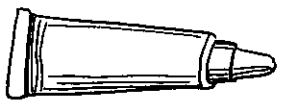


Intoxication	• Household toxins, insecticides, rodenticides, drugs • CS: acute onset of neurological signs (anxiety & dementia early) • Dx: History: helpful, but rarely obtained • Tx: Supportive until recover
Metabolic encephalopathy	• Hepatic diz, hypoglycemia, severe uremia, hyperosmolality of diabetes mellitus) • CS: Episodic or chronic abnormalities of mentation • Dx: Hx, CS, lab

Iris - Anisocoria

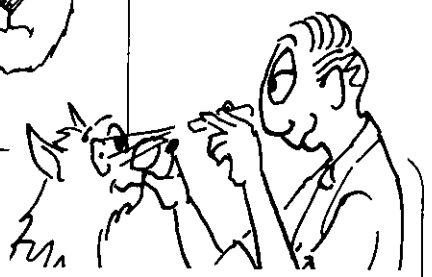
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Anisocoria H2B 1132; I2M 984; IM-WW 87; 5min 14; I-P 16; Sx-S-hb 433; NS-L 121; NS3hb 275, 276; NB 12.18	• **Anisocoria: pupils of different size**	• **Unequal or asymmetric pupils**	• History, CS • Eye exam - Pupillary light response - Menace response to see if blind • FeLV test • Monitor for lymphosarcoma in future	• Treat underlying cause • Symptomatic - Indirect-acting meiotic agents (echiothiophate iodide or demecarium bromide) sid to mask mydriasis





Anisocoria - Causes

- Afferent mydriasis
- Efferent mydriasis (unilat. CN 3)
- Sympathetic miosis
- Feline spastic pupil syndrome
- Horner's syndrome
- Feline dysautonomia
- Central blindness
- Intraocular diz - pupil dysfunction
  - Iris atrophy/trauma/development
  - Anterior uveitis/(miosis)
  - Glaucoma (mydriasis)
  - Synechia
  - Corneal pain (keratitis): oculopupillary reflex (CrN 5-3) (miosis)
- Idiopathic
- Cerebral or thalamic diz (miosis to mydriasis)
- Cerebellar diz (mydriasis)
- Drugs
  - Gas anesthesia, sedatives, morphine
  - Unilateral topical parasympatholytics (mydriasis)
  - Unilateral topical parasympathomimetics (miosis)



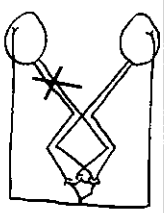
DDx: Anisocoria (unequal pupil size) NS-L 121, DDx 471

Disorder	Affect - ipsilateral pupil (same side)	Further tests
• Unilateral CrN 3 lesion	Dilation (mydriasis)	Unresponsive to light in either eye
• Unilateral sympathetic lesion	Constriction (miosis)	Dilates slightly in reduced light
• Unilateral eye pain (keratitis)	Constriction (miosis)	
• Unilateral retinal or optic n.	Dilation (mydriasis)	Light in affected eye: no constriction in either eye; Light in normal eye, constriction of both eyes
• Iritis	Constriction (miosis)	
• Iris degeneration w/ atrophy	Dilation (mydriasis)	Variable response to light
• Glaucoma	± Constriction (miosis)	Unresponsive to light
• Cerebellar (asymmetric)	Normal, Opposite pupil dilated	Responds to light in both eyes
• Idiopathic in cats		

Mydriasis: afferent anisocoria

H2B 1125; I-S 470; I-G 717

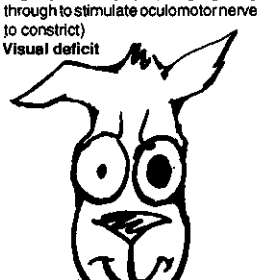
*?



Retina, optic nerve, chiasm & tract Dilated & Visual deficit

- **Mydriasis: dilated pupil** (big word big pupil)
- **Neurological lesion of retina, optic nerve, optic chiasm, optic tract**
- Pupillary light reflex (PLR) & menace response vary depending on site of lesion
- Cause:
  - **Prechiasmal** (most common) optic nerve/retina
    - . Retinal degeneration (progressive retinal atrophy, feline generalized retinal degeneration)
    - . Optic nerve diz (congenital, inflammatory, neoplastic, traumatic)
  - **Chiasma & optic tract**
    - . Canine distemper
    - Granulomatous meningoencephalitis
    - Vascular
    - Meningioma or neoplasia involving hypophyseal fossa
    - Traumatic

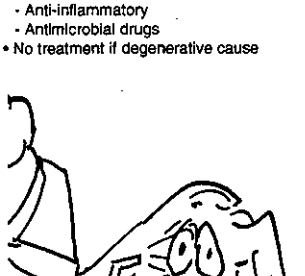
- **Slightly dilated pupil** (no light getting through to stimulate oculomotor nerve to constrict)
- **Visual deficit**



DDx:
- Efferent mydriasis
- Central blindness
- Intraocular diz - pupil dysfunction
  - Iris atrophy, glaucoma, posterior synechia

- **Ophthalmoscope:** for retinal thinning, optic neuritis, optic nerve atrophy
  - Normal if no retinal or optic nerve damage
- **Prechiasmal lesions:** loss of direct PRL & normal PLR on affected sided
  - Unilateral:
    - . **Partial dilation** (mydriasis) in room light
    - . Light in affected eye: neither constrict (loss of direct in affected eye & indirect in unaffected eye)
    - . Light in unaffected eye: both eyes constrict (Normal direct in unaffected eye & indirect in affected eye)
    - . No menace response or vision in affected eye
  - Bilateral: complete mydriasis & blindness (no menace or PLR in either eye)
- **Chiasmal lesions:** loss of both in- & direct in both eyes
  - Bilateral dilated, unresponsive pupils (complete lesion)
  - Absent menace & PLR in both eyes
  - Normal fundus
- **Optic tract lesions**
  - Unilateral lesion
    - . Hemianopia (deficit in half of visual field in both eyes)
    - . Normal PLR in both eyes
  - Bilateral
    - . Partial or complete visual deficit
    - . Menace response absent in both eyes

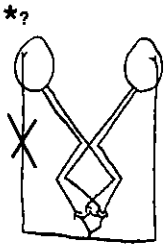
- **Treat underlying cause**
  - Antineoplastic
  - Anti-inflammatory
  - Antimicrobial drugs
- No treatment if degenerative cause



Efferent mydriasis, Internal ophthalmoplegia

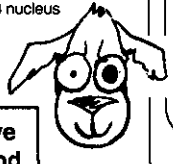
H2B 1126; I-S 453; NS-L 121, 291, 291t

*?



Oculomotor nerve Dilated & not blind

- **Unilateral motor innervation paralysis (Cranial nerve 3)**
  - Paralysis of intraocular muscles of iris sphincter & ciliary body (pupillotonia, tonic pupil, oculomotor dysfunction [CN 3])
- Afferent pathways normal (optic nerve, chiasm, tract)
- Causes:
  - Topical parasympatholytic agents (atropine), belladonna alkaloid plants
  - Orbital diz affecting CN 3
  - Cavernous sinus syndrome
  - Midbrain lesion of CN 3 nucleus
  - Idiopathic lesions

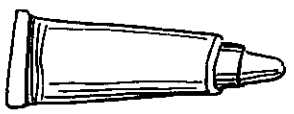


- **Dilation (mydriasis)**
  - Persistent ipsilateral mydriasis w/ normal menace response
- Anisocoria (pupils of different size) accentuated in lighted room
- ± Drooping lid (ptosis) (levator palpebrae)

DDx:
- Afferent mydriasis
- Intraocular diz
  - Abnormalities of iris sphincter
  - Glaucoma
  - Iris atrophy
  - Lens luxation
  - Posterior synechia
- Dysautonomia

- **Eye exam:**
  - PLR: no response to direct or indirect PLR in affected eye, normal direct & indirect PLR in unaffected eye
  - Normal menace response
- Lesion localization:
  - Preganglionic lesion
    - . 0.5% physostigmine test: miosis of affected eye in 20 min
    - . 0.1% pilocarpine test: no miosis
  - Postganglionic:
    - . Dog: short ciliary carry both para- & sympathetic fibers
    - . Cat: parasympathetic innervation separate form sympathetic
      - .. Nasal short ciliary innervate medial iris: "D-shaped" pupil if right eye involved; "Reverse- D" if left
      - .. Malar short ciliary innervate lateral iris: "D-shaped" pupil if left eye involved; "Reverse- D" if right
    - . Dog & cat
      - .. 0.5% physostigmine test: affected eye remains dilated
      - .. 0.1% pilocarpine: miosis in 20 min

- **Treat underlying** neurological condition if possible
- Symptomatic: indirect acting meiotic agents sid to mask mydriasis



Prognosis:
- Topical parasympatholytic agents (atropine) wear off in 1-2 weeks
- Bilateral midbrain lesion: grave
- Unilateral midbrain lesion: guarded
- Caudal brain stem: grave

Blindness

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Vision abnormalities, Blindness H2B 1132; I2M 982; IM-WW 85; 5min 22; I-D 260; Sx-S-hb 433; Sx-S 1276; NS-L 271; 290; NS3hb 274 ****?**	• **Partial or complete loss of vision** • Lesion of visual pathway - Retina - Optic nerve - Optic chiasma- Optic tract - Lateral geniculate body (LGB) - Optic radiation - Occipital visual cortex	• **Partial/complete blindness** • Brain lesions - ± Paresis & neurological signs if brain lesion • Congenital blindness - Searching or wandering nystagmus	• History (Hx) • CS - partial or complete loss of vision • PE: may be difficult to detect in dogs & cats - compensate; obstacle course • Lesion localization - Ocular media opacities . PLR: afferent deficit . Menace response: reduced or absent . Ophthalmoscope: cloudy ocular media, cataracts . ERG (electroretinogram: abnormal) - Retinal lesion - affected eye . PLR: afferent deficit . Menace response: reduced or absent . Ophthalmoscope: probable abnormalities . ERG (electroretinogram): abnormal if photoreceptor lesion - Ganglion cell & optic nerve lesions (affected side) . PLR: afferent deficit . Menace response: reduced or absent . Ophthalmoscope: ± optic disc signs . ERG: normal (photoreceptors OK) . VER (visual evoked response): abnormal - Optic tract, KGB, occipital cortex (eye[s] affected) . PLR .. Optic tract: dilated & unresponsive .. LGB or visual cortex: normal . Menace response: reduced or absent . Ophthalmoscope: normal retina & optic disc . ERG: normal (photoreceptors OK) . Unilateral: ± contralateral hemiparesis . Bilateral: ± Tetraparesis & other neurological deficits • Congenital lesions (retinal dysplasia, hypoplasia, cataracts) - Searching or wandering nystagmus • Radiograph, CAT, MRI for orbital & intracranial lesions	• **No treatment for blindness** • **Treat underlying cause** - Antibiotics for infections - Anti-inflammatory for inflammation - Antineoplastics for tumors • Degenerative conditions not treated Prognosis: • **Guarded to poor** for vision return if total loss • Visually impaired animals make acceptable pets, cats especially compensate well, may not be able to notice blindness

• **Causes - Vision abnormalities**
- Opaque ocular media
. Corneal opacities (pannus etc.)
. Cataracts
. Inflammation of anterior segment
- Retinal diz
. Progressive retinal atrophy
. Retinal detachment
. Retinal dysplasia
. Sudden acquired retinal degeneration
. Ganglion cell hypoplasia
. Congenital stationary night blindness
. Inflammatory diz
- Optic nerve diz
. CN 2 atrophy
. Aplasia
. Hypoplasia
. Glaucomatous cupping
. Optic neuritis
. Neoplasia
. Trauma
- Intracranial diz
. Optic tract lesions
.. Inflammatory diz (canine distemper, etc.)
.. Neoplasia
.. Trauma
. LGB, optic radiation, visual cortex
.. Feline cerebral vascular diz
.. Hydrocephalus
.. Inflammatory diz (canine distemper, GME, toxoplasmosis, abscess)
.. Ischemic cerebral hypoxia (apnea, cardiac arrest)
.. Metabolic storage dizs
.. Neoplasia
.. Tentorial herniation
.. Trauma

Loss of vision
Dx: Hx, CS, PE, Lesion localization
Tx: Blindness - none, Tx underlying cause

Retinal detachment

SAP 1227; H2B 1113; IM-WW 588Q; I-S 433; I-A 183, 213-217, 151, 301-304(f), 296(f); I-D 260, 261, 18A,B; I-G 511, 454; Pys 135
****?**

• **Separation of neural retina from the retinal pigmented epithelium**
- Unilateral detachment may not be detected
- Partial or complete (infundibular); peripheral or adjacent to optic nerve
• Types of detachment:
- Rhegmatogenous: fluid of vitreous body flow through holes or tears in retina
- Nonrhegamtogenous: transudative, exudative or hemorrhagic
• Pathophysiology:
- Retina only firmly attached at ora ciliaris & optic disc
- Separation w/ firm attachment remaining: "morning glory-like" appearance
- Separation plus tear of ora ciliaris, retina hanging into ventral Vitreal space
• Breeds: basenji, dachshund, English springer spaniel, Old English sheepdog, miniature or toy poodle, Rottweiler, Shih Tzu

• **Asymptomatic** until has loss of vision
• **Acute blindness** if bilateral
• ± Visual deficits if unilateral
• Pupils often dilated
• ± Systemic signs

• Sequelae:
- ± "Settles back" - reattaches
• Progressive atrophy & obliteration of retinal architecture
- 2° cataracts
- Uveitis
- 2° glaucoma
- Phthisis bulbi

• History, CS
• Papillary light reflex: normal, incomplete or absent *
• **Funduscopic exam**: constantly change ophthalmoscope setting
- Grey & silvery detached sheet
. ± Undulation w/ movement
- Obscures retina (vessels, disc)
- Tortuous vessels in "hills & valleys"
- Subretinal bleeding
- Holes, tears or folds in retina
• Blood pressure for hypertension
• Ultrasound if can't see in eye
• CBC, chem, urinalysis & serology: if systemic or infectious diz suspected

• **None if no symptoms**
• Treat underlying cause if possible
• Systemic steroids if infection & hypertension ruled out
• Systemic NSAIDs (avoid if intraocular hemorrhage)
• Mannitol if transudative detachment
• Surgery - refer

Prognosis:
• **Guarded**: variable, some reattach & in dog vision may return, rarely in cat

Cause - Retinal detachment
• Trauma/surgery
• Systemic diz: viral, bacteria or mycotic infections, hypertension, bleeding disorders, uremia, toxins
• Congenital: CEA & retinal dysplasia, collie eye, multiple ocular anomalies
• Uveitis: infectious, immune-mediated, neoplastic, lens induced
• Idiopathic: Shih Tzu
• Inflammation/chorioretinitis: distemper, fungal, bacterial (Brucella, Borrelia [Lyme diz], algal [Prototheocosis], rickettsial (ehrlichiosis, Rocky Mt. spotted fever), parasitic (toxoplasmosis, neosporum, etc.)
• Immune-mediated
• Neoplasia: lymphosarcoma, metastatic tumors
• Toxic
• Hypertension
• Tears: cataract formation, intraocular surgery, liquefaction of vitreous
• Traction 2° to healing hemorrhage or chorioretinitis
• 2° to retrobulbar abscess or mass
• Ethylene glycol (cats)

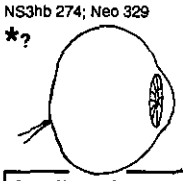
Separation of neural from epithelial retina
CS: Blindness
Dx: Ophthalmoscope
Tx: Treat any systemic diz, steroids, refer

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Optic nerve hypoplasia, ONH, Micropapilla of optic nerve, Optic aplasia

Mk 297; SAP 1224; H2B 1107; I2M 983; I-S 467; I-P 185; I-A 185, 295(f); I-D 254; I-G 514; I-hb 244; NS3hb 274; Neo 329

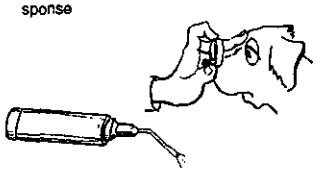
*?



- Micropapilla: no apparent blindness
  - Miniature & toy poodles
- Optic nerve hypoplasia: blindness
  - Collie, Eng. cocker, shepherd, Keeshond, miniature & toy poodle, Tibetan spaniel
- Optic nerve aplasia: absence of optic nerve
  - Miniature poodle, domestic shorthair cats (rare)
- Unilateral or bilateral

- **Asymptomatic** - micropapilla
- ± **Blindness**
- Lack of pupillary light reflexes

- **History (age, breed)**
- **Ophthalmoscope:**
  - Micropapilla: small, normal optic disc
  - Optic nerve hypoplasia: small discolored or dark optic disc
  - Optic disc aplasia: no disc
- **Pupillary light reflex**
  - Micropapilla: responsive
  - Optic disc hypoplasia or aplasia: no response



- **No treatment**
- Hypoplasia or aplasia: don't breed

Prognosis: not progressive

Small or absent optic nerve
CS: Asymptomatic - Blindness
Dx: age, breed, Ophthalmoscope
Tx: Non, don't breed

Papilledema,

Optic disc edema; Papillary edema, Choked disc

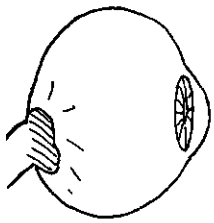
SAP 1228; 5min 906; I-P 172; I-A 202-204, 299(f); I-D 259; I-G 518; NS3hb 274; Neo 333

**?

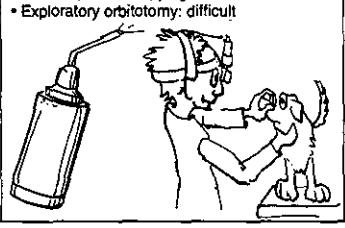
- **Rare in dog**
- **Bilateral swelling of optic disc (nerve head)** due to reduced blood flow & axoplasmic flow form optic disc
- Cause:
  - Pressure on optic nerve: tumor or granulomas
  - ↑ **CSF**/intracranial pressure
    - Brain tumors, intracranial trauma, optic neuritis of viral encephalitis
  - Pancreatitis (relationship unclear)

DDx:
- **Optic neuritis**

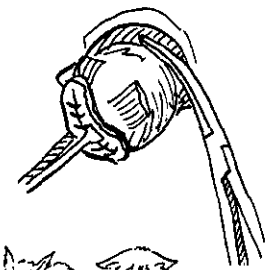
- **Vision is usually unaffected**
- Sequela:
  - Blindness if damage to central optic pathway or visual cortex



- **Differentiate from optic neuritis**
- **CS: normal vision, neuritis- blind**
- Ophthalmoscopic exam:
  - Swollen optic disc: protrudes into vitreous, margins hazy & indistinct, vessels cascade over edge, Hemorrhage of vessels
- Globe retropulsion for space-occupying lesions in orbit
- Neurological exam: localize CNS lesion
- Ultrasound, radiology, & computertomography: orbital space occupying lesions
- Exploratory orbitotomy: difficult



- Orbital tumors: occasionally may be removed
- **Exenteration** of eye & orbital contents if mass near globe



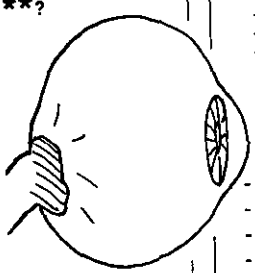
Prognosis
- **Guarded to poor** because often associated w/ CNS tumors

Swelling of optic disc, ↑ CSF pressure
CS: Vision OK, CNS signs?
Dx: Normal vision swollen disc
DDx: Differentiate from optic neuritis
Tx: Remove orbital tumors, Exenteration of eye

Optic neuritis

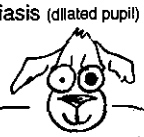
SAP 1228; H2B 1025t, 840t; I2M 983; 5min 22, 881; I-S 468; I-P 173; I-A 204-205; I-D 259; I-G 517; I-G 517; I-hb 259; NS3hb 294, 283; Neo 332

**?



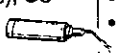
- **Inflammation of optic nerve**
- Cause (see below):
  - Inflammation, infection, neoplasia, trauma all result in optic disc swelling
  - Retrobulbar neuritis: no fundic findings
    - **"Dog & doctor see nothing"**

- Acute blindness if bilateral
- Mydriasis (dilated pupil)

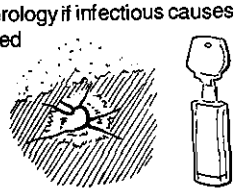


- Causes - Optic neuritis
  - Inflammation & infections (as in CNS dizs & chorioretinitis)
    - Distemper
    - Fungal (blastomycosis, coccidiomycosis, cryptococcosis, histoplasmosis, etc.)
    - Bacterial (brucella, Borrelia (Lyme diz)
    - Algal (Prototheocosis)
    - Rickettsial (ehrlichiosis, Rocky Mt. spotted fever)
    - Parasitic (toxoplasmosis, Neosporum caninum, Leischmaniasis, migrating fly larvae, Toxocara canis larva migrans)
    - Immune-mediated (Autoimmune chorioretinitis, uveodermatologic syndrome)
    - Neoplastic (lymphosarcoma, multiple myeloma, metastatic neoplasia)
    - Toxic (lead)
  - Neoplasia (canine GME, feline lymphosarcoma)
  - Ocular trauma (ocular proptosis)
  - Orbital inflammatory diz
  - Immune-mediated optic neuritis
  - Miscellaneous toxins: rare
  - Retrobulbar neuritis: no fundic findings - "dog & doctor see nothing"

- History (acute blindness), CS
- No pupillary light reflex



- Ophthalmoscope:
  - **Optic disc: hazy, elevated & edematous**
    - Normal if disc not effected: retrobulbar neuritis: "dog & doctor see nothing"
    - Atrophy in time
  - ± Vitreous exudate
  - Hemorrhage at disc or adjacent retina
  - ± Chorioretinitis
- Electroretinography: to rule out SARD if disc normal
- Ultrasound: for nerve swelling if retrobulbar nerve involved
- Neurological exam & CSF for co-commitment CNS diz
- CBC, serology if infectious causes suspected



- Treat underlying diz promptly
- Systemic steroids if infectious dizs ruled out (prednisone)

Prognosis:
- Guarded: can result in blindness despite treatment, may be recurrent

Inflammation of optic nerve
CS: Acute blindness, Mydriasis
Dx: Ophthalmoscope
Tx: Treat underlying diz, ± Steroids

Optic nerve atrophy

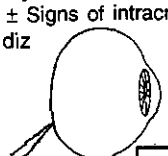
SAP 1229; I-S 470; I-P 173; I-D 257; I-G 518; I-hb 259; Neo 333

*?

- Sequela to other ocular dizs

Causes - Optic atrophy
- Inherited retinal degeneration
- Glaucoma
- Optic neuritis
- Optic nerve trauma (ocular proptosis)
- Orbital inflammation or neoplasia

- Blindness in affected eye
- Mydriatic (dilation)
- ± Signs of intracranial diz



- Hx (other ocular dizs), CS
- Pupillary light reflex absent

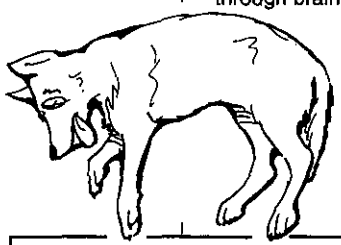
- Ophthalmoscope:
  - Optic disc small, gray, loss of retinal vessels
  - Outline of scleral lamina cribrosa may become visible (esp. cats)
  - Hypertrophy of neuronal supporting cells in dog: margins of disc appear to spread outward

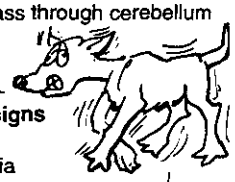
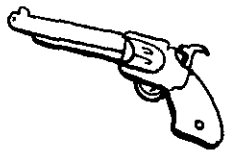
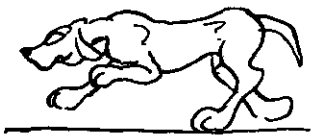
- No treatment effective once atrophy

Prognosis: Grave for vision

Sequel to other dizs; Blindness, Scope, No Tx effective

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Brainstem lesions E-hb 273; IM 731; H2B 239; SAP 1126; E 604; Cat 1518; F-? 1518; DDx 429; Sx-S 1001; NS-C 77, 100; NS-W 25, 120; NS-hb 56; NS-O 51, 305; NS-L 376, 136, 321; NS-Pa 78; NS3hb 55 **	• **Invariably serious** • **Brainstem** (midbrain, pons & medulla oblongata) - **Structural extension to spinal cord** - **RAS**, reticular activating system: **conscious level** - Heart rate, rhythm, & respiration centers (medulla) - **Cranial nerves 3-12** associated w/ brainstem - **Walking (locomotor) reflexes in midbrain** . Necessary for normal gait . Movement initiated in higher centers - descending motor tracts **cross over in the midbrain** . UMN (upper motor neuron) signs to all 4 limbs - **Proprioceptive fibers** pass through brain stem	• **Cranial nerve 3-12 deficits**, more than one, often partial • **Ataxia: vestibular signs** - Loss of balance - Head tilt - Pathologic nystagmus - Circling • ↓ **Consciousness** (RAS) - Depression - Stupor - Coma • **Abnormal gait - UMN** (↑ reflexes, rigidity) • **Weakness/paresis: UMN signs** • **Postural deficits** (proprioceptive) • Decerebrate rigidity: opisthotonus w/ rigid extension of all 4 limbs if midbrain transected between colliculi • Altered heart rate & rhythm or altered respiratory patterns: uncommon, but indicate life-threatening injury	• **Presumptive: cranial nerve deficits w/ any weakness or loss of mental status** • Neuro: - **Identify neurological problem** **1. Consciousness: depression, stupor coma** **. Head tilt, circling, loss of balance** **2. Gait & strength: proprioceptive** deficits, paresis/weakness, ataxia **3. Postural reactions** (proprioceptive, hopping, wheelbarrowing) - **Localize neuro problem** **4. Cranial nerves exam: deficits 3-12** . Ventrolateral strabismus (CrN 3, . Dilated nonreactive pupil (CrN 3 . Vestibular eye movements, no normal nystagmus when move head from side to side . Multiple nerve deficits C. Localize to part of brain - "Head signs": **consciousness** - **Gait + "head signs"** .. Paralysis or weakness of all 4 limbs or 2 on same side (UMN) D. Specific signs of **brain stem**: . Cranial nerve 3-12 deficits . Ataxia, ± vestibular signs . Decerebrate rigidity/ opisthotonus - **5. Spinal reflexes: ↑ rigidity** - 6. Muscle tone: ↑ (UMN sign) - 7. Sensation: pain sensation usually normal in limbs or slightly decreased - Altered heart rate, rhythm or altered respiratory patterns • Radiography: head trauma • Computerized tomography (CT) - for mass lesions • ± CSF analysis	• **If unconscious** - **Airway** (intubation) - **Oxygen** • **Steroid** IV (methylprednisolone) for edema, In absence of infection - to reverse inflammation & alleviate 2° processes: edema, vasculitis - If improves stop steroids to avoid side effects - Mannitol: if no improvement (not if shock) • Monitor for brain herniation • Treat any shock (plasma expanders, blood or crystalloid solutions) • If stuporous or comatose: - Nutrients & fluids (stomach tube) - Bladder & rectum evacuation regularly • ± ABs • ± Antineoplastic drugs - Nutritional Tx: Thiamine (B1) can cause neurological diz • Surgical therapy: if evidence of developing herniation - rarely performed - Decompression #1 surgery - decompress or remove tumors, abscesses & hematomas - usually poor results **Prognosis:** • **Brain stem: poor** • **Sever: grave** • Progression of diz important



Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Cerebellar lesions **? SAP 1127; IM 731, 743; H2B 239; 5min 168; E 604; Cat 1173; F-? 1518; DDx 440, 443; Sx-S 1001; NS-C 56t, 318f, 77; NS-hb 60, 216; NS-W 25, 120; NS-O 52, 519; NS-L 163, 376, 255; NS3hb 225, 61, 219, 264; Pys 219	• **Coordinates movements**, rate & range, but does **not** initiate them - **Vestibular system connections** to help coordinate balance & posture - Proprioceptive fibers don't pass through cerebellum  **Causes - cerebellar signs** • Congenital - Feline panleukopenia - Canine herpes virus - Cerebellar hypoplasia/dysplasia - Cerebellar abiotrophy - Storage dizs • Acquired cerebellar diz - Inflammations: canine distemper, Toxoplasma, Cryptococcus, granulomatous encephalitis, FIP, parasite migration - Neoplasms - Injury/trauma - Lead -Hexachlorophene, organophosphate **Incoordination** **CS: Ataxia, tremors w/o weakness** **Dx: Ataxic but strong** **Tx: Congenital - None** 	•**Incoordination (ataxia) w/o weakness:** excessive range, rate & force of movement, accentuated by circling or turning - **Base-wide stance** from balance deficits, not proprioception - **Irregular, deviating gait**, veering from straight line - **Dysmetria** (too long or too short movements) . Hypermetria (exaggerated response - goose stepping, nose too far in water when drinking) - ± Swaying of trunk while standing, titubation - **Tremors**: regular, rhythmic, oscillating movements . **Intention tremors**: worsened by voluntary movement (eating) . Postural tremor: fine tremor of head, trunk, upper extremities when standing, disappears when recumbent • **Normal strength & reflexes** • **Normal postural reactions** • ± Pathological nystagmus (positional & vertical) • **Paradoxical vestibular signs** (head tilt, nystagmus, circling away from lesion) acquired lesion of vestibulocerebellum • ± **Loss of menace response, but not blind (rare)** • ± Anisocoria: mechanism not understood • Mental status normal - BAR (bright, alert & responsive) because RAS not affected	• **Presumptive: ataxia w/o weakness** • Hx, CS • **Neurological exam** for brain diz - **Identify neurological problem** 1. Stance & head position: head tilt, wide based stance; head tremor/bobbing 2. **Gait & strength: ataxia**, dysmetria but normal strength 3. **Postural reactions**: normal but may be exaggerated (dysmetria) - **Localize neuro problem** 4. Cranial nerves exam: ± No menace response (mechanism unknown) animal is not blind . Pathological nystagmus (positional & vertical) C. Localize to part of brain - "Head signs": **head tremors, BAR** - **Gait + "head signs":** incoordination of gait or dysmetria - 5. Normal spinal reflexes - 6. Normal muscle tone - 7. Normal sensation (pain & proprioception) • Radiography: tumors, lesions of bone or cartilage, head trauma • CSF analysis: usually normal **DDx - cerebellar signs** • Diz causing seizures • Trauma • Hemorrhage • Infarction • Infectious inflammatory diz • Granulomatous meningoencephalitis • Neoplasia • Congenital cerebellar hypoplasia • Virus-induced cerebellar malformation • Cerebellar neuronal abiotrophy • Metabolic storage diz	• **Congenital**: no treatment, ± Euthanasia • Specific Tx: depending on diagnosis - ABs (bacterial, protozoal & fungal) - Immunosuppressive/antiinflammatory drugs - Antineoplastic drugs - Toxin removal: lead • Surgical therapy: uncommon   **Prognosis:** • **Guarded**: compensation possible

VetBooks.ir

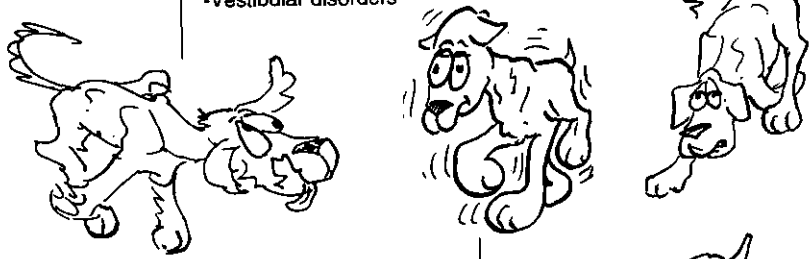
Ataxia

I2M 970; IM 740; 5min 20; IM-WW 75; E 145; NC-C 18, 318, 319, 280, 337, 343; NS-W 34; NS3hb 216, 366; NS-hb 61, 170, 208

**?

- Uncoordinated gait
- Cause:
  - Proprioceptive ataxia: disruption of proprioceptive (position sense) pathways in spinal cord or brain stem, cerebrum
  - Cerebellar disorders
  - Vestibular disorders

- **Staggering & irregular muscular movements**
- Tendency to cross limbs
- Exaggerated or hypermetric movements
- ± Prolongation of weight bearing phase of walking - delayed protraction of affected limb

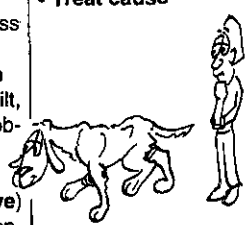


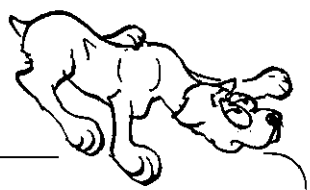
DDx: Ataxia
- **Spinal cord diz #1**
- **Proprioceptive ataxia**
- **Cerebellar disorders**
- **Vestibular disorders**
  - Peripheral
  - Central

Differentiate from generalized weakness

- Hx, CS, PE
- Differentiate form generalized weakness that can make gait look ataxic
  - **Identify as a neurological problem**
  1. **Stance & head position**: head tilt, wide based stance; head tremor/bobbing, intention tremors
  2. **Gait observation & strength**
  3. **Postural reactions (proprioceptive)**
- Localize neuro problem to proprioceptive, cerebellar or vestibular
  - Check for asymmetry of ataxia: Yes in vestibular, no in others usually
  - Postural reactions:
    . Abnormal: proprioceptive ataxia & central vestibular
  - Head & intention tremors: cerebellar only
  - Head tilt: in cerebellar & vestibular
  - Weakness: not in cerebellar or peripheral vestibular, often if brain stem involved (central vestibular or proprioceptive ataxia)
  - Nystagmus: seen in vestibular diz & possible in cerebellar diz

- **Treat cause**





DDx Ataxia
- Vestibular
- Cerebellum
- Spinal cord #1

1st try to localize to spinal cord, cerebellum or vestibular system
- Head tilt & nystagmus
- Incoordination of head, neck & all 4 limbs w/ **normal strength**, dysmetria/hypermetria (movements are jerky & lack control)
- Weakness (paresis) or paralysis (UMN), Use UMN & LMN signs (reflexes, tone) to further locate to area of spinal cord or brain stem

Condition	Facts/Cause	Presentation/CS	Diagnosis

Head tilt, Vestibular diz

E-hb 274; I2M 1002; IM 764, 731; SAP 1138, 1248, 390; H3B 241; H2B 1162, 238t, 239, 257,264; 5min 1150,74; IM-WW 93, 460, 490; E 723; Cat 1560; NS-C 269; NS-W 21, 224; NS3hb 61, 216, 220; NS-hb 56; NS-O 52, 40, 106; 364, 198; NS-L 238, 246, 249; X-T 50; DDx 443; Phs 168; NB 12.19

**

- **Uncommon in dog & cat**
- **Vestibular system**: control posture in relationship to gravity & eye movements in relationship to head movements
  - **Peripheral vestibular centers**: inner ear (labyrinth [semicircular canals, utriculus & saccule] receptors [crista ampullaris, macula] & vestibular nerve (CrN 8)
    . No proprioceptive fibers or UMN fibers
    . More common deficit
  - **Central vestibular system**: brainstem vestibular nuclei, flocculonodular lobe of cerebellum, motor, sensory & proprioceptive centers [brainstem] located in area
    . Poorer prognosis

Peripheral or Central
CS: Ataxia, Tilt, Circling, Nystagmus
Dx: CS, PE, Neuro Exam, Rads
DDx: Central (depression, weakness)
Tx: Tx cause

- **Signs of both central & peripheral vestibular diz**
  - **Head tilt** towards lesion
  - **Circling, falling, rolling towards lesion**
  - **Spontaneous nystagmus** (fast phase away from lesion)
    . Nystagmus may intensify w/ change in body position
  - **Ataxia**
  - ± **Ventrolateral strabismus** (deviation of eye) on side of lesion
  - **Vomiting, salivation** (motion sickness)

- Differentiate peripheral from central vestibular diz
  - **Central: brainstem signs** + common signs
    . **Depression, weakness & postural deficits**
    . Nystagmus: horizontal, rotary or **vertical**, may change direction w/ head position change
    . Recumbency, lesion side down, lean against wall
    . Loss of perception of sensation
    . ± Multiple cranial nerve deficits: facial (7), trigeminal (5) & abducens (4) (6)
    . ± Cerebellar signs (hypermetria, intention tremors)
  - **Peripheral (inner ear) vestibular diz:**
    . No UMN signs (no weakness), No depression
    . **Nystagmus: horizontal** or rotary, doesn't change direction w/ head position change
    . Postural reactions normal if done slowly (ataxia because of loss of balance, not due to proprioception)
    . Cranial nerve deficits: only facial (7) possibly, NO cerebellar signs
- Total lack of nystagmus indicates bilateral vestibular lesions
- Paradoxical vestibular signs: head & body tilts away from side of lesion: damage to flocculonodular lobe of cerebellum & some unilateral space occupying brain stem lesions

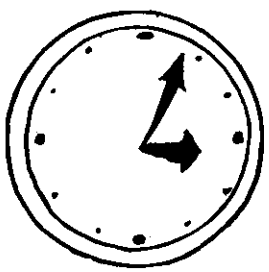
- History, Clinical signs
- **Physical exam:**
  - External ear canal: peripheral - rupture, bulging or cloudy tympanic membrane: middle ear diz suggested
  - Palpate tympanic bulla for pain or asymmetry
  - Examine pharynx & palpate (central - other nerves)
- **Neuro exam: Identify existence of a neuro problem**
  - 1. Mentation: normal (peripheral), depressed (central)
  - 2. Gait/strength: ataxia, head tilt, circling (both); weak (central)
  - 3. Postural normal (peripheral), abnormal (central)
  - 4. Cranial nerves: ± strabismus, head tilt
    . **Nystagmus**: peripheral, central (vertical)
    .. Positional nystagmus test: rotate & hold head: abnormal rhythmic movements of eyes (usually central)
    . **Central: multiple cranial nerve deficits**
  - 5,6. Normal reflexes (peripheral), weak (central)
  - 7. Sensation: normal peripheral, lessen - central
- **Allow time for idiopathic diz to recover**

- Further tests if no improvement
  - CBC & chem: not usually helpful
- Radiograph: Tympanic bulla & bony labyrinth: chronic infection trauma, inflammatory polyps, neoplasia
- ± CSF analysis for central diz
  - Abnormal CSF - central diz
  - Normal doesn't rule out central diz

Causes - Central vestibular diz
- Trauma/hemorrhage
- Infectious inflammatory disorders
  - Rocky mountain spotted fever (dog)
  - Feline infectious peritonitis (cat)
  - Canine distemper
  - Toxoplasmosis
  - Cryptococcosis
- Granulomatous meningoencephalitis (dog)
- Neoplasia
- Vascular infarcts
- Thiamine deficiency
- Brainstem abscess (rare)

Causes of peripheral vestibular diz
- Otitis media/interna
- Middle ear tumors/feline nasopharyngeal polyps
- Neoplasms
- Trauma
- Congenital vestibular diz
- Peripheral idiopathic
  - Geriatric canine vestibular syndrome
  - Feline idiopathic vestibular diz
- Aminoglycoside ototoxicity (rare)

Treatment:
- **Peripheral:** Tx cause
  - Idiopathic (canine & feline): None needed; spontaneous recovery - so time
  - Neoplasia: surgical excision difficult because of invasive nature, radiotherapy or chemotherapy
  - Congenital vestibular diz: none
  - Aminoglycoside toxicity: stop drug
  - Otitis media/interna: ABs, Steroids; Exposure keratitis
    . Tarsorrhaphy, or
    . Ophthalmic ointments, pilocarpine eye drops qid
- Central vestibular diz: Tx cause

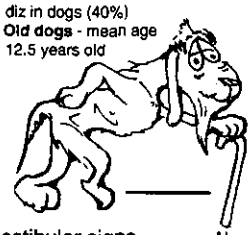
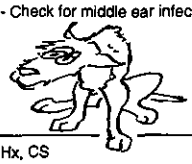
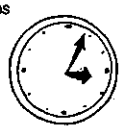
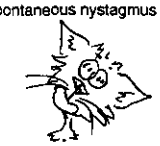
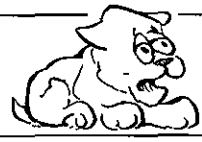


	Peripheral	Central
Vertical nystagmus	No	**May be**
Nystagmus & head position	NO effect	**May change**
Cranial nerve deficits	7	5, 6, 7
Horner's syndrome	**May be**	NO
Proprioception & posture	Normal	**Deficits**
Weakness	No	**Weakness (UMN)**
Cerebellar signs	NO	Yes
Depression	NO	**Yes**

DDx: Central or Peripheral vestibular diz
Head tilt, circling in both
Central = + depression, weakness & posture

Prognosis
- Head tilt may persist indefinitely
- Peripheral: better than central
  - Idiopathic: excellent spontaneous recovery
  - Neoplasia: poor
  - Congenital vestibular diz: may be acceptable pet w/ compensation
  - Aminoglycoside toxicity: good
  - Otitis media/interna: guarded many become chronic
  - Trauma: good
- Central vestibular diz: poor

Vestibular Diz

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Geriatric K9 vestibular diz, Idiopathic *? IM 766; SAP 1138; H2B 264; E-hb 275; IM-WW 490; 5min 1150; NS-L 247; NS-O 364; NS-hb 215; Sx-S 609	• #2 cause unilateral vestibular diz in dogs (40%) • **Old dogs** - mean age 12.5 years old 	• **Sudden unilateral vestibular signs** - Head tilt, ataxia, falling - Nystagmus (often rotary) - ± Severe signs - mistaken for brainstem injury - "Stroke" • Transient nausea, vomiting & anorexia (30%) • No Horner's syndrome (DDx from otitis) **DDx:** • Otitis interna or media • Trauma • Tumor of vestibular nerve • Central vestibular diz: cerebellar disorders • Endocrine neuropathies • Vascular injuries, esp. cat	• **Hx (old dog), CS** • R/O (eliminate) other causes (otitis media) • Improvement in clinical signs w/ time - Spontaneous nystagmus usually resolves in days & replaced by transient positional nystagmus in same direction - Ataxia & head tilt gradually improves 1-2 weeks • Physical exam: - Proprioception & postural reactions normal - All other cranial nerves normal - Check for middle ear infections  	• **None required** - spontaneous recovery • Support • ± Antiemetics (diphenylhydantoin) if severe vomiting **Prognosis:** • **Excellent** for recovery - spontaneous • Recurrence unusual, rare permanent head tilt
#2 cause, Old dogs CS: Acute unilateral vestibular signs **Dx:** Hx (old dog), CS, **improves w/ time** **Tx:** None required - **spontaneous recovery**				
Feline idiopathic vestibular diz, IVD *? IM 766; IM-WW 491; SAP 1138; E-hb 275; H2B 264; Cat 1560, Sx-S 809; NS-C 268; NS-W 224; NS3hb 222; NS-hb 215; NS-O 364; NS-L 247; Sx-WW 288	• Acute, nonprogressive disorder similar to old dog syndrome • Cats of any age • Summer & early fall (75% of cases) • NE USA	• Peracute **peripheral** vestibular signs - Sever loss of balance - Disorientation, falling & rolling - Head tilt - Spontaneous nystagmus  **DDx:** • Otitis interna, media • Trauma • Tumor of vestibular nerve • Central vestibular diz • Endocrine neuropathies • Vascular injuries	• Hx, CS • Physical exam - **Normal proprioception** & other cranial nerves - Absence of ear problems or other dizs 	• **Not needed:** spontaneous recovery, stabilize in a few days & gradually improves **Prognosis:** • **Excellent**: spontaneous improvement in 2-3 days & complete return to normal in 2-3 weeks
Like old dog vestibular diz				
Congenital nystagmus *? H2B 1161; NS-L 252, IM-WW 491	• **Puppies**: congenital, rapid, pendular nystagmus (abnormal eye movements; Usually spontaneously resolves in a few weeks, Cause: unknown • **Cats**: congenital nystagmus: most often in ocular albinism; Siamese: condition persists for life; Chediak-Higashi syndrome cats also (pigmentation & melanin granules abnormal)			
Nasopharyngeal polyps - cat, Inflammatory polyps - vestibular diz IM 166, 769; H2B 1161; IM-WW 491; NS3hb 224	• **Benign growths in kittens** & young adult cats; Pink, polyploid growths often w/ stalk; origin unknown; location: nasopharynx - base of auditory tubes, may extend to middle ear, pharynx & nasal cavity • CS: **Respiratory signs;** Sequelae: vestibular diz/otitis externa (head tilt, nystagmus, Horner's syndrome) • DDx: Visualize; Radiographs: check tympanic bullae for middle ear infection, Biopsy/histo • Tx: **Surgical excision** • Prognosis: excellent			

Neoplasia - vestibular diz IM 766, E-hb 274; H2B 1161; NS-C 299; NS3hb 223; NS-hb 216; NS-L 249, 251 *

- Tumors of bullae or bony labyrinth, tumors w/in ear (squamous cell carcinoma, ceruminous gland adenocarcinoma)
  - Neurofibroma, or neurofibrosarcoma of vestibular nerve (CrN 8)
- CS: **Vestibular CS**, Facial nerve paralysis, ± Horner's syndrome
- Dx: Hx, CS, Skull radiographs: bone lysis in region of bulla, Biopsy to confirm
- Tx: Surgical excision difficult because of invasive nature, Radiotherapy or chemotherapy
- Prognosis: **grave** (bone, CrN 8 neoplasms)

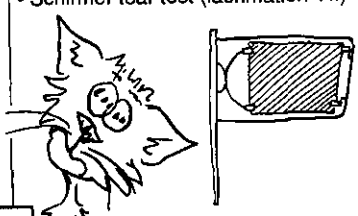
Trauma (hemorrhage in inner ear, fractures): Prognosis: usually good if limited to inner ear & petrous temporal bone

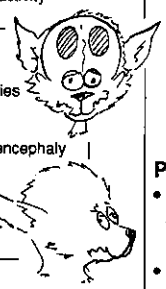
Congenital vestibular diz * M8k 908; E-hb 274; IM 767; H3B 233; H2B 257; Cat 1561; NS3hb 223; NS-hb 215; NS-O 198; NS-L 246, 252	• **Onset < 3 months**, at birth or 1st few months • Breeds: G. shepherd, Doby, Akita, cocker • Cats: Siamese, Tonkinese & Burmese • Cause: ? Inherited?	• **Head tilt, circling, ataxia** • Compensation in time • ± Deafness • ± Nystagmus 	• Hx (age), CS • Normal: CSF, radiographs 	• **None** **None** Prognosis: **many make acceptable pet** w/ compensation, signs do not usually progress

Aminoglycosides ototoxicity IM 767; H2B 1161, 1165; IM-WW 491; E-hb 138, 274; NS3hb 190, 225; NS-hb 216; NS-L 249 **

- **See Tox pg 726: Aminoglycosides:** streptomycin, dihydrostreptomycin, gentamicin, kanamycin; Pathophysiology: degeneration of vestibular & auditory systems; dogs & cats; High doses & prolonged use of dugs usually especially if impaired renal function
- CS: **Unilateral or bilateral vestibular signs**, Hearing loss
- Dx: Hx, CS
- Tx: **Stop drug**
- Prognosis: **Good** if stop early, Deafness may persist

DDx:
- Cerebellar abiotrophy
- Oscillatory nystagmus of Siamese
- Acquired diz of middle ear

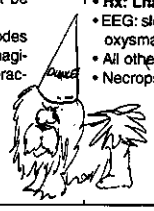
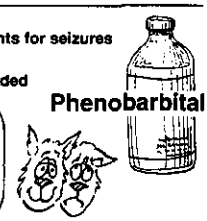
Otitis media /interna ** E-hb 274; SAP 390; H2B 1161; IM 766, 796; IM-WW 490; 5min 896; Cat 1560; NS-W 224; NS-O 361, 488; NS-L 109; 248; NS3hb 220; NS-hb 212; Sx-WW 288; -T 50	• **Common cause of peripheral vestibular diz** • Causes: - Extension of otitis media to otitis interna (bacteria, yeasts, prototheocosis) - Neoplasia • Pathophysiology: Paralysis of vestibulocochlear (CrN 8, facial (Cn7) & sympathetic pathway (Horner's syndrome)	• Unilateral vestibular signs: head tilt, circling, ataxia, rolling, nystagmus • **CrN 7 (facial)** - **↓ lacrimation** - Facial paralysis (drooped ear & lip, drooling, ptosis) - **Exposure keratitis** (can't close eyes) • Sequela: - Brain abscess or meningitis if ascends up nerve to brain, especially in cats	• **Hx (ear trouble)** • **Otoscopic exam** external ear canal & tympanic membrane abnormal tympanic membrane • **Skull radiographs** for fxs • Schirmer tear test (lacrimation VII) 	• **ABs** from culture & sensitivity or cephalosporin, chloramphenicol • **Bulla osteotomy** • **Exposure keratitis** - Tarsorrhaphy, or - Ophthalmic ointments, pilocarpine eye drops qid **Prognosis:** • **Guarded:** many bacterial infections become chronic & frustrating to Tx. Can be controlled w/ long term therapy
Peripheral vestibular diz **CS: Unilateral vestibular signs, CrN 7** **Dx: Otoscope, rads, Schirmer tear test** **Tx: ABs, Bulla osteotomy, Eye drops**				

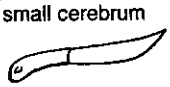
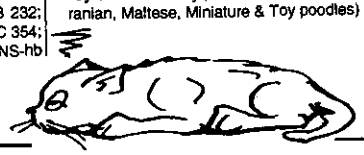
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Hydrocephalus M8k 900; Mk 579; E-hb 278; SAP 1135; H3B 230; H2B 251; I2M 991; IM-WW 461; 5min 686; IM 755; E 616; Cat 1526; Sx-S 1122; I-G 865; Pa-T 337; NS-C 136; NS-W 116; NS-K 110; NS3hb 303, 280; NS-hb 285; NS-Pa 75; NS-O 195, 106, 486, 131, 486; NS-L 46, 30, 208; Sx-WW 285; Pa-T 337 ****?** 	• **Pathological accumulation of CSF in ventricular system or subarachnoid space** • Causes: congenital or acquired (2°) - 2° Meningitis, neoplasia, head trauma • Types: - Communicating: increased production of CSF - External: decreased meningeal absorption (arachnoid villi) of CSF - Internal/obstructive or noncommunicating: obstruction of CSF flow . Blockage sites: cerebral aqueduct or lateral foramen of 4th ventricle • Breeds for 1°: **toy breeds & brachycephalic dogs** (Chihuahua, Pomeranian, Boston terriers, Maltese, Yorkshire terrier, Toy poodle, Cairn terrier, Pug, Pekingese) • 1° Hydrocephalus rare in cats	• **Occult, asymptomatic** • **Slow learner, dull, depressed** • Congenital (1°) hydrocephalus - **Seizures** - Visual deficits - Dementia - **Dome-shaped calvarium** • 2° hydrocephalus - Rapid progressive cerebral dysfunction (increased cranial pressure) . Depression, decreased mentation, head pressing, severe seizures, slowing of postural reactions, limb weakness, & hyperactive reflexes, blindness w/ normal pupil responses 	• **Hx (breed), CS** • Physical exam: opened fontanels not diagnostic - may be normal in breed - Bilateral divergent strabismus ("setting sun" sign) ocular mobility normal) • Radiographs: - **Enlarged & thin calvarium** - Loss of gyral pattern (ground glass cranium) - Contrast ventriculography definitive • CT scans: for size & shapes of ventricles • Ultrasound if opened fontanels diagnostic • EEG: high-voltage fast activity • CSF: normal usually **DDx:** • Lissencephaly • Metabolic encephalopathies • Other causes of seizures • Acute encephalitis • Porencephaly or Hydranencephaly • Nutritional disorders • Degenerative disorders • Inflammatory disorders 	• **Severe congenital: Tx futile** • **Obstruction** - Long term steroids - Diuretics (Lasix®) & osmotic agents (mannitol) • Surgery drainage: ventriculovenous & ventriculoperitoneal shunts • Anticonvulsants: phenobarbital **Prognosis:** • **Poor** if neurological signs - Damage to brain is permanent (dull & limited ability to learn) • Secondary: depends on cause

CSF in ventricular system or subarachnoid space, toy & brachycephalic
CS: Symptomatic, slow learner, seizures, dome-shaped calvarium
Dx: Hx (breed), CS; PE, Rads
Tx: Congenital - futile

Hydranencephaly Mk 579; H2B 252; Pa-T 338; NS-O 197: cerebral hemispheres replaced by CSF

Otocephalic syndrome: Rare; Beagles: group of head abnormalities (hydrocephalus, short lower jaw & others), Epilepsy & neuro signs

Lissencephaly, "Lhasa apso smooth brain" ★ M8k 900; E-hb 236; SAP 1136; H3B 280; H2B 252; IM 758; IM-WW 462; NS-C 138; NS-K 116; NS-Pa 73; NS-O 197, 131; NS-L 25, 265, 33 Sx-WW 285;	• Developmental abnormalities • **Smooth brain**: absent or limited number of cerebral convolutions: gyri & sulci • Cause: inherited in **Lhasa apso**, also reported in Wirehaired fox terrier, Irish setters & 1 cat • Onset: 1st year of life • Cerebellar hypoplasia may be concurrent **Smooth brain - Llaso apso - Dumb**	• **Dumb**: slow learners, may not be able to housebreak • Mild behavioral disorders (episodes of aggressiveness, growling at imaginary objects, confusions, hyperactivity) • Visual disorders: blindness • **Seizures** • Symptomatic at birth of shortly after 	• **Hx: Lhasa apso < 1 year old, CS** • EEG: slow-wave, high-voltage patterns, paroxysmal wave patterns • All other tests normal necropsy • Necropsy: smooth brain **DDx:** • Hydrocephalus • Metabolic encephalopathies - Hepatoencephalopathy - Toxic encephalopathies: lead - Hypoglycemia	• **Symptomatic** • **Anticonvulsants for seizures** Prognosis: **guarded** **Phenobarbital** 

Cerebellar hypoplasia, Panleukemia M8k 901; Mk 578; E-hb 279; SAP 1136; H3B 231; H2B 253; IM 743; IM-WW 462; 5min 431; E 616; Cat 1526; NS-C 325; NS-W 121; NS-K 113; NS-Pa 82; NS-O 197; NS-L 262; Sx-WW 288 ****** 	• **Cats & dogs** • Incomplete development of cerebellum at birth • Cause: - Genetic - In utero viral or toxic injury . **Feline panleukopenia virus** . **Herpes virus - puppies** - Idiopathic • Genetic: Irish setters, Airedales, Chows, also reported in Weimaraners, Dachshunds, Labs • Other CNS malformation (e.g., hydranencephaly) can occur	• Asymptomatic (some in litter affected, some not) • **CS present at birth** • Nonprogressive cerebellar signs - **Tremors** - **Ataxia: hypermetria, swaying, falling on turns - dancing kitten** - **Normal strength** - **Menace** • Fading kitten syndrome • No other neurological signs 	• **Classical CS, Hx** • R/O other dizs • Necropsy - confirmatory • MRI/CT: small cerebrum  **DDx:** • Cerebellar abiotrophy (progressive) • Lysosomal storage diz (CNS)	• **None available & in most, none needed** • Anticonvulsants if seizures (phenobarbital) **Phenobarbital** **Prognosis:** • **Good**: for most, mildly affected: functional pets • Not a progressive disorder & functional impairment usually mild, CS are static - pet may improve as learns to compensate
Cerebellar abiotrophy, Cerebellar malformations & degeneration ★ M8k 901; E-hb 280, 238; SAP 1136; H3B 235; H2B 254; IM 740; IM-WW 461; E 618; Cat 1527; Pa-T 368; NS-C 327; NS-W 120; NS-K 117; NS-hb 220; NS-Pa 85; NS-O 187, 188; NS-L 266; NS3hb 229	• **Group of inherited, slowly progressive degenerative dizs of cerebellum** - Frequently progressive - cell dysfunction & death • Onset: few months after birth • Breeds: **Kerry blue terriers**, Gordon setters, rough-coated Collies, Border collies, Bull mastiffs & others • Also reported in cats, not confirmed • Pathophysiology: premature aging & death of **Purkinje cells**	• **Normal at birth** • **Slowly progressive cerebellar diz signs** - Ataxia (hypermetria, crossing of legs, stumbling) - Tremors - Normal strength - Decreased menace • Slowly progressive - symmetric throughout life • Sequela: Eventually incapacitating	• Hx (age), CS • R/O other causes • Diagnostic test normal: cerebellum normal in size grossly, Films, CSF & EEG **DDx:** • Cerebellar hypoplasia (nonprogressive) • Lysosomal storage diz (CNS) • Encephalitis • Neuraxial dystrophy	• **None** • **Euthanasia** if disability great enough **Prognosis** • **Guarded**: usually not fatal, but may lead to euthanasia - Kerry blue: incapacitating illness in 20 weeks - Gordon setter: imperceptible progression - >7 years
Malformation of foramen magnum; Occipital dysplasia M8k 920; Mk 586; H3B 232; H2B 253; SAP 51; NS-C 354; NS-O 198; NS-L 28; NS-hb 221; NS3hb 231, 182; ★ 	• **Congenital abnormalities in size & shape of foramen magnum** • Pathophysiology - malformation results in: - Compression of cerebellum & spinal cord - Obstruction of CSF flow = hydrocephalus • Cause: Unknown • **Toy breeds** usually (Yorkshire terriers, Pomeranian, Maltese, Miniature & Toy poodles)	• **Asymptomatic usually** • Vary from cervical pain to seizures • **Tremor, ataxia**: hypermetria, swaying, falling on turning • Abnormal head posture (ventroflexion of head) • Mild at first, but may progress as repeated trauma 	• Hx, CS • **Radiography** for abnormalities - F.M: abnormally enlarged & misshapened - Abnormal occipitoatlantal joint • Myelography: not necessary • Necropsy - definitive **DDx:** • Atlantoaxial luxation • Cerebellar hypoplasia • Cerebellar abiotrophy (progressive) • Lysosomal storage diz • Encephalitis • Meningoencephalitis	• **Asymptomatic: none needed** • None available • Surgical correction has been tried unsuccessfully Prognosis: • **Guarded**, often progressive

Condition	Facts/Cause	Presentation/CS	Diagnosis

Seizures, Convulsion, Ictus, Fit - Epilepsy

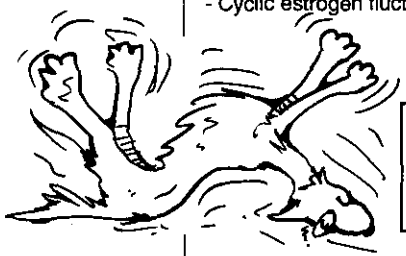
M8k 900; Mk 581, 580; E-hb 81; SAP 1147; H3B 220; H2B 243; I2M 988, 987; IM 761, 752, 416; IM-WW 89; Smin 144, 558; E 152; Cat 1518; F3M 389; DDx 449; Sx-S 1124; NS-C 119, 177; NS-W 95, 191; NS-K 41; NS3hb 313; NS-hb 296; NS-O 285, 123; NS-L 326; Sx-WW 287; Pys 257

**

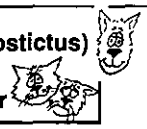
- **Involuntary, paroxysmal, synchronous discharge of neurons in brain manifested as uncontrollable muscular activity**
- **Epilepsy: condition of recurring seizures**
  - . 2-3% of dogs epileptic
  - . 0.5% of cats
- **Idiopathic epilepsy**: cause not found (#1)
  - . Dog: 80% of cases
  - . Cats: 50% of cases
- **Symptomatic epilepsy**: if cause found
  - . Extracranial causes
  - . Intracranial causes
  - . Acute symptomatic seizures: seizures w/in a week of known cause of seizure
  - . Remote symptomatic seizures: occurring weeks to months after known cause of seizures
- **Status epilepticus**: seizure lasting longer than 15 minutes or repeated seizures w/o recovery to consciousness
- **Cluster seizures**: 2 or more seizures occurring in same 24 hour period
- Facilitating conditions: drugs & physiologic states that lower seizure threshold
  - Phenothiazine tranquilizers (acepromazine)
  - Cyclic estrogen fluctuations

- **Seizures:**
  - **Aura/preictal**: short period just prior to seizure
  - . Behavior changes: **restlessness, crying, hiding**
  - **Ictus**: actual clinical seizure
  - . Brief < 2 min, but may be clusters of seizures: Abnormal consciousness, muscle tone, autonomic function, involuntary muscle movement, altered sensation & behavior
  - . **Tonic clonic generalized motor**: ↑ muscle tone (tonus) alternate w/ relaxation (clonus)
  - **Postictus**: period of neuronal recovery - variable length usually < 30 min.
  - . Behavior, weakness, dementia, pacing, blindness

DDx:
- Narcolepsy
- Syncope (fainting)
- Behavior disorders
- Transient vestibular attacks
- Neck spasms
- Myasthenia collapse

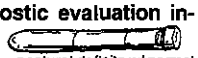


Idiopathic #1
CS: Seizure (Aura, Ictus, Postictus)
Dx: Hx, CS
Tx: Anticonvulsant, Monitor

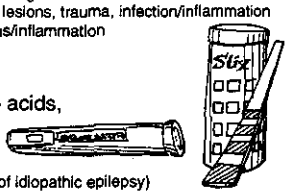


- **Many have only 1 seizure - so allow follow up & another fit before medication**
- **Goal differentiate idiopathic from symptomatic**
- Hx: seizure pattern (type & frequency, signalment)
  - Longer animal epileptic less likely to find cause
  - Interictal (between seizure) behavior (interictal dementia common in extracranial diz)
  - Previous trauma, CS of inciting cause
- Physical exam

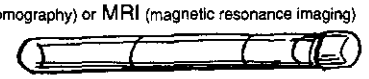
- **Neurologic exam - interictal**
  - Normal: Idiopathic, 1°, acquired, metabolic & toxic epilepsy & some structural causes
  - **if abnormal: a vigorous diagnostic evaluation indicted**



  - . Diffuse cerebral signs: altered consciousness, postural deficits w/ normal gait, cortical blindness, placing/propulsive behavior
  - .. Metabolic encephalopathy, toxic, hydrocephalus, lissencephaly, infectious/inflammatory diz, cerebral neoplasia
  - . Focal cerebellar? signs: contralateral proprioception & postural deficits, contralateral visual deficits, circling
  - .. Cerebellar tumors, vascular lesions, trauma, infection/inflammation
  - . Multifocal CNS signs: infectious/inflammation
- **Minimum data base:**
  - CBC
  - Biochemical profile, bile acids, fasting blood glucose
  - Urinalysis
  - +/- CSF (if highly suspected of idiopathic epilepsy)
  - Repeat data base before initiating anticonvulsant treatment



- **± EEG** (electroencephalography): interictal EEG abnormalities eliminate idiopathic so vigorously pursue etiology
- Skull radiographs: hydrocephalus, head trauma, or tumor
- Funduscopic exam: systemic illness or inflammatory diz
- Blood lead level in certain areas
- CT (computerized tomography) or MRI (magnetic resonance imaging)



Seizures - causes

- **Idiopathic** (most common - K9 & cats)
- Extracranial causes
  - Metabolic encephalopathies (endogenous toxins)
  - . Hypoglycemia
  - . Hypocalcemia
  - .. Eclampsia
  - .. Lymphocytic parathyroiditis
  - . Hepatic encephalopathy
  - . Uremic encephalopathy
  - . Hypoxia
  - . Thiamine deficiency
  - . Hypernatremia
  - . Moldy foodstuff
  - . Hypoparathyroidism
  - . Renal failure
  - . Acute pancreatitis
  - . Hyperlipoproteinemia
  - . Acid base balance/electrolyte disorders
  - Poisoning
  - . Ethylene glycol
  - . Lead
  - . Organophosphates
  - . Carbamate
  - . Chlorinated hydrocarbons
  - . Metaldehyde (slug bait)
  - . Mycotoxins
  - . Strychnine
- Intracranial
  - Primary epilepsy
  - Trauma
  - Encephalitis
  - Tumors - 1° & 2° (metastatic)
  - Inflammatory dizs
  - . Viral: Canine distemper (K9), Feline infectious peritonitis (F)
  - . Bacterial - Brain abscesses
  - . Polioencephalomyelitis (F)
  - . Toxoplasmosis
  - . Fungal (cryptococcosis)
  - . Granulomatous meningoencephalitis
  - . Pug dog encephalomyelitis
  - . Rabies, Aujesky's diz
  - Infarction
  - Lysosomal storage diz
  - Congenital: Hydrocephalus, Lissencephaly

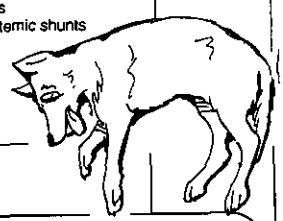
- **Classification of seizures**
  - **Generalized seizure**: bilaterally symmetric in brain, no localization, unconsciousness, #1 in dog
  - . **Generalized convulsive**: involuntary, uncontrolled motor activity
  - .. **Grand mal seizure**: most common - involves entire body (major motor, tonic-clonic), ± autonomic release, always lose consciousness
  - . **Generalized nonconvulsive (absence/petit mal) seizure**: loss of consciousness & muscle tone (transient collapse [confused w/ narcolepsy]), rare in animals
  - **Partial (focal/local) seizure**: start from a focus in cerebral motor cortex, Asymmetric clinical manifestations, May progress to generalized seizure, Almost invariably acquired
  - . **Simple partial asymmetric**: local muscle involvement
  - . **Partial complex (psychomotor, temporal lobe, limbic) seizures**: alteration of consciousness + abnormal behavior (Running fit, Fly catcher, Tail chaser, Rage syndrome [Springer Spaniel])

Causes < 6 months old

- Juvenile epilepsy
- Inflammatory/infectious dizs
  - Canine distemper
  - FIP
- Toxicities
- Trauma
- In utero insults (acquired epilepsy)
  - Trauma, hypoxia at birth, metabolic disorders, encephalitis
- Metabolic disorders
  - Hypoglycemia
  - Hepatic-portosystemic shunts
- Congenital
  - Hydrocephalus
  - Lissencephaly
  - Lysosomal storage dizs

Causes 6 mo - 5 yr old

- **Idiopathic epilepsy**
- Inflammatory/infectious dizs
- Metabolic disorders
  - Hepatic-portosystemic shunts
  - Hypocalcemia
- Viral encephalitis
- Toxicity
- Trauma
- Acquired epilepsy

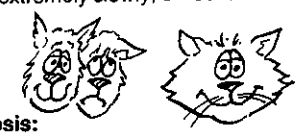


Causes > 5 years old

- Cerebral neoplasia (1° & 2°)
- Metabolic disorders
  - Hypoglycemia: insulinoma
  - Hepatic: end stage liver diz
- Acquired epilepsy
- Toxins
- Trauma

Treatment:
- Treat cause if found; if not, treat seizure
- When to start treatment? Arbitrarily
  - At least 3 seizures - make sure epileptic
  - > One seizure every 6 weeks
  - Cluster of seizures once every 8 weeks
  - Status epilepticus (any cause)
- **Define goals to client**: complete control not expected, control = 50% ↓ in seizure frequency w/o toxic reaction
  - Relapses common
  - Give client calender for recording seizures & visualize achieving goals

- **Phenobarbital (PB)**: only anticonvulsant w/ proven efficacy, DOC in dogs & cats
  - First line (> 60% of dogs can be controlled w/ PB)
  - Increase in increments & **monitor** PB serum levels & liver enzymes
  - . Goal PB serum levels of 100-120 µmol/l (140 toxic)
- Potassium bromide (KBr) added to PB if toxic levels (>130 µmol/l), or toxicity reached (elev. liver enzymes) & seizures not controlled
  - Monitor PB & KBr levels at 6 wks & 5 months; may take 4 months for KBr to reach steady state (10-20 µmol/l)
- Other antiepileptic drugs: appear to be less effective & have greater side effects - primidone; phenytoin, diazepam (Valium®), diphenylhydantoin (Dilantin®), Valproic acid
- Diazepam (Valium®): effective long term in cats only
- Stop medication only after minimum of 12 months seizure free
  - Stop extremely slowly, 3 weeks to 6 months



Prognosis:
- **Guarded to good**; 50-80% success of antiepileptic Tx
- Worse prognosis: complex partial seizures w/ 2° generalization

Seizures

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Idiopathic epilepsy, Primary epilepsy M8k 900; SAP 1147; I2M 997; IM 752, 761; 5min 558; H2B 244; NS-W 119; NS3hb 316; NS-hb 299; NS-L 332; NS-O 123 ***	• **Cause: unknown as name implies** - ? Imbalance in neurotransmitter levels? • **#1 cause of epilepsy in dogs & cats** - 80% of cases in dogs - 50% of cases in cats? • 6 months - 3 years old • Younger at onset, more severe • Large breeds: severe & in clusters	• **Generalized tonic -clonic seizures** - Ictus: falls over unconscious . Limbs rigid, opisthotonus, running or paddling, chewing movements . ANS: salivation, defecation, urination . < 2-3 min - Postictal: disoriented, confusion, pacing, blindness - Normal interictal period • ± Loss of consciousness • Recur: in weeks to months • Frequency may increase w/ age • Clinically normal between seizures	• Hx (**age**) repeated seizures w/ no demonstrable cause • Diagnosis made by exclusion • Normal physical, neurological, ophthalmologic exams • Normal CSF • Interictal ECGs normal	• **None** may be needed if only one seizures of mild, short infrequency • **Anticonvulsant - phenobarbital** Prognosis: ??
#1 cause in dogs & cats **CS: Generalized tonic -clonic seizures** **Dx: Hx (age)** **Tx: None, Anticonvulsant - phenobarbital**				• Breeds: inherited in Germ. shepherd, Belgian Tervuren, Keeshond, Beagle, Dachshund; recognized in St. Bernard, Cocker spaniel, Irish setter, Siberian husky, Miniature poodle, Wirehaired fox terriers, Lab, Golden retriever, sporadic in all breeds of dogs & cats
Juvenile epilepsy IM 761; H2B 244	• **Unknown etiology** - **Severe form** of idiopathic epilepsy • < 16 weeks of age at onset • Breed predisposed: **Cocker Spaniel** • Rule of Thumb: the older the puppy (>16 weeks) at the onset of seizures, the more likely he will become an adult epileptic, or the least likely he will grow out of it	• **Severe epilepsy**: frequent seizures per week, to status epilepticus - Generalized tonic-clonic, no lateralizing signs	• No abnormality in the data base except those related to age • CSF: normal	• **Phenobarbital** BID, increases until serum levels are 100-120 umol/L - Check PB levels every ? weeks until desired level reached - Puppy has a different metabolism for the drug - After 6 months seizure-free, wean the animal off Prognosis: **Good** once status epilepticus or clusters under control. These puppies grow to be normal dogs free of drugs & seizures usually
Acquired epilepsy H3B 220; H2B 243; I2M 998; IM 761	• **Prior insult** (inflammatory, traumatic, toxic, metabolic or vascular) - Alters a focus of neurons - spontaneous discharge - seizure • In utero or perinatal insults	• **Partial seizures only or partial seizures that generalize**	• **Hx of previous** insult 6 months to 3 years before seizure, usually cause can't be determined • Neuro exam, blood tests, CSF usually normal • ECG often abnormal (different from idiopathic)	• **Anticonvulsant - phenobarbital**. No matter how bad it looks, attempt treatment as nervous system very "plastic" in young Prognosis: may be better than for idiopathic in large breeds

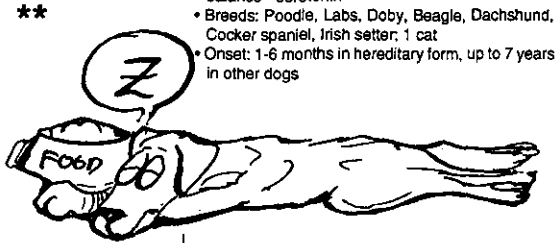
Status epilepticus & Cluster seizure SAP 1153; H3B 220; I2M 1001; IM 757, 763; 5min 146; NS-O 298; NS-L 337 **	• **Status epilepticus**: seizure lasting longer than 15 minutes or repeated seizures w/o recovery to consciousness - Specific causes of most unknown, systemic metabolic derangement & inflammatory brain injuries may predispose - **Cluster seizures**: 2 or more seizures occurring in same 24 hour period • Sequela: - Permanent neuronal damage if continuous seizure > over 20 min - Hyperthermia, lactic acidosis, hypoxemia, cardiac arrhythmias, pulmonary edema, death	**DDx:** • Vestibular diz • Narcolepsy • Tetanus • Hypocalcemia • Hypoglycemia • Organophosphate poisoning
Metabolic encephalopathies SAP 1147; H2B 245; NS-L 328; NS3hb 318; NS-hb 302 **	• Changes in metabolic state of brain can change available precursor for neurotransmitters; Reversible seizures once underlying disorder corrected • Hypoglycemia: rare but #1 metabolic seizures, Insulinoma: dog > 5 years-old, transient & recurrent juvenile hypoglycemia < 4-5 months old • Hepatic encephalopathy • Hypocalcemia: rare (Eclampsia, Lymphocytic parathyroiditis)	
Inflammatory/ infectious dizs * H2B 243; NS3hb 318; NS-hb 302	• **Viral dizs**: Canine distemper, Feline infectious peritonitis; Protozoal dizs - toxoplasmosis, Fungal dizs; All subacute progressive dizs • CS: ± Systemic signs, Canine distemper: "chewing gum" seizures • Dx: Hx, CS; Abnormalities on the physical, neurological or funduscopic examinations; CBC, profile, U/A; Abnormal CSF: ↑ cells & protein, ± organisms (cryptococcus), often normal in canine distemper; ECG; Serology: toxoplasmosis, FIP, canine distemper • **Treat primary etiology & apply symptomatic treatment for seizures** • Prognosis: Guarded to poor	
Cerebral neoplasia - seizure * H2B 243; NS3hb 318, NS-hb 302	• Thalamocortical tumor, 1° gliomas: Boxer, Boston terrier; Meningioma: nonbrachycephalic breeds, cats • CS: **Seizures & behavior changes**; ± Other cerebellar signs (contralateral conscious proprioception & postural deficits, gait often normal, ± contralateral visual deficit, altered conscious level, circling) • Dx: Skull radiographs, CSF: increased pressure & or protein w/ normal WBC, neoplastic cells rarely seen; Thoracic radiographs for metastasis, CT (computer tomography) diagnostic • Tx: **Refractory to treatment** • Prognosis: **Grave**	
Toxicities H2B 243; NS3hb 319, NS-hb 302, 346 *	• **Extracranial seizurogenic toxins**: Slug bait, Spoiled dairy products (mycotoxins), Strychnine (rare), Lead poisoning • Toxin accumulated in the cerebrum causes the seizures; thus **continuous seizure** activity until treatment is applied • CS: Generalized tonic-clonic, Muscle fasciculation (shaking, trembling of hind limbs progressing to whole body & then convulsions, ataxia, altered level of consciousness, GI Signs, normal interictal period, Lead: pyschomotor seizures: hysteria w/ excessive crying, barking & running • Tx: **Diazepam** IV or rectally as a bolus followed by diazepam infusion 5-20 mg/hr until seizure activity has stopped for 4 hours	

Treatment status epilepticus

- Establish seizure as in preceding page, Rule out DDx
- Catheterization - IV
- **Pentobarbital, check serum drug levels**, if inadequate (<15-45 mg/l) adjust dose
- Initial Tx
  - **Thiamine** (B-complex vitamins) & dextrose for 1st time epileptic
  - IV fluids if confirmed idiopathic epileptic
- **Antiepileptic** if above doesn't control - IV for most
  - Phase 1
    - . **Diazepam** (Valium®) bolus IV + **Phenobarbital** IV slowly
    - .. Diazepam short acting, PB onset in 15-30 min
    - . ± Steroids (dexamethasone) to minimize edema, necrosis & inflammation of brain
  - Phase 2
    - . **Maintenance phenobarbital** started if seizure controlled by above
    - . If seizure continues at lower frequency: Valium® q6h for 48 hours & maintenance PB
    - . If seizure last longer than 60 sec - additional dose of Valium®
  - Phase 3: for refractory patients
    - . **Diazepam drip**
    - . If 3 or more seizures during Valium® drip
    - .. Phenobarbital IV bolus to achieve general anesthesia for 24 hours
- **Supportive care**
  - **Oxygen therapy**
  - Soft bedding & repositioning/2 hours
  - Temperature, pulse/EEG monitoring

Narcolepsy

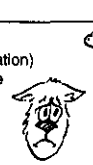
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Narcolepsy/ Cataplexy, Sleep disorders M8k 900; SAP 1154; H3B 228; H2B 323; 5min 867; E 157; DDx 451, 452; Cat 1561; NS-O 299; NS-L 337, 88; NS-C 223; NS-W 92, 119, 196; NS3hb 325; NS-hb 308; Sx-WW 287; Pys 257 **	• **Cataplexy: sudden loss of muscle tone resulting in collapse** - Motor inhibition of short duration - Completely reversible - Initiated by: excitement (eating, playing, sexual arousal) • **Narcolepsy: excessive daytime sleeping, disturbed nocturnal sleep** - If not associated w/ cataplexy difficult to diagnosis - Pathological rapid eye movement (REM) sleep • **Usually transient & of short duration** • Cause: unknown, genetic • Pathophysiology: abnormalities in neurotransmitter balance - serotonin • Breeds: Poodle, Labs, Doby, Beagle, Dachshund, Cocker spaniel, Irish setter; 1 cat • Onset: 1-6 months in hereditary form, up to 7 years in other dogs	• **Sleep episodes at inappropriate times** - Stimulation (restraint, feeding, change in environment) - Stimulation = falling down & appear comatose, muscles hypotonic (seconds to 30 min.) - Arousable usually - REM (rapid eye movement) sleep: ocular motility, twitching of facial muscles, whining - ± many episodes in one day - ± Remain alert • **Cataplexy: sudden loss of muscle tone resulting in collapse** • Animal appears normal between episodes	• Hx (**attacks stimulated by eating**), CS • Food cataplexy test: watch dog eat; cataplexy have 2-20 attacks while eating • Pharmacological tests - **Yohimbine challenge**: positive if 90% reduction of attacks (4 hours duration) - **Imipramine challenge**: improves arousal - Physostigmine challenge: causes increase in number & duration of episodes - Atropine response: marked ↓ in attacks **DDx:** • Cataplexy - Myasthenia gravis - Hypoglycemia - Hypocalcemia - Adrenal insufficiency - Polymyositis - Nonmotor epilepsy - Syncope - Cardiac arrhythmias - Hypokalemia - Partial seizures • Narcolepsy - Hypothyroidism - Chronic hypoxia - Obesity - Other metabolic illnesses	• **Incurable disorder** • Drugs to reduce severity - **Yohimbine (Yobine®)**: current drug of choice, alpha adrenergic blocker - Imipramine (Tofranil®) (0.5 mg/kg) anticataleptic drug - Methylphenidate (Ritalin®) general stimulant, supplement to imipramine - Dextroamphetamine (Dexedrine®): supplement to imipramine • Contraindicated: MOI (monoamine oxidase inhibitors) • Avoid dangerous activities: swimming, free roaming **Prognosis:** • **Good**: not a fatal diz - Many improve w/ age • Guarded for cure: may remain symptomatic, treatment expensive

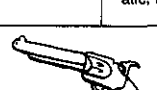


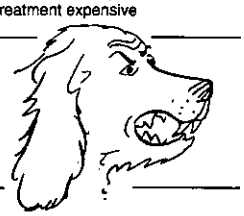
Sudden collapse w/ excitement, Sleep episodes, normal between episodes
Dx: Hx, CS
Tx: Incurable disorder, Yohimbine

Rage syndrome - Springer spaniel
NS-L 323; NS-W 119

- **Episodic rage behavior in Eng. springer spaniels**; normally well-behaved, Onset 1.5 years old, Cause unknown
- CS: **Episodic rages** of seconds to few minutes, return to normal inbetween. Snapping & marked bilateral mydriasis (dilation) w/ glazed appearance to eyes, few tremors in pelvic limbs; wag tail, growl & bite animate objects, crouching under table
- Dx: Hx (**spaniel**), CS; no measurable abnormalities
- Tx: High levels of **progestins (Ovaban®) & vigorous training program**, but neither completely eliminate aggression, **Euthanasia**
- Prognosis: **Poor** for complete elimination of aggression







Lysosomal storage dizs, LSD, Degenerative diz

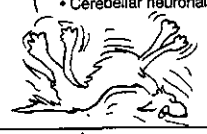
M8k 900, 907; Mk 582, 591; SAP 1145; H3B 233; H2B 255, 279; IM 759, 744, 788; IM-WW 460; E-hb 280; E 617, 676, 708; 675; 5min 87; Cat 1527; NS-C 139, 223; NS-W 114, 154, 220, 224; NS-K 119, 124; NS3hb 341; NS-hb 285, 322; NS-Pa 214; NS-L 296, 271; NS-O 185; Pa-T 341
*

- **Rare**
- **Progressive multifocal neurological disorders**
- Metabolic storage diz due to inherited enzyme deficiencies causing neuronal death or demyelination of axons
  - **Accumulation** of nonremovable substrates causing **loss of function** of affected cell
  - Autosomal recessive pattern
- Most likely in purebred dogs w/ inbreeding
- **Only single member of litter effected**
- Classification:
  - Lidoses: defect in degradation of lipids
  - Leukodystrophies: defect in degradation of myelin
  - Glycogen storage disorders: inability to metabolize glycogen
- Pathophysiology:
  - Lysosomes: packets of hydrolytic enzymes
  - Genetic enzyme defects w/in lysosomes
  - Material builds up in lysosomes resulting in cell death
  - Neurons affected most because they don't divide

- **Normal at birth**
- **Signs develop in 1st year, progressive**
- Disseminated process
  - **Ataxia, tremors**
  - **Paresis**
  - **Visual loss**
  - **Seizures**
  - **Behavioral changes/mental status**
- **Multisystem** (liver, skin, hemopoietic)
  - Failure to grow, corneal opacity, hepatosplenomegaly, blunt-broad facial features

- Hx, CS
- Lab
  - Abnormal storage products in cells & tissues
  - Blood WBCs - vacuoles or metachromatic granules
  - Bone marrow aspirates
  - Aspirates of bone marrow, liver, lymph node abnormal storage material
- Necropsy - histo: to confirm

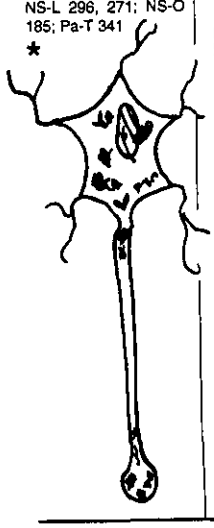
DDx:
- Inflammatory CNS diz
- Hydrocephalus
- Lissencephaly
- Cerebellar hypoplasia
- Cerebellar neuronal abiotrophy



- **None: always fatal by 4-6 months of CS**

Prognosis:
- **Grave: always progressive & fatal**

Rare, Progressive multifocal neuro dizs
CS: 1st year, Progressive, Multisystems
Dx: Hx, CS, Lab
Tx: None, always progressive & fatal



Globoid cell leukodystrophy, Krabbe's diz
- **See pg 573**: Cairn terriers, West Highland white terriers, Beagles, Blue tick hounds, Poodles
- Onset: 11-30 weeks
- CS: Ataxia, intention tremors, dysmetria, paresis, visual deficits, seizures, behavioral changes
- Lesions: CNS only

Ganglioside Gm1, NormaNS-Landing diz, Derry's diz
- **Beta galactosidase deficiency**
- Breed: Siamese, Korat, DSH cat; Beagles, mixed breed dogs
- Onset: < 6 months
- CS: Ataxia, tremors, paresis, visual deficits, seizures, behavioral changes
- Lesions: Cornea, Retina, Liver, Pancreatic acinar cells

Ganglioside GM2, Tay-Sachs diz, Sandoff's diz
- **Hexosaminidase deficiencies**
- Germ. Shorthaired pointers, DSH cats
- < 6 months
- CS: **Dwarfism, Corneal opacity**, Ataxia, tremors, paresis, visual deficits, seizures, behavioral changes
- Lesions: CNS, liver, bone marrow, spleen, kidney

Sphingomyelin lipidosis, Neimann-Pick diz
- Sphingomyelinase deficiency
- Siamese, DSH cats
- Onset: 3-6 months
- CS: **Stunted growth**, Ataxia, tremors
- Lesions: CNS, liver, lung, spleen, lymph nodes, kidney, bone marrow, adrenal glands

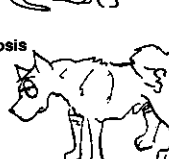
Glucocerebrosidosis, Gaucher's diz
- **Glucocerebrosidase deficiency**
- Sidney silky terriers
- Onset 7 months
- CS: Ataxia, hypermetria
- Lesions: CNS, liver

Metachromatic leukodystrophy
- Cats
- Onset: 2 weeks old
- CS: Seizures, opisthotonus

Neuronal ceroid lipofuscinosis
- English setters, DSF cats
- Onset: 14-18 months
- CS: Mental changes (dementia, depression), ataxia, tremors, paresis, visual deficits, seizures, behavioral changes
- Lesions: CNS, lymph nodes, salivary glands, prostate, kidney

Cavitating leukodystrophy
- Dalmatians
- Onset: 3-6 months
- CS: Decreased vision, ataxia, progressing to paresis
- Lesions: CNS only

Glycogen storage diz, Glycogenosis
- Lapland terrier, DSH, Toy breeds, Akita, German Shepherd
- Onset: 6-12 weeks
- CS: recurrent episodes of hypoglycemia: incoordination, weakness, collapse, muscle tremors, seizures



Encephalitis

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Inflammatory brain disorders, Infectious encephalitis Mk 608; E-hb 280; Sap 1140, H3B 236; H2B 260; I2M 1007; IM 760; 5min 544; NS-C 127; NS-K 59; NS-Pa 102, 144; NS-C 127; NS-O 216; NS-L 381; NS3hb 299; Sx-WW 286	• **Inflammation of brain tissue** • **#1 disseminated brain disorder** • Often associated w/ meningitis • Often also affects the eye (most commonly in viral & granulomatous diz)	• **Acute multifocal neuro diz, generally progressive** - **Cerebral:** seizures, dementia, visual deficits, weakness, interictal neuro abnormalities - **Brain stem:** cranial nerve deficits, head tilt, nystagmus, coma - **Cerebellar:** ataxia, head & limbs, tremors, torticollis • Suspicious but not pathognomonic CS of cause - Myoclonus (chorea): canine distemper - Optic neuritis: canine distemper - Extreme, erratic behavior: rabies - Intense pruritus: pseudorabies • **Systemic organ involvement**	• Hx, CS (multifocal) • **CSF: diagnostic test of choice** - Increased WBCs (highest in granulomatous & bacterial diz) - ± Eosinophils: systemic fungal, protozoal or parasitic - Lymphocytes predominate in viral infections - Increased protein - minimal in viral (distemper & rabies) - Organisms - bacterial & fungal - culture difficult, negative doesn't R/O • **Ophthalmoscopic exam** - Concurrent chorioretinitis, uveitis, corneal changes • Serology: test for antibodies - Time limitation & less reliable than CSF • CT/MRI: more helpful for mass lesion than disseminated inflammation • Necropsy	• **ABs IV** (cross blood brain barrier) - **Ampicillin** (initial drug of choice), penicillin G, chloramphenicol, cefoxitin, cefotaxime, trimethoprim sulfa, metronidazole • **Antifungal:** amphotericin B (Fungizone®), Flucytosine (Ancobon®), Ketoconazole (Nizoral®), rifampin • **Steroids:** not for infectious diz - Recommended for idiopathic, immune-mediated or meningitis & vasculitis • General supportive - Fluids - Anticonvulsants: phenobarbital • If brain crisis - edema w/ herniation - Diuretics, mannitol Prognosis: • **Poor to guarded** - Bacterial & rickettsial may resolve w/ long term Tx - Rabies, canine distemper, FIP, pseudorabies, & prototheocosis invariably fatal - Some agents not found until necropsy(infectious canine hepatitis, pseudorabies, encephalitozoonosis, Neosporum - Mycotic & protozoal difficult to treat morbidity & mortality high - Neonatal herpes infection: often mild, self limiting - Postvaccinal: usually fatal • Residual neurological deficits may be seen if recover

Dog: Causes encephalitis
- Canine distemper
- Infectious canine hepatitis
- Granulomatous meningoencephalitis?
- Systemic fungal diz
- Toxoplasma, encephalitozoonosis, trypanosomiasis, babesiosis
- *Neosporum caninum* encephalitis
- Rabies
- Pseudorabies
- Prototheocosis
- Ehrlichiosis, salmon poisoning
- Bacterial (rare)

Cats: Causes encephalitis
- FIP
- Toxoplasmosis
- Systemic fungus (cryptococcosis)
- Rabies
- Pseudorabies
- Bacterial (rare)

DDx:
- Other multifocal diz
  - GME
  - CNS lymphosarcoma (reticulosis)
  - Larval migrans
  - CNS toxins
- Infectious meningitis

#1 disseminated brain diz
CS: Multifocal CNS
Dx: Hx, CS, CSF
Tx: Tx cause

Encephalopathy due to sepsis NS-W 117; SAP 1142 **	• **Septicemia may cause encephalopathy** - CNS microabscesses; infarction & hemorrhage - No serum biochemical changes or any recognizable cause for diz - Intoxication from by-products of bacteria & WBCs	• Sepsis - Fever - Shock • CNS: - Acute ↓ in consciousness - Multifocal seizures	• Hx (septicemia), CS • CBC: Neutropenia w/ degenerative left shift • CSF: usually normal • EEG: diffuse or multifocal abnormalities	• Correct underlying septicemia • Supportive therapy
Toxoplasma * encephalitis, Toxoplasmosis Mk 590; E-hb 192, 305; H2B 260; I2M 1015; IM 774; IM-WW 466; NS3hb 388; NS-C 153; NS-W 118; NS-K 71; NS-Pa 163; NS-O 235; NS-L 191	• **Rare** • ***Toxoplasma gondii:*** ubiquitous protozoa - Definitive host: cat - Intermediate hosts: amphibians, fish, reptiles, birds & mammals • **Encephalitis rare unless immunosuppression** • Disseminated or multifocal CNS diz dog, rare in cat	• **Hyperexcitability**, depression, tremor, intention tremor, ataxia • **Seizures** • Pelvic limb paresis (UMN &/or LMN) • Rigid hyperextension & pronounced atrophy of pelvic limbs • ± Systemic signs: retinochoroiditis, myositis, lymphadenopathy, cholangiohepatitis, pancreatitis, intestinal granuloma, abortion, neonatal diz, gastroenteritis, pneumonia, hepatitis, retinitis, febrile illness	• **Antemortem Dx difficult** • Microscopic identification • Serology: rising titers in paired sera or high single sera • FeLV & FIV test in cats • Fecal exam for oocytes (shed for only short time)	• **Sulfonamides** w/ or w/o pyrimethamine & clindamycin at near toxic doses **Prognosis: guarded** once CNS signs
Brain abscess E-hb 280; SAP 1134; H2B 261 123; E 609; NS3hb 386; NS-hb 107; NS-Pa 156; NS-O 231 *	• **Rare in dog & cat** • Focal or multiple accumulation of pus in CNS; any place in brain esp. cerebrum & hypothalamus • Causes: - Extension from otitis interna - Extension from chronic sinusitis (frontal lobe) - Migrating foreign bodies • Pathophysiology: - Rapidly progressive mass lesion - ± Necrosis & edema of adjacent neural tissue	• Acute to subacute - rapidly progressive • Focal relation to location • ± Systemic symptoms (malaise, fever) • Sequela: brain herniation	• **Hx (previous inner ear, respiratory or oral infection)** • Neuro exam: focal deficits • CSF: (test of choice) - ↑ cells (PMNs) - phagocytized material - ± Cultures & gram stain • Elevated protein - globulin - normal if extradural • CT/MRI: appear similar to tumor or hemorrhage	• **ABs:** trimethoprim/sulfa, chloramphenicol, ampicillin) 1 month past cessation of signs • Steroids contraindicated • Surgical drainage is impractical in most cases • If herniation suspected: steroids & mannitol Prognosis: • **Grave**

Rare
CS: Hyperexcitability; Seizures
Dx: Antemortem Dx difficult
Tx: Sulfonamides

DDx:
- Trauma
- Vascular injury (not progressive)
- Tumors (not as rapid)
- Granulomas
- Aberrant parasite infections

Rare, Pus in brain
CS: Rapidly progressive, focal signs, ± systemic; Sequela: brain herniation
Dx: Hx, Neuro exam, CSF
Tx: ABs, Px: Grave

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Metabolic encephalopathies H3B 245; H2B 263; SAP 1144; IM-WW 462; E-hb 277; E 613; F3IM 373; NS-W 116; NS-hb 274; NS-O 255, 380, 131 ***?	• **2° impairment of CNS** • Usually cause bilateral, diffuse dysfunction of cerebrum (high energy requirement) • Pathophysiology: - Disturb ideal environment for CNS neurons (composition of blood, integrity of blood brain barrier, electrolytes, acid base etc.) - Encephalopathy frequent sign of underlying diz	• **Cerebral signs**: diffuse, symmetrical - **Altered consciousness (confusion, delirium, stupor, coma)** - ± **Seizures** • Oculomotor abnormalities (random roving eye movements, normal light reflexes) - ± Dilated pupils • Abnormal motor responses - Spasms, of rigidity, tremors, paratonia or flaccidity • Abnormal respirations - Hyperventilation: hepatic encephalopathy, diabetic ketoacidosis, uremia, hyperadrenocorticism - Hypoventilation: ethylene glycol coma	• **Hx, CS** • Physical/neuro exam - Altered mentation w/ normal pupillary reflexes & ocular mobility - Absence of localizing asymmetric deficits • Tests: for underlying illness R/O, work up seizures	• **Correct underlying cause** Prognosis: • **Good** if correct underlying problem

Causes of metabolic encephalomyopathies

- Energy depriving
  - Hypoxia, ischemia: oxygen
  - **Hypoglycemia**: glucose
- Endogenous neurotoxins
  - **Uremia**: renal failure, urinary obstruction
  - **Hepatic encephalitis**/Hyperammonia (portosystemic shunts, liver failure) - ammonia
- Endocrine dysfunction
  - **Hyper- or hypoadrenocorticism**
  - **Thyrotoxicosis or hypothyroidism**
- Biochemical imbalances
  - Acid-base abnormalities: hypercapnia, bad acidosis or alkalosis Tx
  - Osmolality changes:
    - . **Hyposmotic states: diuretic** Tx, hyponatremia, fluid Tx
    - . **Hyperosmotic states**: hypernatremia, hyperglycemia
  - Electrolyte disturbances: **hyper- or hypocalcemia**
- Exogenous neurotoxins, nutritional deficiencies
  - Toxins: molds, sedatives, salicylates, anticholinergics, ethylene glycol
  - **Thiamine deficiencies**
- **Hyperthermia** (heat stroke); **Hypothermia**

DDx:
- Diffuse encephalitis
- Encephalopathies (poisoning, hydrocephalus, canine distemper, idiopathic epilepsy, encephalitis
- 1° CNS disorders
- Hydrocephalus
- Certain brain tumors

Hypoxia - cerebral: Reduction in oxygen to brain; Intrinsic safeguards usually protect brain from hypoxia. Causes: anemia: toxins (carbon monoxide, nitrates [rare small animals]), ↓ tissue utilization (ex. cyanide toxicity), cerebral ischemia (stagnant hypoxia), cardiac arrest (ex. anesthesia, syncope), cerebral infarction in cats; Pathophysiology: cell damage = edema ± brain herniation
- CS: **Cerebral signs**: stupor or coma, seizures, blindness, paralysis w/ decerebrate rigidity, deafness
- Tx: **Supplement oxygen** - Partially or wholly reversible

Acidosis: pH of atrial blood < **7.4**; Cause: respiratory acidosis (↑ carbon dioxide - pulmonary dysfunction), metabolic acidosis (accumulation of acids; shock, diabetes mellitus, uremia)
- CS: **Depression, delirium or coma**
- Tx: Correct underlying diz, bicarbonate given slowly

Alkalosis: When **ph > 7.4**; Cause: respiratory alkalosis (↓ carbon dioxide) or metabolic alkalosis (low or sequestration of body acids); most commonly from chloride loss from **vomiting** or sequestration
- CS: Less pronounced than acidosis: transient confusion, muscular weakness

Hyperthermia, heat stroke: high temperature may cause cerebral edema
- CS: **Fever** 105-111°F (40.6-43.9°C); salivation, tachycardia, polypnea, injected mucous membranes, sweating & panting
  - Prolonged heat: cerebral edema, disseminated intravascular coagulation, stuporous, pale, petechiae, death ensues.
- Tx: **Lower body temperature**: spraying or submerging in cold. Monitor rectal temperature - not to fall below 103°F (39.5°), Steroid or mannitol if CSF signs

Hypothermia: cold ambient temperatures or prolonged anesthesia
- Causes reduced brain blood flow & oxygen uptake
- CS: Temp < 90°F (32°C), altered mental attitude, cardiac arrhythmias
- Tx: **Blankets**, warmed fluids, water bottles, electric heating pads may cause peripheral vasodilation & internal cooling

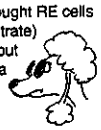
Other: see below & next pages

Granulomatous meningoencephalitis, GME, Granulomatous meningoencephalomyelitis, Reticulosis; Inflammatory reticulosis, Histiocytic encephalitis, Neoplastic reticulosis, Ocular reticulosis **

Mk 589; E-hb 283; SAP 1140, 1158; I2M 1010; IM 770; H3B 237; H2B 267; E 625, 659; IM-WW 299; 5min 824; I-G 862; NS-C 156, 285; NS-W 118, 150; NS-Pa 110; NS3hb 390, 382t, 361; NS-hb 335t; NS-♂ 228, 233; NS-L 382

#2 CNS-itis, ?
CS: CNS
Tx: Steroids Px: Grave

- **Progressive nonsuppurative meningoencephalomyelitis**
- **#2 inflammation of CNS** (dog), canine distemper encephalitis #1
- **Cause: unknown (idiopathic)**
  - ? immunologic, infectious agent?
- Lesions: disseminate or focal
  - **Massive accumulation of histiocyte-like cells around blood vessels** (perivascular accumulation of mononuclear cells throughout brain, spinal cord & meninges)
  - Lesions tend to coalesce - focal or multifocal masses
- Forms: disseminated, focal or ocular
  - Focal form: brainstem, cerebral cortex, cerebellum, spinal cord
  - Disseminated form: lower brainstem, cervical spinal cord, meninges
  - Systemic rare, eye form occurs
- Incidence: females, small breeds, poodle & poodle mixes, 1-6 years (any age)
- **Dogs, not in cats**
- Called reticulosis because thought RE cells (mononuclear-phagocytic infiltrate) (reticuloendothelial system), but really GME or CNS lymphoma can cause infiltrate



- **Variable depending on location**
- Continuous or episodically progressive
- **Forms:**
  - **Focal form**: mimics expanding mass, CS reflect site
  - Disseminate form: rapidly progressive, fever & peripheral neutrophilia but no other systemic signs
- Multifocal - various CNS signs
- **Cerebral signs**: seizures, dementia, behavioral changes, circling
- **Brain stem**: loss of balance, head tilt, cranial nerve paralysis, blindness, facial & trigeminal paralysis
  - Hemi- or tetraparesis, nystagmus
- Meningitis, neck pain & fever
- ± intermittent fever
- **Ocular form**: blindness, dilated pupils - unresponsive to light, rarest form & slowest progression

- **CS: acute onset of disseminate encephalitis**
- Histopathology to confirm
- Tentative Dx: CS, CSF & R/O others
- CSF: elevated WBC - mononuclear (800 ± 300/µl) no eosinophils, elevated protein (40-1000 mg/dl)
- EEG: diffuse multifocal cerebral involvement
- Postmortem to confirm
  - Perivascular accumulation of lymphocytes, plasma cells & histiocytes - **tumor like masses**

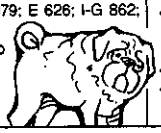
DDx:
- CNS lymphosarcoma (reticulosis)
- Acute renal degeneration (toy breeds)
- Infectious encephalitis
- Other neoplasia
- Metabolic encephalopathies & toxins

- **Steroid** - lifetime may improve CS for days to years, not curative
- Cyclophosphamide & azathioprine being evaluated
- Radiation therapy - experimental

Prognosis:
- **Grave**: generally progressively **fatal** diz, disseminate: 25% die in 1 week
- Survival time generally short 2-8 months

Pug encephalitis *

M8k 900; E-hb 284; SAP 1141; H3B 238; H2B 268; I2M 1011; IM 771; IM-WW 469; 5min 979; E 626; I-G 862; NS-C 34t, 157; NS-W 119; NS-hb 358t; NS-Pa 111; NS-L 384; NS-O 229



- Chronic granulomatous meningoencephalitis
- **Only reported in pugs**
- Cause: ? familial, immunosuppression ?
- Pathophysiology:
  - Similar to GME but more malacia
  - Affects all brain regions
- Young adults (9 months to 7 yrs)
- California & NE USA

- **Cerebral signs**: **seizures**, dementia, head pressing
- **Brain stem**: circling, head tilt, nystagmus, blindness
- ± Cerebellar signs - incoordination
- Cervical rigidity & pain
- Rapidly progressive: 5-7 days - recumbency, unable to walk & comatose

- Hx (**pug**), CS
- CSF: abnormal, inflammatory pleocytosis, ± eosinophilia
- Histo: diffuse perivascular mononuclear infiltration & white matter degeneration
- ± Postmortem: definitive, brain biopsy
  - Diffuse, degeneration of white & gray matter
  - Large **perivascular cuffs** of lymphocytes & histiocytes

Only in pugs, like GME - more malacia, grave

- **Corticosteroids** - palliative for short periods
- Anticonvulsants for seizures (phenobarbital)
- ABs ineffective
- Euthanasia w/ progression

Prognosis:
- **Grave: invariably fatal**, usually w/in few weeks, maximum 6 months

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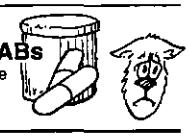
Pyogranulomatous meningoencephalomyelitis: H3B 240; E- hb 306; Sx-S 684

- **Mature pointers**, Acute rapidly progressive diz (2-3 weeks)
- CS: **Cervical rigidity**, Kyphosis, Nose held close to ground, Reluctance to move, Incoordination, Head tilt, Falling/rolling, Nystagmus, Seizures, Vomiting, Horner's syndrome
- Dx: Hx (**pointer**), CS, Marked pleocytosis, ↑ protein in CSF
- Tx: **Antibiotics** - resulted in temporary remission •Px: **Very poor** for recovery



Uremic Syndrome

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Uremic syndrome E-hb 117, 134; H2B 263, 574; IM 481, 754; IM-WW 462; NS-C 75, 161, 188, 226; NS-O 264; NS-L 79; ***	• **See Urinary 344** • **Uremia: end products of protein metabolism in blood** • Cause: Renal failure, Postrenal disorders (urethral obstruction, urinary bladder rupture) • Presumed uremic encephalopathy described in dogs • Pathophysiology of uremic encephalopathy: uremic blood has toxic substances (organic acids) that affect the brain	• **Encephalopathy** - Dementia, delirium - Seizures may occur w/ terminal uremia - Coma • Anemia • Gastroenteritis • Acidosis • Pneumonitis • Osteodystrophy	• Hx (renal failures) CS • PE (physical exam) • Lab - ↑ BUN - ↑ Serum creatinine - ↑ Serum phosphorus	• **Tx: Treat renal problem** Prognosis: • **Grave** if terminal renal failure • **Good** if renal failure can be corrected

Uncommon, urine in blood, renal failure, Postrenal disorders
CS: Encephalopathy (dementia, delirium, seizures, coma), GI, Lungs
Dx: Hx, Lab
Tx: Treat renal problem • Px: Grave

Cavernous sinus * syndrome
H2B 271; Cat 1559; Sx-WW 288

- **Lesion of cavernous sinus**: Cause: **neoplasia** (hemangiosarcoma, pituitary tumors, lymphosarcoma); Infectious: FIP, fungal infections
- Cavernous sinus lies lateral to pituitary gland, associated w/ CrN 3,4,6
- CS: Mid range **fixed pupils, paralysis of globe**; vision usually spared; usually no signs of brain involvement
- Dx: Hx, CS; Infraorbital venography - obstruction of sinus; Radiographs: ± lytic lesion; Serology: R/O infectious causes; CT, MRI - mass; CSF
- DDx: Retrobulbar abscess, Brain stem injuries, Other causes of anisocoria
- Tx: **Treat cause**
- Prognosis: **Poor** - most progressive, untreatable & cause death

Biotin deficiency
H2B 1008t; 1281t
*

- **Rare** w/ most diets: possible w/ **raw egg** diet
- CS: **CNS**: weakness progressive spasticity & paresis of rear limbs; scaly dermatitis, alopecia, anorexia, secretions of eyes, dried saliva around mouth
- Tx: **Return to normal diet is usually curative**

Riboflavin (B2) deficiency **B2** *
H2B 1281t

- **Rare, Degeneration of neurons in brain & spinal cord**
- CS: CNS (rear limb weakness, ataxia, cramping & convulsions); dry scaly skin, erythema, anemia, sudden death, cheilosis, glossitis, reduced fertility

Other deficiencies & convulsions *

- **Niacin deficiency**: anorexia, weight loss, diarrhea, oral ulcerations & CNS signs (weakness, convulsions, coma; Degeneration of nervous tissue
- **Pantothenic acid**: rare: CS: anorexia, hypoglycemia, hypochloremia & azotemia, CNS (convulsions, coma & death)

Hepatic encephalopathy, HE,

Hepatoencephalopathy, Hyperammonia, Portosystemic shunts
M8k 900; E-hb 277; SAP 722, 751; H3B 246; H2B 437, 441; IM 428, 407, 384, 422; NS-O 261, 131; NS-L 329, 429; Cat 1534; F3IM 377; NS-C 159,188, 226; NS-W 92, 116, 202, 220; NS-K 131; NS3hb 348; NS-hb 328; NS-Pa 208
**

- **Uncommon in dog**, rare in cat
- Pathophysiology:
  - Accumulation of substances (**ammonia**) toxic to CNS
  - Bacterial in colon produce toxic substances (ammonia (split form urea), mercaptans, short chained fatty acids & GABA)- Liver normally detoxifies these
  - High protein diet exacerbates (substrate for toxins)

- **Cerebrocortical diz** - intermittent (wax & wane) & exacerbated by feeding
  - **Seizures**
  - **Stupor or coma**
  - **Altered behavior**
  - **Compulsive walking, head pressing, circling, blindness, hypersalivation**
- ± Systemic sign of hepatic diz
  - Polydipsia, anorexia, weight loss, diarrhea
- ± Stunted growth if shunts, ± ascites

- **Suspect if cerebrocortical diz + hepatic dysfunction**
- Neuro exam: may be normal
- Clin path:
  - Low serum albumin
  - Low BUN (not converting ammonia to urea)
  - ↑ ALT & SAP usually
  - ↑ bile acids
  - BA/blood ammonia
- Delayed BSP excretion
- Once diagnosed figure out cause
  - Radiology: small liver
  - Contrast angiography - portosystemic shunt
  - Ultrasound
  - Liver biopsy

- **Emergency**
- **IV fluids - diuresis** (Ringers or 0.9% saline)
- Restrict protein: **k/d diet**, multiple small meals
- **ABs** to kill urea splitting bacteria in colon (neomycin, metronidazole)
- ± **Lactulose** (Cephulac®) (synthetic disaccharide) cathartic & colonic acidifier)
- Cleansing enemas (bacterial in colon)
- Prevent GI hemorrhage
- Treat underlying cause
  - Ligate shunts

Hepatoencephalopathy - Causes:
- **Hepatic failure**
- **Portosystemic shunts**
- Cirrhosis, Hepatic lipidosis
- Hepatotoxicity
- Hepatitis
- Neoplasia
- Congenital urea cycle enzyme deficiency (rare)

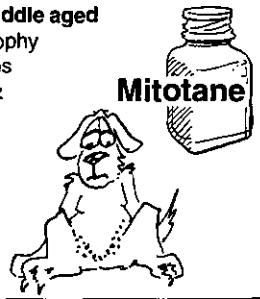
Dog, ammonia toxic to CNS
CS: Cerebrocortical diz + hepatic dysfunction
Dx: ↑ ALT, SAP, bile acids, ↓ BSP excretion, Ancillary tests
Tx: Emergency, IV fluids, k/d diet, ABs

Prognosis: variable???

Urea cycle enzyme deficiencies
H2B 441
*

- **Rare**, congenital - dog; Deficiency of hepatic enzyme needed for converting ammonia to urea in liver
- CS: **Hepatic encephalopathy**: cerebrocortical diz (seizures, stupor or coma, altered behavior), intermittent GI signs [vomiting, diarrhea]; Anorexia, Stunting
- Dx: ± Postprandial hyperammonemia, **abnormal ammonia challenge test**; ± Hypoalbuminemia, Other hepatic test usually normal (ALT, SAP, bile acids); Portography to R/O PSS, Liver biopsy
- DDx: PSS, Acquired disorders of urea metabolism
- Tx: **No specific Tx available, supportive care similar to PSS** (low protein diet, oral ABs, Lactulose)

Brain Trauma — NEUROMUSCULAR SYSTEM

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Hyperadrenocorticism, Cushing's syndrome	• **See Endo pg 654: Chronic exposure to excess** glucocorticoids; commonest endocrine dizs in dogs, rare in cats; **Middle aged** - **Causes:** 1. Pituitary dependent (85%), **2. Adrenal tumor** 15% (AT), **Iatrogenic:** prolonged steroid Tx - adrenal atrophy - CNS sequela: pituitary neoplasia & thalamic compression or invasion: CNS, ± polymyopathy, Mature female poodles • **CS: PU/PD**, Polyphagia, **"potbelly"** 90%, **skin changes, muscle weakness**, Lethargy, **Immunosuppression & diz** - **CNS signs**: large pituitary tumor - dullness, seizures, somnolence, wandering, head pressing, ataxia, blindness, anisocoria, Horner's syndrome, Cranial nerves 2, 3 & 4 involvement • Dx: Hx (**steroid Tx**), CS, PE, **Stress leukogram, ↑ ALP,** Clin path: **plasma cortisol assay, ACTH response test, Dexamethasone suppression test** • EMG: bizarre, high frequency discharges ("dive bomber" sound); ± Myotonic dimpling • **Tx: Pituitary dependent: Mitotane, Lysodren® (o,p'-DDD), Ketoconazole** (Nizoral®) lifelong BID Tx - **Adrenal tumor: Adrenalectomy** ; Monitor Cushing's patients				**Mitotane** 
Cranial vascular diz * SAP 1133; H3B 247; H2B 257; IM 760; E-hb 239; E 607; Cat 1536; Sx-S 1029; Pa-T 351; NS-O 244, 131; NS-W 119; NS3hb 296; NS-hb 281; NS-Pa 244; Sx-WW 287; X-T 75	• **Rare in dog & cat** - **Cerebral hemorrhage rare in animals compared to high incidence in humans** - Generalized atherosclerosis is rare in dog • **Cause: hemorrhage or infarcts** - Hemorrhage: arteriovenous malformations, bleeding disorders (warfarin, thrombocytopenia, DIC, Clotting factor defc.), vascular neoplasia, idiopathic, trauma - Infarction: sepsis, vasculitis (Rocky mountain spotted fever), disseminated intravascular coagulation [DIC], atherosclerosis (2° to hypothyroidism), hypercoagulable states, cardiomyopathies (esp. cats), bacterial endocarditis, hypertension, idiopathic	• **Acute onset of severe focal signs** - Stabilizes rapidly - If survive 48 hours - improves slowly • **CS reflect location** - Cerebrum: seizures (1st), blindness, circling, personality changes (aggression) - Brain stem: vestibular (head tilt, nystagmus), cranial nerve deficits, depression, tumor, coma, cardiac arrhythmias, respiratory arrest - Cerebellum: ataxia, tremor, torticollis, head tilt, nystagmus • Limb signs w/ profound extensors rigidity • ± Concurrent systemic diz & signs • Brain-heart syndrome	• **Hx: acute onset or asymmetrical CS that rapidly stabilizes** • Physical exam: Cardiac arrhythmias & or myocardial infarction • Hematology - Hemostasis screen, bleeding time & activated clotting time - Evaluate CBC for sepsis or vasculitis • Serum biochemistries - Check for renal failure or hypothyroidism - Thyroid stimulation test • CSF analysis: normal ± increase in cells • CT/MRI: best tool by limited availability, expensive	• **Supportive care** - Steroids for edema & inflammation - Moderate fluid restriction if not in shock - Monitor cardiac arrhythmias - Nutritional support • Specific therapy - Treat cause if possible Prognosis: • Guarded to good if survive 48 hours & no underlying diz • Cerebellar infarcts best, brain stem worse
Feline cerebral infarction, Feline stroke, Idiopathic feline ischemic encephalopathy, FIE E-hb 239; H3B 247; I2M 996; IM 760; 5min 548; IM-WW 474; Cat 1537; NS-C 216, 231; NS-W 119, 222; NS3hb 296; NS-hb 282; NS-Pa 242; NS-O 246; NS-L 144; Pa-T 352; X-T 75	• **Necrosis of cerebral tissue - cerebral infarct** - Middle cerebral artery most often • Sporadic in adult male & female cats • Especially **summer** months, NE USA • Cause: unknown, vascular occlusion only occasionally, no cardiomyopathy	• **Nonprogressive, variable & acute** • **Depression, dementia** • **Circling to seizures** • **Changes in attitude: aggression** • May modify or disappear w/ time	• Hx (cat), CS • CBC, chem., skull radiographs, & CSF usually normal • EEG: abnormal	• **Support + time 2-7 days** • Anticonvulsants if seizures • **Euthanasia if aggression persists** **Prognosis: poor** for complete recovery. Aggressive behavior may not improve necessitating euthanasia

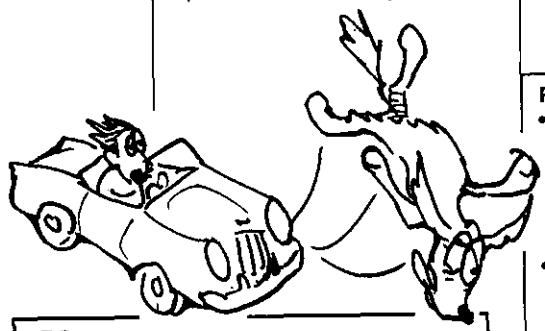
Brain trauma,

Craniocerebral trauma, CCT, Head trauma

E-hb 273; H3B 250; I2M 981; 5min 402; SAP 1137; IM 760; E 605; Cat 1539; F3IM 406; Sx-S 1027, Sx-WW 280; 1122; Pa-T 343; NS-C 228; NS-W 221; NS-K 147; NS3hb 290; NS-hb 275; NS-Pa 189; NS-O 303, 470, 128, NS-L 356

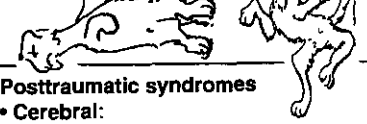
****

- **Cause:**
  - **HBC (hit by car)**
  - Blunt trauma, animal fight, falls, gunshot wounds
- Pathogenesis:
  - **± Fractures**: (linear nondisplaced) or depressed: minimal or severe brain damage
  - **Contusion** &/or **brain stem hemorrhage**
    . Coup injuries: under area of impact
    . Contrecoup injuries: diametrically opposite area
  - **Edema** (vasogenic/"leaky" vessels)
  - **↑ Intracranial pressure**: edema or hemorrhage
    . **Tentorial herniation** of cerebrum into cerebellar compartment: usually fatal
    .. **Midbrain compression**
  - Epidural & subdural hemorrhages relatively rare



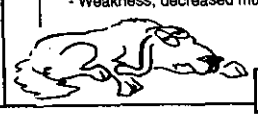
HBC
Dx: Hx (HBC), CS, Neuro exam, Rads
CS: Depend on location
Tx: If NO CNS CS: observe
If CS: Oxygen, Medical, Sx, Euthanasia

- **Varies w/ location & severity**
  - Motor activity:
    . Normal to recumbency & no reflexes
  - Brain stem reflexes:
    . Normal to bilateral/unresponsive mydriasis (dilation) & blindness
  - Consciousness:
    . BAR (bright alert & responsive) to coma (brain stem usually)
- **Worsening signs** w/in a short time of injury indicate
  . Hematoma (uncommon)
  . Brain swelling
  . Tentorial herniation
  - Prolonged coma suggests brain stem lesion
  - ± Recovery in 3-4 weeks



Posttraumatic syndromes

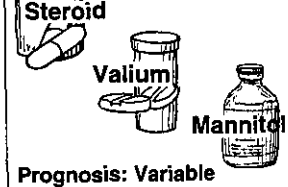
- **Cerebral:**
  - Concussion: temporary loss of consciousness
  - Wide circles toward lesion
  - Proprioceptive deficits & mild weakness
  - Decreased mentation
  - Seizure: at trauma or later (delayed)
  - Normal to Cheyenne-Stokes respiration
- **Brain stem:** invariably serious!!
  - Stupor or coma
  - Cranial nerve deficits
    . Bilat. dilated & unresponsive pupils
    . Ventrolateral strabismus
  - Weakness, decreased muscle tone [UMN])



- **Hx (HBC)**
- Signs
- **Physical exam:**
  - Injuries to head (lacerations, bruising), fractures
  - Check airways
  - Check for shock & entire body for injuries
  - Respiration & pulse rate: ataxic RR & slowing pulse precedes respiratory arrest
- **Neuro exam:**
  - Consciousness level: BAR to coma
    . Static, worsening or improving
  - Pupillary, palpebral, corneal, swallowing reflexes
  - Limbs: tone, reflexes
  - Conscious pain perception
  - ± Motor & proprioception function
- Radiographs: for skull fractures (don't use anesthesia or anesthetics)

- **Tentorial herniation:**
  . Progressive deterioration of consciousness
  . Decerebrate rigidity
  . Then flaccidity & falling respiration
- **Cerebellum**
  - Truncal ataxia
  - Limb hypermetria
  - Head dysmetria
  - ± Nystagmus
- **Vestibular damage** (peripheral better than central)
  - Head tilt
  - Loss of equilibrium (swaying & falling to side)
  - Wide based stance
  - Horizontal nystagmus & downward strabismus
  - Weakness & proprioceptive deficits (central)
  - Loss of hopping reflex on same side (central)

- **If NO CNS abnormalities: observe**
- Unconscious: intubate
- **Oxygen**
- Medical
  - **Steroid** (methylprednisolone) for vasogenic edema
  - **Diuretics**: mannitol (osmotic), carbonic anhydrase inhibitors & Lasix® to reverse CNS edema
  - **Diazepam** (Valium®) for seizures
- Surgical management
  - Skull fractures & penetrating wounds
  - Those deteriorating w/ medication
- Supportive:
  - Treat any shock: fluids
  - Comatose animal
    . Turn (ulcers), feed
- **Euthanasia**: especially if coma for 1 week



Prognosis: Variable

- **Poor:** if stuporous, comatose w/ dilated unresponsive pupils (brain stem)
- Poor to grave: if signs worsen
- Grave: if coma > 48 hours
- Excellent: if mild signs & no loss of consciousness
- Good: cerebellovestibular injuries: 3-4 weeks

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Larval migration, Parasitic meningitis/ myelitis/ encephalitis Mk 603; E-hb 274; H2B 262; IM 776; E 608, 624, 683, 686; Cat 1532; NS-O 241t, 242; NS-C 158, 146t; NS-W 120; NS-hb ; NS-Pa 159 *	• **Rare in cats & dogs** • Aberrant migration through brain tissue • Pathophysiology: Migration = physical destruction & inflammatory response - ischemia, edema, mass-like effects, toxic injuries • Parasite migration - Toxocara larvae - Ancylostoma caninum - Angiostongylus (Australia) - Dirofilaria immitis (heartworm) - Cuterebra sp. - Coenurus sp. (larvae of Taenia multiceps) - Cysticercus cellulosae - Acanthamoeba - Encephalitozoan **Rare in cats & dogs** **CS: Reflect area of injury** **Dx: Difficult antemortem, CSF tap, Necropsy** **Tx: No therapy successful; Px: Grave**	• **Signs reflect area of injury** - Cerebrum: seizures, blindness, circling, abnormal consciousness, weakness - Brain stem: head tilt, nystagmus, stupor, coma, cran. nn. deficits, weakness - Cerebellum: ataxia of head & body, tremor, torticollis - Spinal cord disorders • Usually acute & rapidly progressive • ± Neck pain & fever	• **Difficult antemortem** • CSF tap: diagnostic test of choice - Eosinophilic pleocytosis >5/µl uncommon but suggestive - Elevated spinal protein >35 mg/dl • ± Peripheral eosinophilia • Definitive Dx: demonstrate parasite in CNS - CSF toxoplasma titers: dramatically high if organism present • Fecal for eggs, supportive • Microfilaria supportive • Necropsy **DDx:** • Brain abscesses • Focal encephalitis • Brain tumor	• **No therapy successful** • Appropriate anthelmintics require specific antemortem diagnosis **Prognosis:** • **Grave**: all cases confirmed have ended in death
Thiamine/B1 deficiency, Polioencephalomalacia, Cerebrocortical necrosis, "Castek's paralysis" SAP 1144; H2B 264, 1278; IM 760; E-hb 277; E 613; Cat 1533; NS-C 163; NS-W 120, 223; NS-hb 285; NS-Pa 277; NS-O 271; NS-L 251, 385 *	• **Rare** • **Water soluble B1 vitamin** - Essential for aerobic metabolism - Deficiency causes switch to glycolysis = lactic acid & neuronal dysfunction - End result: hemorrhagic necrosis of CNS - mid-brain - Must be supplied in diet especially in cats . **Cats** fed **reddish fish** (tuna, salmon) contains thiamine -inactivating enzyme (**thiaminase**) may become deficient **Cats - reddish fish (thiaminase)** **CS: seizures & dementia, Blindness, coma** **Dx: R/O differential Dx, Response to thiaminase** **Tx: Inject thiamine & correct diet • Px: excellent**	• **Progressive seizures** & dementia • Blindness w/ normal pupils • Stupor & coma • Episodes of opisthotonus • **Cats:** - Fixed dilated pupils - Paralysis of extraocular muscles - Vestibular crisis/vestibular seizures (rigid extension of all limbs w/ head & neck ventroflexed between front limbs) - Broad based cerebellar ataxia - Pathological nystagmus - vertical - Opisthotonus & coma - Anorexia. vomiting, weight loss - Generalized muscular weakness • Early stages: waxing & waning but then progressive	• R/O differential Dx • CS & Hx • All lab test normal • Serum assay for thiamine metabolites to confirm • Plasma pyruvate & lactate elevated • **Response to thiaminase Tx** THIAMINE **DDx:** • Inflammation • Toxic injuries • Vascular disorders • Hypoglycemia • Hepatoencephalopathy • Hypokalemic polymyopathy of cats • Encephalitis • Polymyositis	• Completely reversible w/ Tx • **Inject thiamine & correct diet** • Vitamin supplementation PO • Avoid IV dextrose before thiamine therapy - m/ exacerbate signs THIAMINE Prognosis: • Excellent if treated • Fatal if untreated

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Brain tumors/ neoplasia Mk 610; E-hb 275; SAP 1132; H2B 269; IM 759; E 610; Cat 1537; F3IM 418; NS-O 278, 282, 136; NS-L 272; NS-C 232; NS-W 116, 220; NS-K 79; NS3hb 299, 255; NS-hb 282, 338; NS-Pa 355; Sx-S 1030; Sx-WW 286; Sx4B 82; X-T 75 **	• 1° tumors rarely metastasize outside cranial cavity or spinal canal • Brain tumors > spinal cord tumors • **>5 years old for most** except ependymal & lymphoma • Breeds: - Brachycephalic (Boxer & Boston terrier): glial tumors, ependymomas, pituitary tumors - Dolichocephalic (Ger. shepherds, collies) meningioma, lymphosarcoma - Cats: meningioma, lymphosarcoma • Pathophysiology: - Destruction &/or compression of brain tissue, damage blood brain barrier, obstruction of CSF flow **> 5 years old, Breeds** **CS: Slow, insidious progressive neuro signs** **Dx: Hx (old), CS, Rads +** **Tx: Steroids, Euthanasia •Px: grave**	• ↑ **Pressure**: change in mentation: dull, depressed & "suddenly old" • Vary w/ locations - **Cerebrum**: seizures (1st), blindness, circling, personality changes - Hypothalamus: endocrine dysfunction - **Brain stem**: vestibular (head tilt, nystagmus), cranial nerve deficits, depression, stupor, coma - **Cerebellum**: ataxia, tremor, torticollis, head tilt, nystagmus - Extramedullary: cranial nerve deficits - Intramedullary: limbs involved early - Superficial cerebral tumors - meningioma: seizures • Usually slowly progressive (acute or insidious; rapid or slow progression) • Metastatic tumors - Multiple areas of CNS usually - Pain & fever (meningeal involvement) • Sequela: - Brain herniation . Stupor & coma	• **Hx (old, slow, insidious progressive neuro signs)** • Physical exam: lymph nodes, spleen, skin, mammary chain, prostate gland for 1° neoplasia • CSF: ± pressure increase (>170 mm H2O), generally elevated protein (>25 mg/dl), tumor cells rarely found • Radiographs: - Skull: usually normal; exception: meningioma & bony tumors - Chest & abdomen for 1° tumor • EEG: ± focal spikes, sharp waves, slow waves • Ophthalmic exam: optic nerve edema in CNS lymphoma, or astrocytoma • CT/MRI: diagnostic tests of choice if available (cost & availability) **DDx:** • Hematoma/infarcts • Brain abscess (rare) • Vascular injuries • GME (granulomas) • Aberrant parasite migration	• **Steroids** to ameliorate (prednisolone) • Radiotherapy & chemotherapy limited roles • Surgery rare (superficial meningioma & chondroid osteomas) • Phenobarbital if seizures • **Euthanasia** Steroid Prognosis: • **Grave** for all brain tumors

Brain tumors

- Ependymal tumors
  - Choroid plexus tumors
  - Ependymomas
- Schwann cell tumors
  - Schwannomas
  - Neurofibroma
- **Meningioma** (#1 in dog & cat)
- Reticulosis (CNS lymphoma)
- CNS parenchymal tumors
  - Astrocytoma
  - Oligodendroglioma
  - Glioblastoma
- Metastatic neoplasms most common
  - Prostatic tumors
  - Mammary carcinoma
  - Osteosarcoma
  - Hemangiosarcoma
  - thyroid carcinoma
  - Bronchial adenocarcinoma
- Generalized (systemic) lymphosarcoma

CNS lymphosarcoma, CNS lymphoma, Reticulosis

H2B 268; SAP 195, 1132; IM 863, 759; NS-O 279t, 282

- Causes marked perivascular proliferation of RE (reticuloendothelial) cells similar to GME (granulomatous meningoencephalitis)
- Both CNS lymphoma & GME cause similar signs
- Tx: **Steroids for temporary improvement**
- Prognosis: **Grave** - fatal

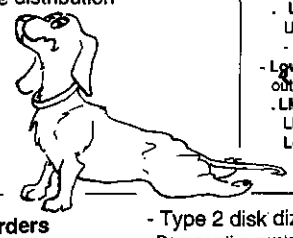
Spinal Cord Disorders

Spinal cord disorders

M8k 919; Mk 574; E-hb 285; SAP 1157; I2M 1018; IM 777, 741; IM-WW 474; H2B 240, 237; E 629; Cat 1542, 1582; F3IM 425; NS-C 55, 335, 341, 397; NS-W 227; NS-K 158; NS3hb 47, 96, 366; NS-hb 128; NS-Pa 86; NS-L 30, 175, 359; NS-O 47, 68; DDx 428; Sx-WW 271, 291; Sx-S 1016, 1030; Sx-B 579, 601, 636; NB 12.13

***

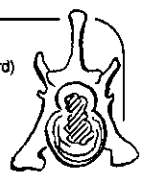
- **Cause dysfunction of 1 or more limbs &/or tail**
- **#1 neurological disorder in small animals**
- **Mechanism of diz**
  - Transverse myelopathy: single focal lesion
  - Multifocal disorder: severe focal lesions
  - Disseminated diz: diffuse distribution
  - Unilateral or bilateral



- **Pathophysiology: UMN & LMN clinical signs** help differentiate peripheral from central lesions & if central, helps localize spinal cord level of the lesion
  - **Upper motor neuron (UMN)**: CNS neurons in descending motor tracts located in ventral & ventrolateral white matter of spinal cord, Functions:
    - . **Transmit motor information to body & limbs** (Excitatory UMNs: initiate & maintain consciousness movements & provides tone to extensor muscles [posture], they are inactive until needed)
    - . **Inhibitory UMN regulation of LMN** (constantly keep LMN under control)
    - . **UMN signs:** caudal to damage, severity depends on amount of damage to spinal cord (white &/or gray matter). ± Uncontrolled hyperactivity of LMNs due to decreased inhibition o, **Tone - normal to increased** (hypertonic), **Reflexes** - normal or incr. (normo- or hyperreflexia), **Slow atrophy** (disuse)
  - **Lower motor neuron (LMN)**: motor part of reflex arc to muscles or glands (peripheral nerves). Spontaneously active w/ out input of inhibitory UMN
    - . **LMN signs** to area innervated by damaged segment (axon or its cell body in CNS) (no UMN signs because require intact LMNs): **Flaccid weakness or paralysis** ("limp as a dish rag"), **Loss of tone** - decreased to none (hypotonia - atonia), **Loss of reflexes** - decr. to absent (hyporeflexia - areflexia), **Fast atrophy** (neurogenic atrophy) w/in 1 week

DDx/Causes - Spinal cord disorders

- Acute
  - **Trauma - fractures, luxations**
  - **Type 1 disc diz**
  - Fibrocartilaginous embolism
  - Toxic: tetanus, strychnine
  - Caudal aortic emboli (cat)
- Subacute/progressive
  - Infectious inflammatory diz: myelitis, encephalitis, infectious meningitis, rabies, **canine distemper**, feline infectious peritonitis, toxoplasmosis, rickettsial dizs, parasitic myelitis)
  - Noninfectious inflammatory diz (**granulomatous meningoencephalitis**, meningeal vasculitis, **steroid responsive meningitis**, feline polioencephalitis)
  - **Diskospondylitis**
- Chronic progressive
  - **Neoplasia**
  - Type 2 disk diz
  - Degenerative myelopathy (Ger. shepherd)
  - Cauda equina syndrome
  - **Wobbler's diz**
  - Hypervitaminosis A (cats)
  - Arachnoid cyst
- Progressive in young animals
  - Neuronal abiotrophies & degenerations (spinal muscular atrophy, hereditary ataxia, demyelination dizs)
  - Lysosomal storage dizs
  - **Atlantoaxial luxation**
- Congenital/anomalous (constant)
  - **Vertebral anomalies (Hemivertebra?)**
  - Spinal bifida
  - Pilonidal cyst
  - Cauda agenesis of Manx cats
  - Spinal dysraphism
  - ? Calcium deposits in great Dane
  - Multiple cartilaginous exostoses
- Asymptomatic
  - **Spondylosis deformans**
  - Dural ossification



UMN signs: "thumbs up" caudal to damage

- **Spastic weakness or paralysis**
- **Tone** - normal or increased
- **Reflexes** - normal or increased
- **Slow atrophy** (disuse)

LMN signs: "thumbs down" at level of damage

- **Flaccid weakness or paralysis** ("limp as a dish rag")
- **Loss of tone** - decreased to none
- **Loss of reflexes** - decreased to absent
- **Fast atrophy** w/in 1 week

Loss of proprioceptive & sensation at & caudal to lesion

Spinal cord segments - vertebrae

Segments	Vertebra/dog cat	Nerves - origins
C1-5	C1-4	Cervical nerves
C6-T2	C5-T1	Brachial plexus
T3-L3	T2-L3	Spinal nerves - T3-L3
L4	**L3**	**Femoral nerve**
L5-7	**L4-L5**	**Sciatic nerve**
S1-S3	**L5-L6**	**Pudendal nerve**
Caudal	**L6**	

- **General signs or spinal cord lesions**
  - **Focal or generalized pain**
  - **Ataxia** (proprioception/motor)
  - **Weakness/paresis or paralysis**
  - Occasionally inability to urinate
- **Severity of compression**/mild to severe signs
  - No compression but irritation: neck pain w/o neurological deficits (meningitis)
  - Mild compression of cord: ataxia & weakness
  - Severe compression: loss of motor
    - paralysis & loss of superficial sensory
  - Severest compression/severance: loss of deep pain sensation
- Localization by UMN & LMN signs to limbs see box

Quick localization of spinal cord

C_{1-5}, Cervical - no "head signs"
- UMN signs to all 4 limbs

C_6-T_2: Cervicothoracic
- Tetraparesis/paralysis
  - LMN signs to thoracic limbs
  - UMN signs to pelvic limbs
- ± Horner's syndrome

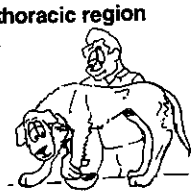
T_3- L_3, Thoracolumbar
- UMN signs to rear limbs
- ± Cutaneous trunci
- Normal thoracic limb (+/- Schiff-Sherrington)

L4-S2: Lumbosacral & cauda equina
- LMN signs to rear limb
- Normal thoracic limbs
- UMN signs: bladder, anus & urethra

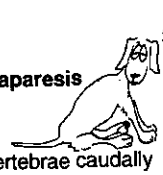
Signs - spinal cord region damaged

C_{1-5}, Cervical region
- **UMN signs to all limbs**, worse to rear limbs
  - Spastic weakness (usually not paralysis or respiratory death)
  - All reflexes intact/hyperactive in all 4 limbs
  - Slow (disuse) atrophy
- **Ataxia/proprioception & weakness all limbs**
- ± Cervical pain, rigidity
- Respiratory failure if complete severance (phrenic nerve (C5-7)
- Anal tone & reflexes usually normal
- ± Horner's syndrome (rare)

C_6-T_2: Brachial plexus/Cervicothoracic region
- **LMN signs to thoracic limbs**
  - Flaccid paresis/paralysis
  - ↓ tone & reflexes
  - Fast neurogenic atrophy
- **UMN signs to pelvic limbs**
  - Spastic paresis/paralysis
  - ± ↑ tone & reflexes
  - Slow, disuse atrophy
- **Proprioception & sensation loss in all 4 limbs**
- ± Horner's syndrome
- ± Complete decrease or absent cutaneous trunci response
- T-limb signs may be worse than rear limbs (LMN over UMN)
- Anal tone usually normal



T_3- L_3, Thoracolumbar region
- **UMN signs to pelvic limbs/paraparesis**
  - Spastic paresis/paralyses, ataxia
  - ± ↑ tone & reflexes
  - Slow atrophy
- **Cutaneous trunci** absent 1-2 vertebrae caudally
- **Normal thoracic limb**
  - +/- Shiff-Sherrington (serious sign)
- **Proprioception & sensation loss in rear limbs**
- Anal reflexes & tone normal to increased usually (UMN)
- ± "UMN bladder"* (paralysis w/ loss of voluntary control)



L4-Ca5: Lumbosacral & cauda equina
- **LMN signs to pelvic limb**
  - Flaccid paresis/paralysis
  - ↓ tone & reflexes
  - Fast atrophy
- Loss of proprioception & sensation to pelvic limbs
- **Normal thoracic limbs**
- UMN signs: bladder, anus & urethra

L4-L6: Caudal lumbar spinal cord
- LMN signs to femoral nerve
  - Loss of patellar reflex
  - Unable to bear weight on limb (inability to extend stifle)
- UMN signs to sciatic nerve
  - + Withdrawal reflex
- Normal thoracic limbs
- Anal reflexes & tone normal to increased usually
- "UMN bladder"* (paralysis w/ loss of voluntary control)

L7-S1
- LMN to sciatic nerve
  - Loss of withdrawal reflexes
- Normal femoral nerve
  - + Patellar reflex & bears weight
- Normal thoracic limb
- Anal reflexes & tone normal to increased usually
- "UMN bladder"* (paralysis w/ loss of voluntary control)

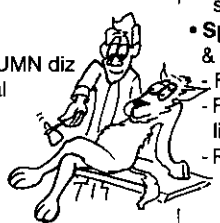
S_2- Cd_5 Sacral region (cauda equina)
- Normal thoracic & pelvic limb
- LMN signs - bladder, anus & urethra
  - Flaccid paralysis of anus & tail
  - No defecation
  - Loss of reflexes & sensation to tail, penis, vulva & perineum
  - Distended, flaccid bladder; incontinence; easily expressed

"UMN bladder": may occur w/ lesions above S1
- Paralysis w/ loss of voluntary control
- Initially urine retained (catheterize)
- Reflex urination occurs in 1 week

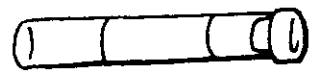
Spinal Cord Disorders

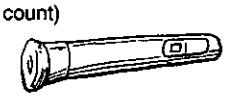
Diagnosis - spinal cord disorders

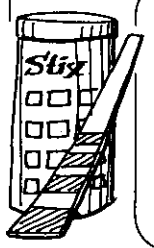
- Hx (breed, onset, progression)
- Physical exam: including otic & ophthalmic)
- **Neuro exam:**
  - **First confirm neuro problem**
    . Gait observation & strength
    . Postural reactions: proprioceptive positioning reaction, Hopping, Hemi-stands & Hemi-walks, Wheelbarrowing
  - **Second: try to localize**
    . R/O disorder above foramen magnum
    . Mental attitude, Stance & head position are normal (no vestibular & cerebellar problems)
    . Cranial nerves exam: normal w/ cord problems
  - **Localization to peripheral nerves or spinal cord:** correlate UMN &/or LMN signs found w/ spinal reflex, muscle tone & sensation (see box UMN/LMN)
    . **Spinal reflexes**: Patellar reflex, Flexor reflex of rear limb, Cutaneous trunci, Withdrawal reflex of forelimb, Perineal Reflex, Schiff-Sherrington syndrome
    . **Muscle tone**: palpation of the musculature (limb)
    .. ↓ Tone/flaccidity = LMN
    .. Normal tone: Normal or UMN diz
    .. ↑ Tone: UMN diz, normal excitement, tetanus
    . **Sensation**
    .. Superficial pain
    .. Deep pain: "last to go first to show"
    .. Map superficial sensation: if LMN signs



- Minimum data base (MDB) for all neuro cases
  - CBC (complete blood count)
  - Serum biochemistries
  - Urinalysis
  - Fecal analysis
  - Heartworm test in endemic areas
- Determine etiology once localized
  - **Radiology**: for subluxation, fractures, malformations, disk diz, neoplasia, diskospondylitis
    . Correspond radiographs w/ CS localization: spinal cord segment cranial to corresponding vertebrae
    . If radiographs normal:
  - **Myelography**: differentiates intramedullary & extramedullary (expansive & compressive) lesions
    . Contraindicated CNS inflammation (encephalitis, myelitis, meningitis) or if increase in cranial pressure suspected
  - Referral centers: CT, MRI
  - CSF analysis for neoplasia or inflammation
  - Electrodiagnostic tests: EMG, NCV
  - ± Surgical exploration in some cases
  - If CSF & myelography & radiology normal suspect vascular or degenerative diz
- **Specialized laboratory tests**: based on PE & MDB
  - Fine needle aspiration - lymph nodes
  - FeLV, FIV, FIP, Distemper, toxoplasmosis, ehrlichiosis, fungal tests
  - Resting & challenging endocrine functions tests

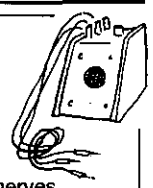






DDx:

- UMN to all 4 limbs
  - Brain diz
- LMN signs
  - Peripheral nerves: unilateral
  - All limbs - diffuse diz
    . Affecting many peripheral nerves
    . Neuromuscular junction
    . Ventral gray matter of cervicothoracic & lumbosacral intumescences



Order of loss of spinal cord function due to compression:

1st: Conscious proprioceptive deficit: 1st sign of spinal cord damage
- Disturbance in ascending sensory tracts from cutaneous receptors & joint receptors to the brain
  . Delayed or no correction of knuckling, postural deficits
  . Postural deficits (wide base stance, knuckle over)
  . Delayed initiation of movement

2nd. Loss of unconscious proprioception is next to go
- Disturbance in ascending tracts carrying muscle & joint position sense
  . Sensory ataxia

3rd: Voluntary movement (motor)
- Disturbance of descending motor tracts
  . Paresis to paralysis

4th also: Superficial pain loss: lost at the same time as motor function loss. If superficial pain is perceived, so will deep pain. (A withdrawal reflex, DOES NOT require pain perception)

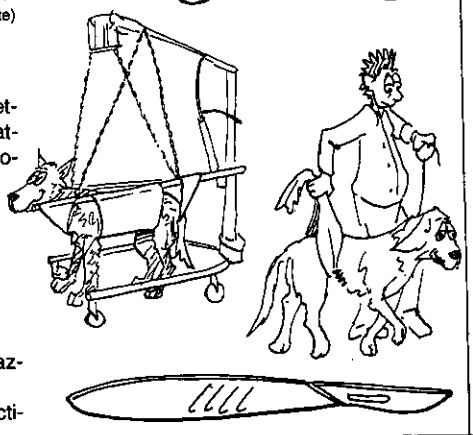
5th: Sphincter control loss
- Incontinence; UMN bladder (spastic, hyperreflexic detrusor muscle & external sphincter contraction)

6th: Deep pain: 1st to show pain & last to disappear (**first to show, last to go**) loss of deep pain is a bad prognostic sign. Evaluated only when superficial pain is absent.

In recovery, return of function occurs in reverse order!

Treatment - spinal cord disorders

- Tx depends on cause, degree of damage; often only palliative
- **Medical Tx**
  - **Trauma** (edema & ischemia) - Antiinflammatory:
    . **Steroids** (antiinflammatory) dexamethasone or methylprednisolone (Solu-Medrol®) (+ H2 antagonist (cimetidine or ranitidine) + GI protectants (sucralfate)
    . Mannitol for brain edema
    . DMSO more commonly used in large animals
  - **Infections**
    . **Antibiotics** (trimethoprim-sulfa combinations, rifampin, metronidazole, chloramphenicol, Itraconazole - high penetrating ability); (Avoid aminoglycosides, amphotericin B, ketoconazole - poor penetration)
    .. Diskospondylitis especially difficult may require surgery also
  - **Neoplasia/Degenerative disorders**
    . **Steroids**: to slow degeneration & lymphosarcoma
    . Chemotherapy rarely ineffective in CNS neoplasia
    . Radiation
  - **Intoxication**
    . Tetanus: ABs (tetracycline, penicillin, metronidazole, Diazepam, barbiturates)
    . Strychnine: stop absorption, aspiration of stomach, activated charcoal; Diazepam, barbiturates
- **Surgical**: for compressive extramedullary diz
  - As soon as possible
  - If conscious deep pain gone for hours to days Sx of little value
  - Hemilaminectomy or dorsal laminectomy TL spine, Ventral slot decompression - cervical area
  - Prophylactic disk fenestration
  - Fracture stabilization
- Extensive postoperative physiotherapy (swimming, towel walking, limb manipulation, muscle massage)
- Nursing care required: evacuate bladder (q4-6h) padded clean bedding/waterbed (decubital ulcers; daily baths)

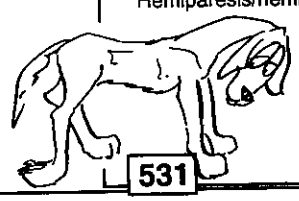


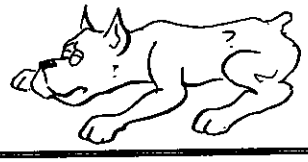
Prognosis:

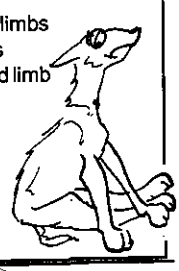
- Degenerative: poor but progression may be slow
- Anomalous: nonprogressive so depends on extent of injury
- Neoplasia: varies greatly
  - Intramedullary: poor
  - Nerve root tumor: variable
  - Extramedullary: variable, good lymphosarcoma & meningioma
  - Vertebral: poor (osteosarcoma & multiple myeloma)
- Infection: guarded generally
  - Granulomatous meningoencephalitis: grave for survival, good for short term
  - Tetanus: good
- Toxicity:
  - Strychnine: poor w/o immediate Tx
- Trauma/vascular: highly variable
  - Thoracolumbar area: good
  - Aortic thrombi: guarded to poor
  - Fibrocartilaginous embolism: guarded to poor
  - Loss of deep pain: grave

Definitions

Monoparesis/paralysis:	Weakness/paralysis of one limb
Paraparesis/paralysis:	Weakness/paralysis of both rear limbs
Tetra-quadriparesis/paralysis:	Weakness/paralysis of all 4 limbs
Hemiparesis/hemiplegia:	Weakness/paralysis of front & hind limb on same side

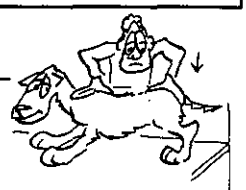






Paresis/paralysis M8k 942; I2M 971; IM 741; 5min 118; IM-WW 69; NS3hb 129, 173; NS-C 16, 43, 398, 433

- Disturbance of initiating voluntary movement causes weakness (paresis) or paralysis, depending on severity & location of lesion

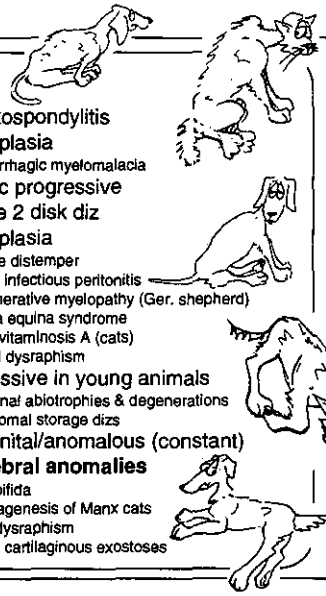


DDx: Paresis/paralysis

- Unilateral lesions of cerebral cortex — Mild almost undetectable hemiparesis of opposite limbs; postural reactions abnormal
- Unilateral brainstem lesion — Same side hemiparesis; severe postural deficits, Depression & cranial nerve deficits
- Cervical or cervicothoracic cord lesion — Ataxia & paresis or paralysis of all 4 limbs w/o depression or cranial nerve deficits
- Thoracic or lumbar spinal cord lesion — Ataxia & paresis or paralysis of rear limbs w/ normal thoracic limbs w/o brain signs or cranial nerve deficits
- Diffuse diz of peripheral nervous system & neuromuscular dizs — Flaccid (LMN) paresis or paralysis w/o ataxia, loss of reflexes, normal postural responses if supported
- Metabolic, cardiorespiratory & muscular system disorders — Generalized weakness w/ normal postural reactions, normal reflexes & absence of ataxia

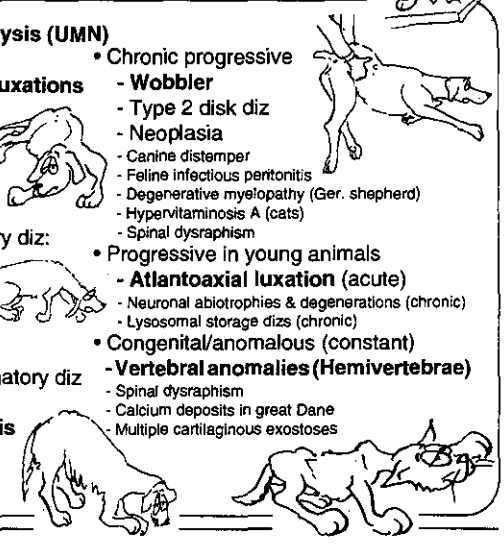
DDx - Pelvic limb paresis/paralysis Dx 431

- Acute nonprogressive
  - **Trauma - fractures, luxations**
    - Fibrocartilaginous embolism
    - Toxic: tetanus, strychnine
    - Caudal aortic emboli (cat)
    - Myelodysplasia
    - Hemorrhage
- Acute/progressive
  - **Type 1 disc diz**
  - Infectious inflammatory diz:
    - . Myelitis
    - . Meningitis
    - . Canine distemper
    - . Rabies
    - . Parasitic myelitis
  - Noninfectious inflammatory diz
    - . **Granulomatous meningoencephalitis**
    - . Immune meningitis
    - . Feline polioencephalitis
    - Diskospondylitis
    - Neoplasia
    - Hemorrhagic myelomalacia
- Chronic progressive
  - Type 2 disk diz
  - Neoplasia
    - Canine distemper
    - Feline infectious peritonitis
    - Degenerative myelopathy (Ger. shepherd)
    - Cauda equina syndrome
    - Hypervitaminosis A (cats)
    - Spinal dysraphism
- Progressive in young animals
  - Neuronal abiotrophies & degenerations
  - Lysosomal storage dizs
- Congenital/anomalous (constant)
  - **Vertebral anomalies**
    - Spinal bifida
    - Cauda agenesis of Manx cats
    - Spinal dysraphism
    - Multiple cartilaginous exostoses



DDx - Tetraparesis/paralysis (UMN)

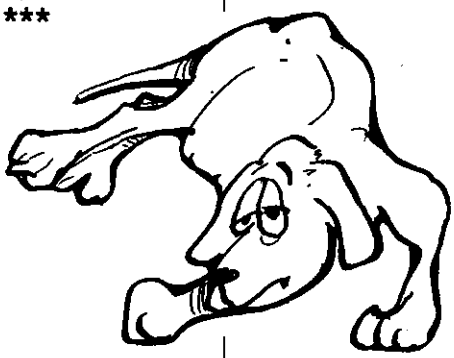
- Acute nonprogressive
  - **Trauma - fractures, luxations**
    - Fibrocartilaginous embolism
    - Toxic: tetanus, strychnine
    - Myelodysplasia
    - Hemorrhage
- Acute/progressive
  - **Type 1 disc diz**
  - Infectious inflammatory diz:
    - . Myelitis
    - . Meningitis
    - . Canine distemper
    - . Rabies
    - . Parasitic myelitis
  - Noninfectious inflammatory diz
    - . **Granulomatous meningoencephalitis**
    - . Immune meningitis
    - . Feline polioencephalitis
- Chronic progressive
  - **Wobbler**
  - Type 2 disk diz
  - Neoplasia
    - Canine distemper
    - Feline infectious peritonitis
    - Degenerative myelopathy (Ger. shepherd)
    - Hypervitaminosis A (cats)
    - Spinal dysraphism
- Progressive in young animals
  - **Atlantoaxial luxation** (acute)
    - Neuronal abiotrophies & degenerations (chronic)
    - Lysosomal storage dizs (chronic)
- Congenital/anomalous (constant)
  - **Vertebral anomalies (Hemivertebrae)**
    - Spinal dysraphism
    - Calcium deposits in great Dane
    - Multiple cartilaginous exostoses

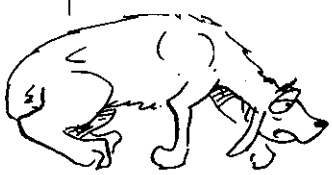


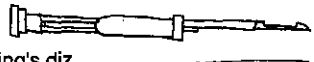
Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Cauda equina syndrome, Lumbosacral stenosis, Lumbosacral instability, Lumbosacral spondylopathy ** M8k 922; Mk 585; E-hb 300, 743; I2M 1035; IM 786; H3B 260; H2B 292, 45; 5min 778; IM-WW 481; E 673, F3IM 381; NS-W 173; NS-C 450; NS-K 208; NS3hb 158; NS-hb 155; NS-L 74, 82, 363; NS-O 206; NS-Pa 433, 454; X-RP 81; Sx-WW 298; Sx-B 629 Sx-S 1056, 1094	• **Compression of terminal end of spinal cord & nerves (cauda equina)** • Breeds: instability: middle aged **Ger. shepherd**, any breed • Congenital stenosis: small-breeds DDx/Causes: Cauda equina • Instability or stenosis of L7-S1 intervertebral disk space • Intervertebral disk diz in area • Fractures • Neoplasia • Diskospondylitis • Granuloma, progressive spinal stenosis • Congenital vertebral malformation **Compression to caudal cord** **CS: LMN - rear limb, bladder, Mutilation** **Dx: Hx, Rads** **Tx: Medical, Surgical**	• **Lumbosacral pain** - Reluctance to jump, run, sit or climb stairs • **Proprioceptive deficits** in 1 or both pelvic limbs (50%) • **LMN to rear limb:** lameness, weakness, hyporeflexia - Sciatic nerve paralysis w/o femoral n. involvement possible . Loss of withdrawal reflex . Hyperactive patellar reflex (UMN) • Hyperesthesia or paresthesia of perineum & tail base • ± Urinary & fecal incontinence (pudendal & pelvic nn.) • ± Self-mutilation of tail, perineum or pelvic limb • **Sequela: Cystitis**	• Hx, CS • Lumbosacral pain on deep palpation or dorsal flexion of tail • **Radiographs** - **Subluxation of L7-S1** - Bony stenosis - Ventral &/or lateral spondylosis at L7-S1 - Erosions of end plates if concurrent diskospondylitis • Epidurography • Myelography of limited value - subarachnoid space small compared to spinal canal **DDx:** • Musculoskeletal disorders: coxofemoral dysplasia, polymyositis, cruciate ligament, polyarthritis • Cauda equina disorders: infections (neuritis, diskospondylitis), neoplasia, disk diz, trauma, fibrocartilaginous emboli • Disorders of T3-L3 (UMN): degenerative myelopathy, neoplasia, type 2 disc protrusion	• **Conservative** if only pain or mild motor deficits - Restrict exercise - Analgesics (aspirin, PBZ (phenylbutazone) - Steroids: prednisolone • **Surgery** if progressive, or moderate to severe motor deficits - Dorsal laminectomy & occasionally L7-S1 foramenotomy &/or stabilization Prognosis: • **Surgery: good**, not curative in all cases • Conservative: many dogs become refractory & require surgery
Congenital syringomyelia & Spinal dysraphism M8k 920; Mk 582, 586; H2B 275; I2M 1045; IM 793; E 692; Cat 1589; NS-C 406; NS-W 154; NS3hb 162; NS-hb 157; NS-Pa 89; NS-L 26, 194; NS-O 200; Pa-T 339 *	• Inherited congenital maldysplasia - **Spinal cord abnormalities:** incomplete development & closure of neural tube . Bilateral or absent central canal . Hydromyelia: dilation of central canal . Syringomyelia: cavitation in white matter, abnormal grey column cells • Cause: unknown • **Weimaraners,** often associated with spina bifida	• **Signs present at birth** • **Symmetric, bunny-hopping pelvic limb gait** • Wide based stance • Scoliosis, torticollis • UMN or LMN signs depending on location • Depressed proprioception (position sense) • Signs not progressive in Weimaraners	• Hx (birth, breed), CS • Normal patellar reflex • Pelvic flexor reflex stimulates flexion if both pelvic limbs • Myelography: obstruction of CSF at foramen magnum	• **No treatment** Prognosis: • **Not progressive** so if only mildly affected they can lead a normal life

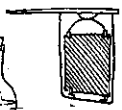
Episodic Weakness

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Episodic weakness & collapse, Periodic weakness, Exercise intolerance Cont Ed 12(2) pg141 Feb 1990; IM 742; NS3hb 350; NS-C 389; NS-W 189; NS-hb 332; NS-L 88; DDx 433 ***	• **Many neurological dizs are episodic** • Episodic weakness prominent in a large variety of dizs • **Metabolic & cardiorespiratory #1 causes** • Syncope: fainting/loss of consciousness, usually due to inadequate O2 or glucose to cerebrum	• **Episodic weakness** - Worsens w/ exercise & improves w/ rest - Waxes & wanes, normal in-between - Varies form mild pelvic limb ataxia to total collapse or syncope • ± Normal when vet sees animal	• **Difficult to diagnose** • Hx (important because vet may never see an episode): number of episodes? Is there a pattern? What time of day? Any relationship of episode to exercise? Feeding? Excitement? Prodromal seizure phase? Loss of consciousness? Describe episode: generalized motor seizure? Syncope? Pallor or cyanosis? Slowing or fast heart rate? Length of episode? How is animal afterwards? Appetite? Thirst? Weight loss? Urination? Vomiting? Diarrhea? Exercise intolerance? • Physical exam: full general & neuro exam on all animals • Form a differential diagnosis list - Rule out DDx - Minimum data base . CBC . Urinalysis . Fasting blood glucose, urea . Serum electrolytes (Na, K, Ca, Mg) . Serum enzymes (muscle: CK, AST, liver: ALT, ALP) . Electrocardiogram ECG on all - Additional data often necessary . Heartworm test: depending on geography . Radiographs: to R/O cardiopulmonary diz, other conditions suggested by PE . Response to imipramine . Edrophonium response test (Camsiolon®, Tensilon®): short acting anticholinesterase used to diagnose myasthenia gravis - improved ability to exercise . Muscle biopsy . Liver function test - bile acids . ACTH stimulation test for Cushing's diz . Basal T4 for hypothyroidism . Immunological tests: ANA for polymyositis, antibodies to AcTH for myasthenia gravis . Blood gas & acid base estimates . CSF in some . EEG, nerve conduction & electromyograph	• Treat cause





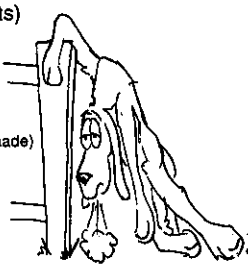




Large variety of dizs. Metabolic & cardiorespiratory #1
CS: Episodic weakness
Dx: Difficult to diagnose; Hx, PE, lab, test
Tx: Treat cause

DDx - Episodic weakness

- **Neuromuscular disorders**
  - Myasthenia gravis
  - Polymyositis
  - Myotonia - Chow
  - Hereditary myopathy in labs
  - Dermatomyositis in collies
  - Episodic collapse
  - Hyperadrenocorticism myopathy
  - Feline hypokalemic polymyopathy
  - Ischemic neuropathy (thromboembolism)
  - Malignant hyperthermia
  - Mitochondrial myopathies
  - Exertional myopathy
  - Sex linked muscular dystrophy
  - Hereditary myopathy - Devon rex cats
  - Hereditary myopathies - Labs
- **Cardiovascular disorders**
  - Arrhythmias (bradycardia, tachyarrhythmia)
  - Congenital hear diz (shunts)
  - Acquired hear diz
    - Congestive heart failure
    . Valvular diz
    . Myocardia
    . Pericardium (cardiac tamponade)
  - Heartworm diz
  - Vasovagal syncope
  - Aortic thromboembolism



- **Respiratory diz** (severe)
  - Laryngeal paralysis
  - Upper respir. tract obstruction (brachiocephalic)
  - Severe coughing
  - Tracheal collapse
  - Pulmonary diz
  - Pleural effusions
  - Thoracic masses
  - Filaroides osleri

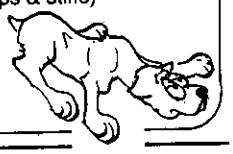
- **Hematologic disorders**
  - Bleeding hemangiosarcoma
  - Anemia, regenerative & nonregenerative
  - Myeloproliferative disorders
  - Hyperviscosity syndrome
  - Hemoglobinopathies
  - Idiopathic pyrexia
  - Polycythemia

- **Metabolic disorders**
  - Hypoglycemia (#1 metabolic cause)
  - Hyperglycemia
  - Hypokalemia
  - Hyperkalemia/hypoadrenocorticism
  - Hypercalcemia
  - Hepatic encephalopathy
  - Uremic encephalopathy
  - Hypernatremia
  - Hypocalcemia
  - Hypermagnesemia
  - Hypomagnesemia
  - Acidosis
  - Heat stroke (hyperthermia)
  - Shock
  - Hypoxia

- **Endocrine disorders**
  - Insulinoma
  - Hyperadrenocorticism myotonia
  - Hypoadrenocorticism
  - Hypothyroidism
  - Hypoparathyroidism
  - Pheochromocytoma
  - Diabetes ketoacidosis

- **Neurological dizs**
  - Cataplexy/narcolepsy
  - Scottie cramp
  - Epilepsy
  - Thoracolumbar disc diz
  - Spinal disorders
    - Wobbler syndrome
  - Cerebellar disorders
  - Vestibular disorders
  - Congenital disorders
    . Hydrocephalus
  - Old dog encephalitis
  - Tumors
  - Thiamine deficiency
  - Lysosomal storage diz
  - Progressive axonopathy (boxer)
  - Giant axonal neuropathy
  - Botulism
  - Tetanus
  - Generalized tremors
  - Jack Russell ataxia
  - Episodic falling (Cavalier King Charles spaniel)

- **Orthopedic disorders**
  - Degenerative joint diz (hips & stifle)
  - Polyarthritis



Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Spina bifida, Spina cystica; Myelodysplasia, Myelorachisis M8k 921; Mk 586; E-hb 307; E 685; I2M 1045; IM 793; IM-WW 482; H3B 255; H2B 276; Cat 1641t, 1546, 1589; NS-O 199; NS-L 26, 184; NS-C 407; NS-W 153, 230; NS3hb 162; NS-hb 159; Pa-T 339; X-RP 74 *	• **Failure of 1 or more vertebral arches to close** (absence or cleft in arch) - Spina bifida occulta: no protrusion of meninges - Spina bifida manifesta: protrusion of meninges or spinal cord through defect . Meningocele - protrusion of the meninges. . Myelomeningocele - protrusion of the spinal cord & meninges - Myelodysplasia: anomalies of spinal cord - Myelorachischisis: neuroectoderm continuous w/ skin • Cause: unknown (genetic & environmental) • Most common in the lumbar region • **Eng. Bulldogs, screw tailed breeds & Manx cats** • Myelodysplasia: congenital malformation of any part of spinal cord, spina bifida is an example	• **Asymptomatic usually** (spinal bifida occulta) • Spinal cord dysfunction - Caudal lumbar (L4-S3) #1 transverse myelopathy . Pelvic limb ataxia, paresis/paralysis . Urinary & fecal incontinence . Perineal analgesia, decreased pelvic reflexes . Decreased anal tone . Signs seen when start to walk • Often associated spinal dysraphism • Usually an incidental finding with no coexisting neural deficit • Mass or draining fistula on lumbar dorsal midline • Lumbar dimple or abnormal hair direction	• Hx (breeds) • **Radiographs**: incidental radiographic finding if no CS • Myelography for meningocele	• **None needed if no CS** (Spinal bifida occulta) • Not effective for CS • Surgery for meningocele if no CS **Prognosis:** • **Good**: spinal bifida occulta • **Poor**: spinal bifida manifesta + CS
Block Vertebra * M8k 920; Mk 585; E-hb 290; H3B 254; H2B 276; E 649; Cat 1546; F3IM 436; NS3hb 160; NS-C 407; NS-W 149; NS-O 203; X-T 84; X-RP 74 • **Fusion of 2 or more vertebrae** (bodies or arches alone or the whole vertebra), cervical or lumbar spine usually • CS: **Asymptomatic**, stable & rarely cause clinical signs • Dx: **Radiographs (incidental finding)** • DDx: Diskospondylitis, healed vertebral fracture • Tx: **None needed** • Px: **Good**				
Transitional vertebrae References as in block vertebrae • Vertebrae at major divisions of spine assuming anatomical characteristics of adjacent division • Usually of no clinical significance				
Butterfly Vertebra * References as in block vertebrae • **Cleft vertebrae** in sagittal plane, screw tailed breeds (French, Eng. bull dogs & Boston terriers) • CS: **Usually not clinically significant** • Dx: Radiographs (funnel-shaped cranial & caudal vertebral ends-plates, VD views resemble butterfly, Myelography for cord compression • Tx: **none needed** • Prognosis: **Good**				
Hemivertebra * References as in block vertebrae • **Wedge-shaped vertebrae**; Usually in screw tailed dogs, Inherited in Ger. shorthaired pointers, Thoracolumbar spine • Severe angulation to the spine - can get canal narrowing & instability = spinal cord compression & trauma • CS: **Often incidental**; Occasional CS: scoliosis, kyphosis, lordosis, progressive paresis & ataxia • Dx: radiographs (**wedge-shaped vertebrae** & angulation of spine), Myelography for compression • DDx: Compression fracture • Tx: Asymptomatic - none; Spinal compression - surgical decompression & stabilization • Prognosis: **Good** if no clinical signs				
Dermoid sinus, Pilonidal cyst, * Pilonidal sinus & epidermoid cyst M8k 920; NS-W 153; Mk 585, E-hb 305 • **Invagination of skin dorsal to spine**, extending variably ± in subarachnoid space. Rhodesian Ridgebacks & crosses most commonly • CS: asymptomatic; meningitis or myelitis (progressive transverse myelopathy between T3-L3 • Dx: Hx (Ridgeback), CS; Palpate cord under skin, Fistulography of myelography for communication; • Tx: as for meningitis & myelitis (ABs) surgical excision is essential				

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Sacrococcygeal dysgenesis of Manx Cats M8k 920; Mk 586; E-hb 306; I2M 1045; IM 793; H3B 256; H2B 278; IM-WW 483; E 684; Cat 1589; F3IM 439; NS-C 457; NS-W 153; NS3hb 164; NS-hb 160; NS-Pa 87; NS-O 200 *	• **Congenital malformation** of sacrococcygeal spinal cord & vertebrae in tailless **Manx cats** - Dysgenesis or agenesis of sacrum, meningocele, myelomeningocele, syringomyelia, spina bifida, shortening of the spinal cord, absence of the cauda equina - Inherited autosomal dominant trait & may be **lethal** in some homozygote cats	• Variable depending on degree of malformation • **Asymptomatic** • **Hind limb LMN signs** - Hopping or crouched (plantigrade) pelvic limb gait • Urinary/fecal incontinence (nonprogressive) • Chronic constipation • Sequela: - Recurrent urinary tract infection - Megacolon	• Hx (**tailless**), CS • Palpation of lumbosacral abnormalities • Radiographs • Myelography: meningocele	• **No treatment** • Incontinence: manual bladder expression & fecal softening agents • Surgery for meningocele **No Tx** Prognosis: • **Depends on clinical signs**
Congenital malformation, Tailless Manx cats **CS: Asymptomatic, Hind limb LMN signs, UTI** **Dx: Hx (tailless), CS, PE, Rads, Myelography** **Tx: No treatment •Px: Variable**				
Spinal curvature deformities IM-WW 452; NS-Pa 90, 200; NS-L 190, 195; X-T 82; X-RP 76 • Cause: usually congenital malformation of 1 or more vertebrae, but may be acquired from trauma Types & causes • Scoliosis: lateral deviation - Hemivertebra - Transitional vertebrae - Muscle spasm - Vertebral luxation & fractures - Malunion of vertebral fractures		• Kyphosis: dorsal deviation: hunchback - Hemivertebra - Malunion vertebral fractures - Vertebral luxation & fractures - Muscle spasms - Abdominal pain causing arching of back - Back pain from disk protrusion		• Lordosis - ventral deviation: sway back - Hemivertebra - Malunion vertebral fractures - Vertebral luxation & fractures

Spinal Problems

NEUROMUSCULAR SYSTEM

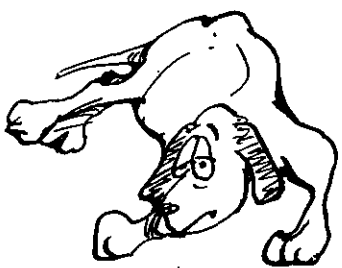
Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Idiopathic feline polioencephalomyelitis, Cerebrocortical necrosis Mk 589; E-hb 294; H3B 240; I2M 997; IM 771; 5min 958; E 626, 658; Cat 1558; I-G 868; NS3hb 382t; NS-C 359; NS-O 229; NS-L 83; NS-Pa 119 *	• **Chronic, slowly progressive degenerative diz of brain & spinal cord** • Multifocal CNS diz • Cause: unknown -? virus? • Cats: 3 months-6 yrs • Pathogenesis: severe neuronal degeneration, demyelination & axonal necrosis	• Spinal cord & cerebellar diz - **Incoordination/ataxia** - **Paresis** (weakness) hindlimbs, tetraparesis • Hypermetria - Intention tremors of head - Seizures • Localized hyperesthesia (pain) • Mentally alert	• Difficult • **R/O other multifocal CNS dizs** • Hx, CS • Cranial nerves normal • Postmortem: only definitive - Perivascular cuffing w/ mononuclear cells, lymphocytic meningitis, glial nodules, with degenerating & demyelination	• **Data lacking** • Isolate Prognosis: **Poor**
Progressive degenerative diz of CNS **CS: Paresis & incoordination** **Tx: ?** **Px: Poor**				
Calcinosis circumscripta E-hb 289; Sx-S 644 *	• Idiopathic • Circumscribed, single or multiple calcium deposits - Periarticular • Young, large breeds (**G. shepherd**)	• **Spinal cord compression:** - Cervical masses: tetraparesis & ataxia - Thoracic masses: paraparesis & ataxia • No pain	• Hx, CS • Rads & myelography: single, round, calcium mass pressing on dorsal spinal cord	• **Surgical removal** if CS Prognosis: Good w/ Sx
Spondylosis deformans M8k 923; Mk 588; E-hb 269; E 690; H3B 262; H2B 293; 5min 1072; NS-C 427; NS-W 153; NS-K 197; NS3hb 153; NS-hb 149; NS-O 205; NS-L 191; X-RP 84 ***	• **Common degeneration of spine - acquired w/ age** - Osteophytes (**"spurs"**) at intervertebral spaces (periarticular) **"bridges"** - Independent of either inflammation or trauma • Age related: ↑ w/ age, some degree in all dogs > 10 years • Large & medium breeds, not associated w/ chondrodystrophic dogs - Thoracolumbar spine - T9-T10, L7-S1 • Cats: later age than dogs • Pathophysiology: degeneration of annulus fibrosis causing osteophytes	• **Subclinical almost always** (no spinal cord compression) • Occasionally impinge on I.V. foramina - nerve root compression • Occasionally vertebral instability • Sequelae: - Intervertebral protrusion & herniation - Traumatic fractures of spurs	• **Incidental finding** • **Spinal radiographs:** - Spurs: small barely discernible nodules to massive ankylosing bridges - Separate centers of ossification in the ventral portion of the annulus - mistaken for fracture fragments	• **None required** • If hyperesthesia (rare) - analgesics/steroids • Surgery rarely indicated
Normal aging change (Spurs), Nonclinical **CS: Subclinical** **Tx: None needed**			**DDx:** • Iatrogenic - previous disc fenestration. • Previous vertebral fracture/dislocation. • Congenital anomaly. • Neoplasia • Spondylosis • Diskospondylitis • Hypervitaminosis	Prognosis: • **Good**, usually subclinical
Multiple cartilaginous exostosis, MCE, Osteochondromatosis, Osteochondroma *	**See Skeletal pg 611: Benign**, proliferative diz of bone & cartilage - metaphyses, stops when growth plates fuse < 18 months, Cause: ?; Transformation? CS: Often **asymptomatic, Firm, distinct swelling near metaphysis**, Lameness (50%), ± Neurologic deficits Dx: H x, CS, Radiology (**"Cauliflower-like"**), Biopsy, ± Myelography Tx: **Not necessary unless neurologic signs** - Surgical excision & Neutering recommended because of possible hereditary			

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Dural ossification, 'Pachymeningitis' * Mk 587; E-hb 294; E 657; NS-W 149; NS3hb 151; NS-hb 149; NS-O 206; NS-L 191	• **Incidental finding in large breeds** • Occurs early 1-2 years but more extensive in older dogs (60% of both large & small dogs) • Anywhere, most common in ventral cranial & caudal cervical areas & lumbar areas • Erroneously called pachymeningitis	• **Asymptomatic** almost always • Rarely causes spinal cord compression & chronic paresis	• **Incidental finding radiographically**	• **None needed** Prognosis • **Excellent**: doesn't cause problems
Incidental finding - large breeds **CS: Asymptomatic**				
Hypervitaminosis A in cats, Dystrophic calcification of skeleton * M8k 927; Mk 591; E-hb 296; H3B 839; H2B 294, 1279; IM-WW 484; E 663; Cat 1553; F3IM 441; NS-W 228; NS3hb 362; NS-hb 344; NS-O 273; NS-L 204; NS-Pa 271; X-RP 77	• 1° affects **cats** • Feeding excessive **liver diet**, cod liver oil supplementation • Pathophysiology: - Extensive **exostosis in cervical & thoracic spine** - New periosteal bone at metaphases - ± **Spinal nerve root compression**	• **Cervical pain & rigidity** • Thoracic limb lameness, ataxia • Reluctance to move • Lethargy, anorexia • Postural changes: marsupial-like, sitting w/ front feet raised	• Hx (excessive intake of vit A or liver), CS • **Radiographs** - **Exostosis** - cervical & thoracic	• **Diet correction** (lower liver): prevents further development of exostosis
Cat, Liver diet, Exostosis of spine **CS: Cervical pain & rigidity** **Dx: Hx, Rads** **Tx: ↓ Liver**				**Prognosis: Good**, usually recover w/ proper diet

Diskospondylitis, Spondylitis, Vertebral osteomyelitis, Vertebral abscess M8k 923; E-hb 258; H2B 284; I2M 1029; IM 782; SAP 1158, 1161; 5min 524; IM-WW 485; E 653; Cat 1550; F3IM 447; NS-W 148, 173; NS-C 360; NS-K 200; NS3hb 155, 387; NS-hb 107, 151; NS-O 231; NS-L 190, 204; Sx-S 1087; X-RP 83 **	• **Diskospondylitis**: infection of I.V. discs & adjacent vertebrae • **Spondylitis**: infection of vertebrae • **Middle-aged large & giant breeds** (Great Dane, German Shepherd, Airedale terrier), rare in cats • 2:1 males:females, young to middle aged • Mid thoracic, caudal cervical & lumbosacral spine usually • Multiple disc spaces often affected • Cause: - **Hematogenous spread #1**: skin, heart, bladder, testes, ovarian stump, uterine infections, renal - 2° to disc fenestration/prior trauma (rare) - Migrating foreign body (plant awn) - 2° to spondylitis - External wounds • Causative organisms: - **Staphylococcus aureus** (#1), Streptococcus, Brucella canis (<10%); Multiple other organisms - rarely involved (E. coli, Corynebacteria, Pasteurella) - Fungal rare - Paecilomyces, Mucor, Fusarium	• **Systemic illness** - Weight loss, anorexia - Depression, lethargy - Poor hair coat - **Fever or unknown cause** • **Kyphosis** (hunchback) • **Spinal pain #1** (hyperesthesia) • Stiff gait, reluctance to run or jump • ± Neurologic deficits (transverse or multifocal myelopathy) - **Progressive paresis/paralysis** caudal to lesion • Brucella infection: insidious • Staph: rapid progression • Sequelae: - Meningitis &/or myelitis	• **CS (spinal pain)** • **Palpation: spinal pain** • **Fever of unknown cause** • ± Leukocytosis • ± Bacteremia, pyuria (50%) • CSF: usually normal, ± protein (chronic compression) or WBC & protein (meningitis, myelitis) • **Radiography**: 1st signs in 4-6 weeks (re-radiograph in 2-4 weeks if negative) - Irregular lysis of vertebral end plates - Widening or collapse of disk spaces - Sclerosis of vertebral end plates - Vertebral osteophytes - Fusion of vertebral bodies - Reaction cross disk space • Scintigraphy (bone scan) for early diagnosis • Myelography: if spinal cord compression suspected • **Blood cultures:** - **Positive in 75% cases** - Urine culture - positive in 25% cases - Tube agglutination test for Brucella (1:200) - Bone cultures: aspiration under fluoroscopy or curettage at surgery	• **Difficult & prolonged**: relapses not uncommon • **ABs 4-6 weeks minimum**: if minimal neurologic deficit - **Staph.** - penicillinase resistant ABs- oxacillin, **cloxacillin, Cephalosporins (cephalexin (Keflex®), cephradine,** clindamycin, methicillin, trimethoprim sulfa, cephalosporin - Streptococcus: (B-hemolytic) - ampicillin, amoxicillin, penicillin. - Brucella - 2 courses of ABs - tetracyclines + streptomycin . Neutering . Euthanasia (zoonotic potential) • If no response in 5 days to ABs reevaluate - Surgery, curettage & culture or different antibiotic • If significant neurologic signs - myelography - Hemilaminectomy, disc curettage + ABs • Average treatment time - 4-6 months • Reassessment + re-radiograph every 2 weeks initially then 1X/month • Clinical improvement occurs long before radiographic improvement. • Repeat blood cultures 2 weeks after treatment cessation
Hematogenous, Staph **CS: Spinal pain, Stiff gait** **Dx: Pain, Rads, cultures** **Tx: ABs - difficult**		**DDx:** • Neoplasia (doesn't cross disk space) • Disk diz • Polymyositis • Spinal trauma • Meningitis • Polyarteritis		Prognosis: • **Good**: most - mild to moderate CS • Guarded: moderate to severe signs • Recurrence common with B. canis

Spinal Trauma

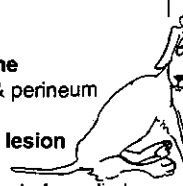
Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Spinal trauma Mk 591; E-hb 308; SAP 1158, 966; H3B 268; H2B 297; I2M 1019, 971; IM 729, 760, 778; IM-WW 486; E 687; Cat 1547; F3IM 442; NS-C 397, 55, 341; NS-W 158; NS-K 158; NS3hb 142, 158, 180; NS-hb 140, 154; NS-Pa 189; NS-O 310, 280; NS-L 359, 184; 196, 81; DDx 428; Sx-WW 299; 291; Sx-S 1031; Sx-B 601; Pa-T 345; NB 12.13 ★★★	• **#1 cause of spinal disorders in dogs & cats** • Causes: - **HBC** (hit by car), Bullet, Falls - **Vertebral fxs**, luxations, subluxation or collapse - **Disc herniation** - Vertebral malformation & instability - Fibrocartilaginous emboli myelopathy • Caudal thoracic spine most common site • Spinal cord trauma	• **Acute & nonprogressive** usually • **LMN signs of segment damaged** • **UMN signs caudal to lesion** • Varying degrees of weakness/paralysis & ataxia • ± Hyperesthesia • ± Progression in disc herniation or spinal instability • Sequela: Spinal shocks: transient <1 hours . Flaccid paralysis (LMN) caudal to lesion . Atonia & areflexia caudal to lesion	• **Hx (HBC), CS** • Physical exam: signs of trauma - Lacerations, abrasions • **Neurological exam** - Evaluate spinal reflexes - **Access perception of deep pain** - Do not test postural reactions - Palpate for malalignment of spinous processes • **Radiology**: condition often worse than radiographs - Evaluate whole spine - Fxs, displacement at time of film doesn't tell amount at time of injury) - Check disc spaces • **Myelography** to localize injury	• Medical Tx to stop edema & ischemia - **Steroids**: antiinflammatory: Dexamethasone or methylprednisolone (Solu-Medrol®) large dose immediately after trauma, then rapid dosage tapering, no longer than 2-3 days . Simultaneously give H2 receptor antagonists (cimetidine or ranitidine) & intestinal protectants (sucralfate) to protect GI - ± Mannitol: 1-2 doses IV for edema - ± DMSO • **Surgical stabilization or decompression**: - Indications: paralysis or severe paresis, progressive neurological dysfunction, instability of spinal cord - Access perception of deep pain in a paralyzed animal before recommending surgery - Refer: hemilaminectomy preferred, spines used to stabilize • **Nursing** - Strict cage confinement 3-12 weeks - Bladder evacuation q4-6h - Padded bedding or water bed - decubital ulcers - Daily baths to prevent 2° dermatitis • **Physiotherapy**: Whirlpool bath, muscle massage, manipulation of limbs, towel walks, exercise carts • **Evaluate suffering** (manage or euthanatize) • **Manage pain**: Demerol® or morphine • **Euthanasia** recommended if loss of deep pain



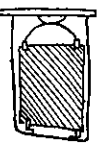
#1 spinal disorders, HBC
CS: LMN & UMN signs
Dx: Hx, Neuro, Rads
Tx: Steroids, Sx, Euthanasia

Quick localization - spinal cord
See lesion location on pg?

- **C1-5: cranial cervical**
  - UMN signs all limbs
- **C6-T2: cervicothoracic**
  - UMN to rear limbs
  - LMN to forelimbs
- **T3-L3: thoracolumbar spine**
  - UMN signs to rear limb
  - Normal forelimbs
- **L4-S3: lumbosacral spine**
  - LMN signs to rear limb & perineum
  - Normal forelimbs
- **S1-3: sacral spinal cord lesion**
  - UMN to perineum
  - Loss of sciatic - withdrawal of rear limb
  - Normal femoral - + patellar reflex
  - Normal forelimbs



DDx:
- Pelvic fxs
- Muscle trauma



Prognosis: varies
- Excellent: only pain & reluctance to move with no abnormalities in motor function or perception
- **Good**: if voluntary motor & deep pain sensation
- **Guarded**: no voluntary motor but deep pain sensation
- **Grave**: no voluntary motor or deep pain, or no improvement in 10 days
- Most animals that recover show improvement w/in first 2 weeks
- Poor/grave: paraplegic or tetraplegic with absent pain sensation & bladder control
  - Lapse of time between spinal cord injury & surgical intervention
    . < 12 hours: incomplete functional recovery 20 - 25%
    . If > 24 hours, < 5% chance of functional recovery

Spinal shock

- Transient state following spinal cord transection; Depression of spinal reflexes in all segments caudal to the lesion.
- CS: Too brief to be of clinical significance in quadrupeds (30-60 mins)

Fibrocartilaginous embolism/ infarct, Ischemic myelopathy

M8k 929; Mk 587; E-hb 300; H3B 265; H2B 285; SAP 1159; I2M 1027; IM 781; IM-WW 487; 5min 596; E 671; NS-C 365; NS-W 149; NS-hb 153; NS-Pa 246; NS-L 81, 409, 194, 205; NS-O 246; Sx-WW 300; Pa-T 353
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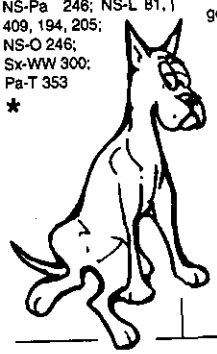
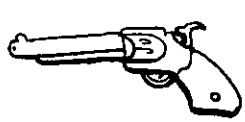


- **Vascular emboli occlude vessels in the spinal cord** (parenchyma & leptomeninges)
  - Ischemia (bilateral or unilateral)
- Signalment:
  - Adults (2-7 years-old)
  - Large breeds (especially **Great Danes**), all breeds
  - Cats rarely affected
  - Rare in chondrodystrophic dogs
- Pathogenesis: largely unknown
  - Originate from nucleus pulposus?
  - Emboli in either arteries or veins of spinal cord
  - Infarcts: hemorrhagic or ischemic (both white & grey matter)
  - Severity of myelomalacia
  - Usually not concurrent IV disk degeneration

- Peracute (sudden) **paresis/paralysis** caudal to lesion
  - **Asymmetric** (hemiparesis/hemiplegia)
  - During or immediately after exercise (50%)
- **Initial cry at onset, then no back pain**
- Nonprogressive after 12-24 hours
- UMN or LMN diz related to embolism location
  - **High % LMN** signs since the cervical & lumbar enlargements #1 sites of embolism
- Horner's syndrome if C1-T3

- **No definitive antemortem diagnosis**, although MRI scan possible
- **Hx (breed, peracute w/ no trauma)**
- **CS: presumptive: acute, nonpainful, asymmetric paresis w/ normal radiology**
- Plain radiographs - normal
- CSF Analysis - normal in most cases
- Myelography - often normal. Some spinal cord swelling (thinning of dye column)
- R/O (rule-out) diagnosis
- Localize lesion by CS (UMN & LMN CS)

- Goal reduce edema & inflammation
  - **Glucocorticoids** (Dexamethasone)
    . Cimetidine for GI Side effects
- Supportive care
- **Euthanasia** if deep pain lost



Prognosis:
- **Guarded:** 50% recover to be acceptable pets
- Mild episode: spontaneous recovery
- Severe paresis/paralysis - if recovery to occur improvement seen in 7-10 days
- Good if retain deep pain perception in limb & tail & have UMN signs
- Extensive LMN signs - poor prognosis
- Loss of deep pain - very poor to hopeless prognosis - often euthanasia
- Decompression surgery does not help

Vascular emboli occlude vessels in the spinal cord
CS: Paresis/paralysis caudal to lesion
Dx: Hx, symmetric paresis w/ normal radiology
Tx: Steroids, support; Euthanasia; Px: guarded

Spinal arachnoid cysts, Meningeal cyst, Leptomeningeal cysts M8k 919; Mk 586; H3B 252; H2B 285; E-hb 294; NS-W 14

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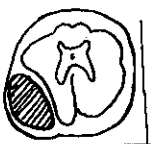
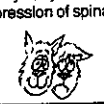
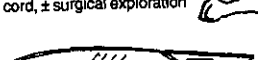
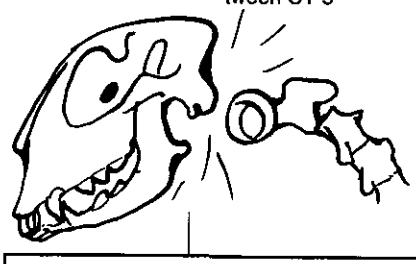


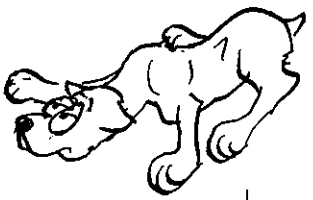
- **Pia & arachnoid membranes containing CSF**; Cause: unknown; ± Compression of spinal cord; Cyst are intradural-extramedullary on dorsal midline
- CS: ± **Signs or spinal compression** (± progressive weakness & ataxia, UMN signs caudal, LMN signs at level of cyst, symmetrical or asymmetrical)
- Dx: Hx, CS, **Rads:** normal or enlarged spinal canal; **Myelography**: pooling of contrast in subarachnoid space & compression of spinal cord, ± surgical exploration
- DDx: Congenital vertebral malformation, Myelitis, Intervertebral disk diz, Neoplasia
- Tx: **Surgical decompression** of spinal cord by **partial excision** of cyst (complete excision not usually possible)
- Px: **Guarded**. Surgery may result in improvement w/o recurrence



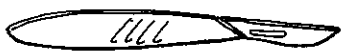


Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Atlantoaxial subluxation, **Atlantoaxial instability,** **Malformation of odontoid process** M8k 919; Mk 584; E-hb 287; SAP 965; H3B 252; H2B 277; I2M 1044; IM 792; IM-WW 482; 5mln 375; E 638; NS3hb 181; NS-O 201, 442; NS-L 199; Sx-S 1048; X-RP 79; Sx-WW 298; Sx-B 593 **	• **Instability of C1-C2 joint,** Atlantoaxial joint: pivot joint "No joint" • Cause: absence, malformation, failure to ossify or insufficient ligamentous support of dens - Rupture of ligaments of dens or fracture of dens • **Breeds: congenital: toy & miniature** (rare in cat); w/ trauma - any breed • Pathophysiology: - **Compression of spinal cord** due to dorsal displacement of cranial axis in vertebral canal - Normally dens held down to atlas by ligaments - Transverse myelopathy between C1-5	• **Transverse myopathy - C1-5** - **Cervical pain** (hyperesthesia) . Extension & rigidity - neck - **Motor dysfunction** in all 4 limbs (UMN) . Varying degrees of paresis & ataxia to paralysis	• Hx, Cs • Palpation: careful, avoid forceful flexion of neck - UMN signs in all 4 limbs - ± Dorsal displacement of axis (C2) • **Radiographs (very carefully):** - Lateral - neck slightly ventroflexed - body of axis displaced dorsally & cranially	• Agenesis: no Tx unless signs • Steroids if cord compression • Traumatic luxation - **Splint head & neck** in extension & strict cage rest minimum of 6 weeks (small dogs best) • **Surgical stabilization** (refer): for mod. to severe CNS CS or recurrent episodes - Wire dorsal atlas to dorsal axis - External support - Restrict exercise 1-2 months





DDx:
- Intervertebral disk diz
- Diskospondylitis
- Cervical trauma
- Meningitis/myelitis
- Neoplasia
- Degenerative

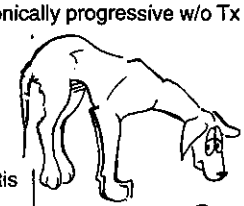


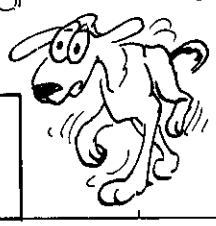
Unstable C1-C2 joint - compression
CS: Cervical spinal cord: neck pain, UMN all 4 limbs
Dx: Hx, CS, PE, Rads
Tx: Surgical stabilization (refer)

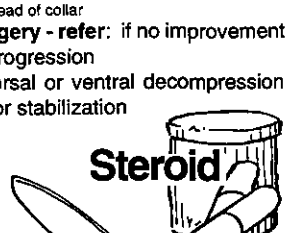
Prognosis:
- Good if voluntary motor function w/ conscious pain perception
- Guarded for acute onset of tetraplegia

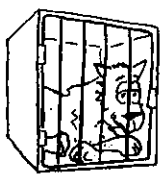
Wobbler's diz, **Cervical spondylopathy, Caudal cervical vertebral instability/ malformation/ malarticulation,** **Cervical spondylomyelopathy** M8k 919; Mk 584; E-hb 289; H3B 261; H2B 290; SAP 969; I2M 1036; IM 787; 5mln 1162, 738; IM-WW 479; E 644; NS-C 349; NS-W 146; NS-K 203; NS3hb 174; NS-hb 180; NS-Pa 198; NS-O 204, 444, 448; NS-L 200; Pa-T 346; X-Gr 36; X-RP 81 Sx-WW 297; Sx-B 759 **	• **Extradural spinal cord compression due** to malformation of bony or ligamentous structures - Hypertrophy of annulus fibrosis from chronic disk diz, vertebral malformation of instability - Static (constant) or dynamic (intermittent) compression • Breeds: **Great Danes** (young) & **Dobie** (middle aged)	• **Slowly progressive paresis or wobbling gait (ataxia)** - **Pelvic limb** > thoracic: crossing, wide abduction, knuckling, collapse - crouched pelvic limb posture, awkward swaying of hindquarters - Scuffling of toenails - Stiff, restricted forelimb gait . ± Atrophy of supraspinatus - LMN of caudal cervical area • **Weakness (paresis)** UMN • ± Paralysis • No overt cervical pain • Chronically progressive w/o Tx	• Hx (breed), Cs • Resistance to cervical manipulation • **Abnormal hopping & conscious proprioception** • **Radiographs:** flexed lateral - Subluxation of vertebrae - **C5-6 & C6-7** most common sites - ± Narrowed disk space if concurrent herniation - Abnormally shaped vertebrae, bony stenosis of spinal canal, hyperostosis of laminae, asymmetry of articular facets, degenerative joint diz of articular processes • **Myelography necessary before Sx** for site & type of cord compression - **Extradural compression** . Dorsally by hypertrophied dorsal ligamentum flavum (yellow) . Ventrally: hypertrophied dorsal annulus fibrosis . Dorsolateral: malformed articular processes . Subarachnoid space usually thinned & narrowing of spinal cord	• **Steroids: prednisolone** alone for mild CNS signs - Restrict exercise: cage rest - harness instead of collar • **Surgery - refer:** if no improvement or progression - Dorsal or ventral decompression &/or stabilization

DDx:
- Coxofemoral dysplasia
- OCD (osteochondrosis)
- Hypertrophic osteodystrophy
- Cervical trauma
- Diskospondylitis
- Meningomyelitis
- Canine distemper
- Granulomatous meningoencephalitis
- Spinal cord tumor
- Intervertebral disc diz



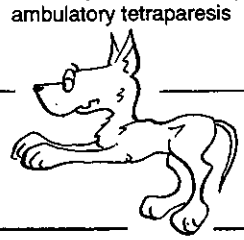






Spinal cord compression - malformation, Danes & Dobies
CS: UMN PL > TL, wobbling gait, weakness
Dx: Hx, CS, PE, Rads (C5-6 & C6-7), Myelography
Tx: Steroids, Surgery - refer •Px: Variable

Prognosis:
- **Extremely variable**
- Poor if tetraparetic patients
- Better if pain alone, paraparesis or ambulatory tetraparesis



Calcium phosphate deposition diz E-hb 289; E 644; NS-O 208

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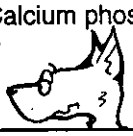


- **Great Dane puppies**, Periarticular calcium phosphate mineralization & bone deformity of axial & appendicular skeleton; Caudal cervical canal stenosis due to dorsal displacement of C7 = compression, not related to Wobbler syndrome, Cause unknown, hereditary?
- CS: **Progressive incoordination & paralysis** in 1-2 month old great Dane puppies
- Dx: Hx (GD puppies), CS, Radiographs: dorsal displacement of C7
- Treatment hasn't been described

Disk Disease

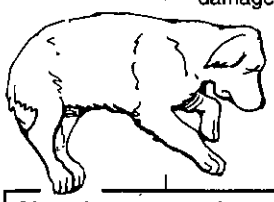
NEUROMUSCULAR SYSTEM

Condition	Facts & Cause	Presentation/CS	Diagnosis	Diagnosis
Type 2 intervertebral disk diz, IVD, Hansen's type II M8k 421; Mk 587; E-hb 297; H3B 258; H2B 286; I2M 1033; IM 785; IM-WW 474; 5min 740; SAP 1158, 1163; F3IM 452; ; NS-W 147, 154; NS-C 413; NS-K 21; NS-hb 145; NS-O 324, 416; NS-Pa 202; X4T 98; X-Gr 46; Pa-T 458; X-RP 81; Sx-B 601; Sx-WW 295; **	• **Disk protrusion**: **bulging of annulus fibrosis dorsally w/o complete rupture** - Older >5 years, large breed, nonchondrodystrophoid dogs (Ger. shepherd, Dobie, Labs) - Cervical disk diz seen in Dobies associated w/ wobbler's - Older cats: protrusion fairly common but rarely causes clinical diz • Cause: unknown • Pathophysiology" - Fibroid degeneration of disc w/ age (calcification rare) - Bulging of annulus fibrosis - Slow spinal compression	• **Slowly progressive course** • **Thoracolumbar** most common - UMN (upper motor neuron) to pelvic limb & normal thoracic limb . Spastic paresis, hyperreflexia • Cervical disk diz - UMN to both thoracic & pelvic limbs: pelvic worse (spastic weakness) • ↑ Hyperesthesia	• **Hx (slow progressive cord diz)** • **Radiographs**: normal in some - Narrowing of disk space - Osteophytes & end plate sclerosis - Calcification rare • CSF analysis • Myelography - Determine site or sites - Localized extradural mass ventral to spinal cord - Extradural compression of spinal cord, narrowing of subarachnoid space	• **Medical: steroids** - not curative • **Surgery:** - Ventral decompression - cervical - Hemilaminectomy & fenestration in thoracolumbar area **Steroid** **Prognosis:** • **Poor** for full recovery because of chronicity before CS • Few dogs experience temporary or permanent worsening of clinical signs postoperatively
Bulging, Less common, Not "weanies" **CS: Slow - UMN - P-limb, Normal T-limb** **Dx: HX, CS, Rads** **Tx: Steroids, Surgery**		**DDx:** • Neoplasia • Degenerative myelopathy • Diskospondylitis • Coxofemoral osteoarthritis • Multiple cartilaginous exostosis • Myelitis • Polyneuropathy		
Progressive hemorrhagic myelomalacia, PHM, Hematomyelia * E-hb 305, 264; H2B 297; 5min 843; IM-WW 487; NS-W 149; NS-O 327; NS-L 82; NS-Pa 191; NS3hb 147; NB 12.16	• Intramedullary, intrameningeal or epidural hemorrhage • Cause: **Trauma (disk diz)** • Pathophysiology: unknown ? ischemia? - **Hemorrhagic necrosis of entire cord** possible in 1-2 days, **ascends & descends cord** (occasionally only descends cord)	• Usually **acute** • Spinal cord signs depend on site - **Initially a transverse myelopathy between T3-L3** . Severe deficits rear limbs - paraplegia - **Progressive diffuse myelopathy** over hours - 2 days . Flaccid paralysis in 1-2 days. ± Diaphragmatic paralysis & bilateral Horner's syndrome . ± Extreme pain	• Hx, CS • Rule out coagulopathies prior to Subarachnoid puncture for CSF • Myelography: epidural hemorrhage	• **PMH: No effective treatment** • **Euthanasia** **Prognosis** • **PHM: grave**: fatal in 7-10 days (respiratory paralysis)

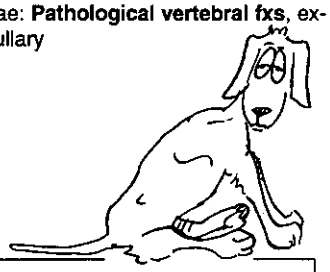
Type 1 intervertebral disk diz, IVD, Hansen's type I M8k 921; Mk 587; E-hb 297; H3B 258; H2B 286; I2M 1021; IM 779; IM-WW 477; SAP 1158, 1163; Cat 1547; F3IM 452; NS-W 147, 154; NS-C 413; NS-K 21; NS3hb 132; NS-hb 133; NS-O 321, 416; NS-L 82; NS-Pa 202; X-RP 81; X4T 98; X-Gr 46; Sx-B 601; Pa-T 458; NB 12.17 ****	• **Extrusion of nucleus pulposus through ruptured annulus fibrosis into spinal canal** • Chondrodystrophoid breeds: **20% of all Dachshunds** (50-70% of all cases), toy poodle, Pekingese, beagle, cocker spaniel • More severe than type 2 usually • **D3-6 years of age** • Cause: unknown? - genetic, hypothyroidism, autoimmune diz? • Pathophysiology: - Disc degeneration- chondroid - calcification of nucleus pulposus - Trauma may cause rupture - Compression of spinal cord &/or nerve roots • Location: **- #1 Thoracolumbar: T11-12, L1-2** - Cervical spine - C2-3: spinal canal relatively large so may not result in significant compression - T1-10 area: rare because of **intercapital ligaments** (connects heads of opposite ribs) - Caudal lumbar: usually results in nerve root compression of caudal equina	• **Some just pain** no neuro signs • **Cervical disk diz** - Acute onset: most cervical pain & no neuro signs **- Head low & neck extended** . Neck pain, spasms of neck muscles - ± Forelimb lameness: root signature - ± Gait: stiff, short-stride w/o neurological deficits - ± Paresis & ataxia to all 4 limbs (tetraparesis) (rarely severe) - ± UMN signs to all limbs - ±LMN to thoracic limb if caudal cervical - ± Horner's syndrome - rare • **Thoracolumbar disk diz** **- UMN signs in rear limbs - normal forelimbs** - Peracute to acute onset **- Pain**: reluctance to move, **arched back** - UMN signs if above L3: spastic paresis & ataxia of hindlimb (paraparesis) - LMN sign if lesion L3-4 to L7-S1 **- No cutaneous reflex 2 vertebrae caudal to lesion** - Urinary & fecal incontinence • Cauda equina compression • Sequela: - Diffuse myelomalacia: rare ascending & descending phenomena, over time, death from respiratory failure	• Hx (breed - **dachshund**), CS • Cervical disk diz - Resists cervical manipulation • Thoracolumbar disc diz - Hyperesthesia of back, 2 vertebrae caudal to lesion • Radiographs: 20-30 % normal survey **- Narrowing or wedging of disk space** (check triads of spaces) **- Calcification of disk** - Mineralized mass in vertebral canal ("cloudy" foramen) - Narrowing of intervertebral foramen (lateral view) ("horse's head") - Collapsed facets - Spondylosis & dural ossification - incidental findings - Oblique cervical radiographs for intraforaminal & lateral extrusion • CSF analysis • **Myelography** if can't localize - Determine site or sites of herniation & lateralization of disk material - Diffuse intramedullary cord swelling over several vertebral bodies, extradural compression of spinal cord, narrowing of subarachnoid space	• Medical: all acute cases, animals w/ apparent pain only or just mild neurological deficits - **Steroids** to decrease edema - **Strict confinement** for 2-3 weeks . ± **Analgesics** (aspirin, PBZ [phenylbutazone]) . **Muscle relaxant**: methocarbamol (Robaxin®) PO tid - ± **Surgical fenestration** (remove nucleus pulposus) - preventative measure **Steroid** • **Surgical**: indications: paresis w/ deep pain perception intact, pain unresponsive to cage rest, radiographic compression, Immediate indication: paralysis - Do as soon as possible - **Dorsal laminectomy/hemilaminectomy**: TOC for thoracolumbar disc diz & caudal lumbar diz - **Ventral decompression**: TOC for cervical disk diz: remove extruded disk - Post Sx: nursing care, steroid PO BID x 2 days, urination assistance, clean & confine, massage & physiotherapy, swimming • **Euthanasia** if truly analgesic for > 48 hours or if significant myelomalacia at time of surgery **Prognosis: guarded** • **Sx: Good** if deep pain retained - **Grave**: loss of voluntary motor & deep pain > 48 hours, poor > 24 hours - Recurrence more common in nonsurgical cases - Most that recover show improvement w/in 2 weeks
Rupture, "Weanie" dog, T11-L2 **CS: UMN P-limb, normal T-limb** **Dx: Hx, CS, Rads** **Tx: Medical, Surgical**		**DDx:** • **Spinal trauma** • **Fibrocartilaginous emboli** • Diskospondylitis • Meningitis/myelitis • Neoplasia • Atlantoaxial luxation • Acute polyradiculoneuropathies • Dural ossification • Calcification of longitudinal ligament • Lateral spondylosis • Oblique radiographic projection		

Spinal Column Neoplasia

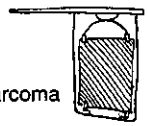
Condition	Facts & Cause	Presentation/CS	Diagnosis
Spinal column neoplasia M8k 927, 957; Mk 591, 610; E-hb 303; H3B 266; H2B 295; SAP 1157, 1163, 972; I2M 1031; IM 784; IM-WW 484; 5min 820, 822; E 677; Cat 1550; F3IM 455; NS-W 152; NS-C 367, 466; NS-K 99, 211; NS3hb 96, 147, 355; NS-hb 145; NS-O 280; NS-L 189, 194, 197; NS-Pa 386; Sx-S 1035; Sx-WW 299, 291; X4T 93; X-RP 86 **	• **Tumors of vertebrae, meninges, nerve roots &/or spinal cord** • Less common than brain tumors • **Dogs: vertebral/bone tumors** most common - Intradural-extramedullary also common - Intramedullary tumors: rare - Large-breeds > small - Older in most (mean age 5-6 years) . Exceptions: lymphoma (any age), neuroepithelioma (young), vertebral osteomas • **Cats: extradural lymphoma** only common spinal tumor • Pathophysiology: - **Chronic, progressive spinal cord dysfunction** (transverse myelopathy) - Extradural & intradural-extramedullary . **Progressive compression of cord** - Intramedullary: greater parenchymal damage, more rapid onset	• **CS related to location** - transverse myelopathy • **Pain**/hyperesthesia (often 1st CS) - Common in extradural tumors - Intradural-extramedullary . Intermittent pain . Root signature - Uncommon in intramedullary • **Progressive paresis & ataxia** caudal to lesion - Acute or insidious . Extradural: 3-7 weeks . Intradural-extramedullary weeks to months . Intramedullary: < 1 month often - Asymmetry common initially • Sequelae: **Pathological vertebral fxs**, extramedullary	• **Diagnosis late - significant compression before CS** • Hx, CS, PE, screening blood tests • Locate lesion site 1st • **Plain radiographs** - Vertebral neoplasia - osteolytic or osteoproliferation (bone production or destruction) . Destruction most common w/ 1° tumors - Pathological fractures - ± Paravertebral soft tissue masses w/ 2° tumors - Intradural-extramedullary & intramedullary: ± widening of intervertebral foramen or vertebral canal - **If a tumor exists: thoracic films for metastasis** • **Myelography**: distinguishes 3 possible tumor location - **Intramedullary**: . Both views: thinning of dye columns & expanded spinal cord - **Intradural-extramedullary** . View 1: widening of 1 dye column (golf - tee pattern) . View 2: expanded cord - **Extradural (outside dura mater)** . View 1: displacement of both dye columns & cord . View 2: widening of cord + thinning of both dye columns • CSF analysis: abnormalities nonspecific, normal in most cases - Normal to mildly increased WBC count - Elevated total protein - Exception: lymphosarcoma - often significant increase in WBC (lymphocytes) - Rare to find exfoliated cells from other tumors • Ancillary tests: - EMG (to localize), SCERs - CT & MRI scanning - CBC, FeLV & bone marrow for lymphosarcoma - Biopsy



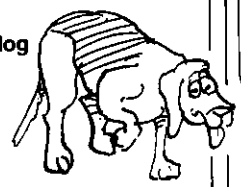
Chronic, progressive cord compression
CS: UMN & LMN signs - location
Dx: Late, Rads, Myelography
Tx: Most impossible once Dx

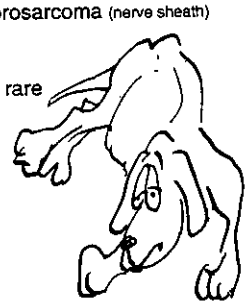


Common locations - thoracolumbar
- **Extradural: thoracolumbar**
- Intradural-extramedullary
  .. Neurofibroma: cervicothoracic
  .. Neuroepithelioma: thoracolumbar
- Intramedullary: cervicothoracic

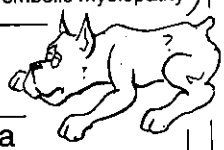


Types of spinal column tumors
- Extradural neoplasm (most common)
  - Vertebral tumors
    . Primary vertebral
      .. **Osteosarcoma #1 1° in dog**
      .. Chondrosarcoma
      .. Fibrosarcoma
      .. Multiple myeloma
      .. Hemangiosarcoma
      .. Lymphosarcoma
    . Secondary/metastatic vertebral
      .. Mammary adenocarcinoma
      .. Prostatic adenocarcinoma
      .. Transitional cell carcinoma
      .. Hemangiosarcoma
      .. Melanoma
      .. Thyroid carcinoma
  - Epidural tumors
    .. **Lymphosarcoma #1 in cat**
    .. Undifferentiated sarcoma
    .. Secondary/metastatic tumors
- Extramedullary-intradural neoplasia
  - Neurofibroma/neurofibrosarcoma (nerve sheath)
  - Meningioma
  - Neuroepithelioma
- Intramedullary tumors - rare
  - Astrocytoma
  - Ependymoma
  - Oligodendroglioma
  - Glioma
  - Lymphoma
  - Neuroepithelioma (<3 years-old)
  - Metastatic tumors





DDx:
- Intervertebral disk diz
- Spinal trauma
- Vertebral osteomyelitis/diskospondylitis
- Meningitis/meningomyelitis
- Degenerative myelopathy
- Fibrocartilaginous embolic myelopathy



Neuroepithelioma

E-hb 265; IM 784; NS-L 423; NS-O 279t, 282; NS-L 189

*

- 1° intradural-extramedullary tumor
- **Young dogs** (6 months - 3 years)
- **Thoracolumbar spinal cord** (T10-L2)
- **German Shepherd**

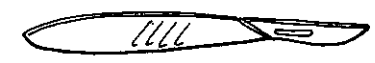
Presentation:
- Very vague signs weeks before neuro. sign onset
- Pain is often the first sign (radicular or periosteal)
- Often progression to paralysis, although pain loss unusual

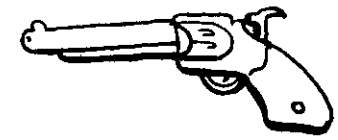
Diagnosis:
- Hx (breed, age), CS
- Plain radiographs
- CSF Analysis: Normal to mildly increased WBC count, Elevated total protein
- Myelography: intradural-extramedullary
- Ancillary tests -EMG, SCERs, CT & MRI scanning
- Thoracic & abdominal radiographs for metastasis

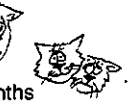
Treatment:
- **Glucocorticoids**: occasionally temporary improvement
- Surgery

Prognosis: poor????

Treatment:
- **Most impossible to treat once diagnosed**
  - Exception: lymphomas
  - Some treatable if diagnosed prior to irreversible spinal cord damage
- **Medical:**
  - **Corticosteroids**: temporary Tx of spinal cord edema
  . Palliative: steroids as adjunct to Sx or if tumor inoperable
  - **Chemotherapy** for epidural lymphosarcoma
- **Surgery**: remove tumor & decompress spinal cord
  - Intradural-extramedullary: if well encapsulated & diagnosed early - possible to remove
  - Extradural tumors: debulked or fully remove, rarely successful
  - Doesn't improve lymphosarcoma in cats
  - Neurofibromas: excision difficult - ± foraminotomy & extensive laminectomy
- **Euthanasia: for intramedullary tumors**







Prognosis:
- **Extradural: poor**
  - Lymphosarcoma remission < 9 months
- **Intradural-extramedullary: guarded** w/ removal
  - Immediate prognosis related to neurological deficits
- **Intramedullary: grave**/hopeless

Condition	Facts & Cause	Presentation/CS	Diagnosis

Meningitis, Menigomyelitis

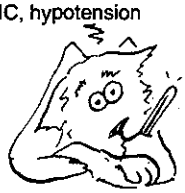
M8k 946, 924, 903; Mk 608; SAP 1141, 1158; IM 769; H3B 246; H2B 260, 281; E-hb288, 291; I2M 1009, 1012, 818; IM 782; IM-WW 464-469; E 619, 641, 650; Cat 1530; NS-C 358, 356; NS-W 93, 153; NS3hb 335, 383; NS-hb 106, 283, 316; NS-O 230, 402; NS-L 204; NS-Pa 156; I-G 184

**

- **Not as common in dogs & cats as in large animals**
- Inflammation of the meninges (pia & arachnoid)
- **May be associated w/ inflammation of underlying brain (meningoencephalitis) or spinal cord (meningomyelitis)**

Causes:
- Infectious (rare)
  - . Bacterial (rare)
  - . Fungal: cryptococcus neoformis
  - . Viral (FIP) - rare
  - . Protozoal rare
  - . Rickettsial diz
- **Steroid-responsive #1?**
- Vasculitis

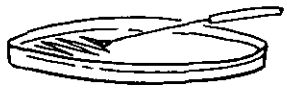
- **Cervical rigidity**
  - Pain/Hyperesthesia - neck pain
- **Fever**
- **Lameness:** stiff stilted gait, mild ataxia
  - Paresis, paralysis, hyperreflexia
  - ± Ataxia & mild paresis in all 4 limbs
  - Spinal reflexes usually normal
- **2° brain involvement:** mentation change, seizures
  - -If severe: opisthotonus, coma, decerebrate/decerebrate rigidity, hemiation, cerebral hypoxia
  - Blindness, nystagmus, head tilt
- Extra neural signs: vomiting, bradycardia, shock, DIC, hypotension



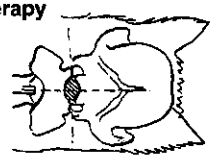
- Complication:
  - CNS edema
  - Hydrocephalus
  - Thrombophlebitis
  - Damage to cranial nerves & spinal nerves

DDx:
- Acute Type 1 disk extrusion
- Polyarthritis
- Diskospondylitis
- Polymyositis
- Cervical intervertebral disk diz
- Meningeal Tumors
- Granulomatous menigoencephalitus

- Hx, CS
- Physical exam:
  - Systemic illness usually, check for bite wounds (back)
  - **Resist passive manipulation** of head, neck & limbs
- Neuro exam: CNS or spinal cord involvement
  - ± Ataxia & mild weakness in all 4 limbs
  - Spinal reflexes usually normal
- CBC normal to PMN leukocytosis (bacterial & immune-mediated); leukopenia in viral
- **Blood cultures** may help identify causative organism

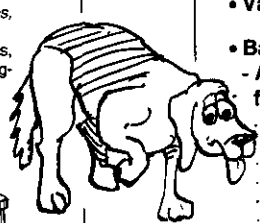


- CSF:
  - ↑ Protein (breakdown of BBB) (often > 100 mg/dl)
  - Turbidity if > 500 cells/µl
  - WBCs - pleocytosis in fungal, idiopathic vasculitis, bacterial, viral, Bacterial: PMN pleocytosis (>1,000/µl)
  - . Viral: mononuclear/lymphocytes
  - . Steroid responsive: shows IDENTICAL cytology to bacterial
  - Bacterial culture - rarely positive
  - RBCs - common, if > 48 hours = xanthochromia
  - Pressure: normal to increased (esp. cryptococcosis)
  - Serology: ± ↑ titers to infectious agents (need paired titers)
  - . ± CSF titers 2° to blood brain barrier (BBB) leakage of globulin
- **Response to antibiotics or steroid therapy**



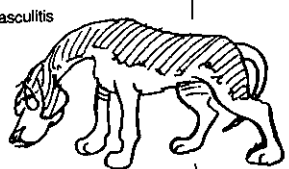
Bacterial meningitis

- **Rare** in cat & dog
  - *Staph. aureus, Staph. epidermidis, Stap. albus, Pasteurella multocida, Actinomyces, Nocardia*
- Causes: Septicemia, Local invasion, surgery, migrating foreign body, Bite wounds, Extension of nasal sinus, inner ear, spinal cord (myelitis) or osteomyelitis; Hematogenous (endocarditis, prostatitis, metritis, diskospondylitis, pyoderma, pneumonia)
- Once infection established spreads rapidly



Steroid responsive meningitis, Aseptic meningitis, Idiopathic meningitis E-hb 291

- Most common form of meningitis in dog, maybe
- Young large breeds of dogs (< 2 years old)
- Indistinguishable from other forms of meningitis
- Pathophysiology: not understood - idiopathic
  - Immune mediated?, repeated vaccinations (MLV) ?; necrotizing vasculitis



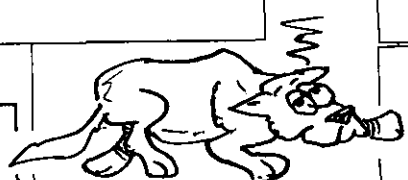
Vasculitis - meningitis

- Immunological mechanism suspected; Beagles, Burmese mountain dogs, Ger. shorthaired pointers & other breeds

Fungal meningitis Mk 589; 608; SAP 1141, 1158; IM 775; H2B 281, 260; E-hb 253; NS-W 150; NS-C 154; NS-K 68; NS-hb 107; NS-O 238; NS-L 191, 384; NS-hb 108; I-B 319

- Fungal Inflammation of the meninges (pia & arachnoid) myelitis
- **Cryptococcus neoformis** (most common), Nocardia, Blastomyces dermatitidis, Histoplasma capsulatum & Coccidioides immitis
- **Rare** in cat & dog

TB meningitis NS-hb 108



Steroid responsive > infectious
CS: Cervical rigidity/pain, Fever, Lame, CNS
Dx: CS, Cultures, CSF, AB & Steroid Tx
Tx: Depends on cause

Treatment:
- **Emergency: fluids, ↓ fever**
- **Valium/Pentobarbital to prevent/control seizures**

- **Bacterial**
  - **ABs (culture & sensitivity): for 3-4 weeks following cessation of CS**
  - . Penicillins: Oxacillin (penicillinase - Staph), ampicillin (gr- orgs) & carbenicillin (anaerobes)
  - . Chloramphenicol - 2nd line of therapy, Sulfonamides, Metronidazole (anaerobes)
  - . Aminoglycosides & cephalosporins - poor choices
  - . **ABs for intrathecal use:** Ampicillin, Cephalosporin, Gentamicin
  - . Can consider combination AB therapy
  - . Not steroids

- **Steroid responsive**
  - **Corticosteroids** IV Dexamethasone or oral prednisone for remission
  - Maintenance: oral Prednisone
  - Long-term Rx often necessary (1-6 months) - taper dose over 1-2 months
- **Vasculitis:** Long term steroids - prednisolone PO BID - 2 weeks
- **Fungal:**
  - Amphotericin B + Flucytosine
  - **Extremely difficult to eliminate**
  - **Intrathecal amphotericin B** recommended (poor CSF penetration)
  - . Given at high doses IV (can be used intrathecally)
  - Rx of cryptococcosis Combination amphotericin B + Flucytosine
  - Ketoconazole - does not cross the BBB - used only as adjunctive treatment
  - Rifampin + amphotericin B & flucytosine for histoplasmosis & aspergillosis

- Rickettsial: tetracycline

Prognosis:
- **Steroid sensitive: good,** Recurrence common (50%)
- Bacterial: **guarded/poor** despite therapy: recurrences common, many die
- Vasculitis: Guarded, some develop progressive brain & spinal cord involvement despite Tx

Viruses

NEUROMUSCULAR SYSTEM

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Canine distemper myelitis & myoclonus, **Encephalitis in immature animals** **	• **See Systemic Dizs pg 689** • **Severe, highly contagious multi-system viral diz** • **Myelitis**: inflammation of spinal cord - T3-L3 affected most often • Progressive, diffuse, multifocal or focal myelopathy - ± Demyelination white matter of spinal cord • ± History of systemic illness • Canine distemper virus: neurotropic • Most susceptible unvaccinated weaned puppies - 3-6 months old - < 3 years-old (any age) - Vaccinated dogs may be affected	• ± **Hx of systemic illness**: naso-ocular discharge, GI enteritis, pneumonia • **CNS multifocal or disseminated** after recover from systemic illness - **Myelitis** signs reflect location of infection . **T3-L3 (#1)** - transverse myelopathy . **UMN: spastic paraparesis/plegia** - **Myoclonus ("corea")**: rhythmic twitching of muscles, pathognomonic . Masticatory & forelimb muscles - **Ataxia, head tilt, circling** - ± Self mutilation: limbs & tail - **"Chewing gum" seizures** - **Pacing, behavior changes** - Hyperesthesia, cervical rigidity • Miscellaneous: dental enamel hypoplasia, **"hard pad" diz**, chorioretinitis	• Antemortem often difficult • Hx (unvaccinated puppy), CS • **Thorough neurologic exam** • Ophthalmic exam: chorioretinitis, hyperreflectivity, "medallion" lesions • CSF not helpful in a high % of cases - (normal) If abnormal - very variable • CSF/serum titers not very reliable -If CSF protein is increased - 1- IgG with specific anti-CDV activity • Immunologic techniques • Virological techniques usually not necessary or practical (inclusions in buffy coat - FA • Serology: rising titers suggestive not diagnostic	• **Often unrewarding**, no reliable therapy for myelitis or myoclonus - myelopathy irreversible • Symptomatic - corticosteroids • Supportive/**good nursing** • Isolate animal • **Euthanasia** if severe, incapacitating, progressive neurologic signs Prevention: • **Distemper vaccination** **Prognosis:** • **Poor for recovery** • In recovered animals: myoclonus & optic neuritis may improve in time

Postvaccine canine distemper encephalitis

E-hb 294; IM 773; H2B 1189; SAP 109; NS-O 220; NS3hb 373t; I-B 59

*

- **Rare**, Young dogs < 6 months; Believed associated w/ **MLV** vaccines in combo w/ parvo vaccine in pups less than 6-8 weeks old
- CS: **Seen w/in 1-2 weeks of vaccination**: anorexia, listlessness, CNS (behavior changes [viciousness] aimless wandering, howling, incoordination, terminal convulsions)
- Dx: Hx, CS, absence of inclusions bodies, DDx: furious form of rabies
- Tx: Symptomatic: ???; Prognosis: guarded
- Prevention: Measles vaccine or MV-CDV combo in pups <6-8 weeks old, then parvo vaccine in 7-10 days. Avoid MLV in immunosuppressed pups or parvo infected

Multifocal encephalitis, Encephalomyelitis M8k 924; Mk 588; IM 772; IM-WW 465; NS-O 218;

*

- **Chronic progressive diz 2°** to distemper virus, 4-8 years-old, Cause: ? immune-mediated demyelinating or chronic progressive encephalomyelitis
- CS: **Incoordination, Weakness** in pelvic limbs to tetraplegia, ± Unilateral or bilateral menace deficit, Head tilt, Facial paralysis, Head tremors w/ myoclonus, ± Falling -ay progress to paralysisBAR (bright, alert & responsive), **No seizures or personality changes**; No concurrent or Hx of signs of young dog distemper
- Dx: Hx (age) CS; Necropsy (multifocal CNS necrosis, cerebellopontine angle usually not in cerebrum)
- Tx: **No treatment** • Prognosis: **Poor**

Old dog encephalitis, ODE, Disseminated encephalomyelitis in mature dogs, Subacute diffuse sclerosing encephalitis, Chronic dementia distemper

IM-WW 465; NS-C 149; NS-O 218; NS3hb 371t; I-B 53; Pa-T 366

*

- **Extremely rare**, a form of canine distemper, Progressive disorder - **fatal, > 6 years old**
- CS: Initial: visual impairment & bilateral menace deficit; Progresses to **CNS CS** (mentally depressed, compulsive circling or head pressing, **personality changes** [stupor, dumb, falls to respond to owner or environment stimuli {dementia}])
- Dx: Hx, CS, Necropsy (disseminated perivascular cuffing, degeneration, demyelination, diffuse sclerosis, cerebellum & brain stem)
- Tx: **Unrewarding - always fatal** • Px: **Grave - all die**

Rabies,

Fatal encephalomyelitis

M8k 966, 925; Mk 575, 588, 619; E-hb 197, 183, 212, 281; SAP 117, 1169; H2B 1199, 265; I2M 1015; IM 773; IM-WW 464; 5min 1008; E 622; Cat 1530; NS3hb 371t; NS-C 151; NS-W 118, 221; NS-K 62; NS-Pa 95; NS-O 220; NS-L 383; I-B 39; I-G 365

*

- **Rhabdovirus** (*Lyssavirus*)
- Worldwide, except some free islands
- **#1 important zoonotic diz** because of fatal encephalitis
- **DDx for all w/ abnormal behavior**
- Progressive, fatal neurological diz of warm blooded animals
- Reservoirs: skunks & raccoons, bats, foxes; less dogs & cats because of vaccinations, cats more susceptible than dogs
- Impossible to eliminate in endemic areas
- Asymptomatic carriers
- Pathophysiology:
- Transmission - bites (in saliva)
- Migrates to CNS over peripheral nn.
- Then antigrade over nerves to salivary glands
- Shed in saliva usually < 10 days after CS (dies in dried saliva)
- Incubation: 3-8 wk (m/b > 6 months)

DDx - anything w/ abnormal behavior

• Dog:	• Cat:
- Canine distemper	- FIP
- Polyradiculoneuritis	- FIV
Certain toxicosis	- Toxoplasmosis
Pseudorabies	- Certain toxicosis
	- Pseudorabies

#1 zoonotic diz, DDx for all
CS: Behavioral, itching, salivation, paralysis
Dx: Suspect, Sub m head to authorities, DFA
Tx: Euthanasia or quarantine
Prevention: vaccination

- **Prodromal stage , 2-3 days**
- **Often unnoticed**
- **Behavioral change**: apprehensive, hide out of fear, wild animals lose fear of humans
- Fever, slow corneal & palpebral reflexes, chewing at bite site (hyperesthesia)
- **Furious form** (excitable or hyperreactive), 1-7 days
- **Behavior changes** (limbic system)
- **Aggression**: attack, pursue & bite animate or inanimate objects, episodic
- Irritability, restlessness, barking, pica (eating unusual objects), photophobia, unexplained roaming
- **Hypersexuality**, mounting inanimate objects
- **Pruritic, regional**
- Proprioceptive deficits - ataxia
- Disorientation (dementia)
- **Paralytic phase, 2-4 days (dumb form)**
- **Severely depressed**
- **Progressive LMN paralysis**
- **Frothy salivation**, inability to swallow (pharyngeal paralysis), "hydrophobia" (inability to drink)
- Change in bark, dyspnea: laryngeal paralysis
- Masticatory paralysis: "dropped jaw"
- Drooped head
- Hypersexuality, paraphimosis
- Die - laryngeal/respirator paralysis
- Comatose or convulse, thrash wildly before death in 2-7 days
- Forms can overlap & **all rapidly fatal**

- **CS - suspect**
- **Submit head** chilled on wet ice in leakproof container (do not freeze)
- **Notify authorities:** postmortem done by state officials
- **DFA test** (direct fluorescent antibody): test of choice - rapid reliable confirmation of rabies antigen (brain)
- Negri bodies (intracellular inclusions) (microscopic brain sections [hippocampus] less sensitive than DFA, found in 75% of rabid dogs but rarely in cats
- Intercerebral inoculation - mice, examine brain in 5 days
- Monoclonal antibody technique: differentiate vaccine virus strain from wild-type strains in DFA-positive brains

Prognosis: Grave

- **Euthanasia or quarantine**
- **Notify authorities**
- **Almost always fatal in domestic animals**

Prevention:

- **Vaccination**: at 3 or 4 months old, at again in 1 year, then annually or triannually depending on vaccine
- NO longer CNS complication to MLV vaccines
- Do not vaccinate wild animals

Pet that has bitten a human:

- Euthanasia immediately & check brain for rabies virus: all wild animals, unwanted cats & dogs & those w/ CNS signs
- Confine for 10 days healthy owned dogs

Manage dogs & cats exposed to rabies

- Revaccinate immediately all vaccinated animals & quarantine at home for 90 days
- Unvaccinated dogs & cats: immediately euthanized or strict isolation for 6 months (revaccinate at 5 months)

Prevention in humans:

- 15% of humans untreated humans bit by a rabid animal become infected
- Once signs develop in humans fatal (almost always)
- Human diploid cell vaccine (HDCV): human **immunization** strongly recommended for veterinarians
- Immediately notify local health department when animal bites a human or possible contact w/ rabid animal
- Humans bitten by animal
- Instruct owner to quarantine healthy animal for 10 days
- Euthanasia wild, stray or rabid animals & examine tissue
- Vigorously scrub wound w/ soap & water (Ethanol 70% & benzalkonium chloride 1-4% are rabidicidal)
- Contact health officials: decide about postexposure prophylaxis
- .. Previously immunized humans: 2 dose of vaccine (on day 0 & 3)
- .. Nonimmunized humans: rabies immune globulin & 5 doses of vaccine on day 1, 3,7,14 & 28

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Feline infectious peritonitis, FIP, Coronavirus **	• **See Systemic dizs pg 688** • **Progressive & fatal systemic diz** • **Relatively common in catteries** • **Rare** in single cat households • Coronavirus • Pathophysiology: **macrophages, vasculitis - effusions, pyogranulomatous** inflammation • **CNS: Non-effusive (dry) form** - **Myelitis & meningitis**, rare in "wet" form - Cats with adequate humoral immunity but partially depressed CMI develop the dry form - Pyogranulomatous lesions begin in subarachnoid & subependymal spaces - inward spread to involve neural parenchyma • Progressive focal, multifocal or diffuse involvement of spinal cord, brain & meninges • Cats < 2 years & aged cats	• Chronic fluctuating fever (unresponsive to ABs) - Anorexia, depression • "Wet" (effusive) form (acute) - Peritonitis/abdominal effusions (85%) - Pleuritis: thoracic effusions - 35% - Ocular & CNS rare • **"Dry" form - Pyogranulomatous** - PU/PD, icterus - **CNS (pyogranulomatous meningoencephalomyelitis)** **. Para/tetraparesis, generalized ataxia, incoordination** **. Nystagmus** **. Convulsions, intention tremors, cranial & peripheral nerve paralysis, hyperesthesia, head tilt, behavior changes, urinary incontinence** . Anterior uveitis • Combination of both wet & dry form • All forms progressive & fatal	• **Strong circumstantial evidence of CS, PE, Hx, Lab, rads, fluid analysis, cytology & biopsy** • Hx, CS (AB resistant fever) • Physical exam: auscultation, palpation, fundic exam • Lab: unspecific - strong circumstantial evidence, peripheral leukocytosis, hyperglobulinemia • CSF: ↑ WBCs (especially PMNs) & elevated protein • Serology: poor distinction between FIP & enteric coronavirus - Dry FIP should have a high titer (> 1:3200), although some cases of CNS FIP have negative or low titers • Biopsy	• **No cure for FIP or prolong life** • Palliative chemotherapy < 10% - Steroid w/ cytotoxic agents • Supportive Tx, may improve quality of life **Prognosis** • **Grave**: once clinical signs develop - nearly always fatal regardless of treatment **Prevention:** • **Vaccination** in catteries: intranasal (IN) vaccine (Primucell FIP®) 1991

Progressive & fatal systemic diz
CS: Fever, "Dry" meningoencephalomyelitis, fatal
Dx: Circumstantial evidence
Tx: No cure • Px: Grave
Prevention: Vaccination in catteries: intranasal (IN)

Other Viruses SAP 91, 110, 120, 121; I2M 1012, 1015; Cat 1529; F3IM 403; NS3hb 225; NS-O 222, 224, 225, 397; I-B 11, 196	• **Herpes virus**: acute puppy encephalitis: acute crying, diarrhea, dyspnea, abdominal tenderness, terminal depression & death usually in 1-3 days; DIC; cerebellar hypoplasia • **Infectious canine hepatitis**: encephalitis (rare): Rapid, progressive tetraparesis, coma, seizures, & death; vomiting, fever, abdominal pain & jaundice • **FeLV**: Seizures, ataxia, blindness, behavior aberrations, motor deficits, etc. • **FIV**: Encephalopathy: behavioral changes, dementia, compulsive wandering, licking motions, facial twitching, seizures • **Feline panleukopenia virus**: cerebellar hypoplasia: nonprogressive ataxia, hypermetria, falling to side, broad based stance & intention tremors • **Parvovirus encephalitis**: Systemic: diarrhea, vomiting; CNS abnormalities

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Pseudorabies, Aujesky's diz, Mad itch M8k 964; Mk 617; E-hb 282; SAP 118; H2B 1201; E 623; Cat 1529, NS-C 472; NS3hb 372t; NS-hb 347t; NS-Pa 99; NS-O 223; NS-L 383; I-B 25 *	• **Neurotropic viral diz - fatal** • **Rare in all but swine** - Sporadic in dogs & cats in enzootic **pigs** area - Ingestion of **contaminated raw pork** • **Herpes virus** migrates up peripheral nerves to CNS - Fulminating **panencephalitis** • Swine inapparent carriers - may be subclinical • Humans not susceptible	• **Behavior changes**: depression, inactivity or anxiety & restlessness • **Intense pruritus** (in most cases) - Excoriation & self mutilation • LMN paralysis • Lack of aggression • Fever, diarrhea, vomiting, copious salivation, various cranial neuropathies (anisocoria, mydriasis, trismus, paresis, paralysis, vocal changes), ataxia, seizures • **Rapid fatal death in 1-2 days** - Progressive depression, dyspnea, coma & death	• **Suspect in acute violent, frantic scratching & self mutilation around face, head, neck & ears** • Hx: exposure to pigs or raw pork • Improbable for definitive antemortem Dx • **Postmortem:** specialized virologic testing of brain tissue by immunofluorescent virus isolation or animal inoculation studies **DDx:** • **Rabies**	• **No effective treatment - futile** Prevention: • Avoid contact w/ **pigs** in endemic area & never feed raw park • No effective vaccine **Prognosis: Grave**: usually fatal in 1-2 days

Swine, Rare & fatal in others
CS: Behavior changes, intense pruritus, self mutilation, death 1-2
Dx: CS, Hx (exposure), Necropsy
Tx: No effective treatment •Px: Fatal

Meningeal vasculitis, Beagle polyarteritis; Polyarteritis nodosa, Necrotizing vasculitis NS-O 248; IM 770; E 677

- **Rare** polysystemic diz, necrotizing vasculitis of unknown cause; Target organs: kidney, skin, mucous membranes, adrenals, **meninges (severe suppurative leptomeningitis - fibrinoid necrosis of meningeal vessels)**, GI, connective tissue, myocardium - Lungs usually spared; Breeds: Beagles, Burmese mountain dogs, Ger. shorthaired pointers
- CS: **Systemic signs** (pyrexia, lethargy, vague pain, weight loss); Organ systems (linear skin ulceration, ulceration of mucous membranes, nasal discharge, cardia & renal failure); **Meningitis: cervical rigidity, spinal pain, fever**
- Dx: Hx; CS; Lab: leukocytosis w/ left shift & proteinuria
- DDx: Hypersensitivity angitis
- Tx: **Glucocorticoids &/or cyclophosphamide**
- Prognosis: **Guarded to poor**

Steroids

Rickettsial meningomyelitis M8k 924; E-hb 288, 242; I2M 1017; IM 775; IM-WW 468; E 626; NS-C 158; NS-O 240; I-B 337; I-G 209 *

- **Rare**; Rocky mountain spotted fever (RMSF Rickettsia rickettsii) & ehrlichiosis (Ehrlichia canis); Concurrent systemic diz; Tick transmission
- CS: **CNS (30% -** depression, neck rigidity, pain, mental changes, ataxia, paresthesia, vestibular signs); **Systemic signs ± fever**, anorexia, depression, vomiting, oculonasal discharge, cough, lymphadenopathy
- Dx: Hx, CS, PE - systemic diz, **Serum & CSF titers**
- Lesions: **Rickettsia**: necrotizing vasculitis, perivascular accumulation of PMNs & lymphoreticular cell infiltrate in most tissues; **Canine ehrlichiosis**: generalized lymphoid & plasma cell accumulation in bone marrow, meninges, kidneys & other organs
- Tx: **Tetracyclines**: doxycycline; Chloramphenicol for young dogs
- Prognosis: **Neurological damage may be irreversible**

Tetracycline

Protothecosis, Protothecosis, Prototheca l meningomyelitis NS-C 159; E-hb 288; NS-O 240; I-B 337; I-G 744 *

- **Rare**, ubiquitous, colorless, unicellular **algae** (*Prototheca wickerhamii, P. zopfii*)
- Isolated from pyogranulomatous lesion of spinal cord, eye & other organs - dog, only cutaneous in cat
- CS: **Ataxia**, circling, & paresis or paralysis; visual impairment, multifocal diz process, deafness, head tilt, dementia
- Dx: CSF ± ↑ PMNs & eosinophils, culture CSF on fungal media, Rectal scraping; Fluorescent antibody exam of tissue sections
- Tx: **Has not been described**

Peripheral Nerve Dizs

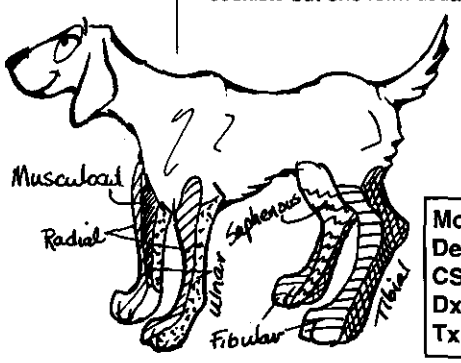
Condition	Facts & Cause	Presentation/CS	Diagnosis

Peripheral nerves dizs, Neuropathies, Peripheral neuropathies, Polyneuropathies

M8k 917; Mk 613; E-hb 316, 79; SAP 1165; H3B 272; H2B 303, 311; IM 794, 798; 5min 930; E 148, 701; Cat 1591; NS-C 337, 79; NS-W 162; NS-K 169; NS3hb 111; NS-hb 113; NS-O 53, 145, 353, 493, 507; NS-L 53, 61, 66, 172; Sx-WW 303; Sx4B 73; Sx-B 50

***

- **Common**
- **Neuropathy**: pathologic changes &/or functional disturbances in PNS (peripheral nervous system)
- Types:
  - **Mononeuropathy**: single peripheral nerve
  - **Polyneuritis**: affect more than 1 group of peripheral nerves
- Pathology: 2 types
  - **Demyelination**: slowing of conduction velocities in the nerve fibres. Myelin sheath is lost while the axon remains intact. Remyelination of the demyelinated areas commonly occurs. Axon intact so little neurogenic atrophy
  - **Axonal (Wallerian type) degeneration**: degeneration of neuron from the lesion distally & concurrent breakdown of the myelin sheath
    . Regeneration of the surviving portion of the axon may occur
    . "Dying back": degeneration begins at distal end & gradually progresses to cell body
  - Often demyelination & axonal degeneration coexists but one form usually predominates

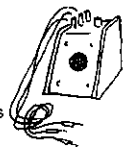


- **Neuropathies - poly & mono**
  - **Lower motor neuron signs**
    . **Flaccid weakness** (paresis) to **paralysis**
    . **Marked atrophy** (neurogenic)
    . **Loss of muscle tone** (hypo-or atonia)
    . **Loss of reflexes** (hypo- or areflexia)
    . **Loss of sensation** to area innervated
    .. Hyperesthesia/anesthesia
    .. Self mutilation
    .. Ataxia/dysmetria - loss of proprioception & touch
- **Polyneuropathies**
  - Pelvic limbs usually affected 1st
  - **Chronic, insidious course** in most
    . Exception: subacute - coonhound paralysis, acute: ischemia
  - ANS signs rare
  - Cranial nerves not commonly affected
    . Exceptions (facial n. in coonhound paralysis & hypothyroid neuropathy, vagus dysphagia in giant axonal neuropathy
  - . Bladder control usually intact
  - . Panniculus reflex usually intact

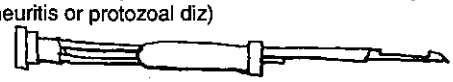
Mono- or poly-
Demyelination &/or axonal degeneration
CS: LMN (flaccid, atrophy, ↓ reflexes & sensation)
Dx: Hx, CS, PE, DMG, R/O
Tx: Time & support

- **Chronic progressive LMN signs:** suggestive
- **Hx, CS**
- **Physical exam/Neuro exam**
  - General screen: gait, strength, postural reactions
  - Spinal reflexes
  - Cranial nerves checked often normal
  - Palpation of limbs for reflexes, muscle tone

- **EMG** (needle electromyography): denervation, decreased nerve conduction velocities
  - 5-21 days to see changes
  - Neuropathy or myopathy: denervation potentials (fibrillations & positive sharp waves)
  - Nerve stimulation tests (referral): Pathology: slowed conduction, amplitude, duration or wave form changes

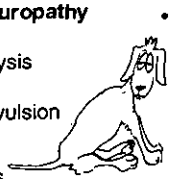


- **Biopsy** of peripheral nerve: may confirm
- **Once polyneuropathy diagnosed: R/O causes**
  - Evaluate for diabetes mellitus all dogs & cats
    . Plantigrade stance in cat
  - Hypothyroidism: dogs: TSH response test
  - Hypoglycemia: suspect
  - Neoplasia: ± rads, aspiration, bone marrow exam
  - Toxins: nerve biopsy
  - Immune dizs: SLE: CBC, proteinuria, synovial fluid analysis, ANA antibody titer
  - Idiopathic or immune mediated: steroid Tx trial
  - Differentiate from muscle disorders
    . Muscle enzyme determinations (LDH, SGOT)
    . Muscle & nerve (referral) biopsy
- CSF fluid analysis for nerve root disorders (polyradiculoneuritis or protozoal diz)



Causes of Polyneuropathy

- **Idiopathic #1**
- Coonhound paralysis
- Tick paralysis
- Brachial plexus avulsion
- Botulism
- Feline dysautomia

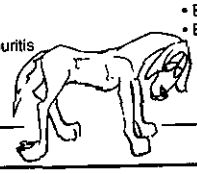


- Myasthenia gravis
- Caudal aortic thrombosis (cat)
- Polyneuropathy w/ hyperchylomicronemia (cat)
- Acute idiopathic polyneuropathy
- Diabetic polyneuropathies: cats > dogs
- Hypothyroidism (dogs)
- Hypoglycemia/insulinoma
- Hyperadrenocorticism
- Systemic lupus erythematosus (SLE)
- Immune mediated: 1° or 2° 0 SLE, polymyositis, glomerulonephritis, polyarthritis, pemphigus
- Paraneoplastic polyneuropathies
- Miscellaneous toxins
  - Heavy metals (lead, mercury, arsenic)
  - Aminoglycosides antibiotics - CrN 8
  - Cancer drugs: vincristine, vinblastin, colchicine
  - Chronic organophosphates
  - Other chemicals: acrylanide, Tri-ortho-cresyl phosphate, carbon disulfide, Carbon monoxide, chlorphenothane (DDT), lindane, pentachlorophenol, thallium, carbon tetrachloride
  - Venoms: coral snake, bee
  - Irradiation
- Chronic relapsing polyneuropathy
- Feline chronic relapsing polyneuritis
- Compressive neoplasms
- Insulinoma
- Neospora polyradiculoneuritis

- Inherited polyneuropathies
  - Inherited degenerative disorders
  - Spinal muscular atrophy in Brittanys, Swedish Lapland dogs, English pointers, German shepherds, Rottweilers
  - Progressive neuropathies: Cairn terriers
  - Axonopathies
    . Progressive axonopathy: boxers
    . Primary hyperoxaluria: domestic shorthair cats
    . Laryngeal paralysis-polyneuropathy: Dalmatians
    . Distal sensorimotor polyneuropathy: Rottweilers
  - Demyelination
    . Hypertrophic neuropathy: Tibetan mastiffs
    . Hypertrophic neuropathy: German shepherds ?
  - Lysosomal storage diz
    . Globoid cell leukodystrophy: West highland white, cairn terriers, domestic kittens
    . GM1 gangliosidosis type II: Siamese & mixed breed cats
    . Sphingomyelinosis: Siamese cats
    . Ceroid lipofuscinosis: English setters, Chihuahuas, Siamese cats
    . Sensory neuropathies: longhaired dachshunds, English pointers

Mononeuropathy

- Radial nerve paralysis
- Sciatic nerve paralysis
- Peroneal nerve paralysis
- Obturator nerve paralysis
- Perineal nerve paralysis
- Facial nerve paralysis
- Trigeminal nerve paralysis
- Laryngeal paralysis
- Esophageal dysphagia
- Esophageal hypomotility
- Esophageal dysphagia



Small print = rare

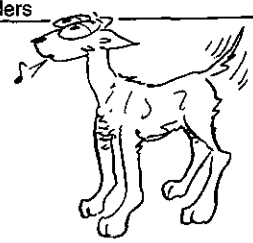
Peripheral Nerves

Mk 613; E-hb 316; SAP 1165; H2B 303; NS-L 53; 166, 172

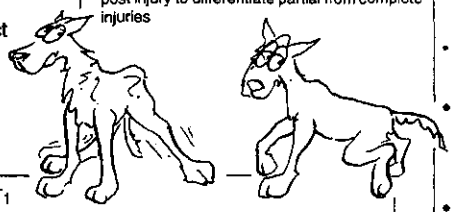
- Peripheral nerves
  - 12 cranial nerves (CrN 1-12)
  - 36 pairs of spinal nerves
- Types of nerve fibers
  - Motor/efferent fibers: cell body in gray matter of spinal cord
  - Sensory/afferent fiber: cell body in dorsal root ganglion
- Types of nerves
  - Motor/efferent nerves: carry motor fibers
  - Sensory nerves: carry sensory fibers
  - Mixed nerves: carry both motor & sensory fibers
- Peripheral nerve:
  - Nerve roots: connect nerve to spinal cord
    . Dorsal root: carry sensory fibers
    . Ventral root: carry motor fibers
  - Axon: fiber from the cell body to the motor end-plate
  - Nerve fibres (axon): myelinated or nonmyelinated
    . Myelin sheath: discontinuous at the nodes, formed from separate Schwann cell
    . Remak cell (Schwann cell containing nonmyelinated axons)
    .. Myelinated fibres: higher conduction velocity & lower threshold for stimulation than nonmyelinated fibers
    .. Sensory modalities (touch & proprioception) & motor function: mediated by large diameter myelinated fibres
    .. Pain sensation: small myelinated & nonmyelinated fibers
    .. Compressive lesions block conduction in the larger myelinated fibres before the small myelinated & nonmyelinated fibres Local anesthetics cause the reverse-order of conduction block
- **Dermatome/Peripheral nerve field**: area of skin supplied by a peripheral nerve
  - Autonomous zone: area supplied exclusively by a specific peripheral nerve only
  - Intermediate zone: area shared with surrounding peripheral nerves (not desensitized after cutting of a nerve)
- Majority of nerve lesions occur in mixed nerves (motor & sensory)

Treatment:

- Key: find cause, Often not obvious
- Supportive care
  - Waterbed or heavily padded surface, decubital ulcers
  - Physical therapy: flex & extend joints BID-TID
  - Proper nutrition
  - Steroids only for immune mediated disorders



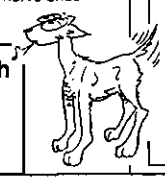
Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Traumatic peripheral nerve injuries, **Mononeuropathy** M8k 917; Mk 613; E-hb 328; SAP 1170; H3B 287; H2B 317; I2M 1046; IM 794; IM-WW 488; Cat 1557; F3IM 380; NS-W 229; NS-C 438; NS-K 180; NS3hb 111; NS-hb 113; NS-O 53, 366, 493, 503, 513; NS-L 70; NS-Pa 415; Sx-WW 305, 303; Sx4B 74; Sx-B 52; Pys4B 94 ***	• **Specific peripheral nerve injury** • **Common cause of monoparesis or monoplegia** • **#1 neuropathy in animals** • Cause: - #1 HBC (hit by car) - IM injections - Fractures & fracture repair - Bite wounds - Lacerations, concussions, stretching • Classifications of nerve injuries: - Neurapraxia: temporary loss of function w/ o disruption of nerve fibers . Recovery of function is usual . Motor function & perhaps proprioception diminished while pain sensation usually spared - Axonotmesis: severance of nerve fibers (sheath intact) . Sensory & motor deficits . Sufficient to cause Wallerian degeneration distally . **Regrowth w/in sheath: 1 inch/ month,** 1-3 mm/day .. If > 12 inches unlikely to reinnervate - Neurotmesis: severance of axons & connective tissue sheath .Unlikely to regrow (no sheath pathway) w/ o surgical apposition of nerve ends	• **LMN** (lower motor neuron) lesion - **Gait abnormalities if limb nerve** - **Weakness/paresis to paralysis (flaccid)** - **Tone depressed or absent** - **Loss of reflexes, or depressed** - **Fast atrophy** • Sensory fibers: hypotonia & hyporeflexia - Hyperesthesia/anesthesia - **Dysmetria/Ataxia (proprioception)** - Reflexes depressed or absent • Pain sensation often spared • Bladder control usually intact (not spinal cord lesion) • Panniculus reflex usually intact • Sequela: Self mutilation in 2-3 weeks due to regeneration of sensory nerves	• **Usually straight forward: localized to only 1 limb** (monoparesis) by **LMN** signs, or cranial nerve • Hx (trauma) , CS • Physical exam - Mosquito hemostat to map sensory area • Hx (unilateral, LMN lesion + some sensory impairment & absence of bladder signs) - Chronic or acute, progressive or nonprogressive • Physical exam - Cranial nerves checked although often normal - Reflexes, atrophy • Needle EMG denervation potentials 5 days post injury • Nerve conduction velocities (NCV) w/in 3 days post injury to differentiate partial from complete injuries	• Key: find cause - Often not obvious • **Supportive care** - Waterbed or heavily padded surface - decubital ulcers - Physical therapy: flex & extend joints BID-TID - Proper nutrition - Sock, bandage or boot to prevent abrasions • **Time**: give 2-3 weeks to heal if contusion & not severance - Severed nerve: see if regrows (serial monthly exams) • Surgery: anastomoses of complete severance or relieve compression of entrapment • If no improvement in 2-3 months - Amputation - Joint fusion • Amputation if self-mutilation



Brachial plexus	C6-T1	
• Suprascapular	C6-7	Supraspinatus & infraspinatus mm.
• Musculocutaneous	C6-8	Biceps brachii, coracobrachialis, brachialis mm.
• Radial	C6-T2	All extensors of arm & forearm
• Median	C8-T2	Most of flexors of forearm
• Ulnar	C8-T2	Some of flexors of forearm
• Axillary	C6-8	Flexors of shoulder
• Sympathetic ANS	T1-3	Dilates pupil
Lumbosacral plexus	L4-S2	
• Obturator	L4-6	Adductor mm. of limb
• Femoral	L3-6	Extensors of stifle (quadriceps)
• Ischiatic	L5-S2	Caudolat. mm. of thigh & flexors & extensors of leg
• Peroneal	L5-S2	Extensors of leg
• Tibial	L5-S2	Flexors of leg

Prognosis:
• **Good** for concussion, few weeks to heal
• **Severance: poor/guarded** for reinnervation
- Over 12 inches - poor

#1 neuropathy, HBC, 1 inch/month
CS: LMN ↓
Dx: Hx, CS
Tx: Support + Time; Px: guarded



Avulsion of brachial plexus & its roots
M8k 917; Mk 613; E-hb 316; SAP 1171; H3B 288, 277; H2B 319; IM 795; E 702; Cat 1557; F3IM 380; NS-W 163; NS-K 180; NS3hb 119; NS-hb 120; NS-O 366; NS-L 73, 361; NS-Pa 453; Sx-WW 305; DDx 425
**

• **Cause: HBC (hit by car) or jumping from moving car**
- Limb abducted or rotated at its attachment to the body = traction injury to the nerves
- Nerve roots of plexus (C6- T1) commonly avulsed from their attachment to the cord
. Occasionally motor roots affected & sensory roots spared

• **Vary** w/ number of nerve roots & branches involved & the degree affected
• **Complete plexus C6 to T1**
- **Limb hangs limp & useless** ("dropped elbow" w/ carpal flexion, appear longer), complete lack of function (radial & musculocutaneous nn.)
. Occasionally brachiocephalicus muscle may advance limb
- Muscle atrophy obvious in 3 weeks (triceps)
- **Knuckling & dragging** - excoriation of dorsal paw
- **Sensory loss: complete distal limb**
- **Partial Horner's syndrome** (T1-3) (55% of cases)
. Miosis of the ipsilateral pupil ± slight ptosis
.. Interruption of the preganglionic sympathetic fibers in the ventral nerve root of T1
- Ipsilateral paralysis of diaphragm (C5-7)
• **Caudal part of the plexus** (33% of cases)
- C8 & T1 - to triceps & muscles below elbow
- **"Dropped elbow"** cannot bear weight on the limb (radial nerve)
- Limb carried with the elbow & shoulder flexed because flexor muscles (biceps)(C6 & C7) OK
• Damage to the cranial plexus
- C6 & C7 nerve roots & branches with relative sparing of C8 & T1 (uncommon)
- Extensor muscles still retain the majority of their innervation
- **Can bear weight on the limb**
- **Lack of elbow flexion** (musculocutaneous n. to biceps)
- Decreased protraction (advancement) of the limb
- Atrophy of the supra- & infraspinatus muscles

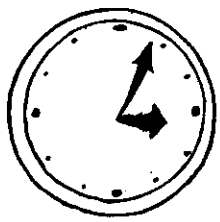
• **History (HBC)**
• **Complete plexus C6 to T1**
- CS
- No reflexes (triceps or biceps or pedal reflexes)
- No ipsilateral panniculus reflex (pathway: lateral thoracic n. & roots of C8 & T1)
- Stimulation of the ipsilateral flank causes muscle twitch on the contralateral side (afferent fibers/lateral thoracic nerve intact)

• Avulsion of **caudal** plexus
- CS
- Elbow flexion test positive
- Loss of ipsilateral panniculus reflex with a consensual response on the contralateral side
- ± Horner's: Ipsilateral miosis due to sympathetic dysfunction

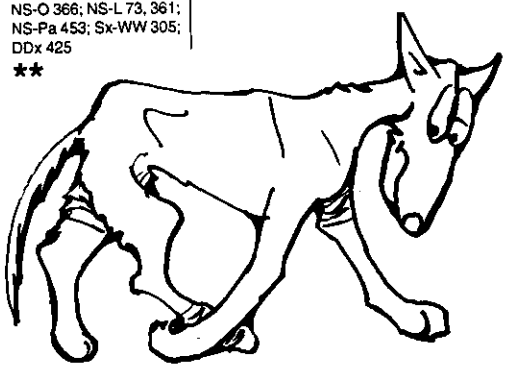
• Damage to cranial plexus
- CS
- Intact panniculus reflex
- No sympathetic dysfunction

• Skin desensitization varies from case to case
• Rare cases for pain sensation remain intact
- In time area of desensitization decreases (nerve fibers from contiguous areas)

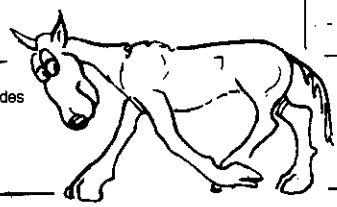
• **No direct treatment** of the condition at present
• **Time**: leave alone if elbow flexion (prevents excoriation)
- Allow 2-3 weeks to recover from contusion w/o avulsion
• Prevent contractures & local wound treatment
• **Amputation** if damaged from dragging or from self-mutilation



Prognosis:
• No definite prognosis early, reexamine at intervals
- Total plexal avulsion: poor
- Cranial part: good
- Caudal part: poor to guarded (any triceps function improves prognosis)
- Recovery slow: 4-6 months



HBC
CS: Vary: useless limb to slight deficits
Dx: Hx, CS, Neuro exam
Tx: No direct Tx, Time & support, Amputation

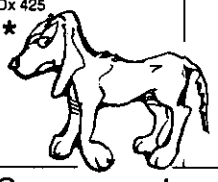


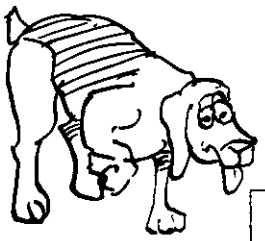
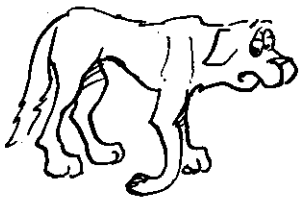
Brachial plexus neuritis *
E-hb 317; E 704; Mk 614; SAP 1169; NS3hb 192; NS-O 359; NS-L 77; NS-Pa 427; Sx-WW 306

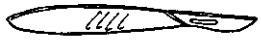
• **Rare**, bilateral symmetric, dog & cats, Cause: ? - allergy: all horse meat diet?
• CS: **Acute thoracic limb weakness** w/ m or absent reflexes, ↓ tone, atrophy; facial paresis; ±allergic episodes of facial edema & generalized urticaria initially
• Dx: CS; Electromyography: denervation potentials, absence of evoke muscle action potentials
• Tx: **Some respond to steroids**

Peripheral Nerves

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Radial paralysis, **Extensor damage** M8k 917; Mk 613; SAP 993, 1170t; H3B 288t; H2B 318t; I2M 1010; IM 795; 5min 930; Cat 1558; NS-C 445; NS-W 163; NS3hb 121; NS-hb 121; NS-O 53, 367; NS-L 70, 361; DDx 425 **	• C6-T1: major forelimb nerve • **Motor to extensors** of elbow, carpus & digits • **Sensory**: dorsal aspect of the antebrachium & paw • **High injury**: upper arm - nerves to triceps - root avulsion • **Low**: below triceps, above elbow - Common w/ fractures of humerus	• **High radial n. injury** - **"Dropped elbow"/collapse of limb** - unable to extend the elbow or carpus . Leg appears longer than normal . Usually from root avulsion - other nerves affected • **Low radial n. injury** - **Knuckling** over of paw (inability to extend carpus & digits) . Compensates by flipping paw forward during movement - Can support weight (branches to triceps intact) - Sensory loss: dorsal forearm & paw	• **Hx, CS enough** • ↓ or absent triceps tendon reflex (high) • ↓ or absent extensor carpi radialis muscle response (low)	• **Time**: allow 2-3 weeks to see if contusion heals • If no return to function, 3 legged animals do well - Amputation: if self trauma or dragging injuries **Prognosis** • **Good**, contusion heal or animal does well on 3 legs





Suprascapular paralysis, Sweeney

References see radial nerve above

- Supplies supra- & infraspinatus muscles ("lateral ligament of the shoulder")
- CS: Gait normal (shoulder jerk outwards on weight bearing)
  - **Prominent scapular spine** due to muscle atrophy, No sensory loss
- Dx: Hx, CS (atrophy), No reflex changes
- **Tx: None needed**

Musculocutaneous paralysis

References see radial nerve above

- C6-8: motor to the biceps & brachialis i.e. the elbow flexors
- Sensory to craniomedial antebrachium
- CS: **No gait changes**, slight straightening of elbow joint
- Dx: Reduced withdrawal & biceps reflexes

Median & Ulnar paralysis

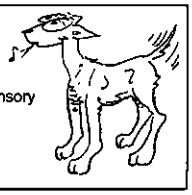
NS-C 445; NS-L 71; NS-O 53, 367 Mk 613; SAP 1170; H2B 318; IM 795; Dx 425

- C8-T2, Together supply all flexors (carpus & digits) & sensory (carpal, metacarpal & digital pads & lateral side of the paw); Section of either nerve individually produces no lameness & no sensory loss where they have common coverage
- Damage to both: fracture of humerus or radius & ulna or blow in these areas
- **CS: None** (single nerves), Not noticeable (both, ± slight carpal extension/"dropped carpus")
- Dx: Reduced carpal flexion on withdrawal reflex
- **Tx: None needed, can do fine**

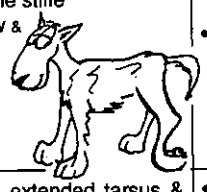
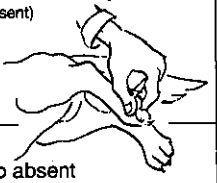
Axillary nerve paralysis

References see radial nerve above

- C6-8 - motor to teres major & minor & deltoideus muscles & sensory to the lateral aspect of the arm
- **CS: none** (compensation by other local muscles)
- Dx: Reduced shoulder flexion on withdrawal reflex
- **Tx: none needed**



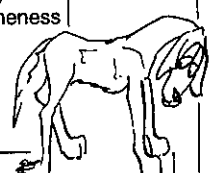
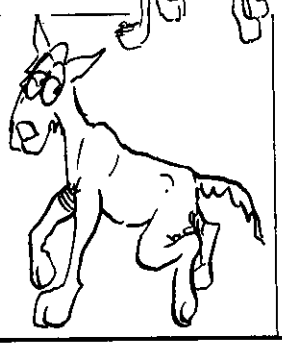
Sciatic paralysis, **Ischiatic nerve damage** References - see radial nerve above *	• L6-7 & S1: motor to **hamstrings** & those of **tibial & common peroneal nerves** • Branches: peroneal & tibial nerves • Damage - causes: - Hip surgery - Hip & femur fractures - IM injections - hamstrings	• **Can bear weight** (can extend stifle - femoral n.) & advance limb (hip flexed) • **Unable to flex or extend tarsus** (hock flexes & extends passively) • Ataxic limb below the stifle • ± **Knuckling** of paw & dragged on the ground • Muscle atrophy (hamstrings, cranial & caudal muscles of leg)	• Hx, **CS** • Loss of tactile placing reflex & paw position sense • ± Pain loss: below stifle except medial limb (femoral n./saphenous) • **Loss of withdraw response** (reduced or absent)	• **Time**: allow 2-3 weeks to see if contusion heals • If no return to function - **Tendon transfer** of long digital extensor to vastus lateralis Prognosis: **Good**
Peroneal/ fibular paralysis References - see radial nerve above **	• **L6-S1: motor to flexors of hock & extensors of digits** • Crosses over the lateral side of gastrocnemius muscle where it can be injured - Tying tarsus to surgery table may cause transient lameness	• Straight hindlimb - extended tarsus & unextended toes • **Knuckling of paw** (walks on dorsum of paw) • Sensory loss: dorsum of metatarsus & digits (pes)	• **Hx, CS** • Reduced to absent hock flexion on withdrawal reflex	• **Time**: allow 2-3 weeks to see if contusion heals • If no return to function, watch for self trauma or dragging injuries - Amputation: 3 legged dogs do well

Obturator paralysis

References see radial nerve above

- L4-6: motor to **adductors** of limb, Injury: as passes down shaft of ilium or transiently during parturition, rectal impaction in cat
- CS: Failure of adduction - **sideways slipping** (abduction)
- Dx: Hx (parturition), CS - lateral slipping - accentuated by turning the animal, No reflexes affected
- **Tx: Time, hobbles**

Femoral nerve damage

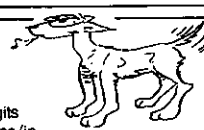
References see Radial nerve above

- L4-6: motor to quadriceps muscle (extensor of stifle) & iliopsoas (flexor of hip)
- Isolated injuries uncommon: positioning the dog with the legs over the edge of the table (as for perineal surgery) with resultant pressure on the medial thigh; Tumors where nerve passes through the iliopsoas muscles
- CS: **Can't bear weight** (unable to extend stifle), Limb collapses or is carried, Short stride, Atrophy of quadriceps (cranial thigh), Sensation loss on medial limb (saphenous)
- Dx: CS, Patellar reflex is lost, sensation loss: medial limb (saphenous nerve zone)

Tibial paralysis

References see radial nerve above

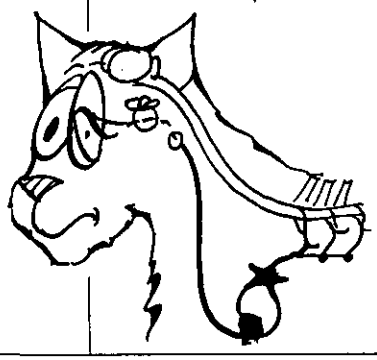
- L6-S2: motor to extensors of tarsus & flexors of digits
- CS: **Unnoticable**, "Dropped hock"/Plantigrade stance (increased flexion of tarsus), Sensation loss: plantar metatarsus & paw, Inability to flex the toes
- Dx: Hx (thigh injection), CS
- Tx: **None, does fine**

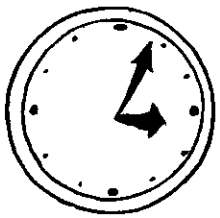


Prognosis: **Good**

Peripheral Nerves — NEUROMUSCULAR SYSTEM

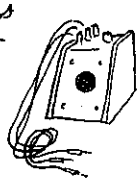
Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Facial paralysis, Idiopathic facial paralysis M8k 913, 936; Mk 601; E-hb 273, 319; SAP 1139; H3B 242; H2B 271; I2M 1049; IM 795; IM-WW 489; 5min 578; E 609, 707; NS-C 274; NS3hb 245; NS-hb 231, 234; NS-L 110; NS-O 38, 364, 368; DDx 427 **	• **Facial nerve paralysis/paresis** • Cause: - **Middle ear damage** (otitis media from otitis externa or pharyngitis) - Trauma to facial nerve . Ear surgery - Neoplasia (schwannomas, neurofibromas) - **Idiopathic:** 75% - dogs, 25% - cats . Cocker spaniels - Endocrine disorders: unknown mechanism, rare . Hypothyroidism . Diabetes mellitus . Hyperadrenocorticism - Associated with: . Coonhound paralysis . Brachial plexus neuritis . In both signs associated w/ paresis not paralysis	• Acute or chronic • **Facial paralysis** - inability to move muscles of facial expression • **Distortion of face** • **Excessive salivation** • Ear & lip droop • Inability to blink eye • ↓ Lacrimation, 2° corneal diz • Sequela: - **Dry eye (exposure keratitis)** denervation of lacrimal gland & inability to close eye - **Middle ear diz** . ± CrN 8 - vestibular diz in inner ear diz - head tilt . ± Horner's syndrome - ± CrN 5 deficits if neoplasia - ± Hemifacial spasm	• Hx, CS • Physical exam: - **Otoscopic exam** in all . Otitis external - abnormal tympanic membrane or ruptured - Neurological exam • **Skull radiographs** - Changes in tympanic bullae - chronic inflammation - increased thickness, ± ↑ density inside bullae - ± Lysis of internal acoustic meatus if tumor - Nasopharyngeal polyps in cats - density inside bullae • Lab test - Thyroid function test - Adrenal test - CSF analysis if other cranial nerves involved - Chem. for metabolic neuropathies • EMG: denervation of affected facial muscles	• **Treat primary cause** - Otitis media/interna: surgical drainage of bullae, ear flushing, systemic ABs - No treatment if idiopathic • **Treat dry eye, serious** - Eye drops - Transposition of parotid duct **Prognoses:** • **Idiopathic: good** - most return to function in 1-2 months • **Guarded** if due to inner ear infections of ear surgery





Idiopathic, Middle ear
CS: Facial paralysis, Dry eye
Dx: CS, Otoscope, Rads
Tx: Tx cause

Hemifacial spasm H2B 272; IM 7969; NS-W 122; NS-C 249; NS3hb 245; NS-hb 234; NS-L 109 *	• ***Chronic contraction of face*** - *Spasm of facial nerve from hyperirritability or lowered excitation threshold* • Cause: - Sequela following facial paralysis - Idiopathic - Otitis media/interna & tumors of middle ear - Brain stem injuries	• **Contraction of facial muscle on 1 side** - Smaller palpebral fissure - Spasmodic retraction of lip to one side - Hypertonic lips - Elevated rigid ear	• Hx, CS • **Anesthesia relieves signs** • Not responsive to antiinflammatory drugs	• **None available** • Alcohol nerve block may be tried - Sequela if successful = keratoconjunctiva sicca Prognosis???
Idiopathic trigeminal neuropathy, Dropped jaw syndrome, Old dog trigeminal palsy, Mandibular neuropraxia, Mandibular paralysis M8k 915; E-hb 275; SAP 1139; H3B 241; H2B 265; I2M 1051; IM 797; 5min 1120; IM-WW 490; E 722; DDx 427; NS-C 245; NS3hb 244; NS-hb 229, 233; NS-L 110; NS-O 364, 368; Sx-WW 288 *	• **Temporary paralysis of muscles of mastication** - Motor dysfunction of CrN 5 • Rare in dog, rarer in cats • **Cause: unknown** • Occurs more often in fall	• **Inability to close mouth** • Dysphagia, drooling, difficulty in prehension • ± Horner's syndrome (rare) • ± Atrophy of masticatory muscle • Sensory abnormalities rare • No other cranial nerves involved • Sequela: - Aspiration pneumonia	• Hx (normal except for paralysis of jaw), CS • R/O differential diagnosis • Motor conduction velocities slowed in CrN 5 • ± EMG - denervation • Physical exam: - No masseter or temporalis mm. atrophy - Sensation to head normal - Otherwise normal dog	• **Recover in 1-2 weeks** • Feed dog w/ head elevated & manually place food in mouth, water in deep container (dogs usually can drink) • Supportive care • Don't use steroids **Prognosis: Excellent** - recovery in 1-2 months in all reported cases



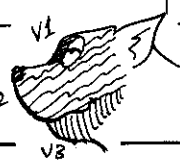
Temporary paralysis of 'jaw'
CS: Inability to close mouth, drooling
Dx: Hx, CS, R/O (rabies)
Tx: Recover in 1-2 weeks •Px: Excellent

DDx:
- Rabies #1
- Brain stem dizs
- Trauma, tumors
- Oral dizs

Sensory trigeminal neuropathy

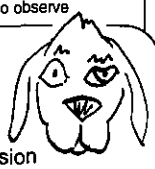
E-hb 326; NS3hb 244; NS-W 122; NS-C 234; NS-O 364, NS-L 174
*

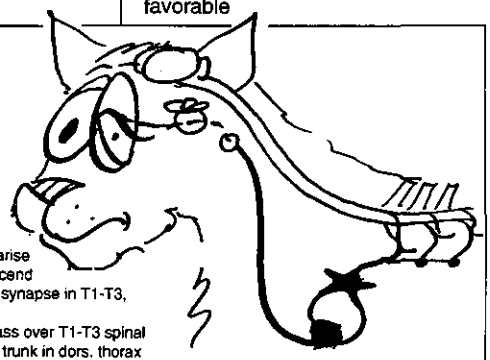
- Common problem in humans (douloureux) **rarely occurs in animals**; Cause: foreign body (plant awn) lodges near peripheral trigeminal n. near base of ear, neurofibrosarcoma, neurofibroma, neurinoma of trigeminal ear
- CS: **Generalized facial pain**, excessive salivation, coughing, dysphagia
- Prognosis: Guarded



Horner's

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Horner's syndrome M8k 375, 886, 937; E-hb 312; H2B 1129; I2M 984; IM 748; SAP 1245, 1184t, 389; E 698; Cat 1559; NS-W 161, 223; NS-C 49, 237; NS-hb 115; NS-L 116, 197, 73; NS-O 39t **	• **A syndrome not a disease** • Loss of sympathetic **innervation to eye & periorbita** • Causes: - **Idiopathic: #1 in dog** - CNS (brain stem, cervical & cervicothoracic spinal cord) . Trauma, ischemia, neoplasia, infectious or inflammatory diz - Preganglionic lesions (spinal roots, ganglion, vagosympathetic trunk) . Mediastinal & thoracic masses (neoplasia, abscess, hematoma, cranial lung lobe diz) . **Avulsion of brachial plexus** . **Neck bite wounds** . Venipuncture of carotid sheath . Surgery on neck - Postganglionic lesions: . **Otitis media** (± facial n. involvement) . **Retrobulbar diz** (injury, neoplasia, abscess) . Cavernous sinus vascular or neoplastic abnormalities	• **Sunken eyeball** (enophthalmos) • **Drooping eyelid** (ptosis) • **Protrusion of 3rd eyelid** (nictitans) • **Constricted pupil** (miosis) & ± anisocoria • ↓ sweating (anhidrosis) in all animals but horse, difficult sign to observe **DDx:** • Enophthalmos - Dehydration - Debilitation • Nictitans protrusion - Enophthalmos - Idiopathic protrusion in cats - Tetanus - Dysautonomia • Miosis - Corneal ulcers - Anterior uveitis - Spastic pupil syndrome in cats - Parasympathomimetic agents - Organophosphate toxicity - Central neurological lesions	• **Hx** • **Diagnosis: 3 of 4 cardinal signs** - ↑ anisocoria in dark - classic (Cn3 relaxed by dark) • 1% phenylephedrine or 0.1% epinephrine - Postganglionic lesions dilate rapidly w/in 20 min - Preganglionic lesion - may dilate in 40-60 min Other diagnostic tests depending on where lesion suspected - X-ray cervical vertebrae or skull, chest - CBC, chem: to rule out systemic diz - Thyroid-stimulating hormone test - Complete neurological exam to R/O brain & spinal cord lesions - CSF if central diz suspected - Ear exam for otitis media	• **Treat underlying causes** • Symptomatic: topical sympathomimetics if 3rd eyelid obscures vision **Prognosis** • **Guarded**: many resolve spontaneously in 6-8 weeks, central lesions less favorable





Sympathetic pathway
- Sympathetic neurons arise in hypothalamus, descend cervical spinal cord to synapse in T1-T3, 4 segments
- Preganglionic fibers pass over T1-T3 spinal nerves to sympathetic trunk in dors. thorax
- Pass through stellate (cervicothoracic) & middle cervical ganglia to pass up neck in vagosympathetic trunk to synapse in the cranial cervical ganglion
- Postganglionic fibers pass through middle ear into orbit to sweat glands of head, dilator muscles of the iris, periorbital smooth muscles & periarteriolar musculature

Syndrome not a diz (sympathetic), Idiopathic
CS, Dx: 1. Sunken 2. Dropping 3. 3rd eyelid 4. Constricted
Dx: 3 or 4 + Anisocoria in dark
Tx: Treat underlying causes

Tongue paralysis, Hypoglossal paralysis

M8k 892; E-hb 428; SAP 632; H3B 216t; H2B 338; NS-C 261; NS3hb 250; NS-hb 238, 233, 237; NS-O 43; NS-L 106
*

- **Rare** for paralysis of tongue w/o other deficits
- Cause of dysfunction (see box):
- Pathophysiology:
  - Neuromuscular abnormalities of tongue
  - Difficult to grab food & form bolus

- **Difficult prehension:** sloppy eating, drooling, quidding (food falling out)
  - Gulping, excessive champing, gagging
  - Eating in prone position
- ± Systemic signs of neuromuscular diz

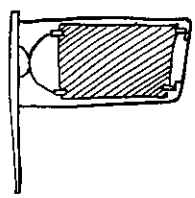
Cause of dysfunction:
- **Hypoglossal nerve dysfunction**
  - Trauma, rupture of hyoid apparatus
  - Neoplasia
  - Iatrogenic injury: bulla osteotomy or sublingual salivary gland removal
- **Brain stem (medulla)**
  - Trauma
  - Vascular (hemorrhage, edema or infarct)
  - Neoplasia

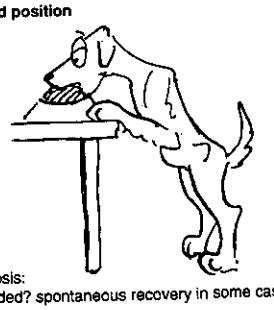
- Hx, CS
- Physical exam
- Neuro exam:
  - **Pull on tongue** - weak retraction
  - Jaw tone & ability to close mouth normally
  - Unilateral - tongue protrudes toward lesion
  - . Bilateral (rare): tongue hangs out of mouth
  - DDx brainstem diz or diffuse neuromuscular diz
  - . Dysphagia, megaesophagus, laryngeal paralysis
- Contrast radiography & fluoroscopy - diagnostic
  - **Pooling of contrast in mouth**, inadequate bolus formation, inconsistent induction of swallowing reflex

- Treat underlying cause if found
- Symptomatic: **Hand feeding or feeding from elevated position**

Prognosis:
- Guarded? spontaneous recovery in some cases

DDx:
- Inflammation of tongue
- Oropharyngeal neoplasia, foreign body
- Fractured hyoid apparatus
- Rabies
- Trigeminal neuralgia
- Masticatory myositis

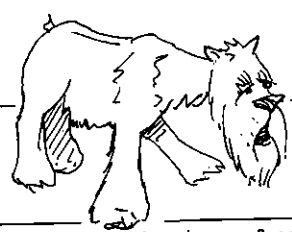




Tongue paralysis rare w/o other deficits
CS: Sloppy eating, Drooling
Dx: Hx, CS, Neuro exam
Tx: Treat underlying, Support

Mega-esophagus
**

See GI PG 37; Dilated esophagus
CS: Regurgitation, Aspiration
Dx: Hx, Rads
Tx: Elevated semiliquid diet • Px: poor



Laryngeal paralysis,
**

See Resp PG 131: Bouvier, Idiopathic , Vagus/brain stem
CS: Dyspnea, Cyanosis, Voice changes
Dx: Hx, CS, Endoscopic, T4
Tx: ± Tracheostomy, CCS, Sx

Dysphagia*

See GI PG 30; Difficulty in swallowing; Causes: Localized dizs of oral cavity, pharynx & esophagus (most common), CNS or cranial nerve diz, Muscle problems
CS: **Sloppy eating, drooling**
Dx: Hx, CS, Neuro exam
Tx: Treat underlying causes, Support

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Coonhound paralysis CHP, Acute polyradiculoneuritis, Acute polyneuropathy M8k 914; Mk 590; E-hb 325; SAP 1169, 1170; H3B 276; H2B 306, 311; I2M 1054; IM 799; 5min 476, 930; IM-WW 493; E 715; NS-C 375; NS-W 214; NS-K 177; NS3hb 187; NS-hb 186; NS-O 358; NS-L 74; NS-Pa 424 *	• **Best known canine peripheral neuropathy** - acute ascending paralysis • **Cause: unknown** -7-10 days after contact w/ a raccoon - Idiopathic - no contact w/ raccoon, **not all bitten dogs get diz, some get diz w/o exposure to raccoons** - Extremely rare in cat - Diz doesn't confirm immunity - Genetic susceptibility? • **Pathophysiology: degeneration**: mild lymphocytic radiculitis, demyelination & axonal degeneration (polyradiculoneuritis) of mainly ventral (motor) roots of spinal nerves. Later, peripheral nerves distal to the affected roots may develop widespread degeneration **#1 peripheral neuropathy, Rare, Cause ?** **CS: Ascending flaccid weakness to paralysis** **Dx: Hx, CS** **Tx: Time, supportive/ nursing • Px: Good**	• **Pelvic limb weakness (paresis)** **- Flaccid** - Ascends rapidly, progressing to paraparesis, quadriparesis & frequently to tetraplegia **- Rapid muscle atrophy** - Time to complete paralysis 12 hrs to a week • Hypotonic, hypo- or areflexic • Proprioception retained in most • **Hyperesthetic** • **Lose bark** (sound hoarse), **facial paralysis** & dysphagia • ± Respiratory collapse & death (rare) • Complications - Cystitis - Aspiration pneumonia - Tendon contracture - Decubital ulcers **DDx:** • Botulism (not hyperesthetic) • Tick paralysis (not hyperesthetic) • Protozoal infections	• **Hx** (fight with a raccoon 7 to 16 days ago) **CS**, usually diagnostic • PE: wound • EMG (needle EMG denervation potentials) - Diffuse spontaneous activity in most appendicular & many axial muscles, suggesting severe denervation - Normal or slowed motor nerve conduction velocities • Cerebrospinal fluid (CSF) usually normal	• **Supportive/ nursing**: preventing bed sores & urine scalds - Physical therapy, bladder evacuation - Assist in eating & drinking • ± Artificial ventilation if respiratory affected Prognosis: • **Good**: recovery starts in 1st week, may take 4 to 5 months - Some dogs never recover, complete recovery in cats poor
Chronic relapsing polyneuropathies, Chronic relapsing polyradiculoneuritis, Chronic polyneuritis M8k 915; E-hb 325, 317; SAP 1170; H3B 280; E 704; NS-C 377; NS-hb 190; NS-O 359; NS-L 78, 173 *	• **Rare**, Adult dogs & cats • Similar to coon hound paralysis but extremely **slow progression** • Pathophysiology: demyelinating polyradiculoneuritis - symmetrical demyelination or remyelination, onion bulb formation, axonal sprouting • Cause: unknown ? autoimmune	• **Weakness ± extremely slow**; m/b mistaken for lameness of musculoskeletal diz - Wax & wane for weeks, periodic remission • **Progression to flaccid paresis or quadriparesis over months** - Asymmetry of weakness usually • Not ataxia, ± Muscle atrophy • ± Facial weakness or other cranial nerve	• **Hx, CS** • Physical exam: ± spinal reflexes • CSF: usually normal (elevated protein, normal cells) • EMG: (muscle degeneration potentials, slowed conduction velocities) • Muscle biopsy	• No treatment effective • Try steroids • **Euthanasia** **Prognosis: grave**: most progressively worse until euthanasia
Protozoal polyradiculoneuritis & polymyositis M8k 915, 926; H3B 272; I2M 1056; NS3hb 195, 388; NS-W 214; NS-hb 192 *	• ***Neospora caninum*** (not *Toxoplasma gondii* as thought before); In utero infection of pregnant bitch; Puppies - 4-8 weeks old; Pathophysiology: inflammation of peripheral nerves, muscles or CNS, spinal nerve root most severely affected • CS: **Paresis & pelvic limb ataxia**, Progression to paraplegia & rigidity of pelvic limbs, Muscle atrophy • Dx: Hx, CS, Serological tests • Tx: **NO treatment; Euthanasia** • Prognosis: **Poor**			
Snake venom neurotoxin E-hb 164; H2B 315; E 321; NS-C 386; NS-hb 359t *	• **See Tox pg 723: Rare** • **Coral snake** • " Red on yellow - kill a fellow"	• **Necrotizing wound** • **CNS depression** • Shock • Flaccid quadriparesis (generalized weakness, pelvic > thoracic limbs)) • Depressed spinal reflexes • ± Respiratory paralysis & death	• Hx (**snake bite**), CS • EMG	• **May recover in 2-3 weeks if doesn't die**
Paraneoplastic polyneuropathy: E-hb 240; SAP 1168, 1175; H3B 286; H2B 313; E 714; NS-W 215; NS-hb 192; NS3hb 195; Sx-WW 306 *	• Some neoplasia may **release a substance** that alters functions of peripheral nerves; Pathophysiology: not understood • CS: **Chronic polyneuropathy**: weakness & ataxia (esp. in pelvic limbs); ↓ Muscle tone; ↓ Spinal reflexes; Loss of tactile & positioning reflexes • Dx: Hx (neoplasia) CS; Identify neoplasia & R/O other causes; ↓ Nerve velocities; Histo: demyelination, ganglioneuritis, axonal atrophy • Tx: **Remove neoplasia if possible** •Prognosis: **Guarded to poor**			
Neoplasia of peripheral nerves M8k 914, 958; Mk 611; E-hb 324; H3B 286; H2B 316, 1016t, 205; SAP 1168; I2M 1048; IM 795; IM-WW 492; E 715; Cat 1556; NS-C 448; NS-W 215; NS3hb 122; NS-hb 123; NS-O 282; NS-L 109; NS-Pa 473; Sx-WW 305 *	• **Schwannoma** (neurinoma, neurilemoma) solitary • **Neurofibroma**: usually solitary • **Neurofibrosarcoma**: often on multiple nerves • Lymphosarcoma (cat > dog) metastasis • Cause: unknown • Effects: single nerve (s), nerve roots - Brachial plexus (C6-T2) most common site - Trigeminal nerve (CrN 7, #1 cranial nerve • Adult dogs, rare cat	• CS due to location • Compression &/or destruction • Usually slow growing - weeks - months for CS • **Lameness of a limb** • Brachial plexus - Lameness - Pain on moving limb - Paresis & atrophy - Horner's syndrome & loss of panniculus reflex (if caudal brachial plexus) • Lymphosarcoma above + signs of multicentric diz	• Hx, CS • Electrophysiology - Denervations potentials - EMG - ↓ NCVs (conduction) • Map sensory loss • Biopsy	• **Surgical removal** may be attempted • **Limb amputation** • Laminectomy for nerve roots • **Euthanasia** in 2-8 months w/ inoperative tumor-slowly progressive **Prognosis:** • **Poor**: even w/ removal, recurrence likely in 1-2 years - Postsurgical metastasis reported (?)
Tick paralysis ****?** Mk 624; E-hb 327; M8k 972, 917; H3B 284; H2B 314; I2M 1055; IM 800; 5min 1104; IM-WW 494; E 721; NS-C 384; NS-K 191; NS3hb 190; NS-hb 188; NS-L 68; NS-O 387, 164t	• North American & Australia • **Ticks:** ***Dermacentor andersonii*** (Rocky Mountain wood tick) or *D. variabilis* (eastern wood tick) - USA & *Ixodes holocyclus* - Australia - Neurotoxins: blocks NMJ = flaccid paralysis - 1 female tick sufficient to cause clinical signs about 7 to 9 days after infestation - Not all ticks cause diz ***Dermacentor*, blocks NMJ** **CS: Flaccid paralysis - ascending** **Dx: Hx, remove of tick** **Tx: Remove tick • Px: Good**	• **Diffuse LMN diz - ascending** - Ataxia & weakness in pelvic limbs - **Flaccid paresis**: rapid progresses to tetraparesis w/in 24-48 hours - No hyperesthesia, pain perception normal - Loss of spinal reflexes, ↓ or absent • Cranial nerves rarely affected • Bark often reduced • Sequela: ± **Death** from respiratory paralysis in 1-5 days if tick not removed	• Hx (tick; LMN) • **Rapid reversal of signs w/ removal of tick** • Electrophysiological studies: EMG normal, NCV normal to decreased, reduced muscle action potentials **DDx:** • Coonhound paralysis (hyperesthesia, atrophy) • Botulism (several animals) • Myasthenia gravis (exercise related) • Organophosphates • Snake bite	• **Remove entire tick = recovery in 24-72 hours** - Australian diz, may continue to deteriorate after removal of the tick - hyperimmune serum • Dipped if suspected & tick not found • **Nursing care**: assist to eat, drink, urinate & defecate Prognosis: • **Good**: prompt recognition & treatment of the diz usually results in complete recovery

Tremors — NEUROMUSCULAR SYSTEM

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
White dog shaker syndrome, * Generalized tremor syndrome, Acquired syndrome, Cerebellitis/non-suppurative encephalitis, Idiopathic cerebellitis E-hb 284; IM 745; H3B 242; H2B 265; SAP 1142; 5min 1060, 168; E 626; NS-L 150; NS3hb 264	• **Usually white dogs:** Maltese, West Highland terrier, Bichon Frise, beagle • Young - to middle aged • Cause: unknown - ? Inflammatory, neurotransmitter defect, demyelinating disorder?	• **Peracute onset of diffuse tremors** • **Continual tremors** - Severe ataxia or gait - Worse w/ excitement, stress or exercise - Chaotic eye movements (opsoclonus), often dysconjugate (eyes move in opposite directions from each other) - **Disappear w/ sleep** - May spontaneously resolve in 1-3 months after onset or continue for life	• Hx (breed), CS, All lab tests normal • Neurological exam: see CS • CSF ± mild lymphocytosis **DDx:** • Dysmyelinogenesis • Intoxication - Hexachlorophene - Lead - Organophosphates - Butyrophenone • Metabolic tremors - Uremia - Hypocalcemia - Alkalosis	• No specific treatment • **Diazepam** (Valium®) • Corticosteroids (prednisolone) • Both may result in faster improvement if given early • Avoid stress • Prevent hyperthermia **Prognosis** • **Guarded:** Spontaneously resolve in 1-3 months after onset or - Continue for life (still make viable pets w/ sedation or quiet environment)
Congenital tremors * E-hb 238; IM 745; H2B 255; NS-L 150	• **Congenital diffuse tremor syndrome;** Associated w/ abnormal myelination in puppies; Autosomal recessive trait in **Chow chow**, other breeds are sporadically affected (Springer spaniel, Dalmation, Australian silky terrier, Samoyed, Schnauzers) • CS: **Diffuse tremors in puppies;** Seen when first walk; Worse w/ exercise or excitement • Dx: All lab tests normal • Tx/Px: **Complete recovery in 1-3 months w/o treatment in most puppies**			
Scotty cramp, Hyperkinetic syndrome M8k 905; Mk 582; E-hb 279; H3B 243; H2B 266; E 617; 5min 862; NS-C 315; NS-W 196; NS3hb 264; NS-hb 252; NS-L 148; NS-O 207 ** in Scotties	• **Scottish terriers** & 2 dalmatians • Autosomal recessive trait - Disorder of **serotonin** neurons? • Spasticity syndrome: disturbance of myotatic reflex mechanism • Onset: 6 wks - 18 months - **Stimulated by exercise or excitement**	• Dogs normal at rest & when start exercise • **CS w/ continued exercise & excitement** • Increased stiffness & hyperflexion (**goose stepping**) followed by hyperextension of limbs • Extensor rigidity of rear limbs - falling or **somersaulting** • ± Muscle spasm of back, neck & face • Severely affected dogs - curl up w/ dyspnea • Rest alleviates signs • Mental status remains normal	• **Hx (Scotties)** • **CS:** cramping on exercise • Challenge tests - symptoms increase w/ methysergide (Sansert®) or p-Chlorophenylalanine (p-CPA®) **DDx:** • Myotonia • White shaker dog syndrome • Leukodystrophies • Toxins - tremors • Hypocalcemia • Myasthenia gravis • Polymyositis	• **Diazepam** (Valium®) PO tid, muscular relaxant of CNS • Vit E elevates threshold • Minimize excitement & exercise • Karo syrup or candy 1 hour before exercise Prognosis: • **Good** for viable pet

Stimulated by exercise or excitement
CS: Cramping w/ exercise - rear limbs
Dx: Hx, CS, Challenge test
Tx: Valium • Px: Good

Botulism M8k 916; Mk 328; E-hb 316; I2M 1055; IM 800; H3B 283; H2B 313, 1326; IM-WW 493; E 702; Cat 1555; NS-C 385; NS-W 234; NS-K 190; NS3hb 188; NS-hb 187; NS-O 386; NS-L 67, 106; I-B 196; Sx-WW 306 *	• **Rare: Dogs generally resistant to botulism** - Several reports of hunting dogs fed carcasses or offal - Not reported in cats • Cause: ***Cl. botulinum*** type C neurotoxin - Gram-positive spore-forming saprophytic anaerobic rod (soil) - **Neuromuscular blockade:** inhibiting release of ACh at the neuromuscular junction - **LMN paralysis** - rapidly progressive • **Toxin:** - Alkaline or neutral soil, decomposing tissue - Prevents synthesis or release of **ACh at NMJ (LMN)** = loss of muscle tone - **No proprioceptive deficits**	• **LMN** (lower motor neuron) defect - Mild weakness to progressive, symmetric, ascending weakness to quadriplegia • **Flaccid paresis/paralysis: limb,** facial, neck, jaw, pharyngeal & laryngeal muscles, & occasionally respiratory muscles - Hyporeflexia, hypertonia - But no muscle atrophy - Stiff, stilted action • **BAR: mentally alert** • Cranial nerve involvement (drool, cough, dysphagia), mydriasis • Megaesophagus rare • ± Voice loss • **No hyperesthesia,** pain sensation OK • Sequela: ± Death from respiratory failure	• Hx (spoiled food), CS • Multiple cases in group of dogs suggestive • Individual dogs: differentiated from MG • Definitive: identification of toxin in sperm, ingesta or feces (neutralization test in mice) **DDx:** • Coonhound paralysis (hyperesthetic) • Tick paralysis (not hyperesthetic) • Myasthenia gravis • Organophosphate intoxication • Snake bite • Rabies	• **Spontaneous recovery may occur** • **Supportive** (muscle massage frequent turning, soft bedding, frequent bathing, monitor urine output, maintain body temperature, nutrition & hydration), General nursing care • Enemas & emetics • ± Polyvalent antitoxin (earlier the better) • Penicillin - prophylactic (aspiration pneumonia from the megaesophagus) • Respirator for apnea **Prognosis** • **Good:** most dogs recover in 1-3 weeks w/only supportive care, if survive first 2 to 3 days will recover

Rare, Dogs resistant, *Cl. botulinum*, NMJ
CS: Flaccid paralysis, BAR, ± Death
Dx: Hx, CS, Toxin
Tx: Supportive •Px: Good

Pain- Neuromuscular

IM 746, NS3hb 333

- Neck pain: arched spine stance, flexed neck, reluctance to move head
- Other spinal regions: reluctance to move, ± paresis/paralysis of limbs
- Limb pain: lameness or reluctance to move, carrying limb

Diagnosis:
- Localize origination of pain
  - Neck pain
    - . Manipulate gently - resistance
    - . Spinal radiographs
    - . ± CSF tap
    - . ± Myelography
  - Other areas of spinal cord
    - . Pressure over vertebrae & lumbosacral area
    - . Resistance to abdominal palpation
    - . Dorsal traction on tail - cauda equina syndrome
    - . Spinal radiograph
    - . ± CSF tap
    - . ± Myelographs
- Limb pain - localize to bone, muscle or joint
  - Palpate muscles for pain
  - Check for wounds (cellulitis)
  - Palpate joint for range of motion
  - ± Radiographs
  - Joint taps

DDx - Pain - neuromuscular
- **Neck pain**
  - Infectious & inflammatory diz of CNS
    - . Meningitis
  - Vertebral instability
  - Diskospondylitis
  - Cervical intervertebral disk diz
  - Tumors - compression
  - Cervical nerve root
  - Trauma
  - Generalized myositis
  - Polyarthritis (atlantoaxial joint)
- **Other spinal regions**
  - Disk diz
  - Diskospondylitis
  - Neoplasia
  - Cauda equina syndrome
- Limb pain, head
  - Muscular pain
    - . Idiopathic polymyositis
    - . Masticatory myositis
    - . Toxoplasma or Neospora myositis
    - . Ischemic myopathy
  - Bone pain
    - . 1° bone tumors
    - . Panosteitis
    - . Osteomyelitis
    - . Myelophthisic diz (hematopoietic neoplasm)
  - Joint pain
    - . Degenerative joint diz
    - . Infections
    - . Immune mediated joint diz

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Neuronal abiotrophies & degenerations H2B 280; SAP 1157; IM 788; E 619; NS-W 158; NS-K 158; NS-hb 140, 154; NS-O 187 *	• **Many degenerative disorders** see below, majority are hereditary • Characterized by premature aging, degeneration & death of neuronal populations • Abiotrophy: premature degeneration • Causes: **unknown** • Tend to be breed related • Onset usually in 1st months of life - Exception: degenerative myopathy in German shepherds - > 5 years old	• **Progressive neurological deficits** usually - **UMN** (upper motor neuron) signs predominate in some - **LMN** (lower motor neuron) signs predominate in some • Some have cerebellar signs	• Antemortem diagnosis difficult • **Hx (breed), CS, age** • Electrodiagnostics, laboratory, & radiology of limited value • No definable cause on screening tests, rads, CSF & myelography • Confirmed on necropsy	• **None described for any of these** **No Tx** • **Prognosis:** • **Poor**: although some are so slow that animal may be an acceptable pet for a long time
	Specific breeds, Cause?, Degeneration **CS: Progressive neuro dysfunction early in life** **Dx: R/O** **Tx: None • Px: Poor**			
Canine degenerative myelopathy, G. Shepherd * M8k 921; Mk 586; E-hb 292; H3B 256; H2B 280; SAP 1157; I2M 1034; IM 786; IM-WW 481; E 650; NS-C 426; NS-W 148; NS3hb 145; NS-hb 143; NS-O 193; NS-L 192; NS-Pa 319; Sx-WW 296; Pa-T 370	• **Axon & myelin sheath degeneration** of long tracts of canine spinal cord -Thoracic, T3-L3 • Old age dogs, rare in cats - **Middle aged (6-11 years)** - Large breeds: **G. Shepherd** & mixes (occas. Boxers, Labrador, Irish Setter) - Males > females • Cause: Unknown • Pathophysiology: -Diffuse degeneration of white matter (axons) in all ascending & descending spinal cord tracts (funiculi), most severe in thoracic regions, Dorsal (sensory) root also involved - 2° astrocytosis & astrogliosis	• **Slow, progressive UMN ataxia & weakness** (paraparesis) of pelvic limbs - Loss of proprioception - knuckling over, wear of dorsum of paw - Reflexes - normal to hyperreflexive - No pain or discomfort (Pain tracts preserved) - Disuse atrophy • Bilateral but asymmetry possible • Urinary/fecal control retained • Thoracic limb normal • ±Loss of pelvic limb reflexes late in diz due to dorsal root involvement • Diz course from 3-12 months (nonambulatory in months to 1 year)	• Hx (older, large breed), CS (slow ataxia & UMN weakness) • Physical exam: **no spinal pain** • **R/O** (rule out diagnosis) excluding inflammatory & compressive thoracolumbar diz - Spinal radiographs, CSF, myelography normal **DDx:** • Hip dysplasia • Osteoarthritis • Type 2 disc diz • Spinal cord neoplasia • Distemper myelitis • Chronic diskospondylitis • Myelitis • Neoplasia	• **None - euthanasia when nonfunctional in 3-6 months** - Support - prevent decubital ulcers - Reported Tx: steroids, vit. B & E, exercise programs, aminocaproic acid (EACA) • Symptomatic - dog cart **No Tx** **Prognosis: poor to hopeless**, most euthanized before nonambulatory
Feline degenerative myelopathy E-hb 292; E 652; Cat 1552 *	• **Rare** (described in a 6 year old cat), slowly progressive thoracolumbar myelopathy; Cause: Unknown, Morphological similarity to CDRM. • CS: Progressive symmetric paraparesis • Dx: R/O (rule out diagnosis) excluding inflammatory & compressive thoracolumbar diz			

Hereditary ataxia in Jack Russell & smooth-haired Fox terriers

M8k 903; E-hb 296, 260; I2M 1041t; IM 789t; H2B 280t; E 662; SAP 1157; NS-C 347; NS-Pa 321; NS-K 123; NS-O 188; NS-L 208 *

- UMN (upper motor neuron) ; Onset at 3-6 months old; Bilateral symmetric **spinal cord degeneration** predominantly involving the spinocerebellar tracts
- CS: **UMN signs**: weakness, rear limb incoordination, progressing to ataxia of all 4 limbs & hypermetria, **"swinging"** hindquarters, **"prancing"** pelvic limb gait, signs may stabilize
- Tx: **No treatment available**
- Prognosis: ?

Spinal muscular atrophy of Brittany Spaniels

M8k 903; I2M 1042; IM 790; H3B 273t; H2B 304t; SAP 1157; 5min 930; NS-O 189; NS-L 84 *

- Onset - 2-6 months old, **Neuronal degeneration brainstem nuclei & grey matter (LMN) of spinal cord**
- CS: **LMN signs: weakness & atrophy of proximal limb muscles**, progresses to tetraplegia, wide based stance, waddling, crouched posture, Hanging & swinging head while walking, head loss of reflexes, tendon contracture, remain alert & responsive
- Tx: No treatment available

Hereditary myelopathy of Afghan hounds, Hereditary Afghan myelopathy

M8k 903; Mk 585; E-hb 296; H2B 280; I2M 1041t; IM 789; E 662; NS3hb 154; NS-C 346; NS-K 122; NS-hb 151; NS-O 192; NS-L 193; Pa-T 371 *

- **Genetic defect in myelin**, 3-13 months old; Caudal cervical & thoracic cord demyelination of spinal cord axons (cavitation & necrosis)
- CS: **Bunny hop gait**, Progressive paresis & ataxia of pelvic limbs, Thoracic limb initially stiff progressing to paretic, Pain perception impaired, UMN (LMN CS late)
- Dx: Hx (**Afghan**), CS
- Tx: No Tx available
- Prognosis: **Grave**, hopeless

Neuronal abiotrophy Swedish Lapland spaniel

Mk 582; H3B 273t; H2B 304t; I2M 1043t 5min 930; IM 790; NS3hb 191; NS-hb 189; NS-O 189; NS-L 84 *

- **Demyelination of the brain stem, spinal cord & cerebellum**; Onset - 6 weeks old; Cause: unknown
- CS: Rapidly progressive; All 4 limb weakness, LMN rapid atrophy = limb deformities & arthrogryposis
- Dx: Hx, CS; R/O rule out other causes of cervical myelopathy; CSF, radiographs & myelography normal
- Tx: **Not effective**

Neuroaxonal dystrophy of Rottweilers, Tri colored cats

H3B 235; H2B 258, 280t; E 680; NS-K 123; NS-hb 189; NS-O 188; Pa-T 369 *

- **Tricolored cats, Rottweiler**, Collie sheep dog Onset at 4-18 months, **Axonal spheroids** throughout the brain & spinal cord
- CS: **Cerebellar ataxia: Clumsy**, Slowly progressive ataxia of all 4 limbs over years, hypermetria, tremors of head, positional nystagmus, decreased menace response, slowly progressive over several years
- Dx: Hx (rottweiler), CS; Rule out other causes of cervical spinal cord or cerebellar diz
- Tx: **Ineffective**
- Prognosis: **Poor**, because of slow nature dog may be acceptable pet for several years, Don't breed

Leukoencephalomyelopathy, Rottweilers *

M8k 903; H3B 233; H2B 280; I2M 1041t; IM 789; E 619, 672; NS-C 347; NS-W 150; NS-O 192; NS-hb 378t; NS-Pa 285

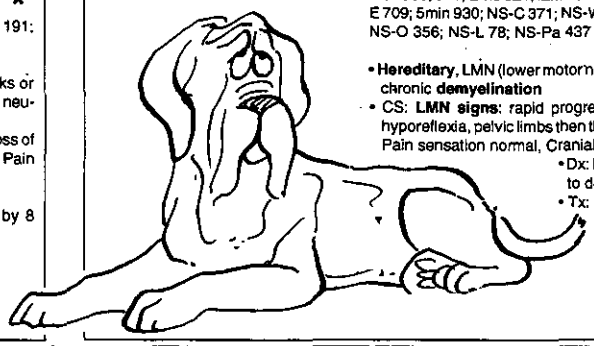
- Hereditary; LMN; Onset at 5-7 weeks old, **Neuronal degeneration of spinal cord** ventral grey matter
- CS: **LMN signs**: rapid flaccid tetraplegia, sever muscular atrophy, Loss of spinal reflexes
- Dx: EMG - degenerative potentials
- Tx: **No treatment available**

Spinal muscular atrophy in Rottweilers *

I2M 1043t; IM 791; H2B 304t; NS-C 371; NS3hb 191; NS-hb 189; NS-Pa 309

- **Rare**; LMN (lower motor neuron), Onset 4 weeks or age; Excessive neurofilament in degenerating neurons
- CS: **LMN signs**: rapid progressive weakness, loss of proprioception, hyporeflexia; Megaesophagus; Pain perception intact
- Tx: **No treatment available**
- Prognosis: **Grave** -tetraplegia & **euthanasia** by 8 weeks old

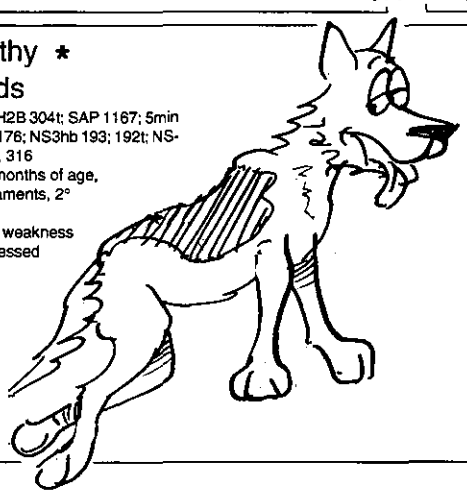
Hypertrophic neuropathy in Tibetan mastiffs *



M8k 905, 911; E-hb 321; I2M 1043t; IM 791; H3B 274t; H2B 304t; SAP 1167; E 709; 5min 930; NS-C 371; NS-W 213; NS-K 174; NS3hb 192t; NS-hb 191; NS-O 356; NS-L 78; NS-Pa 437

- **Hereditary**, LMN (lower motorneuron); Onset - 7-10 weeks old; Extensive, chronic **demyelination**
- CS: **LMN signs**: rapid progressive weakness, loss of muscle tone & hyporeflexia, pelvic limbs then thoracic limbs, ± recumbency w/in 3 weeks, Pain sensation normal, Cranial nerves normal
- Dx: Hx, CS, NCV: slow conduction velocity due to demyelination
- Tx: **No treatment available**
- Prognosis: **Guarded**

Giant axonal neuropathy * in German shepherds



E-hb 320; I2M 1043t; IM 791; H3B 273t; H2B 304t; SAP 1167; 5min 930; E 708; NS-C 372; NS-W 213; NS-K 176; NS3hb 193; 192t; NS-hb 191; NS-O 355; NS-L 79 NS-Pa 444, 316

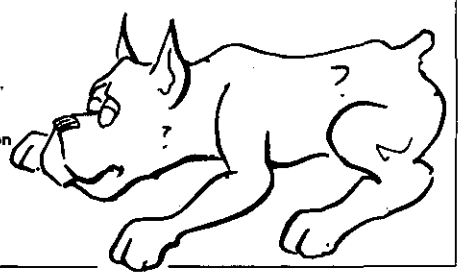
- LMN (lower motor neuron), Onset 15 months of age, **Axonal swellings** containing neurofilaments, 2° demyelination
- CS: **LMN signs**: progressive rear limb weakness (paresis), proprioception deficits, depressed reflexes, atrophy of distal pelvic limb muscles, Thoracic limb normal, ± Megaesophagus, Diminished bark, Some dogs have a curly coat
- Dx: Hx, CS, Spontaneous EMG activity in distal limb, Biopsy: **Giant axonal swelling**
- Tx: **No treatment available**
- Prognosis: **Poor**

Boxer central-peripheral neuropathy *

Progressive axonopathy of boxers

M8k 903, 912; E-hb 282; H2B 305; I2M 1041t; IM 789t; SAP 1167; 5min 930; NS-C 371; NS-W 213; NS-K 175; NS3hb 192t; NS-hb 190; NS-O 356; NS-L 208

- UMN; Onset at 6 months old; **Axonal degeneration** & swelling of CNS, PNS **demyelination** & remyelination
- CS: **UMN** signs predominate: slow, progressive severe rear limb ataxia, swaying hypermetric gait, front limb involvement late in diz
- Dx: Hx (young boxer), CS; PE: **loss of proprioception**, weakness, patellar areflexia, normal flexor reflexes, intact pain perception, normal bladder control, normal cranial nerves; EMG: normal, NCV: normal to ↓; Nerve biopsy: ↓ myelinated fibers, **onion bulb formation**
- Tx: **No treatment available**
- Prognosis: **So slow dog may be acceptable pet for months to years**



Globoid cell leukodystrophy, Krabbe's diz *

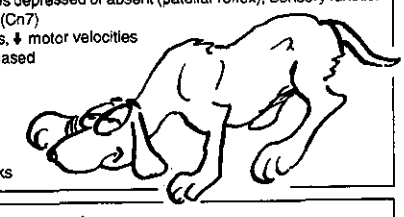
M8k 908; E-hb 320; IM 790; H2B 303; SAP 1167; E 708; NS-C 139; NS3hb 191t, 344t; NS-hb 324t; NS-O 526, 186t; NS-Pa 220, 458; Pa-T 363

- **See pg 517:** Inherited **lysosomal storage diz**; **West Highland White & Cairn Terriers**, bluetick hounds, cats; Onset: 4-6 months old; Demyelination CNS & PNS, enzyme deficiency = **accumulation** of S-galactocerebroside in CNS cells & macrophages (globoid cells)
- CS: **LMN** signs: progressive paraparesis & paraplegia, quadriparesis, Hindlimb dysmetria, Ataxia, ↓ Conscious proprioception & hyporeflexia; Head/neck tremors; Behavioral changes; ± Blindness, nystagmus, Cachexia, Anorexia before death
- Dx: Hx (**breed, age**) **CS**; R/O - rule out other causes of progressive myopathy; Biopsy - histo
- Tx: **Not described**
- Prognosis: **Grave**, hopeless

Distal denervating diz *

M8k 910; H3B 279; H3B 310; SAP 1170; E 706; NS-W 213; NS-hb 191; NS-O 363; NS-L 77 NS-Pa 420, 447

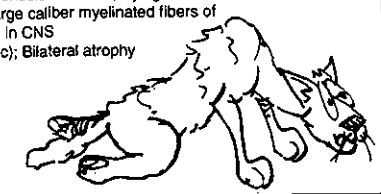
- **Degenerative neuropathy** of distal motor axons; **United kingdom**; Dogs; Cause: unknown; Pathophysiology: ? toxic agent?
- CS: **Weakness all 4 limbs (tetraparesis)** acutely, few days to 4 weeks; Not affected: mastication, swallowing, respiration, bladder control & tail wagging; ± Neck weakness loss of bark; Severe muscle atrophy: proximal extensor muscles; Spinal reflexes depressed or absent (patellar reflex); Sensory function maintained; Cranial nerve dysfunction infrequent (Cn7)
- Dx: Hx CS; Electrophysiology (EMG abnormalities, ↓ motor velocities normal sensory velocities), Muscle biopsy: decreased nerve fiber in intramuscular nerve bundles, neurogenic atrophy
- DDx: Acute idiopathic polyneuropathy/ coonhound paralysis
- Tx: **Supportive care**
- Prognosis: **Good** - complete recovery in 4-6 weeks



Distal symmetric polyneuropathy *

H3B 280; E 707; NS-O 363; NS-L 79

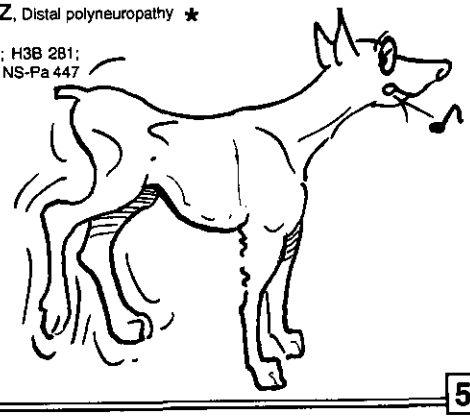
- **Young adult dogs** (1.5-3 years); Cause & pathogenesis unknown; Dying back or peripheral axonopathy?; Fiber degeneration of large caliber myelinated fibers of distal appendicular & laryngeal nerves; No lesion in CNS
- CS: **Chronic limb weakness** (pelvic then thoracic); Bilateral atrophy of distal appendicular & muscles of mastication
- Dx: CS; Electrodiagnostic: fibrillation potentials, positive sharp waves in distal limb muscles & absence of evoke action potentials; Biopsy
- Tx: **No effective Tx**
- Prognosis: **Poor**, progressive



Dancing Doberman diz, Distal polyneuropathy *

M8k 910; E-hb 317; IM 791; SAP 1170; H3B 281; 5min 495; E 705; NS-C 316; NS-hb 327; NS-Pa 447

- LMN (lower motor neuron); onset 3-5 years (**adult**); type 2 muscle fiber atrophy in advanced diz
- CS: Initially hold up 1 pelvic limb, then alternately hold up both ("**dancing**," "**bicycling**"); **LMN signs**: Atrophy of gastrocnemius, semitendinosus semimembranosus; Rear limb weakness; ± Decreased conscious proprioception
- Dx: Hx, CS, EMG: positive sharp waves & fibrillation potentials in gastrocnemius
- Tx: **No treatment available**
- Prognosis: **Slow so may be a good pet for a number of years**



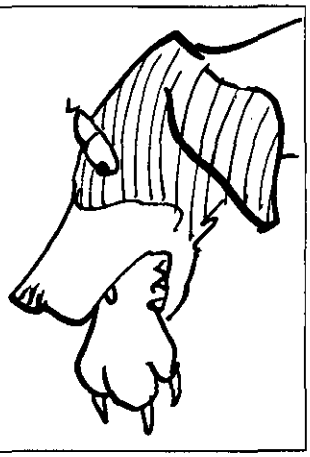
Ganglioradiculitis or cranial polyneuropathy

SAP 1169; NS-O 360; NS-L 173 *

- Combination of cranial nerve deficits in adult dogs, Cause unknown
- CS: Blindness, facial hyperalgesia, dilated pupils, facial paresis, temporalis & masseter muscle atrophy, head tilt, megaesophagus, dysphagia w/ or w/o mild ataxia, & paresis of limbs (± depressed patellar reflexes)
- Dx: Hx, CS < EMG: positive waves & fibrillation potentials, CSF normal, Necropsy: nonsuppurative inflammation of cranial & spinal ganglion & associated nerve roots
- Tx: Steroids, some exhibit slow improvement

Sensory mutilation syndrome, * Sensory neuropathy of English pointers

M8k 905, 912; Mk 582; I2M 1043t; IM 792; H2B 304t; SAP 1167; NS-W 212; NS-hb 191; NS-O 357; NS-L 173



- **Sensory loss**; Onset at 3-4 months old, Suspected inherited nociceptive defect
- CS: **Loss of sensation**, particularly the distal limbs, **Self mutilation** (lick & bite at paws) autoamputation; Normal gait & reflexes; Sequela: **osteomyelitis**
- Dx: Hx (pointer), CS; Loss of pain perception in digits of pelvic limbs; Normal EMG & sensory & motor conduction velocities
- Tx: **No treatment**; Prognosis: **poor**

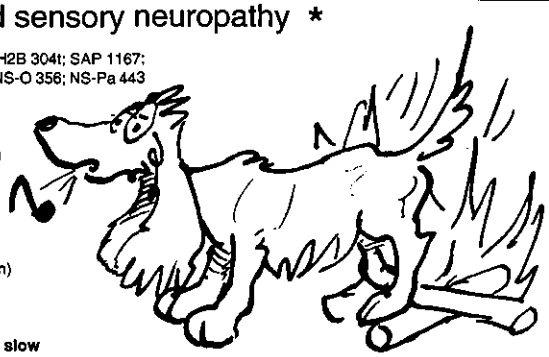
Sensory neuropathy, * Sensory ganglioradiculitis

H3B 277; NS-W 214; E-hb 285; SAP 1167

- Rare: **Adult** dogs
- CS: **Progressive ataxia & loss of proprioception**; No associated weakness, Tendon reflexes are depressed, Sensation to head & body ↑ or ↓, Difficulty swallowing & chewing, Abnormal sensation to rear limbs
- Dx: Hx, CS: Needle EMG normal, Necropsy (degeneration & loss of dorsal root ganglion cells & fibers)
- Tx: **None**
- Px: **Poor** for recovery

Longhaired dachshund sensory neuropathy *

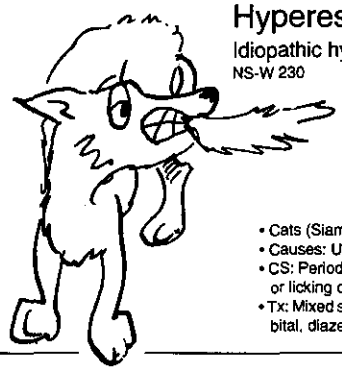
M8k 905, 912; E-hb 282; I2M 1043; IM 791; H2B 304t; SAP 1167; 5min 930; NS-C 29t; NS-W 212; NS-hb 191; NS-O 356; NS-Pa 443



- Loss of LMN sensory signs; Onset - 6 weeks old; **Loss of myelinated fibers** & degeneration of unmyelinated sensory fibers
- CS: ↓ **Superficial & deep sensation**, ataxia (loss of proprioception), urinary incontinence, No weakness, No atrophy, Normal tendon reflexes, **Flexor reflexes absent** (no pain perception)
- Dx: Hx, CS, EMG & NCV - normal, Sensory NCV - absent
- Tx: **No treatment available**
- Prognosis: **poor, but progression may be slow**

Hyperesthesia syndromes, Idiopathic hyperesthesia syndrome *

NS-W 230

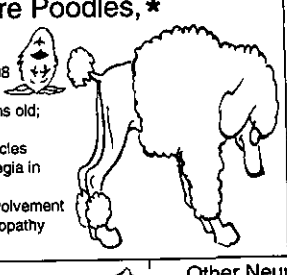


- Cats (Siamese) & dogs
- Causes: Unknown
- CS: Periodic, hysterical, intense chewing or licking of back, tail & rear limbs
- Tx: Mixed success w/ steroids, phenobarbital, diazepam, hormones

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Hypomyelinogenesis, Dysmyelinogenesis, Myoclonial congenita, Congenital hypomyelination M8k 909, 901; E-hb 279; H2B 254; E 617; NS-K 124; NS-hb 254; NS-O 190; NS-L 149; Sx-S 1033; Pa-T 363 *	• **Rare** • Hypomyelinogenesis: **failure to form myelin** • Dysmyelinogenesis: **formation of abnormal myelin** • New pups • Cause: - Congenital: Dalmatians, Weimaraner, spaniel & chow - Sequela to in utero viral infection or thyroid disorders of pregnant dam - Idiopathic: Schnauzer, Australian silky • Pathophysiology: abnormalities in myelin: m conduction velocity, conduction block, failure to conduct, cross talk between adjacent axons, aberrant firing	• **Tremors** (myoclonus) & oscillation of limbs, head & body - Wide based stance, hypermetria, head & body intention tremors ± Bunny hopping gait Body tremors more apparent when exercise - Disappear at rest or sleep - Rear limbs more severely affected - Noted when start ambulating • No weakness	• **Hx (puppies), CS** • R/O (rule out diagnosis all physical & lab tests normal Cranial nerves normal • Necropsy: confirm - histo - demyelination w/ normal axons **DDx:** • White dog shaker syndrome • Intoxication - Hexachlorophene - Lead - Organophosphate • Metabolic disorders - Uremia - Hypocalcemia - Alkalosis - Butyrophenone (Dobie)	• **No specific treatment** • Supportive care - keep quiet Prognosis: **Many recover in time**

Demyelinating myelopathy in Miniature Poodles, * Idiopathic demyelination

M8k 903; E-hb 292; H2B 280t; E 652, 649; NS-O 190; NS-L 193, 208



- Cause & pathogenesis: unknown, Hereditary?; Onset at 2-4 months old; Progressive, diffuse demyelination (cervical region) of spinal cord, Focal malacia in reticular formation of medulla & cerebellar peduncles
- CS: **UMN signs**: Weakness of pelvic limbs, progressing to paraplegia in 2 weeks, then tetraplegia; Marked hypertonia & hyperreflexia; ± **Cerebellar signs**; Pain perception normal; No cranial nerve involvement
- Dx: Hx (poodle, age) CS; R/O rule out other cause of diffuse myelopathy
- Prognosis: Hopeless - **grave**

Spongiform degeneration of CNS *

M8k 907; E 627; Cat 1529; Pa-T 364; NS-O 193

- **Rare: Egyptian Mau cat**, 2 labrador retrievers; silky terrier puppy & Samoyed puppy; Hereditary?
- Vacuolation of brain & spinal cord, Onset kitten 7 weeks old, Improves w/ age
- CS: Pelvic limb ataxia, Hypermetria, Frequent flicking movements of distal limbs when at full flexion
- Tx: Acepromazine may reduce episodes of extensor rigidity; Phenobarbital may produce temporary improvement of signs
- Prognosis: May improve w/ age

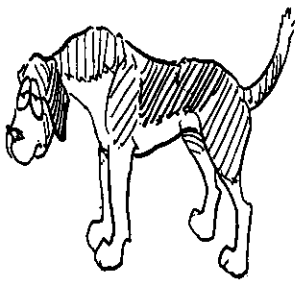
Neurogenic amyotrophy, * Progressive neurogenic muscular atrophy in English & short haired pointers

I2M 1043t; IM 790; H2B 304t

- LMN; Onset at 5 months of age; Cause ? abnormality in lipid metabolism, axonal degeneration, segmental de- or remyelination
- CS: Trembling, weakness, horse voice, Progressing to tetraplegia at 9 months, Extreme **muscle atrophy** (especially shoulders) & hyporeflexia
- Dx: Hx, CS, EMG: denervation
- Tx: **No treatment available**
- Px: **Poor**

Other Neuropathies: *

- Stochard's paralysis (crosses of Great Danes w/ bloodhounds or St. Bernards): NS3hb 191; NS-L 84; NS-O 190; NS-hb 189
- Hereditary quadriplegia in Irish setters: NS-O 189
- Fibrinoid leukodystrophy in Labs: M8k 907; NS-O 192
- Hound ataxia in Fox hounds, harriers, beagles: E-hb 296; NS-O 193
- Dalmatian leukodystrophy: M8k 907; I2M 1041t
- Motor neuron diz of Brittany spaniels & Rottweilers: SAP 1168
- Neuroaxonal dystrophy: M8k 903; NS-hb 221, NS-W 153
- Primary Hyperoxaluria: M8k 905
- Many others



Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Organophosphates, OPs, Anticholinesterase M8k 916, 928, 2058, 2062; Mk 1665, 1669; E-hb 158; H3B 1252; H2B 1314, 313; SAP 1143, 1171t, 1172; IM-WW 473; IM 756; 5min 884; Cat 216; E 313; NS-W 228; NS-C 386; NS3h 267; NS-hb 255; NS-O 265t, 136; NS-L 67; NS-Pa 255; Sx-WW 306; Pa-T 356; Tox 298; Tox-WW 231; NB 20.6 **	• **Major cause of poisonings** • **Commonly used - insecticides, pesticides & anthelmintics** (flea collars, wormers, insecticide sprays & dips, home & garden products) - Trichlorfon, parathion, dichlorvos, malathion, ronnel, chlorpyrifos, trichlorfon; dimethoate, crufomate, diazinon, fonofos, phosmet, disulfoton, coumaphos, famphur, phorate, fenthion - Interaction w/ phenothiazine tranquilizers, succinylcholine, physostigmine, neostigmine, carbamates • **Similar to carbamate except irreversibility** - **Irreversible inhibition** of acetylcholinesterase (AChE), overestimations of parasympathetic ANS, skeletal mm. & CNS . Inhibits muscarinic, nicotinic & neuromuscular synapse	• **Acute (w/in an hour)** • Muscarinic effects: - **"Slobbering"** - salivation - Lacrimation - Defecation, watery diarrhea - GI hypermotility, abdominal pain - Miosis, ± mydriasis - Pallor, cyanosis - **Dyspnea** - **Vomiting** (emesis) • Nicotinic effect: - **Muscle tremors & contraction** (facial & tongue 1st then entire body) - Ataxia & collapse, Paralysis - Tetany (sawhorse stance) • **CNS effects relatively rare** - **Depression** or **hyperexcitability** - **Tonic-colonic seizure** • Death: respiratory muscle paralysis, bronchoconstriction, pulmonary edema Cats: w/ chlorpyrifos toxicity - Delayed onset of CS - Predominantly CNS signs - Tremors, ataxia, depression - Seizures that persist for 2-4 weeks	• Hx w/in 48 hrs + parasympathetic signs tentative Dx of OP's or carbamate • **Response to atropine** therapy • Analysis of stomach contents or hair • Acetylcholinesterase activity (abnormal > 500 IU/l) • Reduced serum & RBC **cholinesterase levels** **DDx:** • Strychnine • Compound 1080 • ANTU • Chlorinated hydrocarbons • Metaldehyde • Bromethalin	• **Emergency** (rapid progression) • **Prevent further absorption** - Remove flea collar - Bathe if topical exposure - Induce vomiting if ingestion witnessed - **Activated charcoal** slurry lavage • **Atropine** to effect (mydriasis & absence of salivations), repeat every 3-6 hrs for 1-2 days (irreversible action of OP's) • **ASAP: 2 PAM®** (pralidoxime chloride) IV every 4-6 hours • Diphenhydramine (Benadryl®): decreases nicotine receptor overload • ± IV Fluids • ± Respiratory support • **Contraindicated**: morphine, succinylcholine & phenothiazine tranquilizers Public health: wear gloves & aprons to protect people **Prognosis: Good** w/ early diagnosis & Tx - weeks to recover
Common poisoning **CS: GI, Slobbering, tremors, down** **Dx: Hx, Response to atropine** **Tx: Emergency, Atropine, 2 PAM**				
Carbamate, Anticholinesterase See OP's above *	• Insecticides (carbaryl) • Not toxic w/ normal use • Inhibit acetylcholinesterase like OP's - **Reversible unlike OP's** • Products: carbaryl (Sevin®), methomyl, propoxur, bendiocarb, aldicarb, cargofuran	• Similar to OPs but of shorter duration	• Similar to OP's except serum cholinesterase activity must be measured early after exposure	• **Like OP's** - Atropine as in OP's, 1 Tx usually enough (becAUSE reversible) - No need for 2-PAM but it doesn't hurt if can't DDx PH: protect people w/ gloves & aprons Prognosis: good
Similar to OPs but of shorter duration & reversible **Tx: Like OP's - Atropine •Px: Good**				

Metaldehyde JAVMA 205(3)p417, 1994; M8k 2074, 2145; Mk 1676; H3B 1256; H2B 1313; E-hb 161; 5min 827; IM 755; IM-WW 473; Cat 229; NS-C 189; NS3hb 366; NS-hb 360t; NS-O 265t; Tox 325; Tox-WW 250, 73t, 82t; NB 20.13 **	• ***Molluskicide*** - slug & snail bait & rat poison, Snarol® - Looks & tastes like dog food - Palatable to dogs & other animals - Reported in dog, cat, sheep & children • Southern lowland, Pacific coast & Hawaii • **Toxic dose: 100-1,000 mg/kg**	• **"Shake & bake"** • Acute w/in 1-4 hrs • Anxiety, hyeresthesia • Ataxia • ↑ HR & RR • **Hypersalivation** • **Muscle tremors** & fasciculations not affected by external stimuli • **Seizures** • Pupils dilated & unresponsive • ± Vomiting & diarrhea (not early) • Nystagmus in cats • **Severe fever** as high as 108°F (42.5°C) • Loss of consciousness, decreased respiration, cyanosis • Sequela: Death by respiratory failure	• Hx (geography), CS, tachycardia • Lab - stomach contents for acetaldehyde (break down product of metaldehyde) • Severe metabolic acidosis • Postmortem: **formaldehyde odor** **DDx:** • Strychnine • Compound 1080 • Chlorinated hydrocarbons • Organophosphates • Bromethalin	• Prevent further absorption - **Induce vomiting** if animal conscious - **Gastric lavage w/ milk, lime water or Na bicarbonate, follow w/ activated charcoal** • No specific antidote • **Maintain relaxation** & prevent hypoxia - Anesthesia - Diazepam (Valium®) IV, methocarbamol or Xylazine (muscle relaxants) • Endotracheal tube, oxygen & artificial respiration • Supportive care for dehydration & acidosis • **Tepid water bath** - hyperthermia Prognosis: ????
Molluskicides, geography **CS: "Shake & bake": ataxia, tremors, seizures** **Dx: Hx, CS, Lab** **Tx: Induce vomiting, Lavage, Charcoal, Relax**				
Arsenic poisoning *	**See Tox pg 735: Insecticides**, SH enzymes - disturbs cellular respiration CS: **Acute GI** (salivation, repeated vomiting, colic); **Staggering**, PU; **Stupor**, Death Sequelae: Shock, renal failure Dx: Hx, CS (**rapid GI signs**), levels **>10 ppm**; PM Tx: ↓ Absorption (vomiting, lavage, charcoal); **BAL**; Fluid Px: **Poor to guarded**			

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Organophosphates, OPs, Anticholinesterase M8k 916, 928, 2058, 2062; Mk 1665, 1669; E-hb 158; H3B 1252; H2B 1314, 313; SAP 1143, 1171t, 1172; IM-WW 473; IM 756; 5min 884; Cat 216; E 313; NS-W 228; NS-C 386; NS3h 267; NS-hb 255; NS-O 265t, 136; NS-L 67; NS-Pa 255; Sx-WW 306; Pa-T 356; Tox 298; Tox-WW 231; NB 20.6 **	• **Major cause of poisonings** • **Commonly used - insecticides, pesticides & anthelmintics** (flea collars, wormers, insecticide sprays & dips, home & garden products) - Trichlorfon, parathion, dichlorvos, malathion, ronnel, chlorpyrifos, trichlorfon; dimethoate, crufomate, diazinon, fonofos, phosmet, disulfoton, coumaphos, famphur, phorate, fenthion - Interaction w/ phenothiazine tranquilizers, succinylcholine, physostigmine, neostigmine, carbamates • **Similar to carbamate except irreversibility** - **Irreversible inhibition** of acetylcholinesterase (AChE), overestimations of parasympathetic ANS, skeletal mm. & CNS . Inhibits muscarinic, nicotinic & neuromuscular synapse	• **Acute (w/in an hour)** • Muscarinic effects: - **"Slobbering"** - salivation - Lacrimation - Defecation, watery diarrhea - GI hypermotility, abdominal pain - Miosis, ± mydriasis - Pallor, cyanosis - **Dyspnea** - **Vomiting** (emesis) • Nicotinic effect: - **Muscle tremors & contraction** (facial & tongue 1st then entire body) - Ataxia & collapse, Paralysis - Tetany (sawhorse stance) • **CNS effects relatively rare** - **Depression** or **hyperexcitability** - **Tonic-colonic seizure** • Death: respiratory muscle paralysis, bronchoconstriction, pulmonary edema Cats: w/ chlorpyrifos toxicity - Delayed onset of CS - Predominantly CNS signs - Tremors, ataxia, depression - Seizures that persist for 2-4 weeks	• Hx w/in 48 hrs + parasympathetic signs tentative Dx of OP's or carbamate • **Response to atropine** therapy • Analysis of stomach contents or hair • Acetylcholinesterase activity (abnormal > 500 IU/l) • Reduced serum & RBC **cholinesterase levels** **DDx:** • Strychnine • Compound 1080 • ANTU • Chlorinated hydrocarbons • Metaldehyde • Bromethalin	• **Emergency** (rapid progression) • **Prevent further absorption** - Remove flea collar - Bathe if topical exposure - Induce vomiting if ingestion witnessed - **Activated charcoal** slurry lavage • **Atropine** to effect (mydriasis & absence of salivations), repeat every 3-6 hrs for 1-2 days (irreversible action of OP's) • **ASAP: 2 PAM®** (pralidoxime chloride) IV every 4-6 hours • Diphenhydramine (Benadryl®): decreases nicotine receptor overload • ± IV Fluids • ± Respiratory support • **Contraindicated**: morphine, succinylcholine & phenothiazine tranquilizers Public health: wear gloves & aprons to protect people **Prognosis: Good** w/ early diagnosis & Tx - weeks to recover
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Similar to OPs but of shorter duration & reversible **Tx: Like OP's - Atropine •Px: Good**				

Metaldehyde *JAVMA 205(3)p417, 1994;* M8k 2074, 2145; Mk 1676; H3B 1256; H2B 1313; E-hb 161; 5min 827; IM 755; IM-WW 473; Cat 229; NS-C 189; NS3hb 366; NS-hb 360t; NS-O 265t; Tox 325; Tox-WW 250, 73t, 82t; NB 20.13 **	• ***Molluskicide*** - *slug & snail bait & rat poison, Snarol®* - Looks & tastes like dog food - Palatable to dogs & other animals - Reported in dog, cat, sheep & children • Southern lowland, Pacific coast & Hawaii • **Toxic dose: 100-1,000 mg/kg**	• **"Shake & bake"** • Acute w/in 1-4 hrs • Anxiety, hyeresthesia • Ataxia • ↑ HR & RR • **Hypersalivation** • **Muscle tremors** & fasciculations not affected by external stimuli • **Seizures** • Pupils dilated & unresponsive • ± Vomiting & diarrhea (not early) • Nystagmus in cats • **Severe fever** as high as 108°F (42.5°C) • Loss of consciousness, decreased respiration, cyanosis • Sequela: Death by respiratory failure	• Hx (geography), CS, tachycardia • Lab - stomach contents for acetaldehyde (break down product of metaldehyde) • Severe metabolic acidosis • Postmortem: **formaldehyde odor** **DDx:** • Strychnine • Compound 1080 • Chlorinated hydrocarbons • Organophosphates • Bromethalin	• Prevent further absorption - **Induce vomiting** if animal conscious - **Gastric lavage w/ milk, lime water or Na bicarbonate, follow w/ activated charcoal** • No specific antidote • **Maintain relaxation** & prevent hypoxia - Anesthesia - Diazepam (Valium®) IV, methocarbamol or Xylazine (muscle relaxants) • Endotracheal tube, oxygen & artificial respiration • Supportive care for dehydration & acidosis • **Tepid water bath** - hyperthermia Prognosis: ????
Molluskicides, geography **CS: "Shake & bake": ataxia, tremors, seizures** **Dx: Hx, CS, Lab** **Tx: Induce vomiting, Lavage, Charcoal, Relax**				
Arsenic poisoning *	**See Tox pg 735: Insecticides**, SH enzymes - disturbs cellular respiration CS: **Acute GI** (salivation, repeated vomiting, colic); **Staggering**, PU; **Stupor**, Death Sequelae: Shock, renal failure Dx: Hx, CS (**rapid GI signs**), levels **>10 ppm**; PM Tx: ↓ Absorption (vomiting, lavage, charcoal); **BAL**; Fluid Px: **Poor to guarded**			

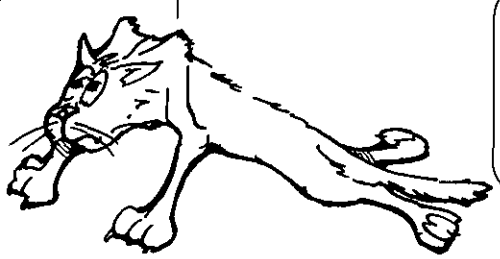
Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Strychnine JAVMA 205(3)p416, 1994; M8k 2156; Mk 1732; H3B 1250; H2B 1305; E-hb 161; SAP 1143, 1158, 1162; 5min 1089; IM 755; NS-C 310; NS3hb 262; NS-hb 250; NS-O 265t; Tox 345; Tox-WW 284; NB 20.12 *	• Alkaloid used for burrowing rodents (rat, mold, gopher) & coyote control - Sweet tasting coating or pellets, dyed purple, red or green •**No rationale for its use! Sale illegal in USA** • Directly affect the spinal cord like tetanus - Competitively blocks inhibitory neuron (glycine) - Results in hyperexcitability, loss of "damping" of spinal reflexes • Lethal doses - Dog: 0.75 mg/kg - Cat: 2.0 mg/kg **Illegal in USA** **CS: Tetanic seizures** **Dx: Hx, CS, Lab** **Tx: Vomiting, Lavage, Charcoal, Valium •Px: Poor**	• Rapid onset - 10-20 min. • Nervousness, apprehension, stiffness early • **Abdominal & cervical rigidity** • Uncontrolled reflex activity: - **Violent tetanic seizures** - spontaneous or 2° to stimuli (light, sound, touch) - Generalized extensor rigidity - **"saw horse stance"** - legs & body stiff, ears erect, lips pulled back (risus sardonicus) - Opisthotonus - Dilated pupils (mydriasis) & semicomatose - Apnea (breathing stops), no paddling, chomping or salivation - Vomiting rare • Sequela: Death due to hypoxia 2° to respiratory muscle riddidity & 2° renal damage	• Hx (**ingestion**), CS • Hyperthermia • Acidosis • Inducing seizures with loud hand clap is NOT DIAGNOSTIC & can be lethal • Induce vomiting - red or green bait • Analysis of stomach contents, liver, kidneys & iurine • High CPK & lactic dehydrogenase • Myoglobinuria **DDx:** • Tetanus • Hypocalcemia • Lead • Zinc phosphate • 4-aminopyridine • Nicotine • Caffeine • Compound 1080 • CHC • Metaldehyde	• Prevent further absorption - **Induce vomiting** if not hyperesthetic or convulsive - Gastric lavage: 1-2% tannic acid or 1:2,000 potassium permanganate followed by **activated charcoal** + saline cathartic • **Control seizures** - **Diazepam** (Valium®) - effective? - **Phenobarbital** - Muscle relaxants PO: Glycerol guiacolate (Geocolate®), Methocarbamol (Robaxin®) - Inhalation anesthesia - **NO** morphine or ketamine • Hasten elimination: - Diuresis (normal saline w/ 5% mannitol) - Acidify urine w/ NH4Cl PO qid once diuresis established, not if acidotic Px: **Guarded** if early Tx, Good if controlled - **Poor** if late Tx & seizures have occurred
Chlorinated hydrocarbons, CHC, **Organochlorine insecticides** M8k 2063;Mk 1666; H3B 1259; H2B 1315; E-hb 160; IM 755; IM-WW 473; SAP 1143; Cat 218; NS-O 265t, 131; Tox 286; Tox-WW 237 **	• **Use curtailed** because of persistence in environment: only **lindane**, endosulfan (Thiodan®), methoxychlor, chlordane & toxaphene approved for use around livestock, - Agriculture products: insecticides: **DDT**, TDE, dieldrin, aldrin, endrin, chlordecone, edosulfan • Recommended levels of spraying usually safe • Accumulate in tissue (fat soluble) • **Cats** especially susceptible • Action: lipid-soluble - absorbed through skin, diffuse CNS stimulant or depressant (causes a true cerebral encephalopathy) **Persistence; Lindane, DDT** **CS: Seizures & neuromuscular involvement** **Dx: Hx, CS, Levels** **Tx: Symptomatic, Valium, Fluids • Px: Good**	• **Stimulate or depress CNS** - Depression alternates w/ muscle activity - Head pressing - Hypersensitive: exaggerated response to stimuli - Vomiting, hypersalivation - Continual chewing motion - Twitching of face & neck - body (severe fasciculation & tremors, ataxia) - **Convulsive seizures** (unlike OP's): clonic-tonic, paddling & foaming at mouth • Hyperthermia • Protracted course - distributed to fat • Comatose • **Death during severe seizure** or complete recovery	• **Hx** (Exposure) • CS: **convulsive seizures & neuromuscular involvement (twitching)** • Levels in brain, liver, stomach contents or SQ fat (glass containers only) - Fat biopsy **DDx:** • Strychnine • Compound 1080 • Organophosphates • Metaldehyde • Lead • Degenerative cerebellar diz • Garbage intoxication	• **No specific antidote** • **Symptomatic TX** - **Dermal exposure: copious wash in soap & cold water** - Ingestion (rare): activated charcoal slurry lavage after seizures controlled • **Control seizures:** - Diazepam (Valium®) IV, Phenobarbital - NOT phenothiazines (lowers threshold) • Remove stress from environment • Maintain hydration & urine output (CHC eliminated in urine - IV fluids or gastric tube) **PH**: protect people w/ gloves & aprons, proper authorities dispose - persist in environment **Prognosis: good** w/ early diagnosis & Tx - weeks to recover
Lead toxicity *M8k 2072;Mk 1674, SAP 155, 1143; 5min 758;* H3B 1271; H2B 1329, 1380; E-hb 162; IM 756; IM-WW 472; E 318; NS-C 162; NS-W 119; NS3hb 267; NS-hb 255; NS-O 264, 136; NS-L 295; NS-Pa 250, 465; Pa-T 354; Tox 107; Tox-WW 191; NB 20.14 **	• *Exposure to lead in* **old paint, car batteries,** motor oil & grease, caulking material, dry wall, fishing sinkers - Dogs that dig or chew in ground w/ high lead levels (leaded gas) - Toxic doses: 10-25 mg/kg lethal • Pathogenesis: - Alters cerebral metabolism leading to edema, **hypoxia, ± cerebral necrosis** - ↑ **RBC fragility** & abnormal erythropoiesis - Effects heme synthesis - maturation • Usually young animals < 1 year-old • Males > females **Chronic; Paint, batteries** **CS: GI, CNS (blind, seizures, behavior)** **Dx: Levels, Nucleated/Basophilic RBCs** **Tx: EDTA, D-penicillamine**	• **GI: vomiting & diarrhea,** anorexia, "lead colic"± constipation - Megaesophagus (rare) • **CNS/cerebrocortical** - **Behavior changes** - Nervousness, barking - **Blindness,** deafness - Dementia - Hysteria - **Seizures**: clonic-tonic • ± Pharyngeal & laryngeal paralysis • PU/PD (polyuria) esp. in older animals **DDx:** • Canine distemper • Epilepsy • Thallium • Strychnine • Compound 1080 • Chlorinated hydrocarbons	• Hx (exposure), CS • **Definitive: lead levels** (heparinized unclotted whole blood, don't use EDTA) - > 0.06 mg/dl (60 µg/dl), >0.5 ppm diagnostic >40 suggestive • CBC (complete blood count) - Anemia (8%) - normocytic normochromic or microcytic & hypochromatic - Leukocytosis (25%) - Elevated liver enzymes (15%) • **Nucleated RBC** (blood smear) 54% w/ normal or ↓ PCV • **Basophilic stippling** (Romanowsky-stained blood smear) • Bone marrow biopsy - Maturation arrest at metarubricyte stage • Radiograph: - Lead line (sclerotic bone usually at metaphases of long bones) - ± Metal dense material in GI tract	• **Stop exposure** if possible, emetics, gastric lavage & activated charcoal, surgical removal cathartics if lead in GI • Chelating: - **Calcium EDTA** (Versenate®) SQ for 5 days (chelating agent, mobilizes lead from (tissue = incr. urinary excretion) or - **D-penicillamine** (Cuprimine®) PO for 14 days • If seizures: anticonvulsants • ± Dexamethasone if progressively decreasing consciousness - edema • Supportive: fluids, electrolyte, acid-base **EDTA** **Prognosis: Good** if early Dx & Tx
1080/1081, Sodium fluoroacetate *	**See Tox 739: Highly toxic**; rodents & coyotes; **licensed exterminators;** ATP block CS: **Rapid** - Vomiting, Urination, Defecation, Dyspnea, **Wild behavior, running fits, Seizures**, Rapid rigor mortis; Cat: above + vocalization Dx: Hx, CS, rapid rigor mortis (**extensor rigidity**), No hypersensitivity to stimuli Tx: Emesis, lavage, charcoal; **Glycerol monacetate** (Monacetin®), O2, barbiturates Px: **Grave** once CS			
Miscellaneous toxins - Polyneuropathies E-hb 283; H3 285; H2B 315; IM-WW 474; NS3hb 192t, 195, 36	• Produce polyneuropathies, CNS is also affected with most - Heavy metals (lead, mercury, arsenic) - Drugs: antibiotics (neomycin, streptomycin, gentamicin, polymyxin B, tetracyclines, sulfonamides), Organophosphates: axonal degeneration - Other chemicals: acrylanide, Tri-ortho-cresyl phosphate, carbon disulfide, CO, DDT, Lindane, pentachlorophenol - Polyneuropathy; Venoms (coral snake, bee); radiation • Dx: presumptive on Hx, CS • Tx: Removal of offending substance results in regeneration of peripheral nerves & often returns to normal • Prognosis: Usually reversible: vincristine, OP's intoxication, Irreversible: aminoglycosides, irradiation			

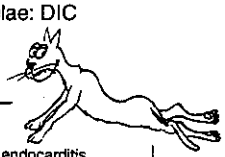
Tetanus

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Tetanus, Lockjaw M8k 929, 447; Mk 590, 330; E-hb 187; SAP 129t, 1158, 1162; H3B 1153, 1269; H2B 1211, 1326, 1422t; IM 745; E 374; I-B 193; I-G 521; NS-C 308; NS-W 162; NS3hb 260, 258; NS-HB 246, 248; NS-O 232; NS-L 141; Sx-WW 306 **	• ***Clostridium tetani*** - **Spores** in soil/feces, gram-positive, anaerobic bacteria - World wide distribution - **Soil contaminated deep puncture wounds (anaerobic environment needed)** - Necrotic tissue, cells lyse, releasing toxin - **Neurotoxin** picked up by nerves to spinal cord (ascending tetanus) - Excess toxin travels by lymph & blood to brain (ascending tetanus) • **Dogs & cats relatively resistant** (horse & man most sensitive) - IP 10 -14 d (week - weeks) • Deep puncture wound (anaerobic) • **Toxin** ascends nerves to spinal cord, causing ascending paralysis, if excess toxin in blood to brain, ascending tetanus - tetanospasmin - Blocks inhibitory interneurons (Renshaw cells) of motor nerves (blocks release of inhibitory neurotransmitters (gamma-aminobutyric acid), causing hyperexcitability of LMN- hypertonia & spasms	• **Hyperesthesia** • **Tonic/clonic muscle spasms** - Elicited w/ slightest sound or tactile stimuli - Masseter, neck, hindlimb & wound location - **"Pump handle" tail** - **"Saw horse" stance** - rigidity - **"Lockjaw"** (masseter muscle) - **"Sardonic grin"** (risus sardonicus/ sneering" expression due to contraction of facial mm. (elevated upper eyelid, wrinkling of forehead, retraction of lips, erect ears) - Prolapse of 3rd eyelid - **Occasionally seizures** • **Dyspnea** (m/b aspiration pneumonia) - Lateral recumbency, extended limbs, Opisthotonus • Sequela: Death from respiratory failure **Dogs & cats resistant CS: Lockjaw, Sardonic grin, Sawhorse Dx: Hx, CS Tx: ABs, Relaxants, Quite**	• **Usually presumptive Dx** • **Clinical signs, History** • Wound may not be evident (CS > 5-20 days after wound) • No reliable clinical test for Dx (try to culture) • Anaerobic culture for organism • Gram stain wound exudate for gram-positive rods **DDx:** • Strychnine • Rabies • Eclampsia • Meningitis • Spinal trauma • Metaldehyde poisoning • Organophosphate poisoning • Canine distemper • Carbonated hydrocarbons • Hypocalcemia • Uremia	• **Massive doses of ABs:** penicillin, ampicillin, tetracycline or metronidazole • **Muscle relaxants, sedatives or tranquilizers** (phenobarbital, diazepam to control muscle spasms) • **Quiet, dark cage,** pack ears w/ cotton • **Equine tetanus antitoxin** early in diz (binds loose toxin to prevent binding to nerves, once bound can't unbind) 1 dose only - Test dose first SQ & observe for 30 min for anaphylaxis • Good nutrition (± nasogastric tube) & fluids as needed • ± Urinary catheterization & enemas • ± Ventilation w/ oxygen for respiratory failure • **Vaccination:** not usually recommended in dogs & cats **Prognosis:** • **If survive 7 days- fair to good** • Poor if signs rapidly progressive, die w/in 5 days • Complete recovery in 4 weeks
Hypothyroid * polyneuropathy	• **See Endocrinology pg 675** • **Dogs** • Hypothyroid & lymphocytic thyroiditis - may develop polyneuropathies • Pathophysiology: ? Neuronal metabolism; Axonal degeneration, segmental demyelination	• **Slow progressive weakness** (paraparesis or quadriparesis) **LMN** • Muscle wasting • Normal or reduced reflexes • ± Cranial nerve disturbances (facial paresis & vestibular dysfunction, laryngeal paralysis) • **Classic signs not always present (obesity, mental depression, skin lesions)**	• Hx, CS • Needle EMG changes & decreased motor nerve velocities; • Thyroid stimulation test	• **Thyroid supplementation: Sodium levothyroxine (T4)** Prognosis: Replacement therapy may improve neurological signs
***Diabetic* polyneuropathy** M8k 913; E-hb 318; SAP 1168; H3B 281; H2B 311; E 706; Cat 1555; NS-C 383; NS-W 202, 216, 228; NS3hb 194, 351; NS-hb 192, 331; NS-O 362, 270; NS-L 79; NS-Pa 462 **Cats > Dogs, Plantigrade**	• **See *Endocrine system* pg 662** • **Cats** > Dogs • Diabetes mellitus • May cause fiber degeneration (mechanisms not understood) • Hyperglycemia/ hyperosmolality	• **Polyneuropathy** - Pelvic limb weakness (paresis) - Proprioceptive deficits - Depressed patellar reflex - Mild muscle atrophy - Plantigrade stance common in cats - Generalized weakness - Confusion or coma form hyperglycemia	• Evidence of DM • Needle EMG, denervation potentials, ↓ conduction velocities • Nerve biopsy: thinning of myelin sheath	• **Treat diabetes see pg 663** Prognosis: neurological signs usually improve over weeks to months w/ control of diabetes
Hyperinsulinism * polyneuropathy, Hypoglycemic polyneuropathy M8k 906; E-hb 321; SAP 1168; H2B 312; IM 745; E 710, 613; Cat 1535; NS-W 202; NS3hb 194, 353; NS-HB 192, 333; NS-O 269; NS-L 328, 89 NS-Pa 246, 472	• **See Endocrine system pg 669, 668** • **Dogs w/ hypoglycemia & hyperinsulinism** • Insulinoma - islet cell adenocarcinoma - Breeds: boxers, poodles, terriers • Other causes: Inadequate glycogen stores - toy breed puppies, Starvation, Glycogen storage diz, Hyperadrenocorticism, ↑ glucose utilization(lactation, exercise, pregnancy) • **Pathophysiology: not understood** - Axonal degeneration & segmental demyelination & remyelination	• **Seizures** #1 signs or hyperinsulinism • ± Weakness (paresis or quadriparesis) w/ depressed patellar reflex • ± Depression of all spinal reflexes • ± Atrophy, collapse • ± Visual impairment, unilateral facial nerve paralysis, behavioral changes	• Hx, CS • Lab - Low resting glucose levels, may be normal (resting, fasting, after exercise) - Serum insulin values usually high - Amended insulin glucose ration >30 • Electrodiagnostic tests: fibrillation potentials & sharp waves	• **Treat underlying cause** • **Treat insulinoma** - Surgically remove all 1° & metastatic tumor . Withhold food for 3-5 days after surgery . Monitor amylase, lipase & glucose levels . Anticonvulsants - Medical: Diazoxide PO tid successful in some Prognosis: neuropathy remains static usually w/ treatment of insulinoma
Hypoadrenocorticism/Hypokalemia *	• **See Endo pg 660:** • Cause: ↓ Intake or ↑ loss in GI & urine, diuresis (vomiting, diarrhea, excessive fluid therapy, or insulin therapy); Loss of neuromuscular function • CS: **Muscular weakness**, depression, ileus, reduced renal concentrating abilities & abnormal cardiac conduction. LMN paralysis characteristic • Dx: Serum potassium • Tx: **Supplementation easiest & safest by oral rout** (hyperkalemia - heart problems), SQ if oral rout not possible (GI complications)			
Hyperkalemia IM 742; SAP 512, 802, 1175; NS-W 203; NS3hb 252; NS-hb 332; NS-L 89 *	• **See Cardio pg 238: Life threatening phenomena;** Causes: oliguric renal failure (failure to excrete) #1 cause, adrenocortical insufficiency, diabetes mellitus, severe acidosis; shock • CS: **Episodic weakness**, bradycardia, depression • Dx: Hx, CS; serum sodium & potassium, ECG, plasma cortisol, ACTH response, blood glucose, urinalysis, BUN, Creatinine, blood pH • Tx: Shift potassium into cell: **sodium bicarbonate** or glucose plus insulin & diuresis, carefully, monitor			
Hypocalcemia E-hb 558; E 1457; SAP 234; IM 754; H2B 263, NS-W 203; NS3hb 260, 350; NS-HB 332; NS-O 259 *	• **See Endo pg 681: Most common in cattle;** Cause in dogs: hypoparathyroidism, renal diz, ethylene glycol toxicity, acute pancreatitis, intestinal malabsorption, hypoalbuminemia, nutritional 2° hyperparathyroidism, Puerperal tetany/eclampsia • Pathophysiology: **Ca essential for neuromuscular transmission**, muscle contraction, membrane stability & clotting process • CS: **Tetany** (neuromuscular excitability [fasciculation, twitching tetany, muscle spasm, gait changes [stiffness & ataxia]), Occasionally seizures (grand mal), weakness; Behavioral changes (restlessness, aggression, panting, hypersensitivity to stimuli, disorientation) • Dx: Low Ca, High phosphatemia: hypoparathyroidism, renal failure, nutritional 2° hyperparathyroidism; ± Bradycardia, hyperthermia, PU/PD & vomiting • Tx: **Calcium gluconate** (10%) given over 14-30 minutes			
Hypercalcemia E-hb 552; H2B 263; E 1437; NS-W 203; NS3hb 352; NS-hb 332 *	• **See Endo pg 676:** Affects cellular function, GI, renal, cardiac & neuromuscular dysfunction; weakness caused by membrane excitability disturbances; Cause: 1° & 2° hyperparathyroidism, Pseudohyperparathyroidism (lymphosarcoma), hypoadrenocorticism, chronic renal failure • CS: **Depression, muscular weakness**, fine muscle fasciculation			

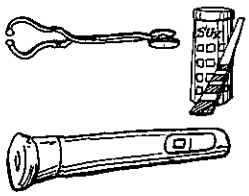
Aortic thrombosis

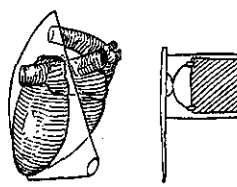
Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Aortic thrombosis, Ischemic neuropathies, Saddle embolus M8k 918; Mk 84; H3B 285; H2B 320, 114; SAP 473; E-hb 321; I2M 1052; IM 103; IM 806; T-HB 45; C12T 857, 866; E 710; 1026; NS-W 173, 216, 226; NS3hb 166; NS-HB 162; NS-O 375; NS-L 72; NS-Pa 453; H-F 454; Pa-T 202; NB 3.40 **	• Prolonged deprivation of blood to nerves • Causes: - **Feline cardiomyopathy** - Bacterial endocarditis (dog) . Originate from valvular vegetations - Heartworm diz & treatment • Embolize to various sites - **#1 - terminal aorta** at bifurcation of iliac arteries **."Saddle thrombus"** - 90% of cases • Pathophysiology: - Stops blood flowing through femoral artery - Substance in clot also ↓ collateral circulation from forming	• ± Cardiomyopathy • **Paralysis of hindlimbs** (lower motor neuron) - **Dragging hindlimbs** (can't flex or extend hocks) . **Intermittent lameness** (claudication = lameness) - **Relentless crying - pain** • Brachial artery - Monoparesis of front limb • Sequelae: DIC	• **Hx (cardiomyopathy)** • **Physical /Saddle thrombus** - Pallor of affected paws, paresthesia, cyanotic nail beds - Absence of femoral pulse, cold extremities - Hard, swollen, painful hindlimbs - Pain & proprioception absent initially - Intact myotatic reflex • Auscultation: Murmur or gallop rhythm: 50% • ECG: Supraventricular arrhythmia • Radiographs: Cardiomegaly • Echocardiography (US) • Elevated skeletal muscle enzymes - ± LDH, CPK & SGOT	• **Manage CHF** • **Butorphanol** (Torbugesic®) for pain • **Aspirin** • Heparin to prolong clotting time 2-3 x • Acepromazine • Treat underlying cause: cardiomyopathy or bacterial endocarditis • **Euthanasia**





DDx:
- Bacterial endocarditis
- Posterior paresis
  - Trauma
  - Intervertebral disc diz
  - Spinal lymphosarcoma
  - Fibrocartilaginous infarction
  - Myasthenia gravis
  - Diabetic neuropathy





Torbugesic

#1 terminal aorta -"Saddle thrombus"
CS: ± Cardiomyopathy, paraparesis
Dx: Hx, CS, PE
Tx: Butorphanol, Aspirin, Tx cause, Euthanasia
Px: Guarded

Prognosis:
- **Guarded**: majority incur other thrombi
  - Motor function may return in 10-14 days & survival of 4 years has been recorded
- Grave: if significant emboli to kidney, intestines or other organs

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Feline dysautonomia, Key Gaskel syndrome, Dilated pupil syndrome, Autonomic polyganglionopathy

M8k 929; Mk 597, 596; E-hb 319; SAP 1170; I2M 1056; IM 801; H2B 1130; 5min 531; E 707; Cat 1555, NS-W 85, 216; N-K 179; NS3hb 250, 192t, 283; NS-hb 239; NS-O 365; NS-Pa 471

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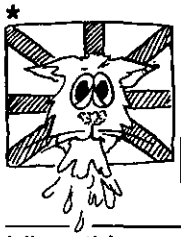


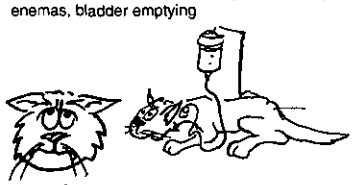
- Disorder of **ANS** - autonomic nervous system (sympathetic & parasympathetic
- **United Kingdom**, rare in USA
- Cause: unknown ?toxicology?
- Rare in cats < 3 years-old, reported in 6 dogs

Disorder of ANS, United Kingdom
CS: Dilated pupils, Dry nose
Dx: Hx, CS, PE
Tx: Supportive • Px: poor

- Rapid onset, progressing over 48 hours
- **Depression, vomiting, & retching, anorexia, lethargy**
- **Dilated pupils** (mydriasis) ± anisocoria
- **Dry nose**, eye (keratoconjunctiva sicca)
- Prolapse of 3rd eyelid
- GI: dry mouth, anal areflexia
- **Constipation**
- **Regurgitation** - megaesophagus

- Hx (Britain), CS
- **Physical exam**
  - Dilated pupils unresponsive to light
  - Dry mucous membranes, nose
  - Bradycardia, hypotension
  - Proprioceptive deficits
  - Loss of anal reflexes
- Postmortem - lesions of ANS

- **Supportive**: fluids, force feeding, lubricate eye, enemas, bladder emptying



Prognosis
- **Poor: mortality** > 70%, some cats recover spontaneously over years
- Some that recover have "D" shaped pupils in left eye, & reverse "D" in right

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Idiopathic hyperlipidemia, Polyneuropathy w/ inherited hyperchylomicronemia - cats

*

M8k 905, 913; E-hb 543; I2M 1052; IM 615; IM-WW 411; H2B 543; E 1412; NS-W 185, 216; NS-HB 239; N-K 179; NS-Pa 471

- **Cats w/ inherited hyperchylomicronemia**
- Persistent-fasting hyperlipidemia (elevated chylomicrons)
  - Familial & inherited
  - Also reported in dog
- Pathophysiology:
  - Multiple nodular lipid granulomas & hematomas in many tissues
  - Lipid granulomas (**xanthomas**): at spinal foramina & bony prominences due to minimal trauma
- **High fat diet predisposes**

- **Asymptomatic, most cats all dogs**
- ± Clinical signs in 8 months
  - **Peripheral nerve paralyses**
    . Slow onset unilateral paralysis
    . Loss of conscious proprioception & motor function
    . Pain sensation remains
    . Nerves: sympathetic (Horner's syndrome) & sciatic nerve
    .. Facial, trigeminal, recurrent laryngeal nerve paralysis
  - Cutaneous nodules (**xanthomas**) over pressure points
  - Lipemia retinalis & uveitis

- Hx, CS
- Physical exam
  - ± Lipemia retinalis: light retinal vessels
  - Palpation: painless granulomas in kidney, liver, intestine
- Lab: **"Cream of tomato soup"** appearance to blood
  - Marked elevation of cholesterol (mean 25 mg/dl) & triglycerides (mean 900 mg/dl)
  - ↑ chylomicrons - electrophoresis

- **Low fat diet** (r/d or w/d) to lower serum triglycerides, stop table scraps

DDx:
- Hyperlipidemia
- Causes of polyneuritis

Prognosis: Good: improve 2-3 months after initiation of a low fat diet

Cats, High fat diet •CS: Asymptomatic, Peripheral nerve paralyses •Tx: Low fat diet • Px: Good

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Swimming puppies

NS-L 208

*

- **Rare**
- **Not a neurological problem** - differential
- Breeds: Eng. bulldogs, Sealyham terriers, Pekingese dogs w/ achondroplasia or osteochondrodystrophy or normal dogs: Ger. shepherd, black & tan coonhounds, miniature poodles
- Mechanism not understood? metabolic or endocrine diz?; poor management (hard slippery surface)

- Puppy - limbs too abducted to stand & walk
- **Make swimming motions**
- ± Severe dorsoventral compression of thorax
- **BAR** (bright alert & responsive)
- Sequela: Permanent joint deformities - ankylosis

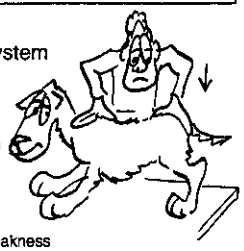
- Hx, CS
- Physical exam
- **Neuro exam: no deficits**

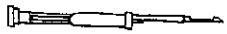
- **Treat early**
- **Hobbles in adducted position**
- **Deep bedding**

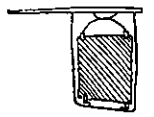
Prognosis:
- Depends on continual attention of owners

Rare, Not a neurological problem •CS: Abducted limbs •Tx: Hobbles

Condition	Facts & Cause	Presentation/CS	Diagnosis
Disorders of skeletal muscles, Myopathies E-hb 329; SAP 1124, 1173; IM 803; IM-WW 306; 5min 854, 864; E 727; C11t 573, 1029, 1043; Cat 1574; NS3hb 195; NS-W 228; N-K 1812; NS-O 145, 376; NS-L 66, 69, 84; Sx-WW 306; ****?**	• Neuromuscular disorders: dysfunction of motor unit - Motor neuron (cell body & axon) - Neuromuscular junction - Myofibrils innervated by nerve • Cause (see box): hereditary, acquired (autoimmune, metabolic, endocrine, neoplastic, infectious, toxic & ischemic)	• **Weakness**: common to all neuromuscular disorders - Focal or generalized • General signs - **Gait abnormalities** - **Paresis or paralysis** - **Tiring** (exercise related weakness) • Other accompanying signs - Masticatory dysfunction - Dysphagia (pharyngeal dysfunction) - Regurgitation (esophageal dysfunctions) - Dysphonia & dyspnea (laryngeal dysfunction)	• Hx (history), CS (clinical signs) • Physical exam including cardiovascular system • **Neuro exam:** - **Evaluate strength - weakness #1 sign** . Gait, exercise, push on animal . ± Postural responses (Wheelbarrowing, hopping etc.) - Stiffness = inflammatory myopathies, myotonias & MG - Ataxia: (sensory sign) suggest neuropathetic disorder - Palpation: muscle tone & spinal reflexes - Note atrophy or swelling - Cranial nerves: weakness possible w/o generalized weakness - Differentiate regurgitation from vomiting • Clin path: - **CBC, chemistries, & urinalysis** for metabolic disorders - **CK** (serum creatine kinase) elevated if muscle damage, doesn't confirm a myositis • **Thyroid & adrenal function tests**: concurrently or cause myopathies • **ANA** (antinuclear antibody assay) suggest autoimmune - Some myasthenia gravis dogs are ANA positive • Serum *Toxoplasma gondii* & *Neospora caninum* titers • Plasma cholinesterase levels: (organophosphate toxicity) • Serum antibodies against masticatory muscle type 2M fibers: immunopathology to chemical method (horseradish) • Serum antibodies against nicotine AChRs: immunoprecipitation radioimmunoassay for acquired MG • **Edrophonium chloride challenge test**: presumptive Dx of MG (Tensilon®) ↑ muscle strength, doesn't R/O MG if negative • **Electrodiagnostic evaluation, EMG** - Conduction velocities of peripheral nerves - Repetitive stimulation - evoked potentials • **Muscle biopsy**: flash freeze in Freon, not formalin (consult for procedure) • Radiology: - Swallowing studies for oropharyngeal & megaesophagus disorders - Plain films for megaesophagus







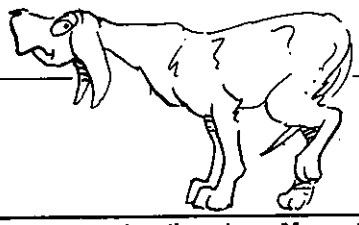
DDx - pain - neuromuscular

- Neck pain
  - Infectious & inflammatory diz of CNS
    . Meningitis
  - Vertebral instability
  - Diskospondylitis
  - Cervical intervertebral disk diz
  - Tumors - compression
  - Cervical nerve root
  - Trauma

  Generalized myositis
  - Polyarthritis (atlantoaxial joint)
- Other spinal regions
  - Disk diz
  - Diskospondylitis
  - Neoplasia
  - Cauda equina syndrome
- Limb pain, head
  - Muscular pain
    . Idiopathic polymyositis
    . Masticatory myositis
    . Toxoplasma or Neospora myositis
    . Ischemic myopathy
  - Bone pain
    . 1° bone tumors
    . Panosteitis
    . Osteomyelitis
    . Myelophthisic diz (hematopoietic neoplasm)
  - Joint pain
    . Degenerative joint diz
    . Infections
    . Immune mediated joint diz

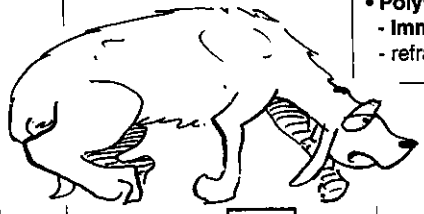
Causes/DDx: Neuromuscular diz

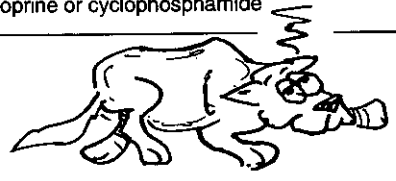
- Hereditary
  - Canine X-linked muscular dystrophy
  - Congenital myasthenia gravis (MG)
  - Familial canine dermatomyositis
  - Hereditary myopathy of Labs
  - Hereditary myotonia of Chows
  - Familial reflex myoclonus of Labradors
- **Acquired muscular disorders**
  - Autoimmune
    . Generalized myasthenia gravis
    . Focal myasthenia gravis
    . Masticatory muscle myositis
    . Feline idiopathic polymyositis
    . Hypokalemia polymyositis
- **Polymyositis**
  - Metabolic muscular disorders
    . Glycogen metabolism
    . Lipid metabolism
    . Nutritional myodegeneration
    . Enzyme deficiencies
    . Hyperthermia - malignant & exercise
- Electrolyte imbalance
  - Hyperkalemic periodic paralysis
  - Hypokalemia - cats
  - Endocrine
    . Hypothyroidism
    . Hypoadrenocorticism
    . Hyperadrenocorticism
  - Neoplastic/paraneoplastic
  - Infectious muscular disorders
    . Toxoplasmosis
    . *Neospora caninum*
    . *Hepatozoon canis*
    . *Leptospira myelitis*
  - Toxic
    . Tick paralysis
    . Botulism
    . Organophosphate toxicity
    . Drugs affecting neuromuscular transmission
  - Ischemia
  - Feline myositis ossificans
  - Local wound myositis
  - Fibrotic myopathy
  - Exertional myopathy



Treatment:

- Hereditary disorders: selective breeding & prevention
- Acquired neuromuscular disorders
  - Treat 1° cause: hypothyroidism, adrenal dysfunction, electrolyte disorders, protozoal infections
- **Generalized MG**
  - **Anticholinesterase drugs**
    - **Pyridostigmine bromide syrup (Mestinon®)**
    - **Neostigmine (Prostigmin®) IM**
  - ABs for any concurrent aspiration pneumonia
  - **± Immunosuppressive steroids (prednisolone)**
  - Thymectomy if thyoma
  - Rare refractory cases: cytoxic agents: Azathioprine & cyclophosphamide
  - Megaesophagus - feed in upright position
- **Focal MG**: pharyngeal & esophageal problems
  - Anticholinesterase 1 hour prior to feeding
  - Feed in upright position & remain upright for 10 min after feeding
  - Percutaneous gastrotomy tube
  - For those not responding to upright feeding
- **Anticholinesterase drugs** value not known, lower doses may be of benefit to prevent regurgitation
- **Steroids (prednisone)** if concurrent immunological dizs
- **Immune-mediated inflammatory myositis MMM**
  - Acute MMM inflammatory diz
  - Immunosuppressive doses of corticosteroid then taper dose
  - Chronic MMM fibrotic diz
  - As for acute + (steroids)
  - Manually open mouth
- **Polymyositis**
  - **Immunosuppressive steroids**
  - refractory cases: azathioprine or cyclophosphamide

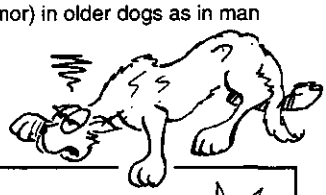


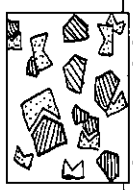


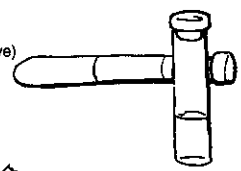
Neuromuscular disorders, Myopathies
CS: Weakness, Gait abnormalities
Dx: Hx, CS, PE, Neuro exam, Lab (CK), EMG
Tx: Tx specific diz

Myasthenia Gravis

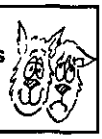
Condition	Facts & Cause	Presentation/CS	Diagnosis
Acquired myasthenia gravis MBk 915; E-hb 323; SAP 1123, 1174, 1177; H3B 278; H2B 307; I2M 1057; IM 801; IM-WW 494; 5min 836; E 712; Cat 1572, 1555; N-K 189; NS3hb 201; NS-HB 197, 228; NS-O 386, 164t; NS-L 69, 89, 106; Pys 291 **	• Means grave muscular weakness • Failure of neuromuscular junction transmission • **Acquired autoimmune disorder** - Also a congenital nonautoimmune disorder • Uncommon in dog - Large breeds: Ger. shepherd, all breeds of St. Bernards, Collies, Great Danes, Akitas & Labradors & ages - 2 years old (1-8 yrs) • Rare in cat (Abyssinian) - 1-4 years (1-11 years) • Premature fatigue that is relieved by rest & anticholinesterase Tx • Pathophysiology: - **Deficiency of Ach receptors on post synaptic membrane** (nicotinic) . **Autoantibodies** binding to receptors . Impaired neuromuscular transmission & marked muscle **weakness** - Many questions: reasons for remission & exacerbation?, some muscles affected & others not • Related to thyoma (mediastinal tumor) in older dogs as in man	• **Progressive muscular weakness** - **Episodic**: exacerbated w/ exercise & improves w/ rest - Gait: normal initially then progressively shorter (stiff stilted) till lays down & refuses to move, then moves after rest . Postural tremor & crouching stance before collapse - Drooping face - facial nerve - Difficulty holding up head, closing mouth - Dysphonia (voice changes - high) - Generalized or predominantly in rear limb or Thoracic limbs • Megaesophagus common - Regurgitation - **Dysphagia** (difficult swallowing) - Salivation (sialosis - flow of saliva) - Regurgitation, gagging • Exacerbation of CS w/ cold (shivering depletes ACh) • Muscarinic stimulation - Salivation - Miosis - Vomiting/regurgitation - Diarrhea • Sequela: Aspiration pneumonia - cough	• Hx (episodic weakness), CS • **Physical exam/Neuro exam:** - **Muscle strength**: gait at walk (strenuous exercise) ..Wheelbarrow, hopping & hemistepping tests, withdrawal (pedal) reflex - Ataxia: conscious proprioception (paw position, sway & reflex stepping tests) - Palpate in lateral recumbency, muscle tone & bulk, pedal & patellar reflexes & conscious pain - Palpation for muscle/nerve pain & percussion for a hypotonic dimple - No sensory problem - Neuro: unremarkable besides weakness & dysphagia? eliminates most form of neuropathy - Cranial nerve dysfunction, weak gag reflex, weak tongue, facial paralysis • **Edrophonium chloride (Tensilon®) challenge test IV** - Presumptive Dx of generalized MG - Improves in 30 seconds, negative response doesn't rule out • Long acting anticholinesterase neostigmine test (Prostigmin®, Stiglin®) improve in 15-30 min - Atropine (0.04 mg/kg, IV) should be given prior to anticholinesterases to block their muscarinic effects • **Serum antibodies against nicotinic AChRs** diagnostic test of choice, positive in 90% of cases (Steroids interfere w/ assay) • Electrophysiological testing - **Repetitive nerve stimulation = ↓ muscle action potential amplitude (decrements);** Decrements of 10% suggestive, >20% MG - EMG & Velocities usually normal • Muscular biopsy: **IgG bound to NMJ** (staphylococcal protein A-horseradish peroxidase method) • AChR antibody titers • Radiology: - Megaesophagus - Thyoma - Aspiration pneumonia (tracheal aspiration if positive) - ± Barium swallow • Muscle biopsy: limited value except to R/O other causes • Laboratory - CBC (complete blood count) & Chem - ↑ CK (creatinine phosphokinase) not diagnostic - Urinalysis • Cerebrospinal fluid: nerve root disorders







Autoimmune
CS: Progressive muscle weakness
Dx: PE, Tensilon, EMG
Tx: Anticholinesterase, Steroids

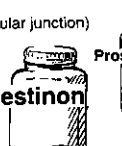


Anticholinergic drugs: inhibit breakdown of ACh thus increase time to interact w/ remaining AChR receptors

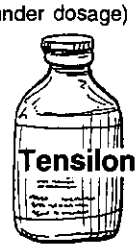
DDx:
- Metabolic disorders
  - Hyperkalemia
  - Hypokalemia
  - Hypocalcemia
  - Hypercalcemia
  - Hypoglycemia
- Cardiovascular disorders
  - CHF
  - Arrhythmias
- Neuromuscular disorders
  - Polymyositis
  - Polyneuropathies
- Megaesophagus
  - Polymyositis
  - Some neuropathies
  - Botulism
- Hypothyroidism
- Damage to muscle - polymyositis
- Globoid cell leukodystrophy

Edrophonium chloride (Tensilon®) challenge test IV (short acting anticholinesterase)
- Presumptive diagnosis of generalized MG
- Procedure: indwelling catheter, atropine premedication, oxygen & endotracheal tube available (respiratory paralysis)
  - Exercise to fatigue
  - Inject Tensilon®, ± 2nd injection
  - Positive test - improvement w/in 30 sec. w/ return to weakness in 5 minutes
  - Negative response doesn't rule out myasthenia gravis
- May induce crisis of cholinergic excess
  - Excessive muscle depolarization, weakness, respiratory failure
  - give atropine + O2

Treatment:
- **Anticholinesterase drugs** (prolong ACh action on neuromuscular junction)
  - **Pyridostigmine bromide syrup (Mestinon®)** PO
    . . Dosage varies w/ exercise, excitement or cold, adjusted according to response
    . . Signs of overdosage resemble the weakness of the primary diz.
  - **Neostigmine (Prostigmin®) IM** if regurgitation doesn't allow Mestinon® use until oral medication can be kept down
- ABs for any concurrent aspiration pneumonia
  - Contraindication: aminoglycosides or streptomycin because both inhibit acetylcholinesterase release
- **± Immunosuppressive steroids (prednisolone)** (autoimmune Tx) only if uncontrolled by anticholinesterase drugs, or immune response continues
- Thymectomy if thyoma
- Rare refractory cases: cytoxic agents
  - ± Azathioprine & cyclophosphamide (immunosuppressive)
- **Pharyngeal & esophageal problems**
  - Megaesophagus rarely responds to Tx
    - Regurgitation
    - Anticholinesterase 1 hour prior to feeding
    - **Feed in upright position** & remains upright for 10 min after feeding
  - Percutaneous gastrotomy tube
    - For those not responding to upright feeding



If animal improves & then deteriorates w/ anticholinesterase Tx; differentiate between myasthenic crisis (anticholinesterase under dosage) & cholinergic crisis (overdose)
- Edrophonium test to distinguish
  . Myasthenic crisis improves
  . Cholinergic crisis worsens

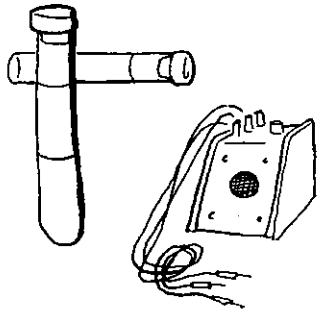


Prognosis:
- **Guarded**: progressive course
- Some dogs spontaneously remission
- Poor if severe megaesophagus
- Mestinon® questionable effectiveness with constant dosage changes being very common
- Corticosteroids if concurrent autoimmune diz

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Congenital myasthenia gravis, MG M8k 905; E-hb 330; SAP 1173; H3B 278; H2B 307; I2M 1057; IM-WW 494; 5min 836; NS-W 198; NS-O 386; NS-L 69, 89, 106; *	• Congenital familial form of MG, inherited autosomal recessive trait • Less common than acquired form • Jack Russell terriers, springer spaniels, smooth fox terrier • **Failure of neuromuscular transmission** - **Results in deficiency of acetylcholine receptor** (AChRs) - Not immune mediated unlike MG not related to autoantibodies to AChR • **Puppies at 6-8 weeks old**, multiple cases in litter	• **Similar to acquired MG** • **Episodic tiring, recovery w/ rest** • **Noted when first walk** - Less active than littermates - Progressive weakness, pelvic limbs to head, to recumbency • Regurgitation due to megaesophagus (less common than acquired)	• **Hx (puppy), CS (MG signs)** • Definitive: reduced density of AChR w/o evidence of autoimmunity • Positive Tensilon® test • Benefit from anticholinesterase Tx • Repetitive nerve stimulation	• Benefit from anticholinesterase Tx - **Pyridostigmine bromide syrup (Mestinon®)** - **Neostigmine (Prostigmin®) IM** - **Immunosuppressive steroids (prednisolone)** (autoimmune Tx) Mestinon Steroid Prognosis: Grave for long term survival
Focal myasthenia gravis E-hb 330; SAP 1178; H2B 307; IM 801; NS-O 386, 164t *	• **Megaesophagus & pharyngeal dysfunction w/o generalized weakness**	• **Megaesophagus** common - Regurgitation - **Dysphagia** (difficult swallowing) - Salivation (sialosis - flow of saliva) - Regurgitation, gagging - Dysphonia (voice changes - high) • Exacerbation of CS w/ cold • Sequela: Aspiration pneumonia - cough	• Hx, CS • Physical exam/Neuro exam: - **Muscle strength**: no generalized weakness detected - Cranial nerve dysfunction, weak gag reflex, weak tongue, facial paralysis • **Positive serum AChR antibody titers**	• Pharyngeal & esophageal problems • Megaesophagus rarely responds to Tx - Anticholinesterase 1 hour prior to feeding - **Feed in upright position** & remain upright for 10 min after feeding - Percutaneous gastrotomy tube, for those not responding to upright feeding • **Anticholinesterase drugs** value not known, lower doses may be of benefit to prevent regurgitation • **Steroids (prednisone)** if concurrent immunological dizs **Prognosis: Good**: majority go into spontaneous remission
Megaesophagus w/o weakness CS: Megaesophagus: regurgitation, dysphagia Dx: No generalized weakness, CrN, AChR antibodies Tx: Feed upright • Px: good				
Hyperadrenocorticism, Steroid excess, Acquired myopathic myotonia of adult dogs E-hb 599, 330; H3B 474; H2B 911; IM 806; SAP 1175; 5min 858; IM-WW 497; E 731; NS-L 87 *? Steroids	• **See Endo pg 654** • Degenerative noninflammatory myopathy • Cause: excess steroids - exogenous or endogenous • Pathophysiology: - ↓ intracellular potassium content - ↓ synthesis & ↑ **catabolism of muscle proteins**	• **Muscle weakness** • **Stiff stilted gait** - esp. pelvic limbs • Muscle atrophy of paralumbar & masticatory muscles • ± Limb rigidity/ hyperextension of all 4 limbs • Proximal appendicular muscular hypertrophy • Classic signs of Cushing's: **PU/PD, hair loss, pendulous abdomen, thin skin** **DDx:** • Hypothyroidism • Myasthenia gravis	• Hx, CS • **EMG**: bizarre high-frequency discharges w/o waxing & waning - Mostly in proximal appendicular muscles • **Muscle biopsy**: myofiber atrophy, lipid deposits in inflammatory infiltrate • Lab: Muscle enzymes mildly elevated • Radiography: osteoporosis or dystrophic calcification •Neuro exam: Normal, ± **myotonic dimple** • Adrenal function tests (ACTH stimulation)	• Control excess steroids - **o,p'-DDD** (Mitotane®) Tx of adrenocortical hyperplasia - Stop steroid treatment Miototane Prognosis: • **Poor:** for complete resolution of myopathy • **Guarded:** myopathy variable • EMG findings persist even w/ improvement
Nutritional myodegeneration H2B 911; NS-L 88; NS-O 384 * Vit E	• **Rarely in puppies** - Commonest in young ruminants • Nutritional deficiencies of **vit E, selenium** or both • Puppies fed semisynthetic **diet** deficient in vit E & selenium • Pathophysiology: Vit E protects anti-oxidative for unsaturated fatty acids, destabilization of lysosomes, rupture & autodigestion of muscles	• **Young puppies** (3-6 wks) • **Stilted gait** • **Weakness** • ± Retinal degeneration (visual deficits) **DDx:** • Infectious myopathy • "Swimming puppy" syndrome • Breed- specific congenital myopathy	• Hx (**puppies, noncommercial diets**) • EMG: fibrillation potentials, myotonic discharges • Muscle biopsy: - Widespread necrosis w/ calcification - Proliferation of sarcoplasmic nuclei - Interstitial histiocytosis w/ active phagocytosis	• **Vitamin E** PO if early
Glycogen metabolism disorders, Glycogenosis or enzyme deficiency M8k 906; E-hb 320, 527, 413; SAP 1174; E 708 *	• **Hepatic glycogen storage diz:** • 6-8 week old toy breeds; CS: Persistent **fasting hypoglycemia** • Dx: Hx, CS, IV glucagon or epinephrine - hypoglycemia, enzyme isolation • Tx: **no specific Tx, control hypoglycemia** • **Px: Poor** • **Amylo-1,6-glucosidase deficiency**: young female German shepherds - CS: poor growth & weakness • **Young Norwegian forest cats**: fever, muscle tremors, **bunny hoping gait** & weakness to tetraplegia, atrophy. Tx: none • Px: poor • **Phosphofructokinase deficiency**: springer spaniel, anemia not weakness problem • Profound skeletal muscular weakness & megaesophagus: seen in some • **Pyruvate dehydrogenase deficiency**: Clumber & Sussex spaniels • **Alpha-1,4 glucosidase** (acid maltase) deficiency: Lapland dogs			
Hypothyroidism E-hb 331; I2M 1063; IM 806; SAP 1175; NS-L 88; NS-O 381	• See **Endo pg 675** • Subclinical myopathy in dogs • Speculation that weakness & tiring (exercise intolerance) related to myopathy, Electrodiagnostic findings are normal			
Neoplasia of muscles H3B 857; H2B 912 *	• 1° **rare** (Rhabdomyoma, Rhabdomyosarcoma) • 2° neoplasia (lymphosarcoma, adenocarcinomas [mammary, renal, thyroid], local invasion from cutaneous tumors) • Locations: head, appendicular skeleton, heart • **CS: Depend on muscle group effected** • Tx: 1° surgical excision; 2° depends on Tx of 1° tumor • Prognosis: **Poor** unless tumor well organized			
Neoplastic/ paraneoplastic *	• **See pg 567** • Association between neoplasia & neuromuscular disorders suspected but not proven • Thyoma associated w/ MG & polymyositis in dogs			

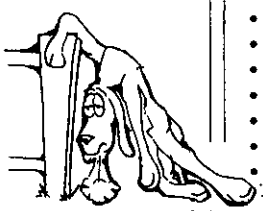
Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Masticatory muscle myositis, MMM, **Eosinophilic myositis, Atrophic myositis, Cranial myodegeneration** E-hb 330; H3B 856, H2B 907; SAP 1174; I2M 1059; IM 803, 259; IM-WW 496; 5min 854; N-K 184; NS3hb 196; NS-HB 193; NS-O 379; NS-L 85; Sx-WW 308 **	• **#1 myositis in dogs** • Cause: unknown? immune-mediated • Types: - Acute: Ger. Shepherd & retrieving breeds, any breed - Chronic: w/ or w/o repeated acute episodes • Focal inflammatory myopathy of muscles of mastication (masseter, temporalis, pterygoid) • Myofibers of masticatory muscles distinct from limb muscles - Type 2M myofibers target of autoimmune disorders • Adult dogs of large breeds, any age	• Acute: - **Swelling of masticatory muscles** (eyes bulge/exophthalmos) - Salivate - Fever, swollen tonsils & mandibular lymph nodes - ± Jaw drop - Trismus (spasm of masticatory muscles, lockjaw) - Jaw held partially open (pseudotrismus), won't open or close mouth - Never paralysis - Weight loss (reluctance to chew, anorexia) - Variable fever - Masticatory dysfunction • **Chronic** (more commonly recognized) - **Severe atrophy (progressive) = skull like appearance to head** - **Difficulty opening mouth** - **BAR** (bright, alert & responsive) - Bilateral atrophy of temporalis & masseter muscles	• Hx, CS • Physical exam: - Presence of atrophy or swelling - Acute: resent manipulation of mouth - Inability to open mouth if chronic • Laboratory: - CBC - ± neutrophilia & eosinophilia - Muscle enzymes normal to slightly elevated (CK, AST) • **Serum antibodies against masticatory muscle type 2 M fibers (80% of cases)** • **EMG**, electromyography - Positive waves, fibrillation potentials, electrical silence in areas of fibrosis • Muscular biopsy (temporalis muscle) - Necrosis & phagocytosis or type 2M myofibers	• Acute inflammatory diz - **Steroids**: Immunosuppressive doses of corticosteroid then taper dose . Monitor by ability to open mouth & serial serum CK levels . Long term low-dose alternate day Tx of steroids because tends to return - + Azathioprine (Imuran®) • Chronic fibrotic diz - As for acute (steroids) + - Manually open mouth Prognosis: • **Good**: steroids - rapid clinical remission • Recurrence common • Complete or partial response occurs

DDx:
- Exophthalmosis
  - Retrobulbar abscess
- Jaw drop
  - Trigeminal neuropathy
- Inability to open mouth
  - Temporomandibular joint diz
- Muscle diz
  - Polymyositis
  - Dermatomyositis
  - Infectious myositis

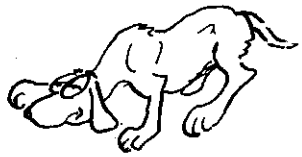


#1 myositis in dogs, Immune?
CS: Masseter swelling, Fever, Atrophy, BAR
Dx: Hx, CS, PE, CK, AST
Tx: Steroids + Imuran •Px: Good

Polymyositis, **Canine idiopathic polymyositis** E-hb 329; SAP 1174; H3B 855; H2B 906; I2M 1061; IM 804; IM-WW 496; NS-W 198; N-K 185; NS3hb 195; NS-HB 193; NS-L 85; NS-O 380; Sx-WW 308 **	• ***Generalized, diffuse inflammatory myopathy*** • Large breed adult dogs - Reported in a few cats • Cause: unknown ?cell mediated immunity?	• **Weakness**, exacerbated by exercise (*fatigues easily*) • Lameness: stiff, stilted gait - Tremors, improved gait w/ rest • Crouched stance • **Painful muscles** • ± Fever • Atrophy • **Lethargy**, depression • Stiffness • Regurgitation (megaesophagus - esophageal dysfunctions) • ± Dysphagia - Salivation - Weak bark (voice change) - Atrophic or swollen muscles of mastication • **Weight loss** (50% of cases) 1° proximal musculature • Sequela: **aspiration pneumonia**	• **Hx, CS (weak, pain, lethargy, wt. loss)** - PE: including cardiovascular system - Neurologic exam: normal proprioception, mental status & cranial nerves • Radiographs: - ± Megaesophagus - Pneumonia • Laboratory: - CBC (complete blood count) & Chem - ↑ CK [creatinine phosphokinase] 2-100 x), ↑ AST • Electromyography: DDx from myasthenia gravis by repetitive stimulation • No response to Tensilon® • Muscular biopsy - definitive - Plasma cell & lymphocyte infiltration w/ muscle necrosis . Check for Toxoplasmosis & *Neospora* • Antinuclear antibody (ANA) assay - Positive ANA w/ an inflammatory myopathy suggests autoimmune disorder • *Toxoplasma* & *Neospora* titers & leptospirosis?	• **Steroids**: Immunosuppressive corticosteroids, reduce to every other day once remission - Attempt complete withdrawal carefully • Refractory cases - Azathioprine & cyclophosphamide • ABs for aspiration pneumonia • Megaesophagus: - Feed in upright position & remain upright for 10 min after feeding Prognosis: • **Good** in absence of aspiration pneumonia

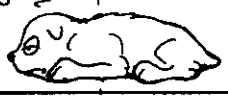


DDx:
- Polymyositis - immune mediated
  - SLE (Systemic lupus)
  - Polyarthritis
  - Polyarteritis
  - Dermatomyositis
- Myasthenia gravis
- Meningitis
- Masticatory myositis
- Polyneuropathy
- Neoplasia
- Toxoplasmosis
- *Neospora caninum*
- Cardiorespiratory problems

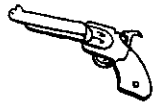


Generalized myositis, Cause: immune?
CS: Weakness, Pain, Lethargy, Weight loss
Dx: Hx, CS, Neuro, Lab, etc.
Tx: Steroids •Px: Good

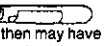
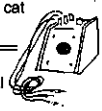
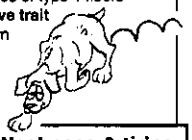
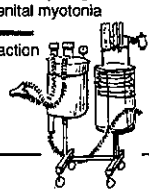
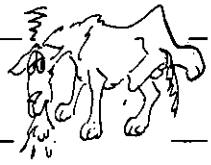
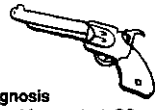
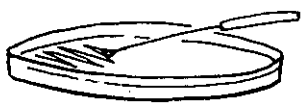
Familial reflex myoclonus of Labs H2B 904 *	• **Described only in labrador retrievers** • Onset 3-6 weeks of age • Intermittent stimulus-sensitive contraction of appendicular muscles • Cause: unknown ? lack of reflex inhibition or exaggerated discharge on stimulation	• **Muscle relaxation at rest** • **Decerebrate rigidity & opisthotonus when handled or auditory stimuli** • Respiratory distress if severe • Muscle firm, not painful • Distortion of facial musculature • No dysphagia	• Hx (**Lab**, young), CS • Physical exam/neuro exam: difficult to perform: generalized **stiffness when handled** • EMG: increased motor unit action potentials, polyphasic MUAPs, multiple motor unit discharges to tactile stimuli, normal NCV • Normal muscle enzymes: CK, Aldolase, AST, LDH • Normal muscle biopsy & histochemical assay	• **No known treatment** • Clonazepam& diazepam little effect • **Euthanasias**: because of severe gait abnormalities **Prognosis: Poor**; usually puppies euthanized



Labs, Opisthotonus when handled
Tx: None, Euthanasias



Hereditary - Muscle

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Canine X-linked muscular dystrophy, Sex linked myopathies, Golden retriever muscular dystrophy * M8k 906; E-hb 331, 413; SAP 1173; I2M 1064; IM 807; H2B 905; C11T 786, 1028, 1042; C9T 792; NS-O 378; NS3hb 197	• **Rare** • Male Golden retrievers, Irish terriers, Samoyeds & 2 male cats • Similar to Duchenne muscular dystrophy (DMD) in humans • Onset dog: 6-8 weeks of age; cat: 12 months old • **Males show CS, females carriers** • Pathophysiology: as in humans, lack duchenne gene transcript & its protein product, dystropin - Disorder of motor unit **Motor unit** **CS: Difficult swallowing** **Tx: No Tx**	**CS dog** • **Difficult swallowing** (1st sign) dysphagia • Stiff gait, cervical rigidity • Stunting • Weakness • Muscular atrophy of most muscles • Hypertrophy hamstrings & tongue • Lumbar kyphosis (hunchback) **CS cat** • Cervical rigidity • Adduction of hocks • Symmetrical enlargement of muscles • Lumbar kyphosis • Peculiar hunched gait • Reduced cardiac contractility & biventricular enlargement	• **Hx** (male, breed), CS • Neuro exam: normal initially, then may have proprioceptive deficits & hyporeflexia • ↑ **CK** (serum creatine phosphokinase) > 10,000 units/l (normal <100 units /l) • **Muscle biopsy** - definitive: fiber necrosis & regeneration, fiber hypertrophy, muscle loss & fibrosis, myofiber mineralization in both skeletal & cardiac muscles • EMG: bizarre high-frequency discharges, diffuse continuous discharge, NCV normal • ECG: arrhythmias  **DDx** • Congenital myotonia (myotonic dimple) • Hypokalemic myopathy - cat • Inflammatory myositis 	• **None available** • **Selective breeding** Prognosis: • **Poor**: diz progressive
Hereditary myopathy of labrador retrievers * M8k 906; E-hb 331; SAP 1174; H2B 903; I2M 1064; IM 807; 5min 860; C10T 820; NS-W 198; NS3hb 197; NS-HB 256; NS-O 378	• **Extremely rare** • Onset : < 5 months old, labrador • Deficiency of **type 2** (fast-twitch/white) muscle fibers & predominance of type 1 fibers • **Autosomal recessive trait** • Mechanism: unknown  **Rare, < 5 mo., Labs; Weakness & tiring** **Tx: None, valium •Px: Good**	• **Progressive muscle weakness w/ exercise intolerance** • Abnormal gait & posture - Initially: inability to hold up head - W/ exercise whole body muscular weakness - With continued exercise: legs stiffen & extend, short, choppy gait, **bunny hopping** (rear limbs) . ± Front limb collapse & continued rear limb hopping - sideways gait - **Signs abate w/ rest recur w/ exercise** - Cold weather aggravates signs - Stunted growth	• Hx (**Labrador**), CS • Creatinuria up to 30 x normal (normal 3 mg/ml) • CK less than normal (normal 45-125 IU/dl) • Muscle biopsy: deficiency of type 2 fibers • EMG: ± myotonic discharges - No decremental response (unlike MG) **DDx:** • Myasthenia gravis (older, decremental) • Nutritional myodegeneration • Congenital myotonia 	• **No known treatment** • **Diazepam** oral may help **Valium** Prognosis: • **Good: stabilizes w/ maturity** • Mildly progressive until maturity • Often stabilize at maturity • Dogs w/ MFD can have a normal life span
Malignant hyperthermia * H3B 853; SAP 1174; NS-W 201, NS3hb 200; NS-HB 195; NS-O 382;	• **Rare** in dog, cat & foal, most common in **pig**: Hypermetabolic disorder of skeletal muscles in reaction to anesthetic agents (halothane, quaternary amine muscle relaxant) • Dogs & 1 cat • An exercise related hyperthermia described in an English springer spaniel  			
Leptospira myelitis * NS-L 84	• **See Urinary pg 351& Systemic pg 695** • *Leptospira icterohemorrhagiae*, **Acute renal failure** • CS: **Icterus** 70% of cases, renal failure, fever, lethargy, anorexia, **stiff gait** w/ severe muscle or lumbar pain • Dx: Hx, CS; ± elevated muscle enzyme Ck, muscle biopsy, usually can't culture organism; mononuclear cell infiltrate w/ hemorrhage & necrosis • Tx: **Procaine penicillin** DOC, Dehydrostreptomycin for carrier state, Treat renal failure &r DIC			
Myotonia, *Hereditary myotonia, Myotonia congenita* M8k 905; E-hb 331; SAP 1174; I2M 1064; IM 807; H2B 904; 5min 861; NS3hb 262, 259; NS-W 199; NS-L 87; NS-O 377 * 	• ***Rare disorder of muscles*** • ***Tonic spasm of muscles*** (continued active contraction after voluntary effort stopped & delayed relaxation of muscle) • Breeds: **Chows**, Staffordshire bull terriers, Labs, West Highland white terrier, Samoyed • Autosomal recessive in chow • Pathophysiology: hyperexcitable muscle membrane • Onset: 2-6 months when first walking **Chows, "Bunny hopping", Euthanize**	• **Generalized muscle stiffness**, stiffness on rising & walking especially after rest • Abnormal gait - Abduction of forelimbs - **Stiff gait, "bunny hopping"** - Arched back - Lessens w/ exercise - Cold weather & excitement exacerbate • Muscle hypertrophy: all skeletal muscles, esp. proximal appendicular, tongue & anal sphincter • Normal resting muscle tone • Dysphagia (difficulty swallowing)	• **Hx (breed)**, CS • Physical exam • Neuro: normal proprioception & mentation • Lab: - ± **CK & AST elevated** (muscle necrosis) • EMG: Continuous insertional activity; ± bizarre high-frequency discharges - wax & wane (dive bomber) - confirm Dx • **Myotonic dimple**: local percussion or manual indentation results in furrow that persists for 30-40 seconds • Muscle biopsy: rarely diagnostic alone	• **Euthanized** - most because of severity • Membrane stabilizing enzymes may help - procainamide, diphenylhydantoin, quinidine & phenytoin • **Avoid extended exercise**  **Prognosis** • **Good** for survival, CS usually stabilize???? • Poor: most euthanized??? 2 different stories!
Infectious myositis, Local wound myositis H3B 849; H2B 910 *** 	• Infection of bite wounds, contaminated surgical wounds • Causes: - Leptospira icterohemorrhagiae, Neospora caninum dogs, Toxoplasma gondii in dogs & cats - generalized myositis - Local wound myositis: Corynebacterium, Streptococcus, Mycobacterium & Clostridium spp - Salmonella typhimurium - muscle abscesses by septicemia - Parasites: Cysticercus, sarcosporidia, Trichinella	• **Inflamed wound** **Wounds** **CS: Inflamed wound** **Hx (bite, Sx), CS, C&S** **Tx: ABs**	• Hx (**bite, Sx**), CS • Culture & sensitivity (C&S) 	• **Antibiotics** (C&S)
Polymyositis, Feline idiopathic polymyositis, **Hypokalemic polymyopathy** * M8k 905; E-hb 331; I2M 1061, 1063; IM 804; H3B 851; H2B 909; 5min 856; Cat 1574; NS-W 200, 229; NS3hb 200; NS-hb 196; NS-L 86; NS-O 382	• **See Circ pg 239 - Generalized, diffuse inflammatory myopathy** • **Polymyositis**: reported in a **few cats** (1-13 years old) • **Hypokalemic**: dogs & cats of all breeds - Young Amer. pit bull - Chronic renal failure & those consuming acidifying diets, PU/PD 2° to hyperthyroidism & anorexic cats at more risk • Cause: unknown, viral? - Immunological ? response to steroids? - Not clear if 2 syndromes or just one? Both show same signs & are treated the same • Clinical features **mimic mild thiamine deficiency**, so Tx w/ thiamine **Polymyositis, Hypokalemic, Mimic thiamine deficiency** **CS: Weakness, Flexed neck** **Dx: Hx, CS, PE, Lab** **Tx: Thiamine, Potassium POm • Px: Good**	• Sudden muscular **weakness** **- Pronounced ventral flexion of neck** - Scapular protrusion (weakness) - Exertional weakness, reluctance to walk - Inability to jump • Stilted, stiff front limb gait w/ adduction of legs when walking • ± Muscle pain, Muscle atrophy • Anorexia, weight loss, ungroomed hair coat • Sequela: Respiratory paralyses **DDx:** • Hypokalemic polymyopathy • Myasthenia gravis • Bilateral vestibular diz • Thiamine deficiencies • Inflammatory myopathies • Thyrotoxicosis	• Hx, CS • Physical/neuro exam **- Thoracic limbs weaker than P limbs** • Laboratory: CBC (complete blood count) & Chem - ↑ CK/CPK (creatinine phosphokinase, 250-10,000 IU/dl normal 26-145 IU/dl) & ↑ AST & aldolase (normal 5-17 IU/dl), LDH - **Hypokalemia** (serum potassium) <3.5 mEq/l **. 70% of polymyositis cats & all of hypokalemic ones** Electromyography: multifocal abnormalities, bizarre high frequency waves, positive waves • Muscular biopsy - definitive - Polymyositis: lymphocyte inflammation & fibrosis, muscle necrosis - Hypokalemic polymyopathy: no histological lesions	• **Thiamine** • **Correct hypokalemia**: potassium gluconate elixir PO; parenteral potassium for severe weakness • **Dopamine** infusion IV in life threatening collapse • Spontaneous remission common - 30% of cases • Steroid • Monitor potassium periodically **Potassium gluconate elixir** Prognosis: • Good if remission • Recurrence common

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Familial canine dermatomyositis * M8k 906; E-hb 329, 3; SAP 1173; I2M 1062; IM 805; IM-WW 497; 5min 856; NS3hb 196; NS-HB 194; Sx-WW 308	• **Rare** diz? dermatitis & myositis • **Young collies**, Shetland sheepdogs • Cause: unknown? immunologic? **DDx:** • Nutritional myodegeneration • Cerebellar dysmyelinogenesis **?, Collies** **CS/Dx: Dermatitis ± Muscle diz.** **Tx: ± Steroids**	• **Severe dermatitis** of face, ears, distal extremities over bony prominences, tail tip - Erythema, ulcers, crusts, scales, alopecia - Mild pruritus - First 3 months of life, fluctuates often, may improve or resolve w/ time • ± **Muscle diz** - Generalized muscle atrophy - ↓ jaw tone, dysphagia - Weakness, Stiff galt - , regurgitation, megaesophagus - Masticatory muscles & muscles distal to elbow & stifle	• **Hx (breed)**, CS • EMG: spontaneous myofiber discharges, fibrillation potentials, positive sharp waves, bizarre high-frequency discharges; Nerve conduction normal • Muscle biopsy: myofiber necrosis w/ mononuclear cell infiltrates, atrophy, regeneration & fibrosis • Skin biopsy/histo: hydropic degeneration of basal cells & separation of dermaepidermal junction, ± perivascular mononuclear infiltrate	• **Do not breed** • **Variable response to steroids** **?Steroids?** Prognosis:?????
Protozoal (Toxoplasma, Neospora) myositis * E-hb 192; H2B 910; IM 806; SAP 1175; NS-HB 192; NS-L 84; NS-O 383	• **Rare** • *Toxoplasma gondii* in dogs & cats, protozoa • **Generalized myositis** • Most common in **puppies** w/ or w/o meningitis or myelitis • Associated w/ immunosuppression in older dogs - Concurrent canine distemper infection - Exogenous steroids, chemotherapeutic agents	• **Progressive painful, swollen weakness** • Atrophy of muscles • ± Progressive rear limb weakness & rigid hyperextension in young • ± Rapidly progressive flaccid paralysis w/ hyporeflexia (LMN) - adults • ± CNS: seizures, stupor, coma, optic neuritis & ocular changes	• Hx, CS; Lab: ↑ CK & AST & liver enzymes - alanine aminotransferase • EMG: spontaneous activity • ± Toxoplasma titers • **Muscle biopsy - definitive** - Cystic lesions of tachyzoites - Necrosis w/ mixed inflammatory infiltrate • CSF: mixed pleocytosis, high protein content	• **Clindamycin** • **Sulfasalazine & pyrimethamine** **Clindamycin** **Prognosis: ???**
Generalized myositis •Tx: Clindamycin	**Incidental parasitic myositis** SAP 1175; IM 806; H2B 910	• Hepatozoon canis, Trichinella spiralis, Sarcocystis, Hammondia, Cysticercus: elicit minimum inflammation; Incidental biopsy finding		
Toxic or drug induced myositis SAP 1175	**Neurotoxins may cause neuromuscular blockade** • Tick paralysis pg 567: Dermacentor & Ixodes ticks secrete neurotoxins inhibiting release of acetylcholine (ACh) • Botulinum pg 569: Clostridium botulinum has a similar mechanism to tick paralysis • Organophosphate insecticides pg 576: have anticholinesterases that bind acetylcholinesterase (AChE) resulting in continuous ACh stimulation - "myasthenia-like" syndrome • Drugs (aminoglycosides, antibiotics, antiarrhythmic agents, phenothiazines, methoxyflurane & magnesium) can reduce safety margin of neuromuscular transmission. • Polymyositis may occur as part of a generalized allergic reaction in dobies to trimethoprim-sulfadiazine			
Gangrene, Myonecrosis Pa-S 26, E-hb 329?	• **Necrotic tissue** invaded by air-born saprophytic & usually putrefactive bacteria (gas bubbles if bacterial form gas) - **Moist gangrene**: swollen, soft, pulpy & usually dark in color, ± putrefactive odor (common) - **Dry gangrene** shrivelled & leather-like usually of light color; Line of demarcation: separation of gangrene from adjoining tissue: swollen, reddish or bluish zone of hyperemia & inflammation - **Sapremia**: condition where saprophytic bacteria, that usually live only in dead organic matter, can survive in blood • Causes: necrosis & exposure to air born bacteria • Tx: Stop spread of necrosis, Amputating if sapremia eminent			

Muscle injuries

Muscle injuries in dogs. RB Fitch. Cont. Ed 19(8)1997 pg 947; E-hb 331; H3B 849, 857; H2B 910; Cat 1575; NS-O 384; Sx-S-hb 643; Sx-S 1996; Sx-WW 308

• ***Muscle injuries*** *most common sports injuries in humans.*
- **Dx**: *PE* (palpation, flexion & extension of joints, compare to opposite side if unilateral), Rads to rule out bone disorders
- **DDx**: myopathies

- **Strain**: very common, tearing to complete rupture, most commonly to musculotendinous junction
. Tx: Ice packs 1st 24 hours; Warm compresses after 24 hours, compressive wraps, antiinflammatories, pain killers, muscle relaxants, rest, controlled exercise, physical therapy
. Surgery if rupture or laceration: **near-far-far-near suture pastern**

***

- **Fibrotic myopathy, contracture**: 2° to injury, shortening due to scaring, horses & German shepherd dogs
. CS: **Gait abnormalities: Infraspinatus** (atrophy of muscle, outward rotation, elbow adduction, abduction of forepaw w/ carpal "flip"), **quadriceps** (from femoral fx, markrd extension of stifle), **gracilis rupture** (jerky gait - shortened stride w/ external rotation of tarsus, medial rotation of foot & internal rotation of stifle); **semitendinosus ribriotic myopathy** (rotation - hock out, stifle in; backward slap of paw at end of stride)
. Tx: Time, ± surgical free up muscle & relieving adhesions may help. Quadriceps: maintain flexion of stifle w/ 90-90 flexion splint
. Px: animal usually does fine ± gait abnormalities, recurrence after surgery common

- **Myositis ossificans**: rare, CS: gait abnormalities; Dx: palpation, radiographs, biopsy, ± ↑ CK
. Dogs: cause: ? - 2° to trauma; Tx: surgical removal if affect on gait unacceptable
. Young cats: progressive diz (cartilage & bone formation in skeletal muscles), Cause: unknown (?)
- Tx: No known treatment in cats, progresses to immobility

• **Compartment syndrome**: common in humans, few reported in dogs (rare)

Exertional myopathy, Exertional rhabdomyolitis H3B 854; H3B 908; NS-W 201; NS-HB 195, 252; NS3hb 264; NS-L 88; NS-O 381 *	• **Poorly defined muscle diz in greyhounds** • Resembles exertional rhabdomyolysis (tying-up, Monday morning diz) in **horses** • Cause: associated with **poor conditioning & heavy exercise w/o "warm-up" period** - Hot humid conditions contribute • Pathophysiology: extreme exercise causes muscle ischemia & cramping & myoglobin release. Self-limiting or fulminating **Monday morning diz in greyhounds** **Tx: Baths, Rest & massage**	• **Stiffness, hyperextension of limbs** - Worse in rear limbs • Painful firm muscles • Polypnea, cyanosis, fever • May recover in 30 min w/ rest • **Fulminating course** - Collapse - Severe hemoglobinemia, myoglobinuria, acute renal failure - Muscle atrophy	• Hx (**greyhound racer**), CS • Lab: - Hemoglobinemia - Myoglobinuria - ↑ Potassium & phosphorus - ↑ Muscle enzymes **DDx:** • Status epilepticus w/ rhabdomyolysis • Heat prostration/ malignant edema	• **Tepid water baths** • Localized signs - Rest & massage • Acute fulminating course - **emergency** - IV fluid, Steroids, ± Sodium bicarbonate - Diazepam (Valium®) muscle relaxant **Prognosis: Good** if mild • Fulminating: guarded, failure to arrest results in death

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DJD - Septic Arthritis

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Degenerative joint diz, DJD, Arthritis, Osteoarthritis, Osteoarthrosis, Osteoarthropathy

SAP 1101; H3B 819; H2B 869; I2M 1076; E-hb 74t, 738; 5min 364; IM-WW 439, 441; C12T 1196; Sx-WW 238; Sx-S-hb 618; Sx-S 1921; Sx-OP 176; Sx-OD 27; X-T 171; Pa-T 455, 453;

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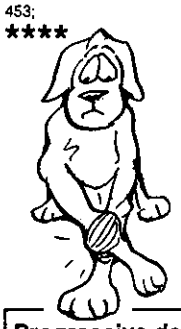
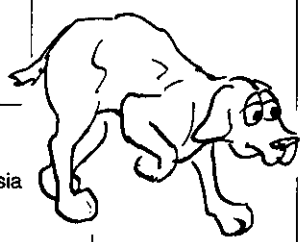


- **Progressive deterioration of articular cartilage**
  - W/ variable degrees of periarticular remodeling
  - **Synovitis first** which results in progressive degradation of cartilage
- **#1 joint disorder in dogs**, rare in cats
- Common joints
  - Hip (dysplasia)
  - Elbow joint
  - Stifle joint
  - Shoulder joint

DJD: Cause - multifactorial
- Trauma
  - Joint instability (hip dysplasia
  - Fxs, articular step defects
  - Luxations
- Malarticulations
- Synovitis (early DJD)
- Infection - septic arthritis
- Prolonged immobilization
- Old age "wear & tear" (rare - dogs & cats)
- Osteochondrosis

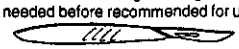
- **Lameness**
  - Episodic
  - May warm out of lameness w/ light exercise
  - Strenuous exercise ↑ severity
- **Stiffness**, made worse by inactivity (sleeping or cage confinement)
- **Pain**
- Heat
- **± Joint effusion**
- **Slow progressive Hx**



- **Hx, CS, PE**
- **Manipulation of joint**
  - **Pain**
  - **↓ Range of motion (ROM)**
  - ± Obvious swelling
  - Crepitus (grinding sensation)
- **Radiology:**
  - Fxs, OCD or cysts
  - Acute DJD & septic arthritis no findings - joint effusion
  - **Marginal osteophyte** formation hallmark, new bone at joint capsule attachment
  - **Subchondral bone sclerosis** or irregularity
  - **Narrowing of joint space**
- **Synovial fluid:**
  - ↑ Volume (10-20 x)
  - Slight ↑ proteins
  - Cells < 3000/µl, rarely above 500
    - 70-80% lymphocytes, 5% PMNs
  - ↓ Viscosity (hyaluronic acid - diluted w/ trauma)
- **Postmortem:**
  - **Cartilage** loses luster - yellow & soft
    - Fibrillation (blistering), Thinning, Micro fxs, Erosions
    - Cartilage fragments (detritus) into synovial fluid
  - Synovia (inflamed): thickened, red or yellow tinged

- **DJD w/ radiographic changes: incurable**, irreversible changes
- Goal: reduce pain, slow degeneration, help function
- **Tx 1° cause**: instability, Fxs, OCD
- **NSAIDs**
  - **Buffered aspirin**: analgesia & antiinflammatory
    - **Cat: use w/ caution**
  - **PBZ** (phenylbutazone) (has side effects)
    - **NOT FOR USE IN CATS!**

- **Steroids**: serious side effects, last resort for pain
- DMSO (dimethyl sulfoxide): to reduce discomfort
- Orgotein (Palosein®): to reduce discomfort
- Adequan® (polysulfated glycosaminoglycans, GAGS). binds to cartilage matrix in areas of cartilage damage
  - Shows promise, trials needed before recommended for use
- **Surgery:**



  - Resection arthroplasty (removal of joint)
    - Excision of femoral head in hip dysplasia
  - Artificial joint (hip)
  - Arthrodesis (surgical fusion of joint)
    - Eliminates discomfort, but compromises function
      - Below elbow & stifle acceptable function
      - Above these levels - significant gait abnormality
- **Supportive care**
  - Weight reduction
  - Moderate & consistent exercise
    - Swimming (nonweight bearing)

Prevention:
- Early diagnosis & treatment
- Adequan® may allow healing of cartilage

Prognosis: **Good** before rad signs
- **Guarded** to poor once rad signs

Progressive deterioration of cartilage
CS: Lameness, Pain, Stiffness, Effusion
Dx: ROM, Rads, Synovial fluid
Tx: Control w/ meds or arthrodesis
Px: Before rad signs - Good; After - Guarded to Poor

DDx:
- Trauma
- Septic arthritis
- Immune-mediated joint diz
- Neoplasia

Septic arthritis, Infectious arthritis, Bacterial arthritis

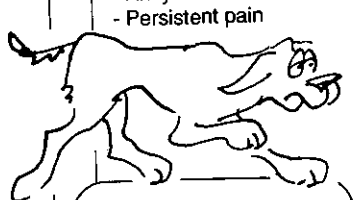
HB3 820; H2B 870; E-hb 739; 5min 366; I2M 1078; IM-WW 444; C12T 1177; E 2362, Cat 608; Sx-S-hb 565; Sx-S 1690; Sx-WW 242; Sx-OP 188; Sx-OD 29; X-T 178

**

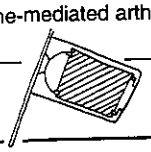
- ***Infection in a joint(s)*** *w/ bacteria, virus &/or fungus*
- **Cartilage damage**
- Pathophysiology:
  - **Rapid cartilage damage** due to release of enzymes, hi WBCs, fibrin & bacteria
    - Invasion of bacteria - inflammation
    - PMNs & fibrin, enzymes & proteinaceous debris
    - Pannus (granulation tissue overgrowth of cartilage surface)
    - Loss of GAGs (protects cartilage)

Cause - Septic arthritis
- **Trauma: Penetrating wound - bite**
- **Extension** from adjacent tissue, especially fungal (uncommon)
- Rickettsial or mycoplasmal infections
  - Rocky mountain spotted fever
  - Ehrlichiosis
- Viral diz rare
- **Lyme diz** (borreliosis)
- **Hematogenous**
  - Umbilical infection
  - Pneumonia
  - Urinary tract infection
  - Endocarditis
  - Dermatitis
  - Otitis externa
  - Periodontal diz
  - Prostatitis
  - Discospondylitis
- **Iatrogenic**
  - Joint injection (steroids)
  - Joint Sx (20%)

- **Shifting lameness, 1 or more joints**
  - Especially carpus & tarsus
- **Joint effusion**
- **Heat**
- **Periarticular swelling** cellulitis (edema to fibrosis)
- **Systemic signs:** fever, depression, anorexia, lymphadenopathy
- Progresses rapidly
- ± Open drainage
  - If draining, often not sore (pressure of distension causes pain)
- **Complications:**
  - Recurrence
  - DJD
  - Ankylosis
  - Persistent pain



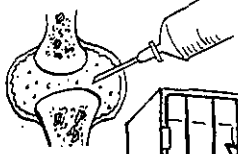
DDx:
- Acute trauma
- DJD
- OCD
- Immune-mediated arthritis



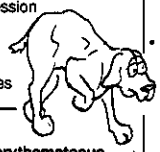
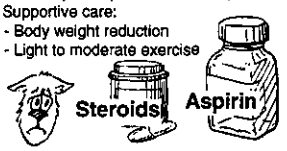
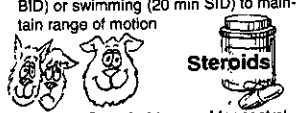
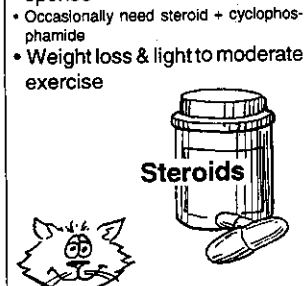
Joint infection
CS: Heat, Swelling, Fever, DJD
Dx: CS, Synovial fluid
Tx: ABs, Drainage, Rest, NSAIDs

- **Dx by CS & synovial fluid**
- **Exam walking (3-legged lame)**
  - **ROM exam** (range of motion) - severely painful
- **Synovial fluid collection before ABs!**
  - **C&S** (culture & sensitivity) (aerobic & anaerobic)
    - ± Culture blood, urine or synovial membrane biopsy
  - **Gram stain**
    - **WBCs** 40,000-280,000/µL (mm^3)
    - PMNs > 90% suggestive
    - Total Protein ≥ 4 g/dl
    - Low viscosity, turbidity, increased total volume, often bloody
    - ± Bacterial or fungi (-) doesn't rule out
  - **Positive bacterial culture** diagnostic
- Lab: ↓ PCV & ↑ WBCs, PMNs & TP
- **Radiology** essential for base line
  - Early:
    - No bony changes
    - Soft tissue swelling & widening of joint space (variable)
  - **Definitive radiographic Dx after irreversible damage**
    - Periosteal proliferation
    - Widening of joint space (weight bearing or stress rads) (cartilage damage)
    - Irregular subchondral bone or loss w/ signs of osteomyelitis
    - Cystic subchondral radiolucencies w/ sclerosis around (**moth-eaten**)
    - Synovial membrane biopsy: C&S, histo
- Search for septic site
  - Rads of thorax, abdomen, spine
  - Ultrasound (US) heart

- **1. Sterile synovial fluid collection 1st**
- **2. ABs** 4-6 wk minimum, 2 wk past resolution
  - **Start on broad spectrum ABs IV**
  - Change if C&S dictates
- **3. Drainage mandatory** if severe
  - **Open drainage - arthrotomy, debride & lavage**: if fibrin occludes needles
    - Synovectomy (culture)
    - Sterile bandages
    - Leave open: "ingress-egress" drainage catheter **most effective**
  - Needle distention-irrigation: alternate infusion & aspiration through needle or catheter: **least effective**
- **Rest cartilage**
  - Passive exercise (15 min BID) or swimming (20 min SID) 10-14 days
    - Maintains good range of motion
  - Leash walk for 3-4 months for cartilage to strengthen
- **NSAIDs** for pain (buffered aspirin, PBZ)
- Corticosteroids contraindicated if infection
- **Surgery for chronic case**
  - Arthrodesis, excision arthroplasty, or amputation if joint destroyed & source of uncontrollable pain



Prognosis: **Guarded to good**
- Good for survival
- Function: depends on severity of damage to articular cartilage

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Erosive polyarthritis, Rheumatoid arthritis, Erosive immune-mediated joint diz HB3 822; H2B 872; SAP 1104; I2M 1085; IM-WW 446; 5min 960; C12T 1188; E 2313; T 130; E-hb 741; Sx-WW 240; Sx-OP 189; Sx-OL 230 *	• Crippling, progressive **EROSIVE** polyarthritis • **Rare** in dog > cat - Adult small or toy breeds (average 5-6 yrs old) • **Peripheral joints most affected** • Cause: **immune mediated** • Pathophysiology: - Host immune complexes formed w/ IgG, IgM & IgA **autoantibodies** (rheumatoid factors) - = joint inflammation & enzymatic activity + - **+ Trauma = cartilage & subchondral bone destruction** - Periarticular structures break down = luxation or subluxation **Immune-mediated + Trauma = Damage** **Lameness, Subchondral destruction** **Tx: Aspirin, Steroid, Immune Rx**	• **Lameness** (shifting leg) • Morning stiffness • Pain in 1 or more joints • Joint swelling (soft tissue or fluid) • Symmetric onset of joint symptoms • Fever, anorexia & depression • Sequela: - Luxation/subluxation - Angular limb deformities  **DDx:** • **Systemic lupus erythematosus** (test for antinuclear antibody) • Other infectious arthritides • DJD • Traumatic arthritis • Septic arthritis • Idiopathic arthritis in Greyhounds • Juvenile polyarthritis in Akitas • Trimethoprim sulfas in Rottweilers & Dobies	• **Hx, CS** • **Positive rheumatoid test** • **Joint fluid analysis** - inflammation, but doesn't R/O infection - Poor mucin clot - WBCs ↑ (3-30,000/µl) - Nonregenerative PMNs 20-95% • Synovial biopsy: - Convoluted villous folds - Thickened synovial lining - Necrotic foci - Plasma cell & lymphocyte infiltrate • **Radiology** - erosive - Synovial effusion - **Subchondral bone destruction**/cyst formation: "punched out" appearance - Pericondylar osteolysis & erosion - Narrowing of joint space - "Mushrooming" of ends or metacarpi & metatarsi (collapse of subchondral bone) - Joint luxation	• **Aspirin** (pain) • **Steroid** (prednisone), given indefinitely • **Cytotoxic drugs:** - **Cyclophosphamide**: urinalysis, stop if hemorrhagic cystitis - **Azathioprine** (Imuran®) or 6 mercaptopurine (Purinethol®) - **Gold salts** for persistent inflammation, Aurothioglucose - Stopped 1 month after normal joint tap - Weekly CBCs - stop if WBCs < 4000/µl • Periodic joint taps to monitor response • Supportive care: - Body weight reduction - Light to moderate exercise  Prognosis: **Poor**: considered incurable & relatively unresponsive to Tx; some m/ respond temporarily, most don't
Feline chronic progressive polyarthritis; Periosteal proliferative form, Reiter's diz H2B 873; I2M 1087; E-hb 741; 5min 960, IM-WW 447; E 2368; X-T 180 *	• **Young male castrated cats**, 1.5-5 yrs-old • Cause: unknown thought to be immunological linked to FeLV & FeSFV (feline syncytium forming virus) • 2 syndromes - **Periosteal proliferative form** (most common) in younger cats - Erosive form in older cats **Male cats, ? FeLV** **CS: Swollen joints** **Dx: Hx, CS, Arthrocentesis, Rads** **Tx: Aspirin, Steroid, Immune Rx**	• Fever for few weeks • Malaise • Lameness • Generalized stiffness • **Periarticular soft tissue swelling** - **Carpus & tarsus** most commonly affected • Regional lymphadenopathy • Weight loss • Ankylosis in 2-8 weeks **DDx** • Hypertrophic osteopathy • Degenerative joint diz • Septic arthritis • traumatic arthritis • Rheumatoid arthritis • Nonerosive arthritis	• **Hx, CS** • **Arthrocentesis** - WBC 4-70,000/µl w/ 25-99% nondegenerative PMNs - Fluid cloudy & yellow tinged • **Radiology** - Periarticular soft tissue swelling - **Periosteal new bone** - Osteophyte bridging of joints - Coarsening of trabecular pattern - Narrowed joint spaces (lysis) • **Immunologic tests: negative** - Rheumatoid factor test negative - ANA test negative • Laboratory: - Leukocytosis (PMNs) - ↑ Fibrinogen (slightly to moderately) - FeLV positive (50-70%)	• **Tx as for rheumatoid arthritis** • **Aspirin** (pain) • **Steroid** (prednisolone or prednisolone) given indefinitely • **Cytotoxic drugs:** - Cyclophosphamide: urinalysis stop if hemorrhagic cystitis - Azathioprine (Imuran®) or 6 mercaptopurine (Purinethol®) - Cytotoxic drugs stopped 1 month after normal joint tap - Weekly CBCs - stop if WBCs <4000 /µl - Not Gold salts in cats: toxic • Periodic joint taps to monitor response • Monitor for clinical manifestation of FeLV • **Euthanize** when poor quality of life Prognosis: **Guarded to poor** (progressive)
Systemic lupus erythematosus, SLE arthropathy H2B 839, 874; 5min 782, 102; I2M 1083; IM-WW 445; Cat 618; C12T 1188; E-hb 741; Sx-WW 240; Sx-OP 192 *	• ***Rarely recognized in dogs or cats*** • ***Immune complex deposition in many organs - Multisystem diz*** • Nonerosive autoimmune arthritis • Cause (etiology): unknown - Almost any foreign substance can lead to immune complex diz . Chronic infections (viral, bacterial, rickettsial & protozoal, parasites [heartworm]) chemical, neoplasia • Pathophysiology: - Immune complexes in synovial membrane (carpus & tarsus especially), activated compliment - vasoactive products & enzymes - **Type 3 hypersensitivity** (IgG & IgM) - Results in inflammation, edema & tissue damage (necrosis of synovial membrane) **Immune complexes - Multisystem diz** **CS: Major & minor CS** **Dx: + ANA titer + 2 Major & 2 Minor signs** **Tx: Remove agent, Tx diz, Steroid, Rest**	• **Waxing & waning course** often - Vary depending on site of immune complex deposition • **Major signs** - **Polyarthritis** 70-90% (usually **nonerosive**) SLE arthropathy . Shifting leg lameness . ± Swollen, painful, warm joint . Carpus, tarsus, metatarsus, stifle, elbow - Glomerulonephritis - Dermatitis - Coombs-positive anemia - Thrombocytopenia, leukopenia • **Minor signs**: fever, pleuritis, peripheral & central neuropathy, myocarditis, pericarditis, myositis (muscle weakness) - Other signs: leukocytosis, lymphadenopathy, hepatosplenomegaly, lethargy, anorexia **DDx**: Extremely long list for SLE, another "**great imitator**"!	• **Definitive diagnosis** of SLE - **Positive ANA titer + 2 major & 2 minor signs** • **SLE arthropathy** - **Hx, CS** - **Arthrocentesis** . **Leukocyte infiltrate 6-370,000 /µl** .. **15-95% PMNs** . Rare LE cells - **Radiology**: usually periarticular swelling only abnormality - **Synovial biopsy**: thickened synovium, infiltrate inflammatory cells, fibrin covering synovial membrane • **Attempt to define underlying dizs** (infections, neoplasia, drug administration) • Autoantibody tests - **ANA** (antinuclear antibody) **test**: not specific for SLE - LE cell test less sensitive than ANA - RF (rheumatoid factor test) - Direct immunofluorescence	• **Remove causative agent** • **Treat any underlying disorders** • **Steroid: prednisone:** start with high dose for 2 weeks then reduce dose over time & if clinical improvement attempt to discontinue - If relapse repeat & maintain, but leave on prednisolone indefinitely - If 3rd relapse or other organs involved combine prednisolone w/ cytotoxic drug . Azathioprine (Imuran®) . Cyclophosphamide (Cytoxan®) . Cyclosporine (Sandimmune®) • **Rest**: to prevent trauma to weakened cartilage • Passive joint flexion/extension (15 min BID) or swimming (20 min SID) to maintain range of motion  Prognosis: **Guarded to good** for control
Idiopathic polyarthritis, **Nonerrosive polyarthritis** E-hb 742; SAP 1104; HB3 833; H2B 840t; 5min 962; IM-WW 445; C12T 1188 **	• **Uncommon** • **Idiopathic immune mediated, nonerosive polyarthritis** • Cause: inflammatory arthropathy that can't be classified - M/b early form of rheumatoid arthritis - Infection remote to joint: respiratory, ocular, urinary, uterine & skin: causes immune complexes to form - GI tract infections - Neoplasia remote from the joint • **Dogs**: most common form of polyarthritis, peak 2.5-5 years, cats **Immune, Nonerosive - #1 Polyarthritis** **CS: Cyclic fever, Lameness** **Dx: Hx, CS, Synovial fluid, Rads** **Tx: Steroids • Px: Good**	• **Cyclic fever**, dullness & loss of appetite • Stiffness • **Lameness**, swollen painful joints • "Walking on eggshells": short strides • Usually multiple joints (particularly small distal joints) • 30% have some skin di **DDx:** • SLE • DJD • Infection arthritis • Rheumatoid arthritis	• **Hx (history), CS** • Synovial fluid: thin, ↑ **WBC** (4,000-100,000) w/ predominantly nondegenerative PMNs (>80%) • Radiographs: ± joint periarticular swellings, destruction rarely seen • R/O SLE or infectious causes • Look for underlying immune mediated diz • ANA & rheumatoid factor negative	• **Steroids**: immunosuppressive dose (remission in 50% of cases) • Steroid + Azathioprine if persists or poor response • Monitor synovial fluid for response • Occasionally need steroid + cyclophosphamide • Weight loss & light to moderate exercise  Prognosis: **Good** in most cases

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Lyme diz, Borrelliosis SAP 1108; HB3 821; H2B 1209; I2M 1016; IM 823, 93, 818; 5min 784; IM-WW 443; C12T 303; C11T 249, 256; E-HB 740, 182; Sx-WW 242; Sx-OP 192 **	• **Borrelia burgdorfei**: spirochete • **Tick** borne (especially Ixodes dammini) & possibly other biting insects - Tick as small as a period (.) • **Geographic**: incidence depends on location, reported in N Eng, Wis, Min, Tx & Cal • Dogs, humans, horses, cows, poorly documented in cats - Human awareness = over diagnosed diz in dogs, • Multisystem diz - Arthritis - Lymphadenopathy - Cardiac abnormalities - Inflammatory joint diz - Glomerulonephritis/renal tubular blockage	• **Asymptomatic** (up to 80% in some areas) • Multisystems - **Lameness** . Recurrent, intermittent nonerosive polyarthritis #1 - **Fever** - **Lymphadenopathy** - Anorexia • ± **Cyclic**: resolve & recur periodically • Sequela: - Chronic diz if not treated promptly . Recurrent polyarthritis . Kidney diz CS . Cardiac abnormalities	• **Hx, CS, S. fluid & Tx** • **Hx: exposure in endemic area** • **Synovial fluid analysis** - ↑ Cell count 46,000 - Most nondegenerate PMNs (85%) • **Cultures usually unsuccessful** • Serology not definitive, paired titers - IFA (indirect fluorescent antibodies) for antibodies - ELISA: mores sensitive & specific ≥ 1:150 indicates exposure not diz • Response to Tx	• **ABs (TOC)** minimum of 3-4 weeks - Tetracycline, doxycycline, minocycline, amoxicillin, ampicillin, cephalosporins - Result in rapid clinical improvement • Refractory chronic cases - Doxycycline, penicillin or parenteral cefotaxime Na Prevention • Reduce tick exposure - Ascaricide sprays & daily tick removal . Tick need to feed for 24 hours for infection - Vaccine - efficacy not proven, but affects serologic interpretation Prognosis: **Good** for symptomatic cases treated aggressively
Tick, Multisystems, Geographic **CS: Asymptomatic, Multisystems (lameness, fever, lymphadenopathy)** **Dx: Hx, CS, Synovial fluid & Tx** **Tx: ABs (Tetracycline) • Px: Good**				
Synovial cell sarcoma, Synovioma HB3 824; H2B 875; E-hb 737; 5min 1091; E 2052; SAP 201; Cat 1619; Sx-WW 241; Sx-OP 187; X4T 183 *	• #1 primary joint tumor • Tumor of synovial cells • **Rare**: dog, 6-8 yr-old (2-14); extremely rare: cat • Usually involves a major joint: stifle or elbow • **Aggressively** & highly destructive to bone - **Crosses joint** (bone tumors do not) - **Metastasize to lungs** (up to 50%)	• **Lameness** • **Pain**	• Hx, CS • **Radiology:** - Initially soft tissue mass near joint - ± Calcified (Hazy & punctuated or linear streaks) - **Crosses joint** (bone tumors do not)	• **X-ray chest for metastasis** • **Limb amputation** • **Chemotherapy of limited value** **Prognosis: Poor** Other joint tumors: • Lipoma • Liposarcoma • Synovial chondrosarcoma • Fibrosarcoma
Aggressive, Lameness, Rads, Amputation				
Hemophilia A, Factory 8 deficiency, Hemarthrosis E-HB 716, 718t; E 2359; H2B 769; 772; SAP 164; 5min 64; C12T 461t *	• **Rare**, most common congenital coagulation defect in humans & animals - X-chromosome-linked recessive disorder • Dogs > cats; (German shepherd) • **Leads to arthropathy:** - **Chronic hemorrhage into joint** from clinical or subclinical trauma = inflammation results . Injury to articular cartilage & subchondral bone - Larger weight bearing joints more likely to be involved (elbow & stifle) - Larger active dogs more prone than smaller less active	• **Nonweight bearing lameness** - Swollen joints - **Painful** • Other areas of spontaneous bleeding (e.g., skin, thorax, abdomen, GI)	• Hx, CS • Laboratory: ↑ **PTT/ACT** • Abnormal toe nail bleeding time • Synovial fluid aspiration - Frank blood during hemorrhage, Xanthochromic w/ ↑ macrophages at other times • Radiology: - ↓ Joint space (thinned cartilage) - Irregular subchondral bone - DJD • Definitive diagnosis: **Low FVIII:C activity**	• **Transfusion** (plasma cryoprecipitate, fresh plasma or fresh-frozen plasma, 1 unit/5 kg BID-TID) • **Nursing care:** - Confinement to limit activity - Feeding soft food - Avoid IM injections - Use peripheral veins for blood sampling & IV catheters • Contraindicated: NSAIDs (aspirin) & sulfa drugs Prognosis: Poor
Bleeding into joint **CS: Lameness** **Tx: Transfusion, Nursing care**				
Chondrodystrophy H2B 287, 884; 5min 739, 740, 886 ****	• **Normal inherent conformation of chondrodystrophic breeds** (bulldogs, pugs, pekingese, basset hounds, dachshunds, etc.) • Angular deformities of limb segments & joints • Cartilage surfaces vary greatly in structure • Joint malalignment to be expected			
Hypervitaminosis A E-hb 746; E 2361; SAP 1157; HB3 839; H2B 1279, 294; 5min 1154, 160; Cat 1639; Sx-WW 229; NB 16.12 *	• **See Neuromuscular pg 540** • **Cats** • **Raw liver diet** or excessive Vit. A supplementation • Dystrophic calcification of the skeleton - Inhibits intramembranous & endochondral ossification	• Lethargy, anorexia • Sit in marsupial-like position with front feet raised • **Lameness** • Cutaneous hyper- or hyposensitivity • Neck or joint stiffness	• History (**cat**), CS • Check diet for excess Vit A • Radiology: - Bridging exostosis of cervical vertebrae C1-T2 - New bone formation on bone metaphysis of surrounding joints - Periarticular ankylosis of limb joints (elbow) • Frequently misdiagnosed as DJD	• **Remove source of excess Vit. A from diet** Prognosis: **Good** if diet corrected early
Cat, Raw liver diet **CS: Lameness** **Tx: Change diet**				

OCD - Articular Fxs — SKELETAL SYSTEM

Condition	Facts/Cause	Presentation	Diagnosis	Treatment
OC, **Osteochondrosis, Dyschondroplasia, OCD, Osteochondrosis dissecans** E-hb 128, 735; SAP 1080; H3B 817; H2B 862; 5min 888; C12T 1173; E 2042; Sx-OD 136; Sx-OL 185; Sx-WW 221, 243; Sx-OP 192; X4T 131; Pa-T 457 ***-***	• **Failure in endochondral ossification** • **#1 shoulder joint** (also elbow, tarsocrural [tarsus] & stifle) - 51% bilateral • **4-10 month old, rapidly growing large breeds, males 3x** • **Cause** iated w/overnutrition - Genetics - Mineral imbalances - Low copper diet ↑ incidence - Hormonal imbalances - Trauma: causing or affecting abnormal cartilage, ↓ emphasize past 20 years - **Diet & trauma only factors that can be controlled** • **Pathophysiology** - Cartilage outgrows its nutritional supply (synovial fluid) . Deepest cartilage cells die . Trauma may cause dissecting flap & joint mice in joint space, some are stellate cartilage fxs	• **Variable lameness** • ± **Swelling** (distention of joint/ synovitis) • Muscle atrophy • Sequelae: - **DJD**	• **Hx**, CS (lame & joint distention) • **Manipulate for pain** • **Radiology** (cartilage not seen) - Subchondral bone changes m/ indicate cartilage damage - **Flattening or cratering** of subchondral bone - **Subchondral bone sclerosis** (thickening) - **"Joint mouse"** floating piece of cartilage in joint space (m/b calcified) - **Radiograph contralateral joint** as well ± **Arthrography** to see flap or "joint mouse" • Arthroscopic (large patients)	• **Conservative or surgical?** Differs depending on joint involved • Can heal spontaneously or become DJD • **Conservative**: poor results for all joints - Rest (exercise on leash only for 6 months) - Restricted feed intake - Training delayed - NSAIDs (buffered aspirin or PBZ for comfort) • **Surgery** - arthrotomy better results, except in tarsus - Debridement - **Curettage**, scrape down to hemorrhagic bone, let fibrocartilage fill in defect • Remove "joint mice" • Untreated becomes DJD

Osteochondrosis dissecans:
• Osteochondrosis w/ a dissected flap of cartilage
• Fragment can calcify &/or break off - " **joint mouse**"

DDx
• Septic arthritis
• Osteomyelitis
• Bone abscess
• True bone cyst

Predictable anatomical sites
• **#1 Heads of humerus** (pg 626)
• Medial humeral condyle (pg 628)
• Medial & lateral femoral condyle (pg 646)
• Medial coronoid process of ulna (pg 628)
• Nonfusion of anconeal process (pg 628)
• Proximal, medial trochlea of talus (pg 649)
• Femoral head (very rare) (pg 642)

Cartilage defects
Young, Fast growing, Large breed males
CS: ± Lameness, Swelling, Atrophy
Dx: Palpation, Rads
Tx: Conservative, Sx • Px: Good

Aspirin

Bute

Prognosis:
• **Good** for soundness if Tx early
• **DJD**: poor for Sx or conservative Tx

Prevention:
• Do not overfeed (controversial)
• Check for mineral balancing diets (copper/calcium/zinc)

Articular fractures, Joint trauma

H2B 875; Sx-OP 187, 215
***

• Fx of articular cartilage &/or bone
- **Articular & chip fxs**
- **Step defect in articular cartilage leads to DJD**
• Immature animals physeal fxs (Salter 3 or 4)
• Must be correctly Dx for surgical reduction

• See different bones for CS
• **3-legged lame**
• ± Swelling
• **Sequela:**
- **DJD**
- Premature closure of physis after Salter fx correction (w/in 2-3 wks)
. Segment shorten
. Curvature
- Ankylosis, ↓ ROM

• **Hx, CS**
• **Palpation**
• Avoid nerve blocks & exercise
• **Radiology**
- 2 radiographs at right angles (craniocaudal & lateral)
- Obliques added, esp. if chip or avulsion fxs

• **Anatomical reduction & rigid skeletal fixation**
- Must perfectly align cartilage surface (no step defect) or will rapidly lead to DJD
- Use arthroscopy to check alignment after reduction (rarely used in dogs & cats)

Prognosis:
• **Good** if anatomical reduction, delays m prognosis
• Poor if step defect (**leads to DJD**)

Step defects = DJD
Tx: Rigid anatomical reduction

Sprain

Sx-S-hb 603; Sx-WW 251; Sx-OP 203; X4T 177
***

• Stretching or tearing of support ligaments, but integrity of joint not lost
• Tendons, ligament & capsule
- Not visible radiographically

• Mild: may go unnoticed
• Moderate: ± laxity in joint
• **Lameness**

• Hx, CS
• **Palpation:** 1° diagnostic method
• Radiology:
- Mild only soft tissue swelling, hard to Dx
- Severe sprain
. Soft tissue swelling
. Joint instability or subluxation
• Stress radiographs (may require sedation)

• **Time**
• **Ice**: reduce swelling
• Aspirin: pain relief
• **Rest**
• Support bandages; cast if severe
• Surgical repair of torn ligaments

Aspirin

Prognosis:
• **Good to excellent**

Stretching or tearing
CS: Asymptomatic to lame
Dx: Hx, CS; Palpation, ± Rads
Tx: Ice, Aspirin, Rest, Support bandage

Luxation (dislocation) & subluxation

E-hb 737; HB3 827; H2B 861; 863t, 877t; E 2049; Sx-OL 143; Sx-S-hb 574, 404, 609; Sx-WW 251; Sx-OP 186
***

• **Luxation: complete dislocation of a joint**
• **Subluxation: partial dislocation of a joint**
• Loss of integrity of one or more ligaments
- Avulsion fxs of ligament attachments

• **Lameness, mechanical dysfunction**

Locations
• Carpal pg 634
• Elbow pg 632
• Hip 640
• Shoulder 624
• Stifle pg 644
• Tarsus pg 648
• TMJ pg 623

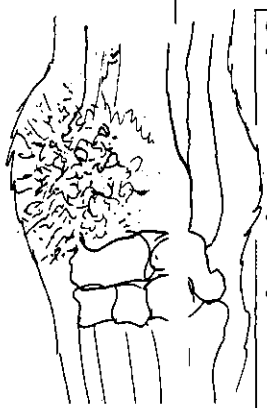
• **Hx, CS, PE**
• Luxation: obvious clinically & radiographically
• Subluxation: more difficult to Dx
- Radiology: weight-bearing, simulated weight-bearing or stress views (flexed or extended positions)

• **Emergency: reconstruct joint congruity**
• **Closed or opened reduction**
- Immobilization of joint for 1-4 weeks depending on instability
• Surgical repair of torn ligaments

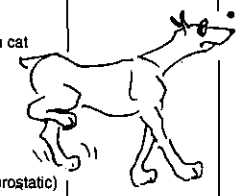
Prognosis: depends on time to correct: ↑ time = ↓ prognosis

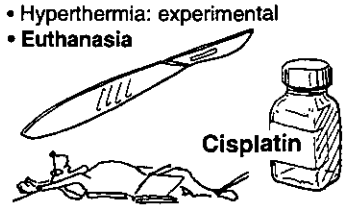
Complete or partial dislocation
Dx: Hx, CS, Rads
CS: Lameness, Mechanical
Tx: Reduction & immobilization

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Neoplasia - bone E-hb 746; SAP 972, 1068; H3B 840; H2B 893; 5min 892; 12M 1146; E 2097; Cat 1623; Sx-WW 225; Pa-T 447 **	• **Bone tumors: inherently malignant with aggressive lesions** • Causes: unknown, non-metaphyseal locales (IM pin corrosion, fracture), irradiation, bone infarcts, viral	• **Pain**, paresis • **Altered function** • **± Palpable mass** • **Lameness**: mild to 3-legged lame • Localizing signs - Nasal discharge - Cranial nerve deficits - Nerve root signature • Sequela: **Respiratory problems with metastasis**	• **Hx** (age, breed, sex, site, duration, surgery), CS, PE • **Radiology: impossible for definitive Dx from radiographs alone** - Aggressive bone lesion . Simultaneous bone lysis/pone proliferation . Indistinct margins between normal & abnormal bone . "Codman's triangle" - Aggressiveness • Bone scintigraphy - Synchronous 1° bone tumors (< 10%) - Metastasis • **Biopsy: required for definitive Dx** - Wedge or trephine - Matrix type . Fibrous: osteosarcoma, chondrosarcoma, fibrosarcoma . Cartilaginous matrix: chondrosarcoma, osteosarcoma . Osteoid matrix: osteosarcoma - Dx of fibrosarcoma or chondrosarcoma are viewed w/ suspicions - Common to miss lesion & get DDx of "reactive bone" - repeat biopsy	• **Surgical excision** (TOC) if possible - Amputation, partial excision, limb salvage, mandibulectomy - Follow up rads every 3 months for metastasis • **Chemotherapy/immunotherapy** - Cisplatin (Platinol®) + limb amputation . Monitor renal profiles . Thoracic rads every 3 months for metastasis • **Radiation therapy**: potential in nonosseous locally invasive neoplasia . Squamous cell carcinoma . Acanthomatous epulis - Combine w/ surgical excision - Monitor rads of local bone lesion & thorax • Hyperthermia: experimental • **Euthanasia** Prognosis: • **Poor** for life • Amputation & ↑ quality of life



Classification of bone neoplasia
- Primary tumors:
  - **Osteosarcoma** #1 - 80% dog & cat
  - **Chondrosarcoma**: 10% in dog, rare in cat
  - Fibrosarcoma
  - Hemangiosarcoma
  - Multiple myeloma: rare
  - Lymphosarcoma: very rare 1° bone tumor
- Secondary (metastatic) tumors:
  - Adenocarcinoma (mammary, 1° lung, prostatic)
  - Lymphosarcoma: multicentric
- Nonosseous tumors that invade bone
  - Squamous cell carcinoma
  - Malignant melanoma
  - Acanthomatous epulis
  - Fibrosarcoma





DDx:
- Osteomyelitis: bacterial, fungal
- Trauma/acute fracture
- Ischemia
- Hypertrophic osteodystrophy
- "Healing" fx

Prognosis:
- Surgical: palliative only: 1° neoplasia (osteosarcoma, hemangiosarcoma, metastatic tumors, nonosseous invasive neoplasia (malignant melanoma)
  - Potentially curative: 1° tumors (osteosarcoma <10%), chondrosarcoma, fibrosarcoma); Nonosseous invasive neoplasia (squamous cell carcinoma, fibrosarcoma, acanthomatous epulis)
- Chemotherapy + amputation: only 30-40% survival for 1 year
- Radiation: secondary neoplasm may develop months to years

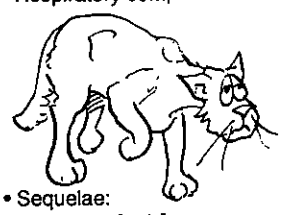
Malignant - Aggressive
CS: Pain, Mass, Lameness, Paresis
Dx: Hx, Rads, Biopsy
Tx: Surgical, Chemo, Rads • Px: Poor

Osteosarcoma

H3B 840; H2B 895; E-hb 746; SAP 972, 1068; 5min 892; C12T 506; E 2097; Sx-S-hb 720; Sx-S 2215; X-RP 18
** - ***

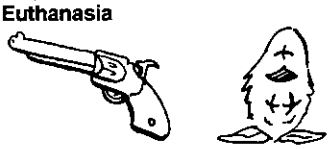
- **#1 bone tumor: dog (80-90%) & cat**
- 7 yrs (1-15 yrs-old)
- Giant breeds: St Bern., G. Dane, Golden retriever, Irish setter, Doby, G. shepherd
- Arise from metaphyseal region
- **Early metastasizes** (except distal ulna - dog)
- **Most relentless of neoplastic diz**
- Bone tumor don't cross joints readily
- **Other bone tumors rare but look identical to osteosarcoma**
  - Biopsy needed to differentiate
  - Fibrosarcoma
  - Chondrosarcoma
  - Hemangiosarcoma

- **Lameness**
- **Swelling**
- ± Fever & anorexia
- Severe muscle atrophy
- Respiratory compromise



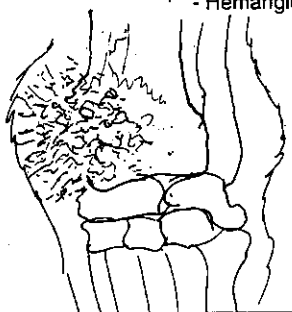
- Sequelae:
  - **Pathological fx**, nondisplaced shorty oblique
  - **Metastasis** to lungs in 90% by time of diagnosis (micrometastases)

- Hx, CS; PE
- **Radiology:**
  - Sclerosis & punctate lytic areas
  - Periosteal proliferation (95%) - rough & irregularly
  . Sunburst periosteal reaction (33%)
  - Metaphyseal region of long bones
  - Pathologic fractures
  - Subtle or explosive
  - Codman's triangle: triangular diaphyseal side of many tumor (not specific for tumors) - lifts periosteum
  - "Cigarette smoke, swirling" appearance (probably a bone infarct & indicative of osteosarcoma)
- **Biopsy for definitive diagnosis**
  - Proliferative, sclerotic, lytic sites (full thickness)
  - Multiple specimens
- Re-rad in 2-3 wks (tumors grow geometrically, very fast, Osteomyelitis grows slowly)
- Chest rads for metastasis (Osteomyelitis doesn't metastasize), 3 views (Rt & Lt lateral & VD)

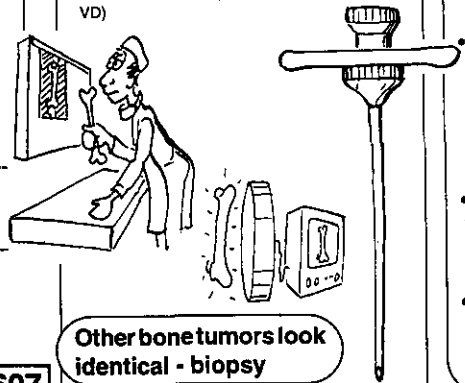


- Sx, chemo, rad, immunotherapy etc.
- **Death inevitable**, make comfortable
  - Inform owner only giving palliative treatment
- Amputate immediately will relieve pain
- **Euthanasia**

Prognosis: **Grave**: death is inevitable
- Median survival time:
  . Amputation only: 3-4 months
  . Amputation + cisplatin: 9-12 months, 35-50% 1 year survival



Common sites
- **> 80% appendicular**
  - **#1 Distal radius**
  - Proximal humerus
  - Proximal or distal tibia
  - Proximal or distal femur
- Distal ulna (dog) only site that doesn't metastasis readily
- Smaller dogs: more axial involvement (nasal, facial, vertebral)
- Cats: hindlimb > forelimb



DDx:
- Other bone neoplasia
  - Fibrosarcoma
  - Chondrosarcoma
  - Hemangiosarcoma
- Osteomyelitis
  - M/b places besides metaphysis
  - Appearance similar
  - Hx of direct contamination (Sx or trauma)
  - Draining tract
  - Doesn't metastasize (X-ray chest)
  - Grows slowly (re-rad in 2-3 wks)
  - Crosses joints, tumors don't usually
- Mycotic osteomyelitis
  - Hematogenous- multiple sites
  - Metaphyseal region frequently
  - M/ look radiographically like tumor
  - Culture, Biopsy
- Traumatic bone lesions
  - ± Aggressive lesion
  - May look radiographically like tumor
  - Biopsy

#1 Bone tumor, Large breeds
CS: Lameness, Swelling, Fx, Metastasis to lungs
Dx: Rads, Biopsy
Tx: Amputate, Chemo, Rads, Immuno • Px: Grave

Other bone tumors look identical - biopsy

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Chondrosarcoma E-hb 747, 363; H3B 840; Cat 1630; Sx-WW 226; Pa-T 446 *	• **Rare but #2 bone tumor in dog** (10% of bone tumors) • Cats: uncommon • Dogs: 6 yr (1-12 yrs), large breed dogs especially G shepherd & boxers • Cats: 9 yr (2-15 yrs) • Sites or origin - flat bones - Dog: **ribs**, nasal cavity, pelvis - Cat: scapula, vertebrae, tibia, mandible	• **Related to location** - Ribs: large, hard, painless swelling at costochondral junction - Pelvis: lameness - Nasal: sneezing, epistaxis, & nasal swelling • Sequela: **Metastasis to lungs** (10%)	• Hx (age, breed, sex, site, duration) • Radiology: impossible for definitive Dx from radiographs alone - **Similar to osteosarcoma but usually** less productive: osteolysis, osteoblastic or reactive periosteum, mineralization of chondrosarcoma, or all of above - Nasal cavity: displaced nasal septum, amorphous pattern to turbinate area - Ribs: mass • **Biopsy: required for definitive Dx** - Matrix type: fibrous: osteosarcoma, chondrosarcoma, fibrosarcoma - Cartilaginous matrix: chondrosarcoma, osteosarcoma - Dx of fibrosarcoma or chondrosarcoma are viewed w/ suspicions for possible osteosarcoma	• **Surgical removal - wide excision** • Nasal chondrosarcoma: radiotherapy w/ or w/o surgery Prognosis: **Good to guarded** if complete excision, if incomplete excision - tend to recur • Metastasis to lungs in 10%
#2 bone tumor, Large breeds **CS: Related to location** **Dx: Hx, Rads, Biopsy** **Tx: Surgical removal • Px: Good to guarded**				
Fibrosarcoma E-hb 747; H3B 940; H2B 893; SAP 972; 5min 599; Sx-WW 226; Pa-T 446 *	• **Rare** in dog, Cat: very rare; 6 yr (1-12 yr), medium & large breeds; Male > female; Location: metaphyseal area of long bones (dist. femur), periosteal tumors - mandible or maxilla, Produces collagenous matrix but no neoplastic cartilage or bone; Slow rate of growth • **CS: Lameness, Swelling** • Dx: Hx (age, breed, sex, site, duration, surgery); **Rads: not definitive Dx (similar to osteosarcoma & chondrosarcoma**, impossible to differentiate between 1° & metastatic tumors, periosteal proliferation early, erosions adjacent to tumor follows, soft tissue swelling; **Biopsy: required for definitive Dx** (matrix type: fibrous: osteosarcoma, chondrosarcoma, fibrosarcoma; Dx of fibrosarcoma or chondrosarcoma are viewed w/ suspicions for possible osteosarcoma • **Tx: Wide surgical excision** (TOC) +? radiation therapy • Px: **Guarded** to good depending on degree of differentiation; Recur & can result in lung metastasis up to 1 yr after amputation			
Hemangiosarcoma E-hb 747; H3B 840; H2B 893; 5min 644; I2M 1143; Sx-WW 227 *	• **Rare**, Dog: 7 yr; Medium & large breeds (G shepherd), Cat: extremely rare; Location: prox. & dist. one-third of long bones, pelvis, sternum, maxilla; **Most disseminated** by blood by time of Dx • **CS: Lameness**; Sequela: **pathologic fxs** at site common • Dx: Hx (age, breed, sex, site, duration, surgery); Rads: not definitive Dx, extensive osteolysis, **mottled "moth eaten"** appearance, confined to medullary cavity usually, **pathologic fxs; Biopsy: definitive**; Metastatic check: thoracic rads & abdominal ultrasound • **Tx: Wide surgical excision**, Adjuvant chemotherapy (doxorubicin, vincristine & cyclophosphamide); **Euthanasia** • Px: **Extremely poor**			
Multiple myeloma, **Plasma cell myeloma** * E-hb 732, 230, 552, 363; SAP 198, 232; H3B 840; H2B 845, 5min 832; Sx-WW 227	• **Rare, Disseminated plasma cell neoplasm**, Middle age or older • CS: **Bone pain, pathological fxs**, neuropathy, Hemorrhage, anemia, **Fever**; Multiple organ failure (renal) • Dx: CS, **Plasma cell infiltration of bone marrow + one of**: Bence-Jones proteinuria (not commonly done), osteolysis, monoclonal proteins • Tx: **Combination chemo** (melphalan, cyclophosphamide, prednisolone); Supportive care; Monitor • Px: **Guarded** w/ proper management, can result in spinal fxs, paralysis or nontreatable pain			

Osteomyelitis, ***Bone infection,*** **Osteitis** H3B 835; H2B 887; SAP 1091; E-hb 747; 5min 890; I2M 1260; C12T 1200; Cat 1640; Sx-WW 223; Sx-S-hb 562; Sx-S 1685; Sx4B 897; Sx3B 906; Sx-OP 163; X4T 154; X-RP 16; Sx-OD 14; Sx-OL 11; Pa-T 441 ***?	• ***Inflammation or infection of bone*** - **Bacteria**: commonly considered infection (pyogenic), 50% due to **Staph spp.** • Cause: contamination of bone - **Surgery** - External trauma, puncture wounds, extension from soft **tissue infection** - Rarely hematogenous spread • Location variable, not confined to metaphyseal region like tumor • **Appearance similar to identical to osteosarcoma**	• Acute: - **Pain, local swelling, hyperemia** - Pyrexia (fever), depression, anorexia - Wound dehiscence • Chronic: - Often previously treated - **Draining sinus tracts** - Pain - Lameness - Lymphadenopathy - Muscle atrophy	• **Hx** (history), **CS** (clinical signs) • Radiology: - **Can look like osteosarcoma** **. Can't DDx by radiographs** - **Sclerosis** & punctate lytic areas - **Periosteal proliferation** - rough & irregularly - **Sequestrum**: piece of dead bone separated from rest - Metaphysis of long bones - Pathologic fractures - Subtle or explosive - Codman's triangle: lifted periosteum if periosteal - Chest Rads to DDx from neoplasia - doesn't metastasize - Gas in soft tissue • Bone scan (scintigraphy) - Detect w/in 3 days of CS • **Bone biopsy & culture to DDx**	• **Acute osteomyelitis** **- ABs may be enough early** . Start on Cephalexin (Keflex®) while waiting for C&S - **Surgical** if no clinical improvement in 72 hours, if abscess or foreign body present . Dependent drainage . Debride wound . Evaluate fx fixation & add cancellous bone graft, re-stabilize if necessary . ABs 30-60 days • **Chronic osteomyelitis** **- ABs on culture & sensitivity** . Cephalexin (Keflex®), cephalothin (Keflin®), cefoxitin (Mefoxin®), cefotaxime (Claforan®), amikacin (Amikin®), Amoxicillin-clavulanate (Clavamox®), ciprofloxacin (Cipro®), enrofloxacin (Baytril®) . Gentamicin impregnated bone cement or beads - **DANGER** - popularity waning rapidly . Antibiotic-loaded paris pellets . Electrically generated silver ions . Hyperbaric oxygen **- Remove sequestrum, very important!** . IV methylene blue injected day before surgery to help ID avascular bone **. Obliterate dead space**, cancellous graft **- Evaluation of fracture stability** . If fx healed remove implant . If unstable - stabilize Prognosis: **Guarded**: despite adequate Tx, 25% develop chronic diz
Bacterial infection of bone, Staph **CS: Pain, Swelling, Draining, Lameness** **Dx: Hx, CS, Rads, Biopsy & culture** **Tx: ABs, Surgical remove sequestrum** **Px: Guarded**		**DDx:** • **Neoplasia (metastasis)** • **Normal reaction to trauma** • **Loose implants** • Benign bone cyst		

Fungal bone infection SAP 1091; H2B 887, 1175; C12T 1200 * - ***	• **See Systemic diseases pg 702: Fungi, Geographic** locations for each affects incidence - ***Coccidioides immitis***: disseminate form, #1 Dx, **CS: lameness**, painful swelling of long bones or joints (50%), **draining tracts**, weight loss, fever, lethargy, other organ CS - ***Blastomyces dermatitidis***: systemic fungal infection that disseminates to eyes, skin, bones & other organs, **CS**: depends on organs; nonspecific: fever, weight loss, cachexia, inappetence & depression (50% of cases), Pulmonary CS in 86%, **Osteomyelitis**: periosteal reaction & soft tissue swelling - ***Histoplasma capsulatum***: respiratory or GI, disseminated to liver, adrenals, spleen, CNS, skin & **bone** - ***Cryptococcus neoformans, Aspergillus fumigatus*** • CS: **Depends on route of entry, localization or dissemination**: asymptomatic, acute sign of localized diz, chronic signs: chest, multiple organ systems • Dx: **Hx, biopsy, cytology, culture** • Tx: **Ketoconazole** (Histoplasmosis - TOC), **Amphotericin B, Flucytosine** (Aspergillosis); **Combo of flucytosine & amphotericin B** (Cryptococcosis); **Combo of amphotericin B & ketoconazole** (Blastomycosis); **Itraconazole** (all); **Fluconazole** (Cryptococcosis) • Px: **Good to poor** depending on severity & response to meds	

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Hypertrophic osteodystrophy Metaphysea osteopathy E-hb 745; SAP 1074; H3B 830; C12T 1175; Sx-WW 220; SX-OP 721; Sx-OL 213; X4T 136; X-RP 22; NB 16.19 *	• **Lameness associated with swelling & inflammation of metaphysis of long bones** • **Developmental diz of young, large, rapidly growing large & giant breeds** • **Large & giant breeds** (G. Dane, St Bernard, I. setter, Lab, Basset , G. shepherd, G. short haired pointer, Irish wolfhound, Weimaraner, Collie, Doberman, greyhound, Dalmatian) • 3 - 4 months (2-8 months) - Only in growing animals w/ open physes • Males > females • **Metaphysis** of long bones (dist. ulna & radius) • Cause unknown: excessive plane of nutrition, Ca/P imbalance, Vit C defc • Usually bilateral **Growth plate; lame; Rads, Tx: Nonspecific • Px: Guarded**	• **Lameness in 1 or more limbs** . Mild to 3-legged lame • **Swelling of metaphyseal region of long bones** (distal radius & ulna #1) • Fever (106°F), may cycle • Reluctance to move, anorexia • Joint heat (pyrexia) Sequela: - Enlarged metaphysis - Angular deformities - Death due to hyperthermia or acidosis **DDx:** • Panosteitis • Bone associated neoplasm • Hypertrophic osteopathy	• CS & history • Palpation: warm, swollen metaphysis, ± pain • Radiology: **Long bones** - Mixed sclerotic & lytic regions in metaphysis (initially) - **Bone cuffing:** metaphyseal region (extraperiosteal mineralization of soft tissue, m/ extend around the whole diaphysis) - **Double physes** (radiolucent line or band parallel to physis in metaphysis)	• **Nonspecific Tx** • **Spontaneous remission** in mild or moderately affected dogs • Correct dietary imbalance & m calories/ energy • ± NSAIDs for pain (buffered aspirin) • Severely affected - support - Prevent decubital ulcers, - Hydration (fluids) - Nutrition (feeding tubes) - Correct electrolyte imbalance Prognosis: **Guarded** • Many dogs recover spontaneously but permanent bone changes & physical deformities may develop • May succumb to hyperthermia
HO, **Hypertrophic osteopathy,** **Hypertrophic pulmonary osteopathy, HPO** Hypertrophic pulmonary osteoarthropathy, Pulmonary osteoarthropathy, Marie's diz, 2° hypertrophic osteopathy H3B 837; H2B 891; E-hb 745 ; SAP 1075; IM-WW 568; 5min 712; Cat 1643; Sx-WW 227; Sx-OP 723; Pa-T 444; Sx-OL 219; X4T 181; X-RP 23, 103; NB 16.19 *	• **Bilateral periosteal proliferation** of distal extremities • Dogs & cats • Middle aged to older (8.5 yr) • **2° to space occupying mass in thoracic or abdominal cavities** - **#1 metastatic pulmonary tumor** (paraneoplastic condition) - 1° pulmonary tumor - Chronic lung diz (pulmonary abscesses, pulmonary tuberculosis, chronic bronchopneumonia) - Rarely other intrathoracic dizs (spirocercosis, Dirofilariasis, rib tumor, bacterial endocarditis) - Abdominal mass (liver adenocarcinoma, bladder neoplasms) • May have history of tumor removal (e.g., mammary tumor) • Pathogenic mechanism unknown **2° to mass in thorax or abdomen CS: Swollen distal limbs • Dx: Rads Tx: Remove 1° lesion**	• CS often precede 1° diz by months • Shifting leg lameness, all 4 limbs • **Swollen distal limbs**, especially Mc's & Mt's (metacarpal & tarsals) • Pain • Febrile, limbs painful, hot • Completely self-limiting • **CS of 1° diz** (respiratory, systemic) **DDx:** • Panosteitis • Hypertrophic osteodystrophy • 1° bone tumor • Osteomyelitis • Hypervitaminosis A (cats) • Mucopolysaccharidosis (cats)	• Hx (history), CS (clinical signs) • PE: swollen, firm, warm distal limbs - Pain on deep palpation of distal limbs • Laboratory: reflect 1° diz not HO • Radiographically: - **Periosteal proliferation** around diaphyses of affected bones (smooth or irregular) - Starts in **metacarpal & metatarsal bones** & then progresses to involve bones of **all 4 limbs** including carpus & tarsus, & may eventually involve the mandible, pelvis, ribs & vertebrae - No endosteal bone proliferation - Often related to the nutrient foramens - Initially soft tissue swelling only • **Radiograph the chest & abdomen essential** - **Space occupying lesion** • Ultrasound for 1° diz	• **Remove 1° lesion**, usually results in regression of the bony lesions - Pain resolves in 1-2 weeks - Periosteal reaction regresses in 3-4 months • Unilateral vagotomy (on side of lesion) may temporary regress CS if 1° mass can't be removed • Steroids: prednisolone, palliative if untreatable 1° diz Prognosis: • **Good** if underlying diz corrected • Some may have persistent lameness • **Grave** if 1° neoplasia can't be treated
Panosteitis, **Enostosis** H3B 832; H2B 889; E-hb 744; SAP 1073; 5min 904; C12T 1172; E 2089; Sx-OP 715; Sx-WW 221; O-L 209; X4T 136; X-RP 16; NB 16.18 **	• ***Temporary inflammation of long bones*** • **5 - 12 months** (2 mo - 6 yr) • Large dogs (**German Shepherd**, G. Dane, I. setter, St Bernard, Dobie, Airedale, basset hound, miniature schnauzer) • Males > females (4:1) • Anywhere (ulna, radius, humerus, femur, tibia) • Cause (etiology): unknown - Unrelated to trauma - Stress, metabolic disorders, allergies, autoimmune reaction, transient vascular abnormalities **Young, Long bones, Cause? CS: Shifting leg lameness Dx: Hx, CS, Rads: ↑ Medullary opacity Tx: Self limiting, Aspirin • Px: Excellent**	• **Shifting leg lameness** (cyclic) - Cyclic: occur in more than 1 bone at more than 1 time, resolves in 1 limb & develops in another - Pain • **Self limiting disease** • ± Fever, malaise, anorexia **DDx:** • Hip dysplasia • Osteochondrosis • Hypertrophic osteodystrophy • Ununited anconeal process • Nutritional 2° Hyperparathyroidism	• **Hx (no trauma, age) CS** • **Pain on palpation of diaphysis of affected bone** • **Radiology** - **↑ Medullary opacity**, nodular opacities to complete opacification of the medullary cavities - Smooth **periosteal & endosteal** reactions w/ time - Associated w/ nutrient foramen - No correlation between radiographs & severity of CS	• **Self limiting diz** • **Symptomatic** - **Pain relief** (buffered aspirin) - Steroids controversial - **Limit activity if severely affected** Prognosis: **Excellent**: usually resolves by 20 months
Multiple cartilaginous exostosis, MCE, Osteochondromatosis, **Osteochondroma** M8k 920; Mk 586; E-hb 304, 744; SAP 1077; H3B 253, 831; H2B 882; E 681; Cat 1629; NS-C 408; NS-W 152; NS3hb 153; NS-hb 150; NS-Pa 201; NS-L 189; X4T 139; X-RP 20, 85 *	• **Benign, proliferative diz of bone & cartilage** - Small bony growths capped by cartilage - Benign bone tumor of any bone: vertebrae (especially thoracic spinous processes), ribs & long bones - **Metaphyseal** region usually - **Spontaneously stops when growth plates begin to fuse** • **Young** dogs, cats, horses & humans - **< 18 months** • Cause: **unknown** - hereditary in dog? acquired periosteal sarcoma? • Pathophysiology: exostoses develop as part of physeal cartilage escape normal remodeling • **Transformation** into osteosarcoma & chondrosarcoma reported **Bony growths, metaphyses CS: Asymptomatic/Pain Dx: Hx, CS, Rads Tx: Time - physes close**	• **Often asymptomatic** • **Firm swelling** • Pain • ± **Lameness** (50%) if compression of over lying nerves or tendons • Neurologic deficits if compress spinal cord **DDx:** • Tumor	• Hx (history); CS (clinical signs) • Smooth immovable bony swelling near metaphysis • ± Pain on palpation • **Radiology** - Radiopaque osseous metaphyseal densities of variable size - "Cauliflower-like", ± radiolucent areas of hyaline cartilage w/in exostosis • Biopsy to confirm • Myelography: for spinal cord compression	• **Not necessary unless neurologic signs,** stoops when growth plates (physes) close • Neurological signs: surgical excision w/ spinal cord decompression • Neutering recommended because of possible hereditary Prognosis: • **Good**: single in mature dog • **Guarded**: if large # at an early age (unpredictable course) • Spinal cord compression, good w/ Sx • Transformation to chondrosarcoma or osteosarcoma reported

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Bone cysts

SAP 1078; E-hb 745; H3B 336; Cat 1634; Sx-WW 227; X-RP 19; Pa-T 446

★

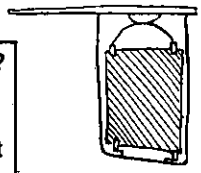
- **Radiolucent cavities in bones**
- Dogs: G. shepherd, Weimaraner, Irish wolfhound, Afghan, Saluki, Great Dane, Doberman
  - < 1 yr old (4-30 months), males > females
- Long bones in metaphysis not involving physis or epiphysis
- Cause: **unknown** for all but subchondral cysts
  - Subchondral cysts result of chronic degenerative joint diz

Types:
- Monostotic (affecting only one bone)
- Polyostotic (more than 1 bone)
- Aneurysmal bone cyst is a neoplasm, locally aggressive
- Subchondral

- **Pain**
- **Swelling** & stiffness of nearest joint
- Sequela: **Pathological fractures**

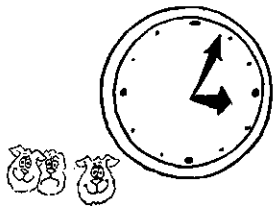
- Hx; CS
- Radiology: **nonaggressive, expansile, cystic** (radiolucent) area
- **"Egg shell"** cortices

DDx:
- Chondrosarcoma
- Osteosarcoma
- Giant cell tumor



Radiolucent cavities in metaphysis, ?
CS: Pain, Swelling, Pathological fxs
Dx: Hx; CS; Rads: cyst
Tx: Benign neglect, Curettage & graft
Px: Guarded to good

- **Benign neglect**
- Curettage & bone graft
- Splinting
- En bloc surgical resection
- Aneurysmal bone cyst
  - Surgical excision or irradiation



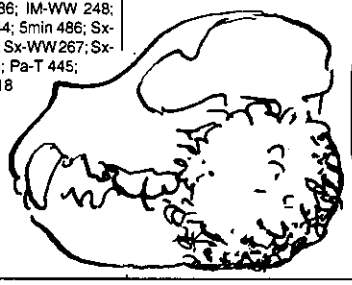
Prognosis: Guarded to **good** depending on size & place

Craniomandibular osteopathy (CMO)

H3B 830; SAP 1076, 5min 486; IM-WW 248; E-hb 744; 5min 486; Sx-OL 211; Sx-WW 267; Sx-OP 725; Pa-T 445; NB 16.18

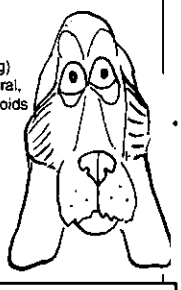
★

- **Nonneoplastic proliferative diz of skull**
  - 1° **affects mandible**, also frontal & temporal bones, tympanic bullae (endochondral bones), rarely long bones of limbs
- Breeds: **Scottish terrier, West highland white terrier, Cairn** terrier; also: boxer, Bostons, Lab, great Dane, Doby
  - 4-12 months old
- Cause: unknown

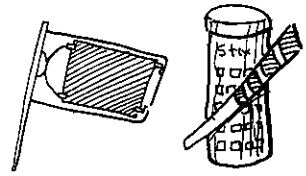


DDx:
- Hypertrophic osteodystrophy
- Bone tumor
- Osteomyelitis
- Temporomandibular malformation
- Myositis

- **May be asymptomatic if mild**
- Symmetric swelling of mandible (body > ramus)
- Difficulty w/ prehension, chewing, swallowing
- ± Fever, lethargy
- ± Pain
- Ptyalism (drooling)
- Atrophy of temporal, masseter, pterygoids

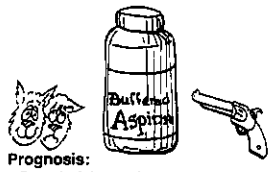


- Hx (history); CS (clinical signs)
- ± Pain on opening mouth
- Mouth may only open an inch or less
- **Radiology:**
  - Symmetrical bony enlargement of mandible
  - ± Fusion of TMJ joints
  - Proliferation slows then becomes static at 1 yr old
    - Partial or complete regression of bone lesion occurs
- Laboratory:
  - ↑ Alkaline phosphatase (AP)
  - Hypercalcemia



Nonneoplastic proliferative diz of skull: mandible
CS: Asymptomatic to head problems
Tx: Symptomatic • Px: Guarded to poor

- **Symptomatic**
- Pain: buffered aspirin
- Nutritional support if can't eat (feeding tube, soft food)
- Surgery unsuccessful
- Euthanasia if animal unable to eat or recurrent, persistent serious episodes



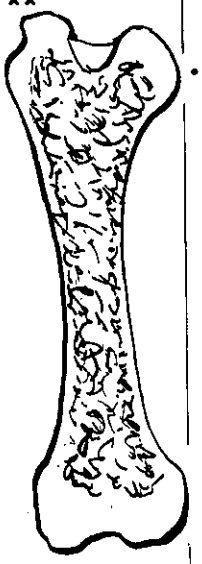
Prognosis:
- **Guarded:** bony changes are reversible but many dogs have some impaired mouth functions but can eat
- Rarely show spontaneous reversal of diz
- Poor if partial or complete ankylosis of temporomandibular joints (TMJs)

Osteopenia, Osteoporosis, Osteomalacia, Rickets,

Hypervitaminosis D

H3B 838; H2B 892; Sx-WW 228; X-RP 17; Pa-T 436; NB 16.20

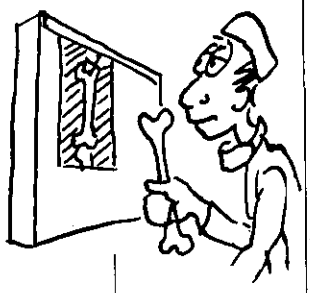
★★



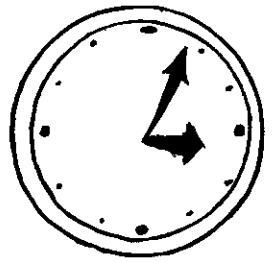
- **↓ Bone density** (↓ Normal mineralized bone)
  - **Not a 1° diz** but a feature of many dizs
- Osteoporosis: demineralization of bone
- Osteomalacia: softening of bone due to impaired mineralization
  - Lack of vitamin D or defect of its metabolism
- Osteodystrophy: defective bone formation
  - Osteodystrophy fibrosa: excessive resorption of bone
- Pathophysiology: dynamic remodeling of bone tipped in favor of resorption over formation
- Rickets in young, osteomalacia in adults

- **Symptoms of 1° diz**
- ↓ Bone density CS:
  - Lameness: weakened bone
  - Spontaneous/pathological fxs
- "Rubber jaw"

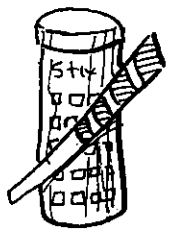
- Hx, CS
- Palpation: "rubber jaw"
  - Extreme pain on palpation of fxs
- **Radiology**:
  - **Generalized ↓ bone density**
    - Vertebral bodies, flat bones of skull, scapula & ilium, metaphysis of long bones
    - Loss of lamina dura (side of tooth alveoli)
    - ± "Folding" fxs
    - ± Metastatic soft tissue mineralizations
- Laboratory:
  - Altered serum calcium, phosphorus & SAP reflect 1° diz process
  - ↑ BUN & creatine in renal failure

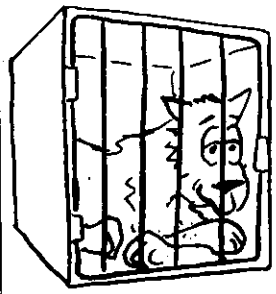


- Correct 1° cause
- Enforced cage rest to prevent trauma (fxs) until bone strength returns



Osteopenia - DDx:
- Disuse/absence of mechanical stress
  - Cast/splint
  - Bone implants (localized effect)
  - Paralysis
- Hormonal imbalance/nutrition
  - 1° Hyperparathyroidism
  - 2° hyperthyroidism
    - Acquired renal diz
    - Congenital diz
    - Nutritional diz
      - Low calcium diet
      - High phosphorus + normal or low calcium diet
    - Gastrointestinal malabsorption
    - Glucocorticoid excess
    - Pregnancy & lactation
  - Hyperthyroidism
  - Diabetes mellitus
  - Hyperadrenocorticism
  - Vit D deficiency
  - Phosphorus deficiency (storage or use)
- Neoplastic disorders
  - Pseudohyperparathyroidism
    - Lymphoma, mammary adenocarcinoma, malignant perianal gland tumors, multiple myeloma, gastric squamous cell carcinoma, thyroid carcinoma, testicular interstitial tumors, nasal adenocarcinoma, pancreatic adenocarcinoma
  - Anal sac adenoma





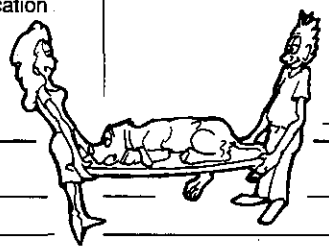
↓ Bone density, 2° diz
CS: Symptoms of 1° diz
Dx: Hx, CS, Rads: ↓ Density
Tx: 1° cause, Rest

Prognosis:
Depends on cause

Fractures (Fx)

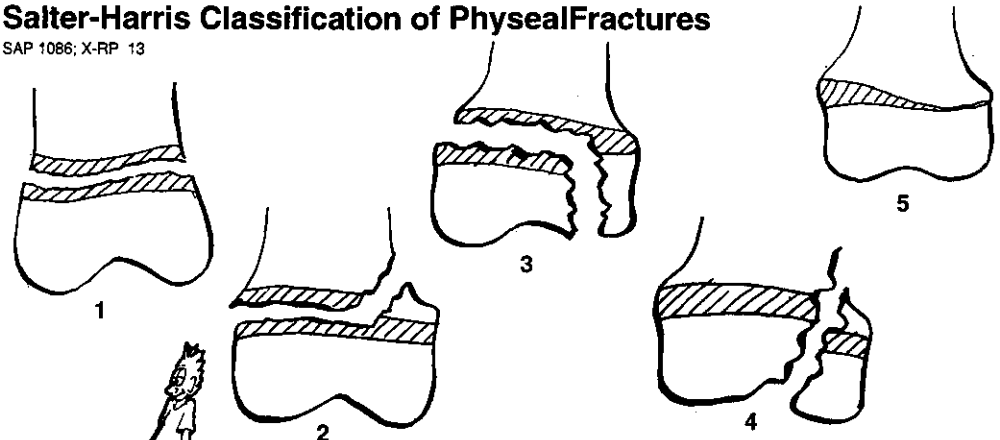
SAP 1088; H3B 942; SX-WW 207, 251; Sx-OP 24, 676; Sx4B 826; Sx-S-hb 537; Sx-S 1595; X4T 142; X-RP 12; Pa-T 430; NB 16.13

- Break in the continuity of the cortex of a bone or cortex
- **Describe:** configuration, joint involvement
  1. **Open or closed**
  2. **Bone or segment** involved (by name)
  3. **Classification**
  4. **Inherent instability of 3**
  5. **Joint involvement**
- **Radiographs: minimal of 2 views** (lateral & cranio-caudal including joint above & below)
  - **Then note the type configuration of the fx**
  - **Physeal fx** use the Salter-Harris classification



Salter-Harris Classification of PhysealFractures

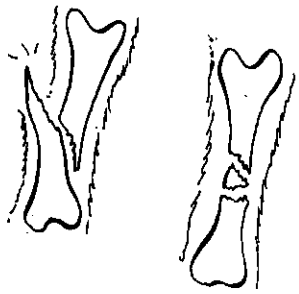
SAP 1086; X-RP 13



Salter-Harris fx: fx of metaphyseal, physeal, epiphyseal area. Depending on configuration of fx have potential prognostic value (depending on effect on growth plate).

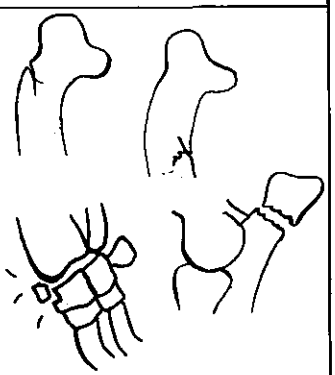
- **Type 1** (I): fxs through the growth plate, adjacent the zone of hypertrophic cells. Involves slipped physis
- **Type 2** (II): through physis & part of metaphysis
- **Type 3** (III): involves physis & some of epiphysis, thus through joint. Results in fusion of growth plate & angular limb deformities
- **Type 4 (IV):** through metaphysis, **physis** & **epiphysis** & thus through joint
- **Type 5 (V):** crushing injury of part or all of growth plate, may result in premature closure of physis

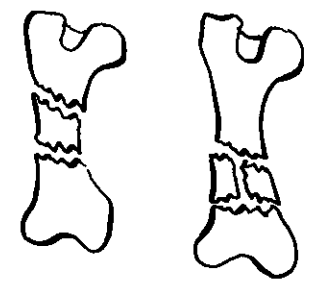
Facture (fx) classification

Type	Facts	Illustrations
Open vs. Closed: 1st step in fracture classification, directly affects prognosis, treatment & management. Open fxs require more aggressive initial Tx		
Open Fractures - (compound is an old word, not used)	• Bone exposed to outside • Skin defect **(assume open)** • Possibility of contamination & osteomyelitis only if mismanaged • SQ emphysema (radiology) - If fragment long, rapier, probably open - If no gas still could be open, check clinically	
Closed fractures	• Not open to outside • Better prognosis than opened	

Fx lines: Simple vs. Multiple

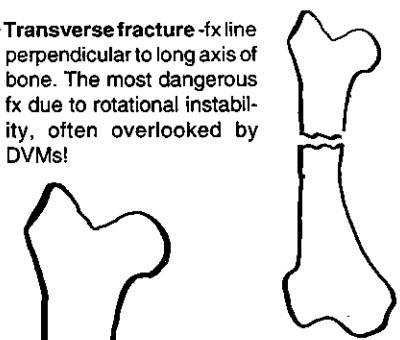
Simple	• **Single cleavage line (fx plane)**
Incomplete or "greenstick"	• **Young animals** • Only 1 cortex breaks (convex side) • Heals quickly, but may become complete!
Torus	• "Folding" fx • Only 1 cortex (concave side)
Avulsion	• Fx of a ligament or tendon attachment • Small fragment
Chip	• Small fragment • Doesn't involve attachments
Multiple	• **More than 1 fx (line) plane**
Comminuted	• 3 or more bone fragments with some fx lines intersecting
Butterfly fragment	• Has a wedge shaped bone fragment
Segmental	• Fxs that isolates a segment of shaft of bone • 2 or more fx lines that don't intersect
Stellate Fx	• Multiple fx lines originating from common point
Stress (fatigue) fx	• Microfractures of bone cortex • Due to stress (prolonged exercise rare in animals)
Impaction fxs	• Fragments driven into each other
Compression fx	• Vertebral bodies, open physes • see line of sclerosis (white line)
Pathological fx	• 2° Fx due to bone weakness due to other 1° process (tumor, hyperparathyroidism, nutritional imbalances)





Direction of fractures

- **Transverse fracture** - fx line perpendicular to long axis of bone. The most dangerous fx due to rotational instability, often overlooked by DVMs!



- **Oblique fracture** - fx line other than perpendicular to long axis of bone.

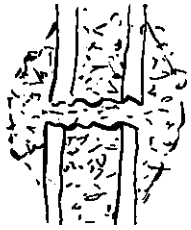
- **Spiral fracture** - curves around, difficult to stabilize - once stable heals rapidly

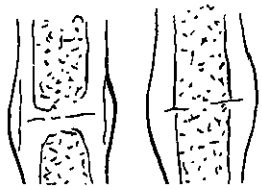
***All fx's heal if properly stabilized w/out delay**

Fracture healing factors

1) **Blood supply**: a must, requires a lot of metabolic activity
2) **Location**: metaphyseal fracture heal faster than diaphyseal because of the greater blood supply
3) **Motion at fracture site**: if can't stabilize then get delayed on nonunion
4) **Type of fracture**
   - Severe displacement w/ overriding of fragments: (vascular disruption potential)
   - Poor apposition affects stabilization & callus formation
   - Physeal fractures can effect germinal layer & result in growth deformities
5) **Infection**: no healing or delayed due to endotoxins
6) **Age & condition**: young heal wonderfully (2-4 wks) , geriatric patients slowly
7) Nutrition, obesity, diabetes, etc. compromise healing

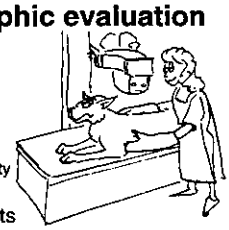
Types or fracture healing





- **1° bone healing (no motion): No callus**; direct healing by formation of bone. Occurs only with **rigid compression fixation**
  - Radiographically: No callus, progressive loss of sclerosis to bone ends, progressive disappearance of fracture line
- **2° bone healing**: when there is **some motion** of fx site
  - **Bony callus** (fibrocartilage or fibrous connective tissue) forms to stabilize fragments, once motion is stopped, callus is progressively ossified. Radiographically - Ideally:
    .. 2 weeks: soft callus appears
    .. 4 wks: callus smoother & more opaque (calcified) starting to bridge gap
    .. 12 wks: callus remodeled for months to years to normal medullary cavity & cortex
  - Excessive or continuous motion leads to callus resorption - NONUNION!
  - "Gap healing": callus formed when bone ends not in close apposition even w/out motion.

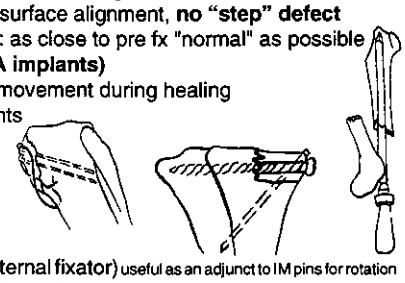
Post reduction & follow up radiographic evaluation



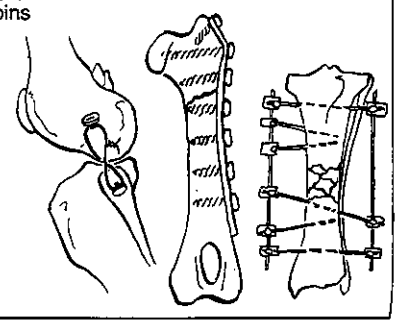
Follow up radiographs taken in the following situations:
- Immediately after reduction
- After major alteration (removal, adjustments or additions)
- Routinely every 6 wks to 6 mo assess healing
- Complication (from CS)

Initial post-reduction radiograph: evaluate fracture reduction & alignment, placement of orthopedic devices, joint congruity

- **Fracture reduction**
  - Simple fxs require at least 50% contact of fragments
  - Joint fx: require precise articular surface alignment, **no "step" defect**
- **Anatomical fragment alignment**: as close to pre fx "normal" as possible
- **Orthopedic fixation device (AKA implants)**
  Evaluate if will be able to prevent movement during healing
  Proper apposition of bone fragments
  Devices



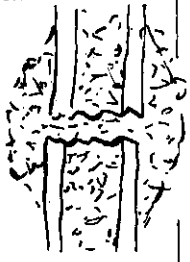
  - **Intramedullary pins**
    . Sufficient size
    . Seated correctly
    . Not penetrate joint space!
  - **Kirshner-Ehmer apparatus** (external fixator) useful as an adjunct to IM pins for rotation stabilization of transverse fxs. 3 pins (2 in 1 fragment) best. Usually can be removed in 3-5 weeks when rotation stabilized by callus. Also used for highly unstable comminuted or open fxs.
    . Low-speed power drill to place pins
    . Properly angled
    . Must penetrate both cortices
  - **Orthopedic wires**
    - Adequate size: 18 & 20 g only
    - Not loose or broken
  - **Bone plates**
    - Correct size
    - Minimum of **5 cortices per side of fx**
    - Anchored securely



Follow up evaluation every 3-6 weeks

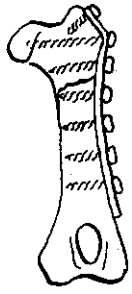
- **ABCDs** (mnemonic, G. Boring)

A- Alignment: reduction or rotation



B - Bone:
- Callus formation; sequestrum (sharp margins & ↑ opacity)
- Opacity - osteomyelitis or osteoporosis, ossifying callus

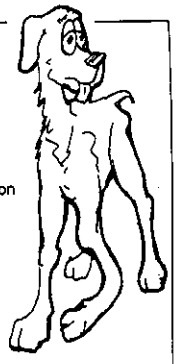
C - Cartilage, joint
- Effusions suggest DJD
- Device into cavity



D - Device
- Compare to previous films
- Check movement, bending, breakage,
- Radiolucency of bone around the device
- Motion of implant or fx fragments
- Osteomyelitis
- Bone necrosis due to heat of drill

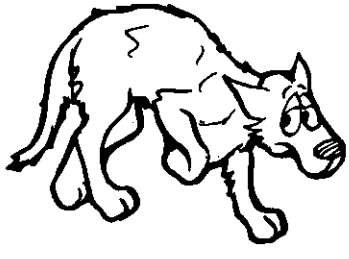
S - Soft tissue
- 7-10 days emphysema & soft tissue swelling from surgery should be gone or almost gone
- Emphysema or swelling indicate infection or communication w/ environment

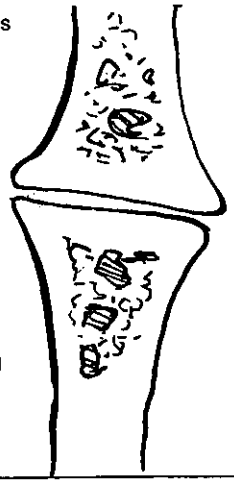
Complication - fx: if bone not healed in projected time (estimated based on age) see delayed union - prolonged healing time - callus, etc.



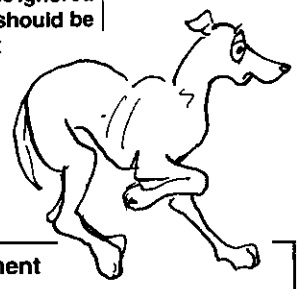
- **Malunion** - healing in abnormal alignment
  - If severe angulation or rotation, may impair weight bearing function & lead to DJD
  - **Step defect** (joint malunion) leads to DJD (degenerative joint diz)
- **Delayed union**: self explanatory (usually due to ↓ blood supply) if corrected will heal if not will go to nonunion
  - Fracture lines still evident
  - Minimal callus bridging
  - Fragments remain sharp
- **Nonunion**: loss of open medullary cavity (pseudoarthrosis - false joint).
  Not a nonunion until medullary cavity closes off. If want to repair, must curette medullary cavity to bleeding bone.

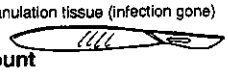
Other complications
- **Osteomyelitis**: not uncommon complication to surgery, rarely hematogenous spread
  - Fever, local heat, swelling, pain
  - **Draining tract**
- **Nerve damage**: e.g., radial nerve w/ spiral fx of humerus, sciatic w/ pelvic fxs
- **Osteoporosis**:
  - Chronic disuse of limb
  - Generalize ↓ opacity
  - Coarse trabecular pattern over entire bone
- **Joint complications**
  - **"Fracture diz"**: 1. stiffness, 2. pain, ↓ ROM (range of motion)
  - Ankylosis
  - DJD
  - Soft tissue & capsular contracture
- **Sarcoma associated w/ fractures**
  - Low incidence
  - Years to develop
  - (Femoral) diaphysis most common
  - Pulmonary metastases

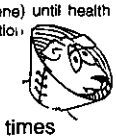


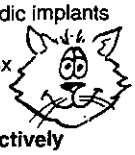


Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Open fxs SAP 1088; Sx-S-hb 540; Sx-S 1608; Sx4B 895; Sx3B 901; Sx-OL 19; Sx-OD 1; X-RP 12 ****	• **Broken bone exposed to environment** - ± **Contaminated w/ bacteria** • **Soft tissue injury** - Simple puncture wound or - Complex w/ vascular compromise & tissue necrosis • Classifications: - **Type 1**: fragment penetrates skin . Soft tissue injury minor & **infection unlikely** w/ proper care - **Type 2**: external penetration causing fx & contamination, generally more extensive contamination than type 1 - **Type 3**: external penetration causing fx, **contamination & severe tissue damage** . Commonly vascular compromise & necrosis or tissue loss . High risk of bacterial infection - **In all 3 types, if wound is ignored & infection develops should be treated like a type 3 fx**	• **Defect in skin** • ± Bone out of skin • Pain, 3-legged lame	• Hx (trauma) CS • Palpation, direct inspection - **If skin defect, presume contaminated** (infected after 8 hrs) unless proven otherwise • Cover all open wounds w/ sterile dressing then: • **Radiology** after dressing placement - Air w/in soft tissue confirms open fx • External coaptation: - Reinforced Robert Jones bandage (injuries below mid femur or humerus) - Spica splint to immobilize shoulder, humerus & elbow • Prepare the wound: - **K-Y jelly** - fill wound always - sterile K-Y from new tube before clipping or shaving - Clip hair around wound (careful to avoid contamination) - Lavage wound w/ copious quantities of lactated Ringer's solution - Alcohol on skin surrounding wound but avoid contact w/ open wound • **Culture & sensitivity** (swab/remove fluid), Gram stain	• **Emergency** • **Success depends on proper soft tissue wound & fracture fixation** • **Broad spectrum ABs** (change - culture & sensitivity) • Surgical debridement (see boxes), culture & sensitivity • Rigid skeletal fracture fixation - Only after surgical debridement - Use a new sterile pack - External coaptation if fx distal to stifle or elbow joint (very uncommon today) - Surgery: avoid contact w/ traumatic wound • ± Penrose drains or delayed wound closure • Reconstructive soft tissue surgery - Closure (1°, delayed, or 2°) - Skin flap reconstruction . Immediate or delay until granulation tissue (infection gone) • Postoperative care: - **Wound care paramount** . Bandage replaced daily at least . Lavage daily w/ dilute povidone iodine (Betadyne®) or dilute Nolvasan (hexachlorophene) until health granulation tissue indicated infection resolution - Restrict activity - ± Elizabethan collar if necessary - Stage implant removal - Radiographic & PE at appropriate times • Complication: - Continued infection: necrotic soft tissue or bone, unstable fx or unstable orthopedic implants - Delayed healing - Need for staged or additional Sx Prognosis: • **Good: if treated quickly & effectively** - proper wound management, fixation & postoperative care

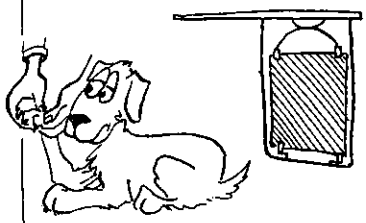




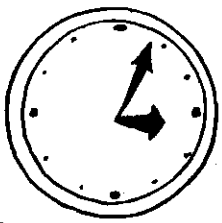




Broken bone exposed to environment
CS: Skin defect, Pain, 3-legged lame
Dx: CS, PE, Rads
Tx: Emergency, ABs, Debride, Fixation, Drains, Wound care
Px: Good if Tx quick & effective



Noninfected open fracture

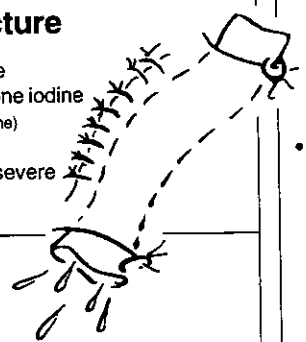


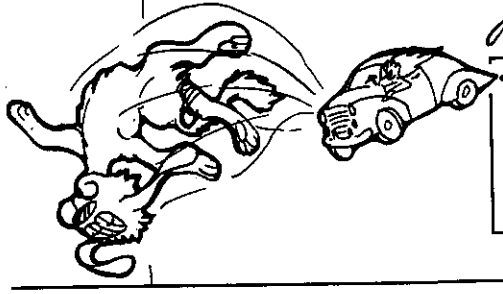
- **"Golden period"**: within 6-8 hours fx may be considered noninfected
- Fracture fixation: stabilize (skeletal)
- ± Penrose drains or delayed wound closure

Golden period = 6-8 hrs

Contaminated open fracture

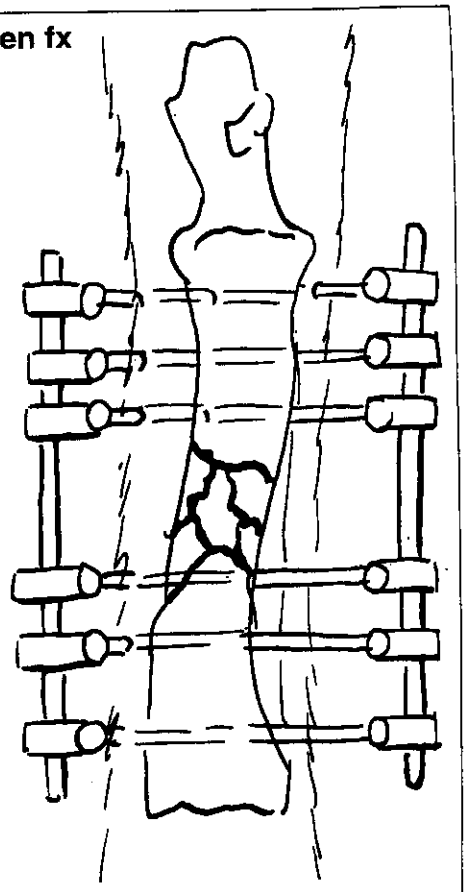
- Carefully debride all nonviable tissue
- Copious wound lavage (dilute povidone iodine (Betadyne®) or dilute Nolvasan (hexachlorophene)
- Penrose drainage
- Delayed or partial wound closure if severe bacterial contamination





Very contaminated open fx

- Handle as an open wound followed by delayed primary of secondary closure
- Extensive debridement (sharply excise grossly contaminated tissue & necrotic muscle, fat, fascia & skin)
- Remove foreign material & small unattached bone fragments
  . Salvage pieces integral to reconstruction
  . Leave bone pieces w/ soft-tissue attachment whether incorporated into the fracture repair or not to preserve blood supply
- **Rigid fixation**: reduce risk & severity of wound infection
  - No IM pins: tends to spread infection
  - Bone plates
  - External fixation recommended if possible



- Controversial: Carpus & tarsus: if arthrodesis is method of fixation
  - Skin reconstruction should precede arthrodesis by 1 month for infection resolution & adequate skin to cover arthrodesis site, other surgeons reconstruct bone/joint 1st and graft soft tissue

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Malunion

SAP 1099; Cat 1700; Sx-OD 13; Sx-OL 118; Sx-WW 209; Sx-S-hb 562; Sx-S 1684; X4T 154

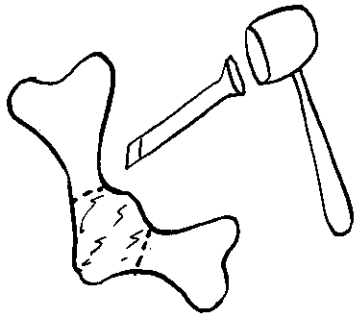
**

- Union w/ a deformity = a functional &/or cosmetic defect
- **Cause: spontaneous healing of untreated fx or improperly treated fx**
- Types:
  - Rotational deformities
  - Limb shortening
- **Affect adjacent joints** directly or indirectly

- **Deformity**
- **± Asymptomatic**
- Sequelae:
  - ↓ Range of motion
  - DJD

- Hx (**fx repair**), CS
- **Radiographs**: characterize the deformity
  - Axis of joint rotation should be parallel to the weight bearing surface
  - Define area w/ most deformity

- **Surgery only when impaired function or cosmetic effect**
- **"Corrective" osteotomy** (may be open or closing wedge, cuneiform, oblique, derotational, transverse, dome etc.)
  - Rigid skeletal fixation
- Postop: exercise restriction, physical therapy
- Complications
  - Under or over-correction
  - Infection (rare)
  - Delayed union or nonunion (rare)
- **Prevent by serial evaluation of healing of fxs. Intervene early & immediately correct**



Deformed fx union
CS: Deformity, ± Asymptomatic
Dx: Hx, CS, Rads
Tx: None to Surgical repair • Px: Good

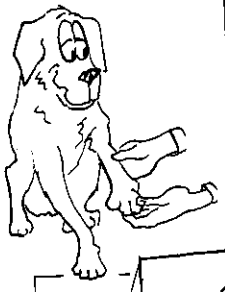
Prognosis: **Good**

Delayed union or Nonunion (pseudoarthrosis)

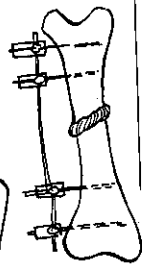
SAP 1096; Cat 1700; Sx-WW 209; Sx-OP 154, 710; Sx-S-hb 559; Sx-S 1676; Sx-B 895; Sx-OL 121; Sx-OD 9; X4T 154 ** - ***

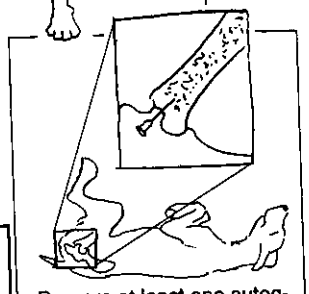
- **Delayed union: healing at a slower than predicted rate**
  - Absolute union will occur eventually
  - Cause: usually age related, blood supply compromises, but existent, Micromotion leads to large viable callus - union
- **Nonunion: failure of a fx to heal**
  - Healing will not occur w/out additional surgery, bone grafting or both
  - > 6 mo for fxs of shaft of long bones
  - > few months for fxs of metaphysis
  - Cause: vascular (viable) or avascular (nonviable)
- **#1 cause: inadequate fixation** & resulting instability
- **Factors associated w/ delayed or nonunion**
  - Fracture location
  - Malposition
  - Fracture gap
    - Soft tissue interposition
    - Distraction (by fixation)
    - Bone loss (trauma or surgical removal)
  - Soft tissue trauma (blood supply loss, trauma or surgery)
  - Inadequate fixation - instability #1
  - Contamination, infection (trauma or surgical)
  - Neoplasia

- **Persistent lameness**
- Sequelae:
  - Disuse muscle atrophy
  - ↓ Range of motion & stiffness
  - Neuromuscular dysfunction
  - Limb angulation &/or shortening

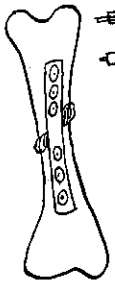


- Hx, CS, PE
- **Radiology** - serial evaluation
  - **Delayed union**: continued healing but slow
    - Persistent fracture line (nonbridging callus)
    - Opened marrow cavity w/o significant sclerosis
  - **Nonunion**: no progression of repair
    - Smooth fx surfaces
    - Sealed marrow cavity
    - False joint
  - Implant instability
    - Radiolucent halo around a screws or wires, etc.
    - Change of position of implant on serial radiographs





- Prepare at least one autogenous cancellous bone door site (ilium & proximal humerus)

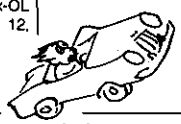
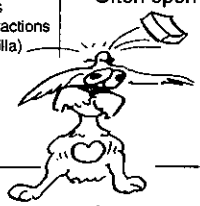
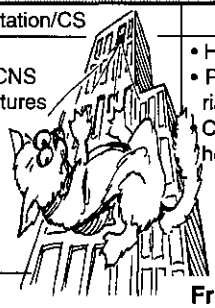
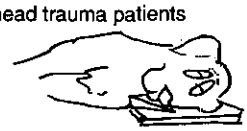
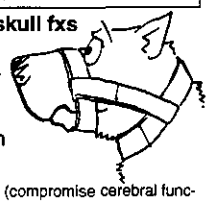


- Culture fx site (anaerobic & aerobic)
- **Perioperative ABs** (Keflin), continuous ABs depending on culture & sensitivity
- **Delayed union or viable nonunion**
  - **↑ Stability** (add IM pins, external fixator, bone plate)
- **Viable (vascular) nonunion: requires compression only**
  - **↑ Stability** (add IM pins, external fixator, bone plate **under compression**)
- **Nonviable (avascular) nonunion: requires resection, graft & compression**
  - **Debride fx site** to restimulate fx healing
    - Remove fibrous connective tissue (debridement, transverse ostectomy
  - Reestablish medullary continuity (drill sclerotic bone)
  - "Single" or decorticate small chips of bone on either side of nonunion
  - ± Autogenous cancellous bone graft
  - ↑ Stability (bone plates only under **compression**)
  - Close
    - Suction drain if infection or dead space
    - Leave open if grossly infected; 1° wound closure w/ cancellous bone graft later
- Postop: Physical therapy
  - Passive range of motion therapy
  - Short walks & swims
  - Encourage controlled weight bearing (improves circulation)
  - Open wound management
    - Change bandages daily
    - Keep bone & soft tissue moist
    - Goal is healthy granulation tissue

Prognosis: Good
- Tolerates up to 20-30% loss in length before gait abnormalities
- Healing will proceed if stable in presence of infection

#1 inadequate fixation
CS: Persistent lameness
Dx: Rads
Tx: Delayed union: ABs; ↑ Stability
Nonviable nonunion: ABs; Debride fx, ↑ Stability
Px: Good

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Fractures of skull SAP 941; SX-WW 260; Sx-hb 616; Sx-S 1910; Sx-4B 473; Sx-B 883; Sx-OL 108; X4T 45; X-Gr 12, 154(f) **	• **Cause: trauma** - HBC (hit by car) - Fighting, gunshots - High rise falls in cats - Iatrogenic: tooth extractions (mandible or maxilla)	• **CS of trauma** • Intercranial fxs: CNS - Often open fractures	• Hx (**trauma**), CS, PE • Radiology: may require serial rads if poly trauma Complete neuro exam for all head trauma patients	• **Conservative: for most skull fxs** • **Surgery: uncommonly performed** because fine motor movement not required in small animals pets - Performed for depression fxs of frontal sinus (#1), fxs depressing into brain (compromise cerebral function), Zygomatic arch Sx if compromises mastication or ocular structures

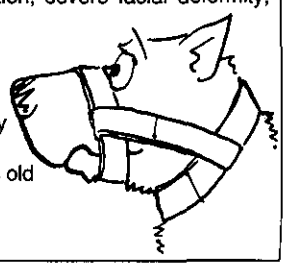






Zygomatic arch fractures:
- Tx: Conservative Tx if nondisplaced fxs; Sx: reduce fx - orthopedic wires
- Px: Good for conservative (nondisplaced fxs) & surgery

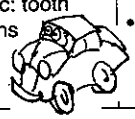
Extracranial fxs:
- Facts: Traumatic fxs of nuchal crest, sagittal crest, frontal sinus, usually nondisplaced because of cranial muscle mass
- Tx: Conservative: usually nondisplaced because cranial muscle mass provides stability; Surgery: elevate periosteum for anatomical reduction, orthopedic wire reduction, do not use small pins: pin migration into eye & brain
- Px: **Good**

Intracranial fractures:
- Facts: **Usually closed fxs**, may lacerate venous sinuses, meninges or cerebral cortex
- CS: **CNS compromise**, medical management of CNS trauma (concussion & 2° cerebral edema) prior to anesthesia for diagnostic procedure. If progressive deterioration despite medical care - skull radiology
- Tx: **Sx**: drill multiple small holes for elevation, elevate depressed calvaria fxs w/ small elevator, remove comminuted fragments that may cause laceration of cerebrum, remove any hematoma. Temporalis adequate coverage for any defect. Monitor post surgery: serial neurologic exams
- Px: **Good** for cranial fx repair; Guarded: variable neurological recovery

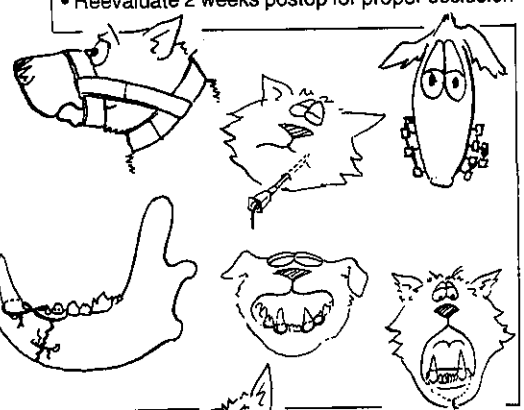
Fractures of maxilla:
- Facts: Cause: trauma, CS of trauma, Nasal/airway problems (epistaxis)
- Stabilize animal first, airway very important, check occlusion/malocclusion, Radiology
- Treatment: **Goal: Restore normal anatomical alignment** (dental occlusion)
  - **Conservative: Tape muzzle**, avoid complete closure of mouth; ± Elizabethan collar, Soft diet, 4-8 weeks
  - **Sx: Interfragmentary wiring**: comminuted fxs maxillary or incisive bone
  . **Interdental wiring**: [22-24-gauge] close to gums, twist on buccal side, cover twist w/ resin or wax (Ivy loop: wiring pattern between 2 firmly embedded teeth, Stout continuous loop: wiring pattern between teeth that are loose)
  . Small bone plates & K/E external fixators
  . Open reduction: indictions: airway obstruction, severe facial deformity, oronasal defect, lack of alternate Tx;
  . Soft diet (gruel or liquid), deny balls, bones, stick, owners monitor occlusion
  . Complications: infection, oronasal fistulas, bone sequestration (rare), chronic respiratory obstruction, malocclusion or tooth loss, altered normal growth in animals < 6 months old
  . Prognosis: **Good** if adequate stabilized & soft tissue managed



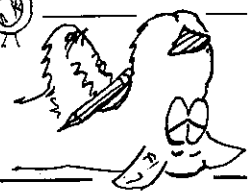
Mandibular fxs SAP 945, Cat 1653; Sx-hb 617; Sx-S 1912; Sx4B 977; Sx3B 890; Sx-WW 261; Sx-Fx 4; Sx-OP 659; Sx-OL 108; X4T 45; X-Gr 20, 154(f) ***	• *Cause:* **trauma** - *HBC (hit by car)* - Fighting, gunshots - High rise falls in cats - Iatrogenic: tooth extractions	• Asymmetry of jaw • Nasal oral hemorrhage • Nasal obstruction • Majority open fxs • Sequelae: Malocclusion, Osteomyelitis, Nonunion, Malunion, Implant failure, Infection of soft tissue	• Hx (**trauma**) , CS • Palpation: crepitation on manipulation • Malocclusion • Oblique radiographs - Check for other fxs (maxilla)	• **Surgery**: pass intubation tube through a temporary tracheostomy so occlusion can be checked - Insure proper dental occlusion - Rigid fixation: earliest return to function - Tooth roots can interfere w/ placement of fixation devices, avoid roots & mandibular canal - Mandibular body fxs, consider as open fxs = ABs - Don't remove a tooth in a fracture line if it stabilizes reduction, exposed tooth roots at a fx line promote nonunion • Nursing care: pharyngostomy or gastrotomy tube - Daily oral flushing postsurgery • Reevaluate 2 weeks postop for proper occlusion

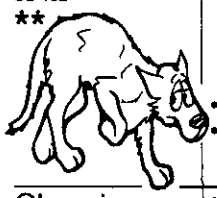
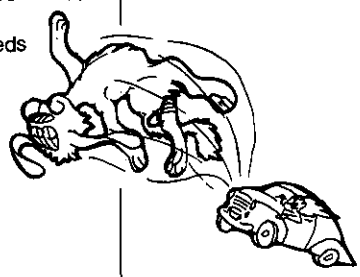
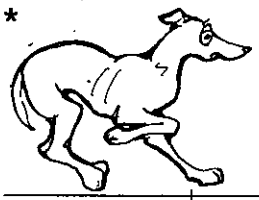
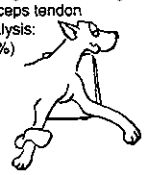
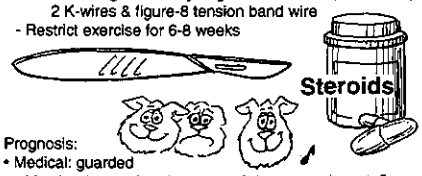


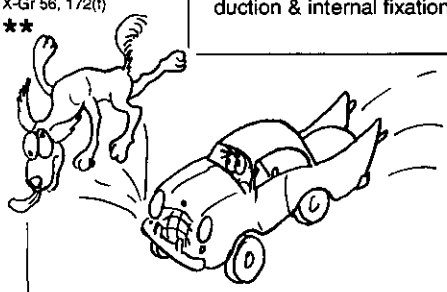
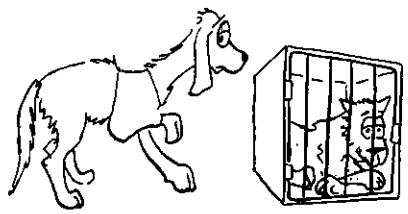
- **Mandibular symphyseal fxs** ***: most separation of the cartilaginous joint; Wire stabilization - full cerclage (hypodermic needle guide for wire through skin). Soft food until wire removed, heal by fibrosis
- **Rostral mandibular body fxs**: repair complicated by small amount of bone for implants & common bilateral fxs
  - Tx: **Tape Muzzle**: tolerated by most dogs; Cats & brachycephalic breeds not as well; Figure eight wire: for bilateral fxs; Cross pinning: K-wires or IM pins in selected cases (avoid roots)
- **Central mandibular body fx**
  - Tx: **Plate fixation** (TOC) , 2 screws at least on either side of fx; **Severely comminuted fxs**: external pin fixation (pins, clamps & connecting bars; **Stable fxs & tight teeth**: interdental wiring around fx line & figure eight around teeth; **Tape muzzle**
- **Caudal mandibular fxs:**
  - Tx: **Tape muzzle**: for minimally displaced fxs; Bone plates & interfragmentary wiring: for displaced & unstable fxs
- Mandibular ramus fxs:
  - Tx: **Tape muzzle**: enough for many especially if high up; Lower ramus fxs: small plates, interfragmentary wiring, K-wire fixation in combination w/ orthopedic wire
- Condyloid process fxs *: usually are minimally or nondisplaced, Evaluate TMJ joint radiographically
  - Tx: **Benign neglect** (most heal), Displaced fxs internal fixation may be beneficial; Condylectomy: for non-reducible condyloid process fxs



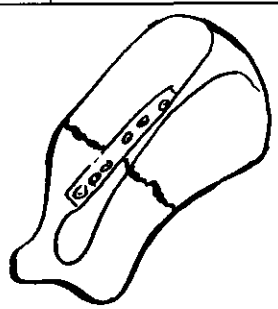
Jaw locking * SAP 950	• Trapping of condyloid process lateral to zygomatic arch - Can occur when dog yawn widely or due to trauma • Treatment: open jaw as wide as possible & push on bulge of condyloid process & then close jaw while continuing pressure	
TMJ/mandibular luxation SAP 950; Cat 1653; Sx-hb 618; Sx-S 1918; Sx-WW 267; Sx-OP 669; X4T 54 **	• Isolated injury or associated w/ other mandibular fxs; Cause: trauma, temporomandibular dysplasia: nontraumatic cause; Reported in St. Bernards, Basset, I. setters, Amer. cocker • Dx: Palpation & radiology • Tx: Replace mandible via closed reduction: anesthetized in dorsal recumbency, pencil or dowel across last molars, close mouth over pencil & move jaw back in place. Tape muzzle for 2-3 weeks. Soft diet for 4-6 weeks	



Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Shoulder luxation H3B 814; E 2338; Cat 1689; Sx-S-hb 570; Sx-S 1710; Sx-WW 251, 252; Sx-OP 230; Sx4B 1075; Sx3B 740; Sx-OL 170; Sx-OD 132 ** 	• **Uncommon** in dogs & cats • Cause: - **#1 trauma** - Conformation, miniature breeds • Lateral luxation - Small & miniature breeds • Medial luxation - Miniature breeds - Underdevelopment of medial glenoid cavity - Subscapular injury • Cranial luxation • Caudal luxation 	• **Dislocation of shoulder** • **Lameness**	• **Hx, CS** • **Palpation**, difficult if inexperienced 	• **Conservative** - Lateral luxation: reduce luxation . Nonweight bearing sling or Spica splint 2-3 weeks - Medial luxation: reduction . Velpeau-type bandage 2-3 weeks (maintains shoulder, elbow & carpus in flexion & prevents weight bearing) • **Surgery:** - Medial or lateral transposition of biceps tendon - Excision arthroplasty Prognosis: Guarded to good
Chronic bicipital tenosynovitis JAVMA 207(2) 201, 1995; Sx4B 1074; Sx-OP 252 * 	• Unilateral:bilateral - 23:3 • Cause: - **Idiopathic in most** - Trauma • Synovial sheath surrounding biceps tendon is continuous with shoulder joint 	• **Intermittent or progressive, weight-bearing forelimb lameness** - Worse after exercise • Atrophy of infraspinatus & supraspinatus (15%)	• **Pain on palpation** of bicipital tendon in intertubercular groove or manipulation of shoulder, digital trapping of the tendon with the shoulder extended followed by flexion = pain • **Radiology** (C/Ca, Lat & craniodistal-craniproximal flexed or bicipital groove) - Subtle changes or none - **Sclerosis or osteophytosis** of intertubercular groove (100%) - **DJD** (joint osteophytes) (60%) - Mineralization of biceps tendon (20%) - Arthrography: filling defects or irregularities along biceps tendon • Synovial fluid analysis: DJD findings (80%) - ↑ Nucleated cell counts 1,500 - 4,800 Cells/μl 	• **Medical Tx** - **Steroid** (Methylprednisolone acetate [Depo Medrol®] new bottle each case!) into tendon sheath - **Restrict exercise** for 2 weeks - Repeat Depo Medrol® at 2 week intervals if lameness doesn't improve • **Surgical:** - **Tenodesis** (suturing of the end of a tendon to a bone) of bicipital tendon . Lateral transposition of biceps tendon .. Through a hole drilled in greater tubercle or .. Following osteotomy of greater tubercle (replaced by 2 K-wires & figure-8 tension band wire - Restrict exercise for 6-8 weeks  Prognosis: • Medical: guarded - May be due to chronic nature of dogs tested, acute? • **Surgery: excellent**
Suprascapular nerve injury * 	• **See Neuro pg 560**: Called Sweeney in horses • Marked atrophy of supraspinatus & infraspinatus mm. • No gait change			

Scapular fxs SAP 977; Cat 1659; Sx-S-hb 545; Sx-WW 214, 252; Sx-OP 221; Sx-Fx 73; Sx4B 1000, 878; Sx3B 736, 756; Sx-OL 82; Sx-OD 129; X-Gr 56, 172(f) ** 	• *Cause: trauma* • May be associated w/ thoracic trauma, brachial plexus damage (especially suprascapular nerve) • Articular fxs: requiring accurate reduction & internal fixation	• **3-legged lame** • Sequelae: - Thoracic trauma, brachial plexus damage, Horner's syndrome	• Hx (trauma), CS • **Radiology**: at least 2 views 	• **Articular fxs requiring accurate reduction & internal fixation** • Postop: - Coaptation splint support or - Nonweight bearing sling - Restrict activity for 6 weeks - Evaluate at 4-6 week intervals until healed • Complication: DJD & deformities if malalignment of articular surface 

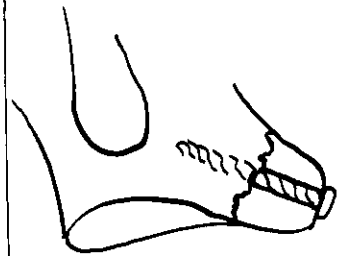
• **Scapular spine & body fxs:**
- Tx: conservative: TOC, Velpeau sling 2-3 weeks
- Displaced fxs: minimal internal fixation + Velpeau sling (small finger plate & interfragmentary wire)



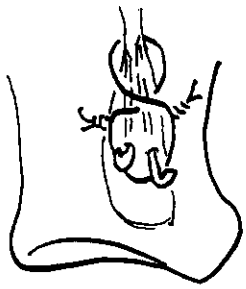
NONARTICULAR SCAPULAR FXS

• **Supraglenoid tubercle:**
- Facts: Biceps brachii m. origin, immature animals most often, distracted distally by biceps
- Tx: Internal fixation: approach; single lag screw or tension band (1-2 Kirschner pins & a figure-8 wire)

• **Acromion fxs or osteotomy**: distracted by deltoid m.
- Tx: Lateral or craniolateral approach over fx, lag screw if large enough, 2 or more hemicerclage wires or figure-8 cerclage wire w/ or w/o Kirschner pins

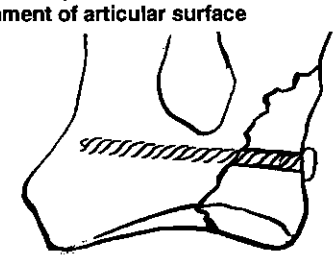


• **Scapular neck fxs:**
- Facts: tend to override (pull of deltoid muscle & pectoralis muscles); Sequelae: limb shortening, brachial plexus trauma, joint malalignment
- Tx: Internal fixation (identify & protect suprascapular nerve), fingerplate, mini-finger plate, standard plates or cross Kirschner pins



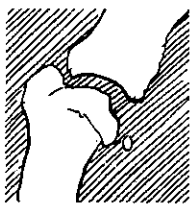
ARTICULAR SCAPULAR FXS

• Glenoid fxs:
- Severe comminuted: salvage in spica splint until heals then arthrodese shoulder or excison of humeral head
- All others: **open reduction & perfect alignment of articular surface**



Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Shoulder OC, Osteochondrosis, Dyschondroplasia, Osteochondritis OCD, Osteochondritis dissecans SAP 1085; H3B 862; E-hb 735; C12T 21173; E 2042; Sx-S-hb 630; Sx-S 1947; Sx-WW 221, 243; Sx-OP 244; Sx4B 1069; Sx3B 749; Sx-OL 185; Sx-OD 136; X-Gr 56 ***	• **Dog problem, not in cat; see pg 604** • **Endochondral ossification failure** • Leads to DJD • **#1 site of osteochondrosis** • **Caudal aspect of head of humerus** - Unilateral or bilateral (50/50) - Male:female - 5:1 • Breeds: **Large & giant breeds**, also Brittanies, Bull terriers, Border collies, & Greyhounds • **Cause: unknown** - **4-10 mo-olds, rapidly growing, large breeds** . Overnutrition, genetics, low copper . Trauma (↓ emphasis last 20 years): causing or affecting abnormal cartilage - **Diet & trauma only factors that can be controlled** • **Pathophysiology:** - Cartilage outgrows its nutritional supply (synovial fluid) - Deepest cartilage cells die - Trauma may cause dissecting flap & joint mice in joint space	• **Partial weight-bearing lameness** • **Stiffness in morning or after long periods of rest** - **↓ w/ exercise** • **Swelling** (distention of joint/ synovitis) • ± Pain on extension of shoulder • Sequela: **DJD**	• **Hx (age, sex breed)**, CS • **Manipulate for pain** • **Radiology: lat. view** (cartilage not seen) - Subchondral bone changes m/ indicate cartilage damage - **Flattening or cratering** of subchondral bone - **Subchondral bone sclerosis** (thickening) - **"Joint mouse":** floating piece of cartilage in joint space (m/b calcified) - **Chronic: DJD** (sclerosis, loss of joint space, periarticular osteophytes) • ± **Arthrography** to see flap or "joint mouse" • Arthroscopic in large patients	• **Conservative** (mild cases w/o mineralized cartilage flaps) - **Rest** (exercise on leash only for 6 months) - Passive flexion 10 minutes TID - Restricted feed intake - NSAIDs (buffered aspirin or PBZ for comfort) • ↑ activity to break flap off where it will digest - Alternative to conservative • **Surgery - arthrotomy** if no change w/ conservative Tx after 4-6 weeks or mineralized flap seen radiographically - Caudal approach to shoulder - Debridement - **Curettage**, scrape down to hemorrhagic bone, let fibrocartilage fill in defect - Remove" joint mice" - Postsurgery: **enforced rest** w/ passive manipulation 10 days TID . Controlled exercise program (leash 30 min. BID 6 weeks) + passive therapy **Prevention:** • Don't over feed (controversial) • Check for mineral balancing diets (copper/calcium/zinc) • Breeding?? **Prognosis:** • **Good** w/ surgery (75% normal, 22% mild lameness) • **Conservative - Poor** • **DJD**: poor for Sx or conservative Tx

DDx:
- Fragmented coronoid process
- Panosteitis
- OCD of elbow
- Ununited anconeal process
- Hypertrophic osteodystrophy
- Bicipital bursitis

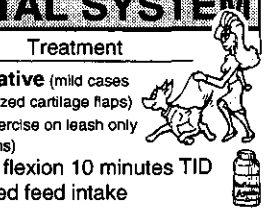


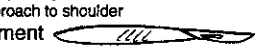
Cartilage defects
Young, Fast growing, Large breeds
CS: Variable lameness, Swelling
Dx: Palpation, Rads
Tx: Conservative (Rest, NSAIDs); Sx

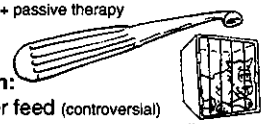
Osteochondritis:
- **Defect in articular cartilage**

Osteochondritis dissecans:
- Osteochondrosis w/ a dissected flap of cartilage
- Fragment can calcify &/or break off - " joint mouse"

Subchondral bone cyst (misnomer: not secreting membrane, rather a wad of necrotic cartilage w/ a sclerotic layer around it)



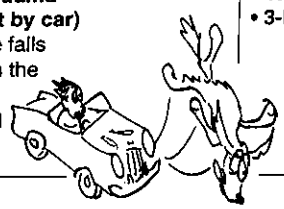




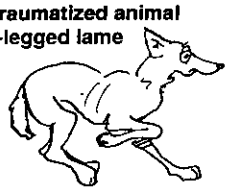
Humeral fxs

SAP 984; Sx-OL 83; Sx-OD 142; Cat 1559; Sx-WW 214, 252; Sx-OP 261; Sx4B 1004, 879; Sx3B 765; Sx-S-hb 572; Sx-S 1716;
***

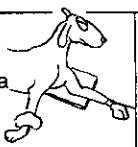
- ***Cause: trauma***
- **HBC (hit by car)**
- High rise falls
- Majority in the middle & distal third



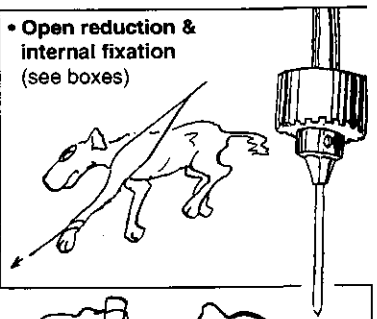
- **Traumatized animal**
- **3-legged lame**



- Hx, CS
- Palpation
- R/O thoracic trauma
- **Radiology:**
- To characterize fx
- Consider thoracic films
. R/O Pneumothorax, hemothorax, diaphragmatic hernia, rib fxs, chylothorax, traumatic pericarditis



- **Open reduction & internal fixation** (see boxes)



- **Proximal physeal fxs**:
- Facts: uncommon, Salter type 1 or 2, normal closure at 10-13 months; Usually complete fxs, also incomplete & impacted
- **Tx: Open reduction & internal fixation**; approach (craniolateral), double Kirschner wires or Steinmann pins or Rush pins (remove when healed)

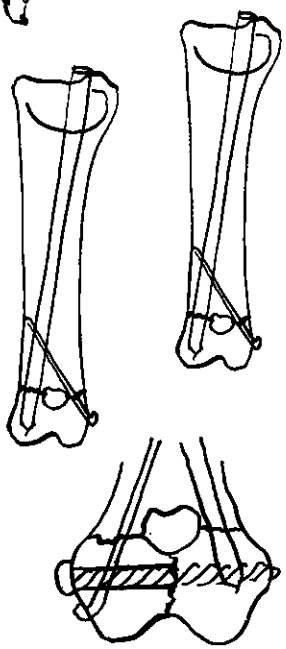
- **Proximal diaphyseal fxs - humerus**: Infrequent
- **Tx: Open reduction w/ internal fixation**, Cranial approach (elevate deltoid *m*); Single or double Steinmann pins normograde; Cerclage wire or type 1 external fixator for rotational stability; Double Rush pins; Bone plate on cranial surface in large dogs
- Postop: restricted exercise

- **Supracondylar fxs**: supratrochlear foramen is weak spot.
- Tx: **Steinmann pin(s) into medial condyle, + cross pin from lateral condyle for rotational stability**; double Rush pins, Small plates
- Post op: physical therapy critical to prevent postoperative loss of elbow function

- Condylar fxs:
- Facts: 90% lateral condyle, spaniels, displaced distally
- Treatment: **open reduction & internal fixation** always necessary for anatomical alignment of joint surface, lag screw
- Post op: early range of motion, screws usually not removed

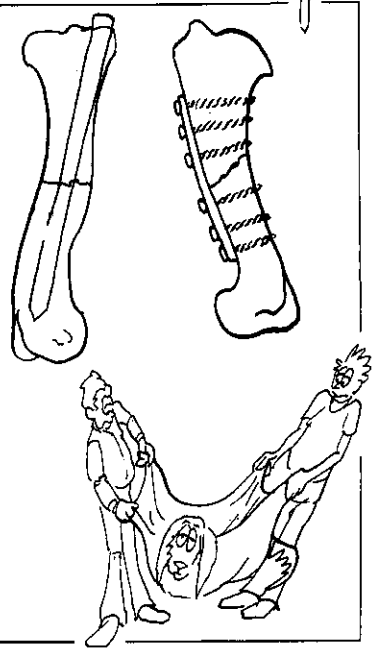
- T or Y (intercondylar fxs): **refer: difficult** to repair

Tx: Surgical emergency, **require immediate Sx** to have function restored. Lag screw condyles together & then connect (lag-screw or 2 bone plates) lateral condyle to diaphysis
Px: Guarded: 46% moderate limb function, 18% severe lameness



Diaphyseal fxs****

- Facts: Often spiral or oblique; may entrap **radial nerve**, overriding of fragments due to muscle contracture
- **Open reduction**: lateral approach, locate radial nerve overlying brachialis muscle, retract muscle to protect nerve
- Normograde pin fixation, engage medial condyle
- Stacked pins
- Full or hemicerclage wires
- Kirschner apparatus (oblique & spiral fxs)
- Plate (cranial), medial or lateral
- Postoperative: Early range of motion, but restrict activity; Remove Kirschner apparatus in 4-6 weeks if clinical union evident; Remove IM pins following healing, Plates can be removed, but usually not done



Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Elbow OC, Osteochondrosis, Dyschondroplasia, OCD, Osteochondrosis dissecans

SAP 1082; H2B 864; C12T 1173; SAP 984; 5min 888, 540; Sx-WW 221, 243; Sx-OP 307; Sx-S-hb 631; Sx-S 1957; X-RP 35; X-Gr 62; X4T 132; Sx-OL 189; Sx-OD 159; NB 16.9

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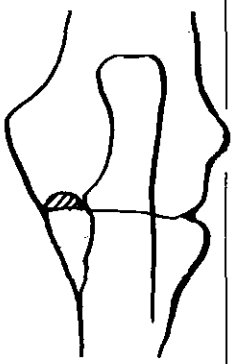
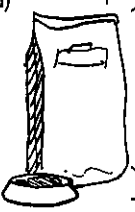
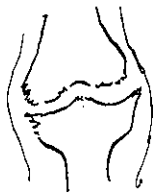


- **Failure in endochondral ossification of elbow**
- Less common than shoulder joint
- Tends to be bilateral
- **Medial condyle of humerus**
  - Subchondral bone cyst (misnomer: not secreting membrane, rather a wad of necrotic cartilage w/ a sclerotic layer around it)
- Often accompanies ununited anconeal process & fragmented coronoid process
- **Cause: unknown**
  - **4-10 mo-olds, rapidly growing, large breeds** (Golden retriever, Lab, Rottweiler)
  - **Overnutrition,** genetics, low copper?
- **Pathophysiology:**
  - Cartilage outgrows its nutritional supply (synovial fluid)
  . Deepest cartilage cells die

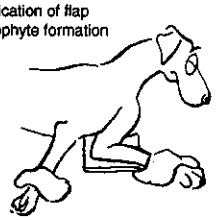


- **Variable lameness**
- **Swelling** (distention of joint/synovitis)



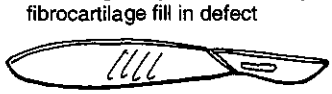
- Sequelae: **DJD**

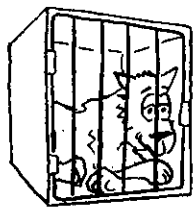
- **Hx (young, large),** CS (lame & joint distention)
- **Manipulate for pain**
- **Radiology** (cartilage not seen)
  - Subchondral bone changes m/ indicate cartilage damage
  - ± Serial films 4-6 weeks apart before shows up
  - **Subchondral bone lucency in medial condyle** (CrCa view)
  - **Subchondral sclerosis** & calcification of flap
  - Osteophyte formation



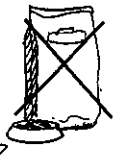
DDx:
- Fragmented coronoid process (FCP)
- Ununited anconeal process (UAP)
- Panosteitis
- Trauma
- Hypertrophic osteodystrophy

- Conservative not recommended because of 2° DJD
- **Surgery - arthrotomy**
  - **Debridement**
  - **Curettage** to good hemorrhagic bone, let fibrocartilage fill in defect





Prevention:
- Do not over feed (controversial)
- Check for mineral balancing diets (copper/calcium/zinc)
- Breeding affected animals controversial



Prognosis:
- **Good** w/ early Sx for soundness
- **DJD**: extremely poor

Cartilage defects; Young, Fast growing, Large breeds
CS: Variable lameness, Swelling
Dx: Palpation, Rads: Cyst in med. condyle
Tx: Sx

Ununited anconeal process; UAP

SAP 1080; H3B 818; H2B 865; 5min 540; C12T 1176; 5min 540; Sx-WW 221, 247; Sx-OP 300; Sx4B 1083; Sx3B 778; Sx-S-hb 638; Sx-S 1977; Sx-OL 193; Sx-OD 160; X4T 132; X-RP 37; X-Gr 16.9

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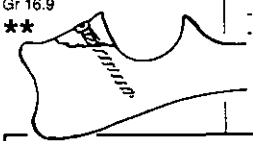
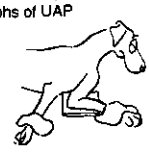


- **Failure of anconeal process to unite w/ ulna**
  - **Separate ossification center**
  - Normally unites at 4-6 months
- Large breed dogs (G. Shepherds)
- Bilateral in 30%
- Felt to be related to OCD
- Types:
  - Cartilage retention nest
  - Delayed union
  - Nondisplaced nonunion
  - Displaced nonunion

- Variable degree of lameness
  - Worsens w/ exercise usually
- ± Swelling

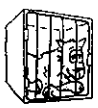
DDx:
- OCD of elbow
- Fragmented coronoid process
- Panosteitis
- Hypertrophic osteodystrophy
- DJD
- Elbow incongruity

- Hx, CS
- Palpation: crepitation & pain on **extension**
- Radiology (Hyperflexed lat. view is diagnostic view (pulls anconeal process out of humerus)
  - **Ununited after 6 mo. of age**
  - **Panosteitis in adjacent bones**
  - Look for:
    . Fragmented coronoid process & OCD
    . ± DJD - elbow (7-8 mo)
- R/O other causes of elbow pain even with positive radiographs of UAP

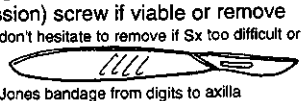


OFA will now certify elbows (flexed lat. film sent for evaluation)

- Cartilaginous retention nests: unlikely to cause lameness
- **Delayed union**
  - Confine/Rest animal
  - Re-radiograph monthly for union



- **Displaced nonunion** (joint mouse)
  - Surgically remove
- **Nondisplaced nonunion**: refer because technically demanding Sx
  - Lag (compression) screw if viable or remove
  - Lateral approach, don't hesitate to remove if Sx too difficult or unsuccessful
  - Postop
    . Modified Robert-Jones bandage from digits to axilla 10-14 days, remove sutures in 10-14 days
    . Long term if reconstruction Sx
    .. Leash walking only for 6-8 weeks
    .. Re-radiograph in 4-8 weeks
    ... Nonunion remove screw & anconeal process
    ... Union: remove screw if lame



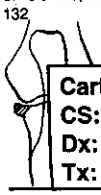
Prognosis: **Excellent** if Sx successful
- Good if process removed, most show lameness at 6-7 yrs of age
- Concommitant FCP, OCD or both dramatically change prognosis

Failure to unite w/ ulna > 6 mo
CS: Lameness
Dx: Rads: Ununited > 6 mo
Tx: Surgically removal, Screw • Px: Excellent

Fragmented medial coronoid process, FCP **

"Ununited coronoid process"

H3B 815; H2B 865; 5min 540; C12T 1174; Sx-WW 221, 247; Sx-OP 310; Sx4B 1090; Sx3B 774; Sx-S-hb 635; Sx-S 1966; Sx-OL 195; Sx-OD 159; X4T 132

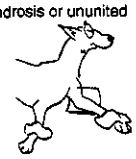


- May be osteochondrosis
- Not a separate ossification center so not ununited
- **Cartilaginous precursor**: improper development & fragments
- **Fast growing large breeds** (Lab, Golden retriever, Rottweilers, Newfy, G. shepherds)
- Often see w/ OCD of medial condyle & elbow incongruity

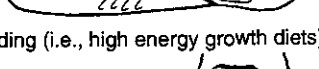
- **Intermittent weight bearing lameness**
  - Worsens after long periods of rest or exercise
- Swelling of elbow

DDx:
- OCD of elbow
- Ununited anconeal process
- Panosteitis
- Hypertrophic osteodystrophy
- DJD

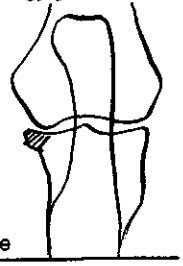
- **Need early Dx**
- **Hx, CS**
- **Often Dx of inference** (cartilage so can't be seen radiographically)
  - **Young dog w/ developing DJD of elbow**
- **Radiography:**
  - Bone proliferation on cranial aspect of olecranon process
  - Sclerosis where the joint capsule attaches
  - No other osteochondrosis or ununited anconeal process
- ± Exploratory arthrotomy to confirm



- Conservative Tx not recommended
- **Removal of osteochondral fragment** (TOC)
  - Arthrotomy from medial side

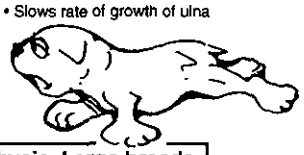
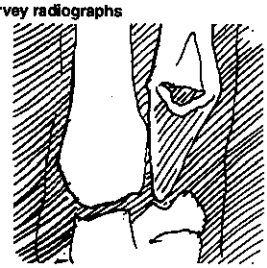
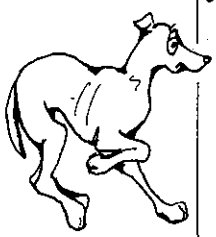
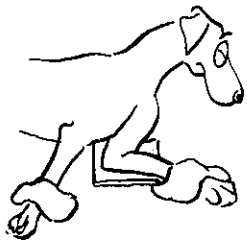
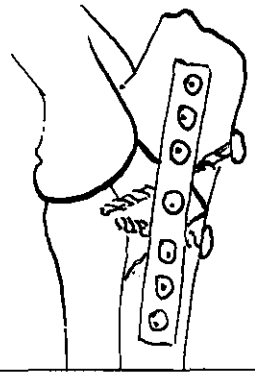


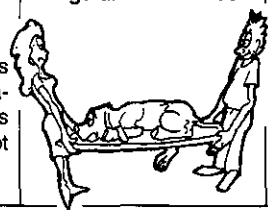
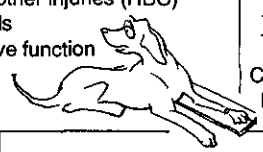
Prevent: feeding (i.e., high energy growth diets)



Prognosis:
- **Guarded**
- **Poor** after 13 months of age

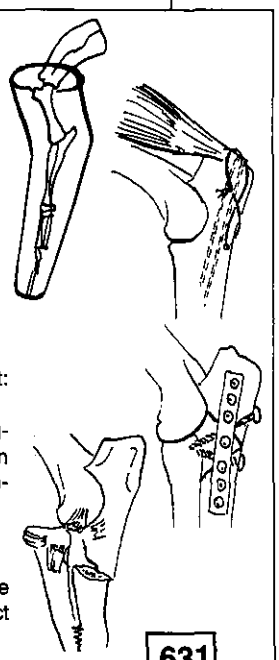
Cartilage + Nutrition of Large breeds
CS: Intermittent lameness
Dx: Often Dx of inference
Tx: Remove fragment • Px: Guarded

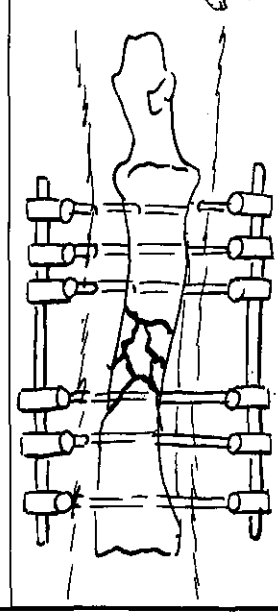
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Retained ulnar enchondral cartilage cores H3B 834; H2B 884; SAP 1078; Sx-WW 222; Sx-OP 697; X4T 137; X-RP 22; NB 16.18 *	• In distal ulnar metaphysis • Young, larger-breed dogs • Cause: unknown • Slows rate of growth of ulna 	• **Incidental finding** • May interfere w/ normal growth of ulna • Sequela: - **Forelimb deformities** . Valgus deviation, external rotation of carpus . Cranial bowing of radius	• Incidental finding if no CS • Deformities - **Survey radiographs** 	• **None w/o forelimb deformities** • Forelimb deformities - Distal ulnectomy in growing animals - Ulnar & radial ostectomy - Distal metaphysis of ulna must be left & retain ulnar styloid
Distal ulnar metaphysis, Large breeds **Tx: None to ulnectomy or ostectomy** **CS: Incidental finding, deformities**				
Elbow joint fxs SAP 984; Sx-WW 252; Sx4B 1279; X-Gr 17B(f) **-***	• Cause: trauma - **HBC (hit by car)** - High rise falls • **Anatomical reduction required or DJD** • Elbow joint articular fxs: - Monteggia: radial head luxation - Humeral condylar fxs - T or Y fxs of humeral condyle - Radial neck or proximal physeal fxs - Trochlear notch fxs - Olecranon fxs 	• **Traumatized animal** • **3-legged lame** 	• Hx, CS • Palpation • R/O thoracic trauma • Radiology - To characterize fx - Consider thoracic films . R/O Pneumothorax, hemothorax, diaphragmatic hernia, rib fxs, chylothorax, traumatic pericarditis 	• **Open reduction & internal fixation** - Because can't immobilize joints on both sides of fx (shoulder joint) w/ closed reduction & external fixation • **Need anatomical reduction to prevent DJD** 
Anatomical reduction required or DJD **CS: 3-legged lame** **Dx: Radiology** **Tx: Open reduction & internal fixation**				

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Radial & ulnar fxs SAP 993; Cat 1662; Sx-WW 215, 252; Sx-OP 321;Sx4B 1021, 881; Sx3B 783; Sx-S-hb 577; 546; Sx-S 1736; Sx-OD 180; Sx-OL 93; X-Gr 64 ***	• ***Cause: trauma*** - HBC (hit by car) - Falling or jumping injuries • Often open • Anatomically impossible to pass an IM pin retrograde in the radius from fx site, but can pass one normograde from distal, not proximal	• **Acute lameness** • **Angular deformities** 	• Robert-Jones bandage or splint to prevent further soft tissue trauma • Hx (history), CS (clinical signs) • Palpation: check for wounds (open fx) • **Radiology** • Check for other injuries (HBC) - Chest rads • Check nerve function 	• **Exact anatomical reduction & rigid fixation is essential** • Early return to weight bearing • Preserve neurovascular structures • Postop: - Soft padded bandage 3-10 days - Revaluate radiographically every 6 weeks until heals - Restrict activity until heals - Monitor for early closure of growth plates Complications: Delayed union, nonunion (toy breeds), joint stiffness, arthritis (DJD)

Fractures of radius & ulna

- **Simple fxs of ulna & radius**: often treated w/ external casts
- **Distal radial & ulnar fxs**: in toy breeds
  - Facts: **Prone to nonunion due to marginal blood supply**
  - Tx: Always Tx w/ **Sx, compression & graft** as 1° method (mini or cuttable plate)
- **Olecranon fxs**
  - Tx: **Tension band appliance** (2 IM pins & figure eight wire) to counteract pull of triceps brachii muscle
- **Trochlear notch fxs**
  - Need exact anatomical reduction because articular; Counteract tension pull of triceps brachii muscle
  - Tx: Small & medium dogs & cats w/ no comminution present: 2 pins & figure eight tension wire as for olecranon fxs
    . Larger dogs or comminuted fxs: large screw butterfly fragments, contour bone plate on caudolateral side, tension application if no comminution, neutralized application if comminution
- **Monteggia fracture**:
  - Facts: Fx of proximal 1/3 ulna w/ radial head luxation
  - Tx: Reduce & stabilize radial head luxation & align & stabilize ulnar fx, Contoured plate on caudal aspect of ulna; reconstruct annular lig.





- Midshaft radial & ulnar fxs
  - Goal: Correct angular rotation & length of limb, **prevent synostosis (fusion) of ulna & radius in growing animals**
  - **Transverse fxs** w/ minimum displacement: Closed reduction & cast fixation
  - **Comminuted & oblique fxs**:
    . Bone plates or external skeletal fixation, if possible, 3 or 4 screws/pins on either side of fractures
- **Radial head fxs**
  - Fact: precise anatomical reduction & rigid fixation or DJD
  - Tx: Kirschner wires & lag screw
- **Radial neck & proximal physeal fxs**
  - Tx: Young : 2 Kirschner wires to stabilize w/o fx compression to prevent premature closure of physis, Anatomical orientation of radial head with humeral condyle. Postop: remove wires in 3-4 weeks & monitor for premature closure

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Luxation - Elbow joint

H3B 814; SAP 989; E 2338; Cat 1678; O-L 175; Sx-S-hb 574; Sx-S 1729; Sx-WW 251, 252; Sx-OP 288,6;??146, 150; Sx4B 1101; Sx3B 772

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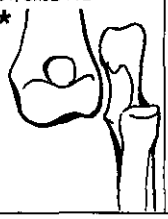
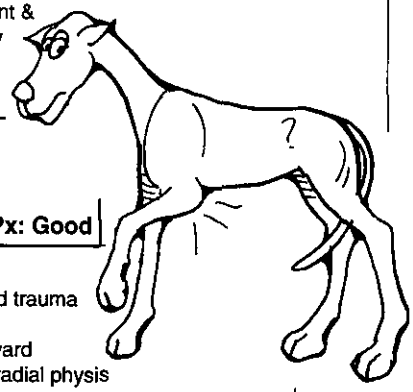
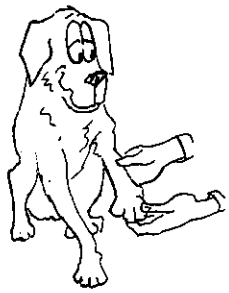


- **Relatively stable joint**
- Cause:
  - **Trauma** usually
  - Following routine activity
- Usually **lateral** luxation because of large size of medial epicondyle
- Results in significant ligament & periarticular soft tissue injury

- Luxated elbow
- **Acute lameness, pain**
- Shortening of limb (proximal displacement of ulna & radius)
- Forearm & paw abducted



- Hx, CS
- Palpation
- **Radiology** - definitive
  - Lateral & craniocaudal views
  - **Check for any fxs**, incl. avulsion fxs of ligament attachments



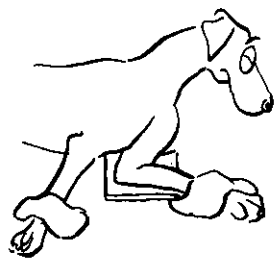
- **Closed reduction luxation** (most cases) best treated as an emergency
  - Possible in first 3 days
  - Anesthesia & muscle relaxation
  - Maximally flex elbow
  - Pull ulnar & radius distally'
  - Rotate forearm internally to engage anconeal process in foramen, then
  - Extend elbow
  - Splint in moderate extension 2-3 weeks
- **Open reduction** if unreducible, unstable on reduction, chronic longer than 3 ds or if fxs present
  - Lateral approach
  - Reduce as for closed reduction above or a transolecranon approach
  - Evaluate ligaments
    - Repair 1 or both collateral ligaments
    - ..Suture or replace w/ 2 screws & figure-8 wire
- Total elbow joint replacement w/ a silicone elastomer prosthesis reported for the future
- Post - reduction
  - Post-reduction radiographs (lateral & CrCa)
  - Splint in extension for radiographs & for 2-3 wk max
    - Schroeder-Thomas or shoulder spica splint
  - Examine at 2, 4,6 & 8 weeks of Sx
  - Controlled exercise program (leash walking) after splint removed for 4-5 weeks

Lateral, Trauma
CS: Lameness, Pain
Dx: Hx, Rads
Tx: Reduce, Splint • Px: Good

Subluxation of elbow

E 2338
**

- Associated w/ growth plate injuries or mild trauma
  - Premature closure of distal ulnar physis
    - Displaces proximal ulna distally/downward
  - Premature closure of distal or proximal radial physis
    - Displaces ulna proximally/upward
    - Medial coronoid process of ulna often associated w/ fx
- Lagging ulnar growth in chondrodystrophic breeds
  - Displaces proximal ulna distal/downward
  - Fxs of anconeal process may occur in chondrodysplastic breeds (Basset hound, English bulldog)
- Associated w/ 3 development diseases of elbow
  - Ununited anconeal process
  - Fragmented medial coronoid process
  - OCD of medial humeral condyle
- Congenital subluxation seen in puppies (Eng. bull & Basset)



Prognosis:

- **Good**: if uncomplicated & promptly treated
- Guarded: if chronic w/ severe cartilage damage or excessive duration of splintage - leads to triceps contracture

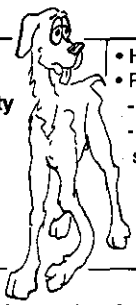
Growth deformities of radius & ulna,

Radial & ulnar dysplasia
SAP 997; H3B 832; H2B 883; Sx-OL 127; Sx-OP 299, Sx4B 1094;Sx3B 793; Sx-S-hb 580; Sx-S 1746

**

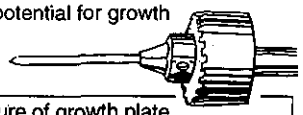
- ***Development abnormality*** *due to asynchronous growth rates of radius & ulna due to:*
  - Total or partial fusion of growth plates: Distal ulna or radius, or proximal radial
- Pathophysiology: **both radius & ulna must grow synchronously or variable curvatures**

- **Lameness**
- Limb pain - variable
- **Noticeable deformity**
- Manifestations
  - Shortening of limb
  - Angulated forelimb
  - Rotated forelimb



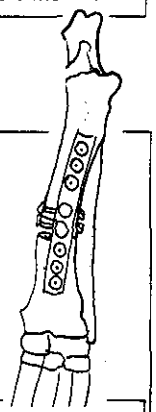
- Hx, CS
- Radiology
  - **Deformity**
  - Elbow & carpal subluxation
  - 2° DJD

- Surgical Tx depends on severity, type of injury, & potential for growth



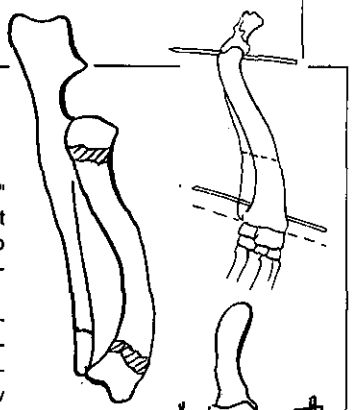
Closure of growth plate
- Ulna
  - Proximal ulna 5-8 months
  - Distal ulna 6-8 months
- Radius
  - Proximal physis 5-8 months
  - Distal physis 6-9 months

Cause:
- Trauma - major or minor fxs
- Hypertrophic osteodystrophy (bone bridging)
- Retained ulnar cartilage core
- Chondrodystrophic breeds
- Inherited distal ulnar closure in Skye terriers
- Synostosis: bony union of radial & ulnar shafts
- Osteochondrosis of growth plate

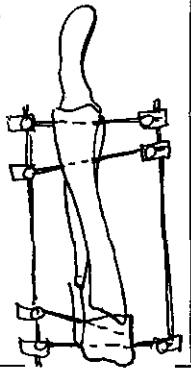


Distal ulnar physis - premature closure

- #1 growth plate disturbances
- Immature dog: Ostectomize 1" (2 cm) of ulna, fill defect w/ fat graft, splint 1 month only if no curvature in radius, if curvature - correct radius ASAP
- **Mature dog**: deformities (bowstring (cranial & medial) of radius, limb shortening, carpal valgus w/ external rotation, elbow subluxation



- **External Kirschner device**: transfixing pin distal radius parallel to articular surface, transfixing pin in proximal radius parallel to articular surface, osteotomy radius at maximum curvature, cut ulna also. Connect bars between 2 transfixing pins so they parallel each other. Drive remaining transfixing pins. Cover device w/ light padded bandage.



Distal radial physis, premature closure

- Closes at 6-9 months, 60-70% of total length, Less frequent than distal ulnar physeal arrest
- **Complete closure** (immature) (bowstringing, valgus deformity of carpus w/ inward rotation, radial head subluxation if early)
  - Tx: Ostectomize 1" (2 cm) section of radius, free fat graft in defect, Splint. When stops growing, reconstruct defect in radius (cancellous bone graft)
- **Incomplete/asymmetrical**: lateral side usually (uncommon) (bowing medially & cranially, distal subluxation of radial head, prox. subluxation of ulna, carpal valgus w/ external rotation, dorsal subluxation of radiocarpal joint)
  - Tx: **Refer**: probe physis w/ 25-gauge needle for extent of closure, curette out closed section, free fat graft in defect, splint till growth stopped, close defect w/ cancellous bone graft

- Proximal radial physis - premature closure*
  - Very rare, Generally noticed when growth is finished; distal luxation of radial head from the humerus
  - Tx: After growth stopped, stepped radial osteotomy. Slide radial head to articulate w/ humerus, 2 Lag screws across osteotomy site, bone plate on cranial radius. Soft padded bandage 10-14 days
  - Immature dog: ostectomy of radius as for complete distal radial closure

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Fxs of carpus SAP 1003; Sx-OL 98; Sx-OD 186; Cat 1665; Sx-WW 253; Sx-OP 351; Sx4B 1103, 1276; X-Gr 66, 184(f) **	• Radial, accessory & ulnar carpal bones • Cause: Trauma - High rise falls - Jump from truck	• **Acute lameness**	• Hx, CS • Radiology: oblique views may be needed	• Remove small chip fxs • Stabilize larger fragments w/ lag screw or multiple Kirschner wires • Partial carpal arthrodesis
Sprain, Luxation, Subluxation: carpal joint SAP 1003; E 2339; Sx-OL 178; Cat 1688; Sx4B 1106; Sx-OP 348 **	• Severe sprain leads to ligament damage • #1 High rise fall w/ limb hyperextended - Rupture of palmar ligaments & joint capsule • Jumping from trucks or decks	• **Plantigrade stance** • Nonweight bearing lameness of 1 or both forelimbs	• Hx (high rise fall), CS • PE: pain on hyperextension • Radiology: anesthesia - **Stress radiographs** in all planes of laxity	• Under 30 lbs: early reduction & cast in flexed position; results in fibrous ankylosis • Over 40 lbs: **arthrodesis** - Pancarpal or partial carpal Prognosis: **Good** if arthrodesis, **guarded** if cast
Medial or lateral carpal instability E 2339; Sx-WW 253; Sx4B 1112 **	• Rupture of medial or lateral collateral ligaments • **Trauma**	• **Lameness**	• Palpation	• **Cast** w/ paw in direction of injury & carpus in slight flexion • Sx: repair any collateral lig. rupture - Prognosis: **Guarded/Good**
Puppy carpal weakness * E 2339	• Insufficient strengthening exercises - Rearing on hard floor, w/ little room for exercise • Noted shortly after go to new owners	• **Hyperextension of carpus** • Trembling of front limbs	• Hx (puppies) • CS • Palpation	• Moderately ↑ exercise - Spontaneously resolves (strengthens) • Contraindicated : splinting or casting Prognosis: Good to poor (especially in giant breeds)
Carpal instability/ Flexion syndrome * C12T 1177	• **Puppies**: 8-16 wks old; Several breeds: Dobie & Shar pei; Cause unknown (taut flexor carpi ulnaris?) • CS: Rapid CS, stand on **flexed carpi**, inward deviation; buckle & walk on lateral forepaw • Dx: Hx (puppy, breed), CS; PE (not swollen, painful or unstable); No radiographic signs, occasionally unilateral • Tx: Spontaneous **recovery** - 2-4 weeks; if worsens or persists - light weight splint in slight extension (3-5 d intervals for 5-7 d; ± cut insertion of flexor carpi ulnaris			
Old age laxity of carpus E 2339 ***	• **Gradual weakness of carpus** • **Old & obese dogs** • Breeds: Doby, Collie, Sheltie, Samoyed, Lab • Metabolic diz	• **Weakness of carpus** • **Plantigrade stance**	• Hx (old), CS	• **No treatment needed** Prognosis: **Good** - Dog does fine

Metacarpal/Metatarsal, phalangeal & sesamoid fxs SAP 1058; Cat 1665; Sx-OD 190; Sx-OL 98; Sx-WW 218, 254; Sx-OP 374; Sx4B 884 **	• Cause: Trauma	• **Acute, nonweight bearing lameness**	• Hx, CS • **Palpation** • **Radiology**	• **Mc & Mt #3&4 must be aligned properly** for wt bearing, Sx judgement call • **Closed reduction** & external coaptation splint or cast: for 1 or 2 metatarsals fractured, other metatarsal supply support, acute phalangeal & sesamoid fxs • **Open internal fixation**: for 3 or more metatarsal fxs: Dorsal approach because of pads on palmar/plantar side - Kirschner wires, plates, lag screws

Onychectomy, Declaw

SAP 1062; CAT 1702; Sx-G 328; Sx-S-hb 145; Sx-S 352

- Surgical removal of 3rd phalanx & claw
- Elective procedure frequently performed on house **cats in USA**
  - Keep from scratching furniture
  - Severely traumatized or infected claw

- Procedure: Surgical prep, tourniquet above elbow
  - Extend claw (grab tip w/ forceps) front limb, it is usually not necessary to remove rear claws
  - **Nail trimmer**: one blade dorsal to distal interphalangeal joint, other blade at distal margin of digital pad
    . Close & twist to remove claw & most of P3
    . May remove, or not, the small piece of P3 left behind
    . **Spare digital pad**
  - or **Scalpel: completely** disarticulate distal interphalangeal joint
  - **Snug fitting bandage** to distal antebrachium for 24 hrs
    . Avoid excessive tightness proximally
- Postop: never send home with bandages on
  - Shredded paper in litter box for 2 weeks
  - **Regrowth** occurs if incomplete removal of ungual crest
    . Disarticulate the distal interphalangeal joint if regrowth happens

Deep digital flexor tenotomy
- Alternative to onychectomy
- Cut DDF tendon: prevents unsheathing claws
- Must trim claws or cat will be able to scratch in time

Digital removal

SAP 1063; Sx-S-hb 145; Sx-G 332; Sx-OP 386

- For severe trauma, osteomyelitis or neoplasia
- Can be removed at metacarpo- metatarso-phalangeal, proximal interphalangeal, or distal interphalangeal joint
- Prognosis: good if 3rd & 4th digits preserved; varying level of lameness if more then 2 digits removed or 3rd or 4th digit removed

Dewclaw removal - dogs ****

SAP 1063; Sx-S-hb 145; Sx-S 352; Sx-G 330;

- Elective procedure
  - Best performed in neonate
- **Neonates**
  - Surgical scrub
  - Grasp nail & cut away from attachment to metacarpal bone w/ a scissor
  - One absorbable suture in skin
  - No bandage necessary
- **Older animal**
  - Anesthetize & surgical prep
  - Elliptical excision around base of dewclaw
  - Ligate metatarsal & dorsal proper digital arteries
  - Disarticulate P1 from Mc 1 if attached, if free cut out
  - Routinely close skin
  - Bandage for 5-7 days

Note: Check breed standard!

Ectrodactyly syndrome, Lobster claw

E 2384

*

- Maldevelopment - longitudinal splitting of extremity
- Autosomal dominant trait

Syndactyly *

E 2384

- Rare union (bony or soft tissue) between 2 or more digits
- Not clinically significant

Apodia *

E 2384

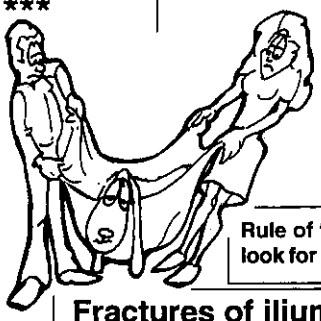
- Congenital absence of forelimb described in the cat
- Tx: Euthanized at birth

Polydactyly, Multiple dew claws

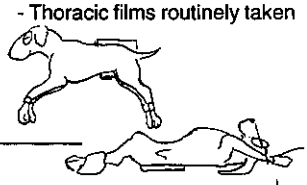
E 2384

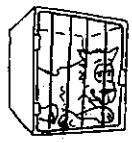
***

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Pelvic fxs SAP 1007; Sx-OL 100; Sx-OD 205; Cat 1665, 1690; Sx-WW 231, 254; Sx-OP 395, 7; Sx4B 1033, 876; Sx-S-hb 585; Sx-S 1769; Sx3B 649; X-Gr 80, 194(f) ***	• **Common: 1/4 to 1/5th of all fxs** • Cause: **Severe trauma** • Associated w/ other injuries (orthopedic & other body systems) - Liver, spleen, urinary bladder, urethra • Others systems injuries may take priority over pelvic injuries	• **Injured animal** • Sequelae: - DJD in acetabular fxs - Narrowing of pelvic canal . Future dystocia - Difficult urination or defecation - Sciatic nerve entrapment	• **Emergency Tx 1st - stabilize** • Physical exam: - Palpate pelvic bones - Manipulate hip joints - Rectal exam: dangerous can lead to rectal perforation - Neurologic exam: spinal cord damage, cauda equina nerve root damage & peripheral nerves • **Radiology:** - 2 views of pelvis (anesthesia often required) - **If see one fx look for 2 more** - Thoracic films routinely taken	• **Conservative** all that is needed for selected pets - **Restricted cage rest** for 4-6 weeks - Padded bedding - Turn regularly to avoid decubital ulcers - Analgesic as needed for pain - Monitor defecation & urination . Manual expression or catheter drainage . Mild laxative or stool softener for constipation - Tape hobbles if weak adduction - Monitor healing radiographically every 4-6 weeks



Rule of thumb - Fractures come in 3, if see one, look for 2 more (one may be a luxation of the hip)





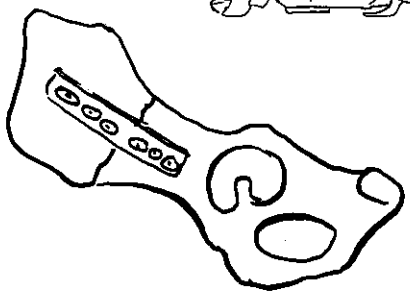
• **Surgery**
- **If delayed past 5 days, muscle spasms & fibrosis may make reduction impossible**
- Indications:
. Unstable acetabulum (Ipsilateral fxs of ilium, pubis & ischium)
. Acetabular (articular) fxs
. Displaced, unstable, or painful sacroiliac fxs
. Severe bilateral fxs of pelvis or displaced pelvic fxs + additional bone injury (hip luxation or femur fx)
. Fx of caudal aspect of acetabulum (ischium)
. Sciatic nerve entrapment (caudal acetabulum/ischial fx)
. Pubic fxs associated w/ abdominal wall rupture & herniation
- Prophylactic ABs at induction
- Purse string suture in anus

Fractures of ilium

- Usually oblique; comminuted
- Often accompanied by other pelvic fxs
- If displaced, caudal fragment moves medially narrowing pelvic canal
- Check sciatic nerve function if displaced

Surgery (ventrolateral [gluteal roll-up] approach)
- Protect sciatic n., cranial gluteal v., a. & n., lateral circumflex vessels
- ASIF bone holding forceps to reduce
- **Contoured bone plate or screws** (in large dogs)
. Don't remove

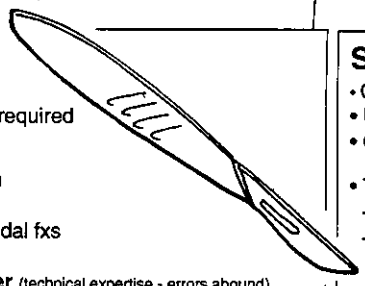
Prognosis:: Good w/ anatomic reduction & no neurologic damage;
Guarded: w/ neurologic damage after surgery



Fractures of ischium

- Usually associated with other pelvic fxs
- **Sx repair usually not necessary**, especially if any other fxs are reduced & stabilized

Fractures of acetabulum

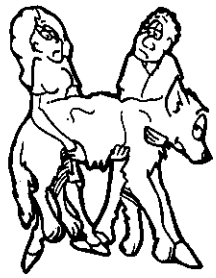


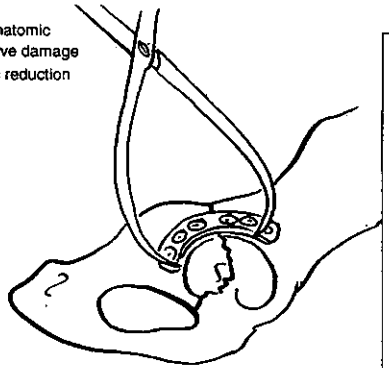
- Often accompanied by other pelvic fxs
- Multiple surgical procedures may be required
- Classification: cranial, central, caudal or dorsal
- Evaluate sciatic nerve for damage
- Sequela: **DJD** if no anatomic reduction

- **Conservative**: for nondisplaced & caudal fxs

- **Surgical reduction**: TOC for all - **Refer** (technical expertise - errors abound)
- Caudolateral or dorsal approach (trochanteric osteotomy or gluteal tenotomy)
- Protect sciatic n., & caudal gluteal vessels & n.
- Reduce fracture
. Maintain reduction w/ point-to-point bone holding forceps (ASIF small reduction forceps, Kern bone holding forceps)
. Precontoured bone plate, acetabular plate, small dynamic compression plate or pelvic reconstruction plate
.. Engage at least 4 cortices on each side of fracture

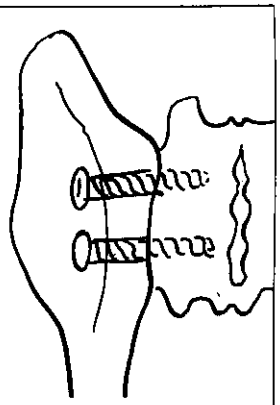
- Prognosis: Good w/ anatomic reduction, stability & no nerve damage
. Guarded: w/o anatomic reduction





- **Comminuted fx that can't be reduced:**
- Conservative management + femoral head & neck ostectomy indicated
- Prognosis: Guarded w/ femoral head excision

Sacroiliac fracture or luxation



- Craniodorsal displacement of ilium usually
- Unilateral more common than bilateral
- Check for caudal equina nerve root signs

- Treatment: **Refer - very difficult**
- Conservative: not recommend for severe cases
- Surgery (ABs)
. Dorsolateral or ventrolateral approach (bilateral - dorsal approach)
. 2 Lag screws - ilium to sacrum (complicated), do not remove screws
. Postop: radiographs to evaluate

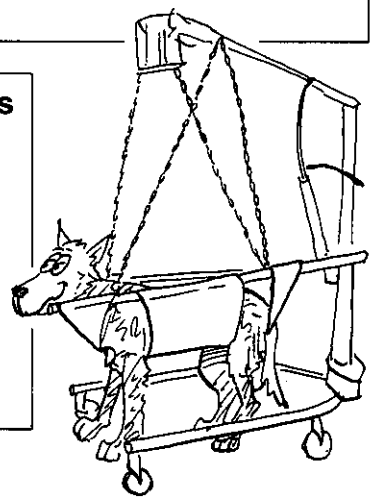
- Prognosis: Sx: Good if no neurologic damage
- Guarded if neurologic damage

Narrowed pelvic canal - pelvic fxs

- Due to healed pelvic fxs
- Especially in small dogs or cats that where managed conservatively

CS: Obstipation, Dystocia

Tx:
- Dystocia: Cesarean section or ovariohysterectomy
- Obstipation: Subtotal colectomy may be necessary
- Pelvic canal widening described



Condition	Facts/Cause	Presentation/CS	Diagnosis

Hip dysplasia

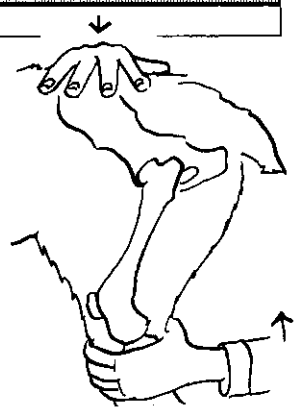
H3B 816; H2B 866; SAP 1017; 5min 676; C12T 1180, 1172, Sx-OD 216; Sx-OL 197; Cat 1608; Sx-WW 244; ; Sx-OP 433, 13; Sx4B 1145, 1159; Sx3B 662; Sx-S-hb 589; Sx-S 1786; X-RP 40; X4T 172; X-Gr 84; Pa-T 452; NB 16.6

****

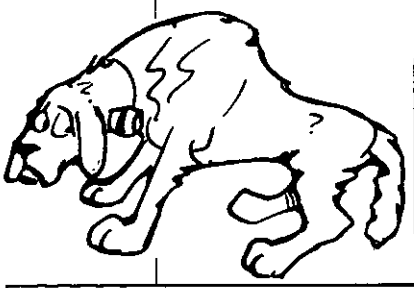
- **Coxal joint instability**, slight subluxation to complete luxation of the femoral head from the acetabulum - results in DJD
- **1° in large & giant breeds**, (sm. dogs & cats)
- **#1 disorder of canine hip**
- **Cause: multifactorial**
  - **Inherited** (0.25-0.50% G. shep.)
  - Overnutrition implicated
  - Biomechanical: pelvic mass
- **Progressive diz - DJD**
- Can be certified hip dysplasia free **after 2 yrs** of age (OFA, Orthopedic Foundation for Animals)

- **Lameness**: weight bearing w/o neuro signs
  - Gait abnormalitie w/o neuro deficits
  - Chronic: more common - older dogs
  - Severe form: young (5-12 mo)
- Pain (limited hip joint motion)
- Difficulty rising in pelvic limbs, especially after exercise
- Muscle atrophy - pelvic limb

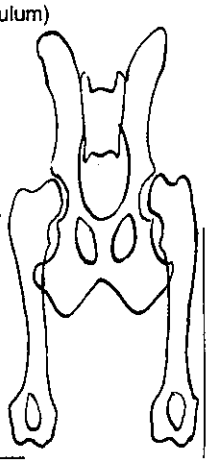
- **Sequelae:**
  - **DJD**, osteoarthrosis, osteoarthritis
  - Luxation or subluxation of the femoral head (worst sign)



- Hx (large breed), CS (clinical signs)
- Palpate joint laxity & pain
  - **Ortolani sign** (joint laxity): click or pop heard or felt as press hand on knee as abduct limb
- **Radiology:**
  - **Hip subluxation (joint laxity)** (worst sign)
    - **Shallow acetabulum, flattened**
      - **< 50%-60%** of femoral head inside dorsal rim of acetabulum
    - Loss of congruency (parallel lines) between femoral head & acetabular cup, especially in cranial third
    - Tangential line from edge of cranial acetabular cup not perpendicular to spinal column
  - **DJD** (degenerative joint diz) mild to severe
    - **Osteophyte proliferation** (perichondral)
    - **Thickened neck** (femur)
    - **Spurring** (proliferation along the edges of cup of acetabulum)
    - Flattening of femoral head
    - **Sclerosis of subchondral bone**
- Scoring methods:
  - OFA 7 point grading system: Excellent, Good, Fair, Borderline, Mild HD, Moderate HD, Severe HD
  - 3-point scoring scale: Normal, Borderline or Dysplastic
  - Norberg angle (Europe), joint laxity, not accepted in USA



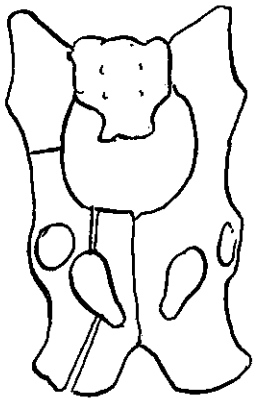
DDx:
- Degenerative myelopathy
- Septic arthritis
- Trauma
- Immune-mediated joint diz
- Ruptured cranial cruciate lig.
- L-S instability
- Panosteitis (young)



Coxal instability, lg & giant breeds, Inherited
CS: Lameness, Pain; Sequelae: DJD
Dx: Hx, CS, PE, Rads
Tx: Conservative: Rest & aspirin; Sx; Don't breed
Px: Guarded, Progressive; Good w/ selective Sx

OFA position/Hip dysplasia view: VD hip-extended
- Dog in dorsal recumbency
- Pull limbs caudally & rotated slightly medially
- Femurs parallel
- Patellas centered in trochlea of femur (if not - see flattening of fovea capitis)
- Superimpose femur & ischiatic tuberosity
- Include from below the stifle to just above hip bones
- No rotation or acetabulum will appear of unequal depth & 1 joint will look artificially worse)
  - Check rotation: obturator foramen equal, width of the wings of the ilium equal

Triple pelvic osteotomy (TPO)
(↑ coverage of head by rotating acetabulum)
- **Only for patients who actively subluxate & no DJD**
- Osteotomies of ilium, pubis & ischium
  - Rotate pelvis until Ortolani manipulation doesn't dislocate hip
  - Stabilize w/ bone plate (transverse osteotomy) or screws & wires (stair-step osteotomy)
- Postop: restrict activity for 8 weeks



Pectoneal tenotomy (symptomatic, palliative): May m joint pain but doesn't alter progression of diz
- **Remove belly of pectineus muscle**
- Post-op: restrict activity for 2 weeks. Drain any seroma that forms
- Prognosis: Variable, in some noticeable improvement. Variable length of relief

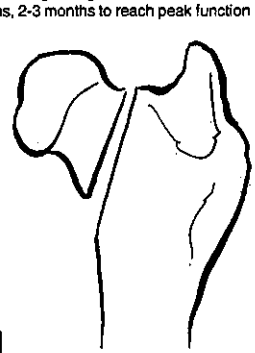
Treatment:
- **Conservative for mildly affected**
  - Restrict activity for inflammation to subside
  - Aspirin for pain

- **Surgery** when conservative non-defective & constantly disabled
  - Triple pelvic osteotomy
  - Excision of head of femur
  - Pectoneal tenotomy (symptomatic)
  - Intertrochanteric osteotomy
  - Total hip replacement
- **Don't breed**

Prognosis: Guarded, progressive
- **Good for selected surgeries**

Intertrochanteric osteotomy
- Patient selection important
  - Marked ↑ in angle of anteversion &/ or inclination
  - Minimum degenerative changes
  - Age close to sexual maturity (6-8 months)
- Tx: Craniolateral approach, **transverse intertrochanteric osteotomy**
  - 2nd osteotomy to remove wedge of bone & ↓ angle, creating a coxa vera
  - ↓ Angle of anteversion to normal by rotating proximal femur caudally
  - Rigid fix w/ 3.5 mm hook plate or w/ standard bone plates
- Post-op: restrict activity for 8 weeks
- Prognosis: significant number pain free w/ normal mobility

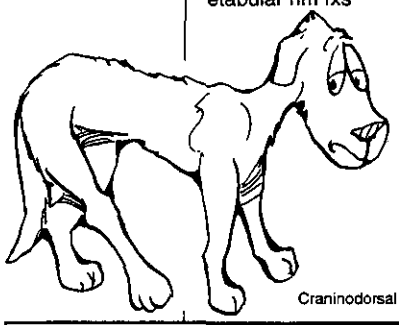
Excision of femoral head (salvage procedure)
- Most effective in dogs < 40 lb
- Craniolateral or ventral approach
  - **Remove femoral head & neck**
  - Incise round ligament of the head of the femur
- Postop: use limb in 3-7 days or passive range of motion.
  - For best results encourage early active (running) motion; swimming also good
  - Radiographs, 2-3 months to reach peak function

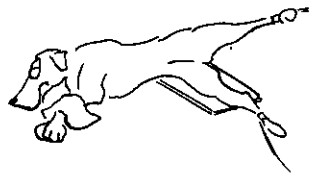


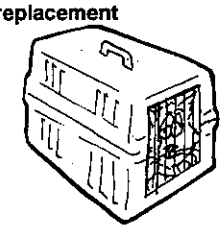
Total hip replacement (salvage)
- Refer - difficult procedure
  - Animal must be at least 9 months old (growth plates must be closed)
  - Minimum weight 30-40 lbs
- Artificial head & acetabulum to one limb rarely required in both limbs
- Potential problems: implant loosening, implant infection, luxation

- Prognosis: **Good**

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Hip luxation, Coxofemoral luxation SAP 1014; Cat 1690; H2B 877t; Sx-S-hb 592; Sx-S 1801; Sx-WW 254; Sx4B 1178; Sx3B 670, 919; Sx-OP 422; NB 165	• **#1 joint luxated** in small animals • Cause: #1 trauma (60% HBC (hit by car)) • Direction of luxation: - **#1 - Craniodorsal**: majority (contraction of gluteal mm.) - Caudoventrally occasionally: femoral head into obturator foramen (associated with falls) - Rarely - caudodorsally •Ligament of head of femur & joint capsule torn, ± gluteal muscles torn, ± avulsion of bone with ligament, ± erosion of femoral head cartilage, ± acetabular rim fxs	• **Nonweight bearing lameness** of hindlimb - **Craniodorsal: abducted, externally rotated** - Caudoventral: abducted, internal rotation • Sequellae: - Avulsion of bone w/ lig. of head of femur - Erosion of femoral head cartilage - Acetabular rim fxs	• **Dx simple**: Hx (trauma) + CS (nonweight bearing lameness of hindlimb) • Physical exam: ± pain & crepitation on manipulation - ↑ Distance between greater trochanter & tuber ischii - **"Thumb test"**: thumb between greater trochanter & ischial tuberosity, externally rotate femur - thumb pushed out if normal hip, not if luxated or head of femur fractured - Shortening of limb: if caudally extended • Radiographs: to confirm (ventrodorsal & lateral) & evaluate - Luxation, ± avulsion fxs, femoral neck & head or acetabular fxs, DJD	• **Closed reduction + nonweight bearing sling** (Ehmer)(TOC) TOC for most cases (see box below) - Success best if done within 10 days • **Open reduction** if avulsion fxs, femoral neck, greater trochanter or acetabular fxs of advanced hip displasia/ DJD (see box) • **False joint forms if not treated** = degree of dysfunction • **If recurrent luxation - salvage**: **- Femoral head & neck excision** or **- Total hip replacement**



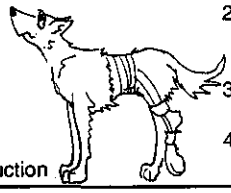




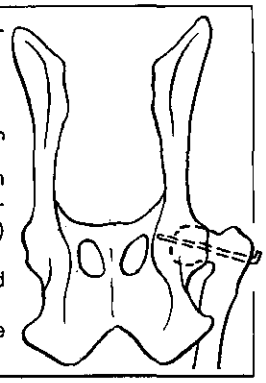
#1 Luxation, Trauma, Craniodorsal
CS: Nonweight bearing lameness of hindlimb
Dx: Hx + CS, "Thumb test", Rads to confirm
Tx: Closed reduction + Ehmer (TOC), Open reduction

• Prognosis (Px):
- Closed reduction: failures up to 50-70%

Closed reduction: if within 10 days & no avulsion fx; do under general anesthesia
• **Craniodorsal luxation**
- Externally rotate femur (head over & away from ilium)
- Pull limb distally (head over acetabulum)
- Rotate femur internally (head into acetabulum)
- Flexion sling (Ehmer), daily reexamine
• Caudoventral luxation:
- Abduct limb (head from under hip bone)
- Externally rotate limb (head into acetabulum)
- Hobbles, daily reexamine
• If easily luxates again - open reduction



Open reduction: clean out acetabulum 1st then reduce head into acetabulum then a stabilizing technique (a few are listed below):
1. **Joint capsule imbrication with retention suturing**:
.. Cruciate or horizontal pattern if enough capsule on both sides remain
.. Through capsule on acetabulum & hole in greater trochanter if not enough capsule on neck of femur
.. Suture through hole in greater trochanter and to screws in acetabular rim
2. **Transacetabular pinning**: a temporary intramedullary pin through proximal femur neck and head & through the acetabulum into pelvic cavity (1 cm) + Ehmer sling for 7-21 days - remove pin, rest 21 more days
3. **Replace ligament of head of femur** between toggle pin in acetabulum and hole in proximal femur & head
4. **Translocate the greater trochanter** caudally so gluteal muscles pull the femoral head into acetabulum

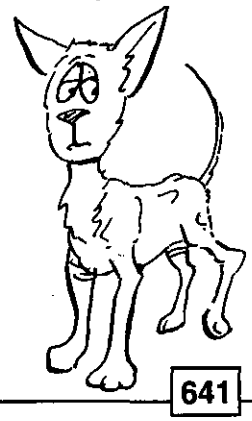


Avascular necrosis of the femoral head, Ischemic/asceptic femoral head necrosis, Legg Perthes diz, Legg-Calve-Perthes diz, Osteochondritis juvenilis, Coxa plana

H3B 813; H2B 868; Sx-OL 207; Sx-OD 223; Sx-WW 222; Sx-OP 13; X4T 134; Pa-T 440; NB 16.19

• **Avascular aseptic necrosis of femoral head & neck**
• **Loss of blood supply to head or neck**
• Cause: **unknown?** ↓ blood flow 2° to ↑ intra-articular pressure
- Fat emboli, Cytotoxic factors
- Genetic factors
• **Small & miniature breeds** (Yorkie, Chihuahua, miniature poodle)
• **4 to 11 months of age**
• Usually unilateral but can be bilateral
• **Pathophysiology:** interruption of blood to femoral head & death of osteocytes, articular cartilage remains OK. Resorption of subchondral bone, stress fxs in subchondral bone, Fibrous tissue or fibrocartilage fill fractures
- **Collapse of femoral head**

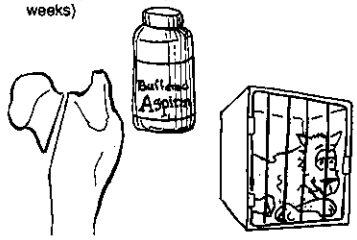
• **Pelvic limb lameness**
- Unilateral & bilateral
• Muscle atrophy (pelvic limb)
• Pain - severe
• ± Shortening of limb



• Hx, CS
• Palpation: pain on abduction, extension ± crepitance
• Radiology - definitive
- **Irregular areas of lysis** (dissolving) head & neck
- **Irregular density** of femoral head & neck
- Widening of articular space
- **Flattening & collapse** of subchondral bone of head
- DJD - osteophytes

DDx:
• Hip dysplasia
• Coxofemoral luxation
• Infectious arthritis
• Ruptured cruciate ligament
• Medial patellar luxation
• Inta-articular fxs
• Neoplasia

• **Remove head & neck** (small dogs tolerate very well)
- Passive therapy (15-20 min BID) 3 days postsurgery
- Swimming (20 min SID) once sutures removed
- Large dogs consider total hip replacement
• Conservative for a few cases:
- Aspirin to control pain
- Strict cage confinement or sling immobilization until appears radiographically resolved (6-12 weeks)

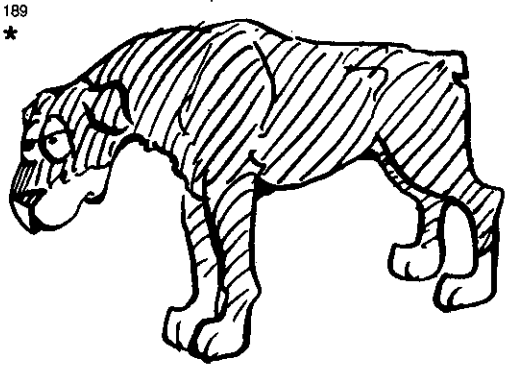


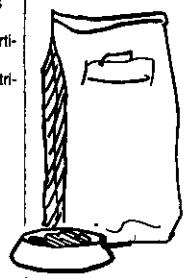
Loss of blood supply, Cause: ?, Small dogs
CS: Pelvic limb lameness
Dx: Radiology - definitive
Tx: Remove femoral head & neck • Px: Good

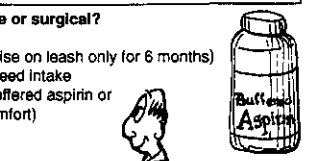
Prognosis: **Good:** toy breeds: only need 3 legs hence are reluctant to use "hurting" 4th

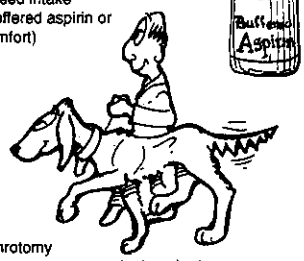
Femoral fxs & OC

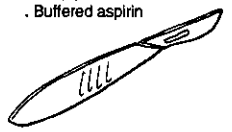
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Femoral head OC, Osteochondrosis, Dyschondroplasia, Osteochondritis, OCD, Osteochondrosis dissecans SAP 1085; H3B 762; H2B 866; 5min 888; C1T 1175; Sx-OL 189 *	• **Dog problem, not reported in cat** • **Failure in endochondral ossification** • **Femoral head - rare** • Breeds: Large & giant breeds (Rottweiler, Lab) • **Cause - unknown** - 4-10 mo-old, rapidly growing, large breeds . Overnutrition, Genetics, Low copper . Trauma: causing or affecting abnormal cartilage • **Pathophysiology:** Cartilage outgrows its nutrition, cells die, trauma cracks cartilage	• **Intermittent lameness** • ± Pain on flexion • Sequela: **DJD**	• **Hx (age, sex, breed)**, CS • **Manipulate for pain** • **Radiology:** **-Subchondral defects of femoral head** **- DJD**	• **Conservative or surgical?** • Conservative - Rest (exercise on leash only for 6 months) - Restricted feed intake - NSAIDs (buffered aspirin or PBZ for comfort) • Surgery - arthrotomy - Debridement, curettage, rarely done in dogs - Femoral head & neck excision < 40 lb - Total hip replacement - Postsurgery . Enforced rest for 6 weeks (leash) . Keep patient thin . Buffered aspirin Prevention • Do not over feed • Check for mineral balancing diets (copper/calcium/zinc) **Prognosis:** Good

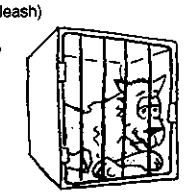


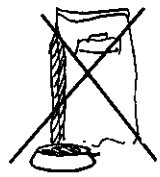












DDx:
- Leg-Perthes diz
- Hip dysplasia
- Osteochondral fx

Failure in endochondral ossification, Large & giant breeds
CS: Intermittent lameness; Sequela: DJD
Dx: Hx, CS; Rads
Tx: Conservative or surgical?
Px: Good

Femoral fxs

SAP 1022; Sx-OL 56; Sx-OD 232; Cat 1668, 1678; Sx-WW 218, 256; Sx-OP 469; Sx4B 885, 887, 1040, 1237; Sx3B 682; Sx-S-hb 593; Sx-S 1805; X-Gr 92, 202(f)

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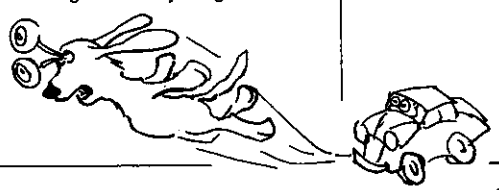
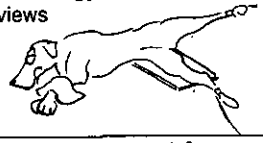
- **#1 bone fx in dog**
- **Trauma: hit by car (HBC)**
- Healing faster in young animal

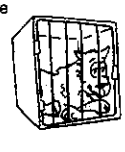


- **Lameness**
- **Traumatic induced recumbency**

- Stabilize animal first
- Hx, CS
- Palpation - crepitation
- **Radiology:** minimum of 2 views



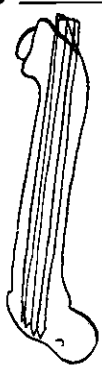
- **Reduction fixation**
- - Intraoperative broad-spectrum ABs IV (induction & repeat if Sx longer than 2 hrs)
- **Post-op**
- - Cage rest 1-3 days
- - Flexion (Ehmer) sling to prevent use
- . Physical therapy (nonweight bearing)
- - **Continue ABs** if open fx
- - Leash walk at 4-5 days if fixation stable, ↑ slowly over 4 weeks
- - Repeat radiographs in 4-6 weeks for healing
- - Remove implants if indicated on healing (IM pins removed at stage of clinical union in immature, radiographic union in mature: usually at 6-8 weeks); screws & plates left unless cause problems or removed at remodeled union stage

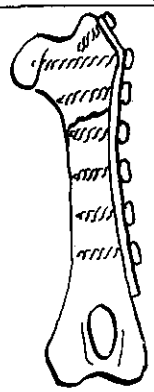


Complication of surgery: Implant failure, Fx collapse, malunion, nonunion, osteomyelitis, large callus from rough tissue handling or immature patient

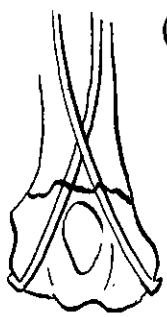
Fractures:

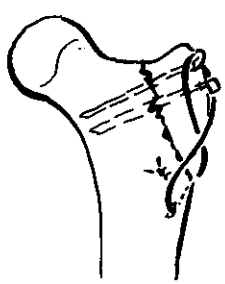
- **Femur diaphysis**
- - Fact: Femoral artery & vein on medial side, sciatic nerve caudal to femur
- - Tx: Craniolateral approach
- . Simple oblique fx: IM pin
- . Comminuted: build proximal & distal fragments into 1-piece fx, combination of interfragmentary screws, figure-8 wire, skewer pins. Save fragments w/o muscle attachment in a blood soaked sponge & use if needed for stability.
- . 2 or 3 piece fxs w/ long oblique fx lines: cerclage wire + 1 or 2 normograde or retrograde IM pins, cancellous bone graft (flush area first)
- . Highly unstable comminuted fxs: add devices for stability (plating or IM pin + Kirschner-Ehmer device) & cancellous bone graft

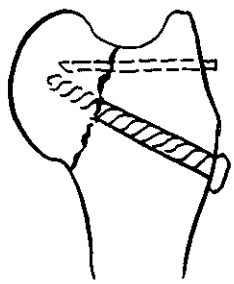




- **Proximal femoral shaft repair**
- - Tx: Craniolateral approach, rebuild into 2 piece fx (cerclage wires, lag screws) then plate & screw 2-piece fx. Postoperative (see above), except cage rest for 24 hrs only
- **Distal femur**
- - Distal femur: metaphysis, condyles, trochlea, Majority are physeal
- - Tx: Lateral, medial or cranial approach (tibial crest osteotomy may be added for better exposure), cross-pinning, multiple pinning & modified Rush pinning, Retrograde. flexion sling. Postoperative (see above), except cage rest for 24 hrs only
- . Complication: Quadriceps tie-down (contracture): adhesions between fx callus & quadriceps, avoid by using a flexion sling & early return to exercise; DJD in intra-articular fxs w/o anatomical reduction; Shortening of leg in immature physeal fxs expected, < 20% doesn't produce clinical signs







- **Femoral neck/capital physeal fx**
- - Tx: Common (craniolateral) approach. Rotate femur out to expose fx, Retrograde Kirschner wire + compression (lag) screw or multiple Kirschner wires. Manipulation to check that there is no crepitation
- **Trochanter fx**
- - Tx: Craniolateral approach, **Tension band** (2 Kirschner wires + figure-8 wire). Postoperative (see above), except cage rest for 24 hrs only
- **Patellar fxs (rare)**
- - Tx: Lateral approach, 2 Kirschner wires lengthwise + figure-8 wire around pin ends on cranial surface of patella. Postoperative (see above), except cage rest for 24 hrs only

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Patellar luxation

SAP 1031; H3B 813; H2B 861, C12T 1172; 5min 912; Cat 1606; S 1117; O-L 152; O-D 254; Sx4B 1232; Sx3B 741; Sx-S-hb 604; Sx-S 1854; Sx-OP 516, 10; Sx-O-Sx 272; RA 1

***

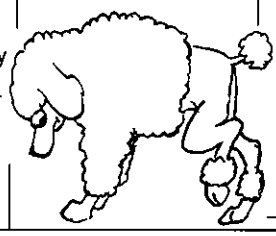
- Dogs > cats
- Small breeds >> larger breeds
  - Poodles (miniature & toy), Yorkshire terriers
- Congenital > acquired
- Medial & lateral patellar luxation (MPL & LPL)
- **Medial > lateral** in every size/breed category MPL:LPL - 7:1
  - MPL:LPL ratio in large breeds - 4:1
- Bilateral:unilateral ratio - 2.5:1
- < 2 yr-old
- Females:male ratio 1.5:1
- Cause: unknown, congenital

Grades of luxation

Grade 1 - Easily luxated, returns when released
Grade 2 - Easily luxated, remains luxated
Grade 3 - Permanently luxated, but can be manually returned
Grade 4 - Permanently luxated, can't be manually repositioned

- **Rear leg lameness**
  - **Intermittent to carrying limb**
- Pain

DDx:
- Leg-Perthes diz
- traumatic ligament rupture
  - Cranial cruciate
  - Med. collateral lig.
- Meniscal injury
- Coxofemoral luxation

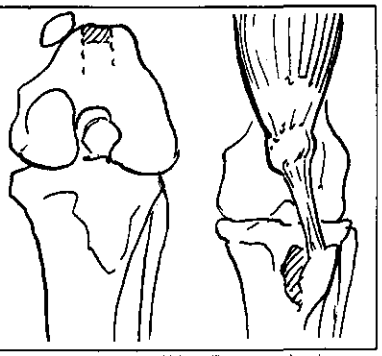


- Hx, CS
- **Palpation:** extend limb & assess grade of luxation
- **Rads: Skyline view:**
  - Sternal recumbency
  - Flex stifle & place animal on its knees
  - Shows depth of trochlear groove, patella & femoropatellar joint space
  - Patellar (trochlear) groove usually shallow in dogs w/ patellar luxation

- **Surgery:** if growth plates are opened whether CS or not
  - Persistent luxation immediate surgical correction
  - Number of procedures, most patients require combination of techniques
- **Conservative** if minimal CS, mature dog > 1 yr-old
  - Weight reduction
  - Controlled exercise
  - NSAIDs
  - Usually ineffective in clinically affected animals

Prognosis: **Good to excellent** w/ surgery

SURGERIES
- Reinforcement of lateral restraints (suture from patella to lateral fabella)
- **Deepening trochlear groove**
  - Trochleoplasty (deepening trochlear groove)
  - Chondroplasty (cartilage flap from trochlear groove replaced after groove deepened)
  - Wedge recession (cut wedge out of groove, then deepen cut & replace wedge)
- **Tibial tuberosity translocation: move** tibial tuberosity to side away from luxation
- Medial release of the joint capsule & muscle insertions onto patella
- **Lateral rotation of tibia**



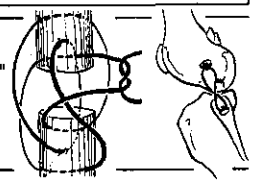
Small >> Larger breeds; Med. > Lat. in all
CS: Rear leg lameness
Dx: Palpation, Rads: Skyline
Tx: Surgery • Px: Good to excellent

Stifle luxation

SAP 1039; Cat 1692; Sx-WW 256; Sx-OP 565; Sx-S-hb 604; Sx-S 1854 *

- **Severe trauma required:** rupture of cr. & ca. cruciate, medial & lateral collateral ligaments, meniscal attachments, popliteus & long digital extensor mm.
- More common in cats
- CS: Lameness
- Dx: Hx, CS, Palpation: total laxity in all directions, lateral medial, cranial caudal & rotational instability
- **Tx: Repair medial & lateral collateral ligaments, popliteus & long digital extensor mm.** (locking tendon loop, "3-pulley pattern", Bunnell suture, spike washer & screw or fascial reinforcement), Correct cruciate by intracapsular or extracapsular imbrication techniques, Suture menisci to periphery or do a meniscectomy - Postop: Kirschner-Ehmer device or cast immobilization for 3-4 weeks; Then Robert-Jones bandage for 2 weeks.

"3-pulley pattern"



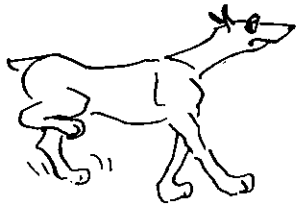
Ruptured cranial cruciate lig.

H3B 824; SAP 1034; 5min 484; Cat 1604; Sx-OD 244; Sx-OL 158; Sx4B 1187; Sx3B 708; Sx-S-hb 599; Sx-S 1824; Sx-OP 534, 10; Sx-WW 255; X-Gr 94; NB 16.11, 16.4

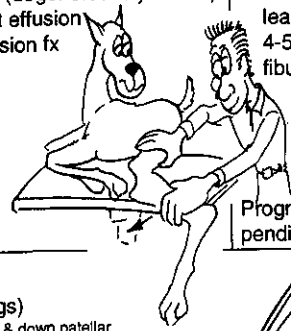
***

- **Cause:**
  - **Middle aged dogs**
    - Overweight
    - Deterioration of lig, other m/ rupture w/in a yr
  - Young dogs: trauma, maybe very minimal

- **Carrying limb lameness**
- May resolve but returns w/ exercise
- Chronic, persistent lameness (older, overweight dogs)



- **CS, history**
- **Cranial drawer sign** (see box)
- Radiology:
  - DJD (degenerative joint diz)
  - Joint effusion
  - Avulsion fx



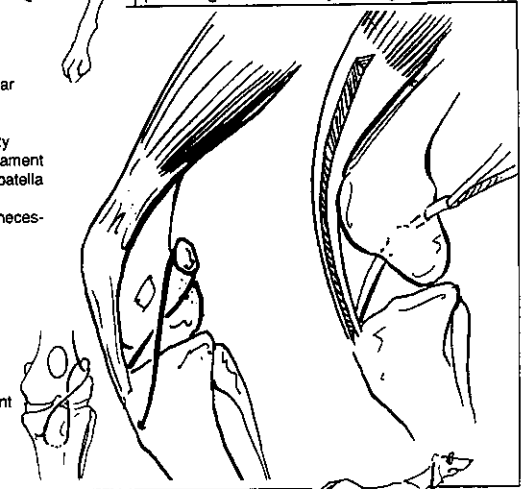
- **Rest for 3-4 months: small dogs**
- **Surgery for large dogs** (see box)
- Postop:
  - Restrict exercise to hand leash only, no stairs for 4-5 months for all but the fibular head procedure

Prognosis: Very **good** to guarded depending on chronicity & surgical expertise

Cranial drawer sign (90%)
- Hold distal femur & prox. tibia with 2 hands
- Position of stifle
  - Cranial drawer sign (flex limb 45-90° or more)
  - Lachman test (modest flexion 15-30°)
  - Tibial in full extension
- Push tibia cranially
- Cranial movement + (only minimal movement normally)
  - Movement in each position - complete rupture
  - Movement in only 1 position - partial

Tibial compression
- Hold femur motionless w/ one hand & the finger on the tibial tuberosity
- Flex the hock
- If tibial felt to move cranially = rupture

Surgeries:
- **Patellar tendon procedure** (25-175 lb dogs)
  - Cut a strip in fascia lata/quadriceps fascia, over patella & down patellar ligament
  - Converging saw cuts in patella
  - Cut proximal end of strip, leaving distal end attached to tibial tuberosity
  - Drill tunnel in the lateral femoral condyle in direction of cranial cruciate ligament
  - Push graft through defect in patellar tendon, fat pad & tunnel (piece of patella in tunnel)
  - Postop: Robert-Jones bandage w/ cranial fiberglass slab for 1 month (necessary)
    - 4 month leash only exercise & no stairs
- **Fascial strip over-the-top procedure**
  - Cut strip in fascia lata parallel & lateral to patellar tendon
  - Push it through fat pad & intercondylar space and over top of lateral condyle
- **Fibular head transposition procedure**
  - Free fibular head & move cranially
  - Lateral collateral ligament then substituted for cranial cruciate ligament
- **Imbrication**
  - Extracapsular medial & lateral imbrication with nylon sutures
    - Around fabellae through patellar ligament of tibial tuberosity



Stifle
CS: Carrying limb lameness
Dx: Cranial drawer sign
Tx: Rest small; Sx - large dogs

Caudal cruciate ligament rupture

H3B 826; SAP 1037; Sx-OL 161; Sx4B 1218; Sx3B 701; Sx-S-hb 603; Sx-S 1846; Sx-OP 555

*

- **Extremely rare**
- CS: Acute hindlimb lameness
- Dx: Hx, CS, caudal drawer sign (tested at 90° of stifle flexion), Radiology (avulsion of bony attachments, caudal sag of proximal tibia in lateral view)
- Tx: Tunnel graft
- Prognosis: Good

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Meniscal problems H3B 826; SAP 1038; Sx-OL 161; Sx-S-hb 601; Sx-S 1827; Sx3B 694; Sx-OP 559, 13 ***	• Usually associated w/ a partial or complete **cranial cruciate tear** - Allows femoral condyle to traumatize caudal horn of **medial** meniscus which is attached to medial collateral lig. - **"Bucket handle" tear** that folds forward or other tears	• **Lameness** • Cranial cruciate damage usually • Persistent pain re-fractory to meds	• Hx, CS • Cranial drawer sign usually • **Click or clunk** during manipulation as femoral condyle slips over double fold of meniscus	• **Treatment controversial** • **Preserve if grossly normal or in cats or small dogs (< 30 lbs)** • **Partial meniscectomy,** complete/total not advised unless both caudal & cranial horns damaged - Arthrotomy approach (medial or lateral) - Correct cranial cruciate damage - Remove caudal horn Prognosis: Surgery improves
Collateral ligament disruption H3B 827; SAP 1039; O-L 164; Sx4B 1215; Sx-OP 563, 13 **	• **Cause: trauma: medial or lateral stress during weight bearing** • Grades - 1st°: stretching & minor disruption of collagen fibers - 2nd°: partial tearing - 3rd°: complete tear or avulsion of bony attachment	• **Acute rear limb lameness**	• Hx, CS • Radiology: **stress radiographs**	• 1st & 2° respond well to rest & restricted exercise • **3rd°: surgical repair** & partial immobilization - Complete ligament tear: Bunnell locking loop or "3-pulley" suture for 1° repair - Avulsion fx: large piece: screw & spiked washer . Small: ligament fixating plate - Alternate: prosthetic ligament (looping figure-8 wire around 2 screws [18-20 gauge]) - Modified Robert-Jones bandage Prognosis: Good if done early
Stifle OC, Osteochondrosis OCD, Osteochondritis dissecans SAP 1085; H2B 865; 5min 888; E 2348; O-L 189; O-D 260; Sx-S-hb 633; Sx-S 1961; Sx-WW 244; Sx-OP 568	• **Rare in dog, not reported in cats** • **Failure in endochondral ossification** • **Sites: Lateral condyle of femur** - **Less common than shoulder** - Unilateral or bilateral - Male:female - 5:1 • Breeds: Large & giant breeds • **Cause - unknown** - **4-10 mo-old, rapidly growing, large breeds** . **Overnutrition,** Genetics, Low copper . Trauma: affecting abnormal cartilage • **Pathophysiology:** cartilage outgrows its nutrition, cells die, trauma	• **Intermittent weight-bearing lameness** • Worsens after rest or strenuous exercise • Abnormal gait: walks w/ flexed stifles • **Swelling** (distention of joint/ synovitis) • ± Pain on flexion • Sequela: **DJD**	• Hx, CS • **Manipulate for pain** • **Radiology: Cr/Ca view** (cartilage not seen) - **Subchondral bone defect of lateral femoral condyle** (medial aspect) - **Don't confuse extensor fossa for OC** - DJD (Sclerosis, loss of joint space, periarticular osteophytes) **DDx:** • Hip dysplasia • Panosteitis • Sprain - ligament damage • Patellar luxation • Chronic CCL	• **Conservative or surgical?** • Conservative - Rest (exercise on leash only for 6 months) - Restricted feed intake - NSAIDs (buffered aspirin or PBZ for comfort) • **Surgery** - arthrotomy - Debridement - **Curettage** to good hemorrhagic bone - Postsurgery: enforced rest for 6 weeks (leash), keep patient thin, Buffered aspirin **Prognosis:** Good **Prevention:** Do not over feed, balanced diets (copper/calcium/zinc), breeding??

Cranial cruciate + medial meniscus ("Bucket handle tear")
Tx: Partial meniscectomy in large dogs

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Tibial & fibular fxs SAP 1041; Cat 1678; Sx-OL71; Sx-OD 241; Sx-4B 888, 1050, 1263; Sx3B 722; Sx-S-hb 606; Sx-S 1866; Sx-OP 581; Sx-WW 219; X-Gr 98, 208(f) ***	• **Common: 25% of all long bone fxs in small animals - HBC** • Unstable fxs if fibula also fractured • **Open fxs are common** because of minimal soft tissue coverage - Needs rigid fixation, but avoid placing large implants in fracture site	• **Acute 3-legged lameness**	• **Hx (HBC), CS (3-legged)** • **Physical exam:** - Palpation: swelling & crepitation - Examine also for orthopedic injuries - Evaluate thorax - Neuro exam for sensory perception & spinal cord damage - Concurrent musculoskeletal injuries . Should be able to support themselves on 3 limbs, if not check for other problems • Check soft tissue injury & fracture contamination - Cover open fxs w/ sterile bandages - Start broad spectrum ABs - Culture & sensitivity - Support compressive wrap or splint until treatment • **Radiographs**	• **Tx depends on variables** • **Open fxs need rigid fixation devices** - **Broad spectrum ABs** - **Robert-Jones bandage** (compression wrap) 3-5 days (protect & prevent soft tissue swelling) - Gauze & tape covering of external fixation devices • **External coaptation, IM pins, cerclage wires, plates** • **Implant removal or not** - Do not routinely remove small implants unless cause problems (joint interference or drainage) - Remove IM pins unless buried by growth - Partially disassemble external fixation device . After early osseous bridging (6 weeks postop) . Stimulates callus hypertrophy & remodelling . Remove rest of device on healing - Bone plates removed if . Limb pain in cold weather . Bone atrophy, or . Chronic infection w/ drainage • **Complication:** Nonunion, malunion, infection, growth deformities

Common, Open fxs common
Dx: Hx, CS, PE, Rads
Tx: ABs, Fixation, R-J bandage

- **Avulsion fxs** of fibular head, lateral & medial malleolus & tibial tuberosity
  - Tx: Reduce fx w/ small fragment reduction forceps, 2 parallel Kirschner wires & tension band figure 8 wire
  - Tibial tubercle fxs in immature animals, don't use tension wire, just 2 pins (allows growth)
- **Intra-articular fxs of proximal or distal epiphysis**
  - Tx: Interfragmentary lag screw reduced intra-articular fx (fracture forceps), additional screws or cross pins to prevent rotation
- **Stable shaft fxs:** IM (intramedullary pin) normograde (50-60% of smallest medullary canal diameter)
  - Interfragmentary wire or 2-pin external skeletal fixation if rotationally unstable
- **Short oblique fxs:** IM pin & interfragmentary wire
- **Long oblique shaft fxs:** Fracture line length ≥ 2 x bone diameter
  - Tx: IM pin & cerclage wires (at least 2 wires per fx line)
- **Comminuted shaft fx:** Interfragmentary lag screw of reduced intra-articular fx (fracture forceps). Additional screws, cross pins to prevent rotation plus neutralization plating or external fixation device
- **Open fxs:** Do not primarily close, Lavage & debride wound q24-48h until healthy granulation tissue covers wound - 7-10 days, then close or let heal by 2° intention
  - External skeletal fixation: at least 3 pins in each fragment. Obtain an angle between at least 2 of the pins in each fragment
  - Plate/screws
- **Salter fxs of proximal & distal physis,** Type 1 & 2
  - Tx: Cross pin (caution that they don't interfere w/ growth plate), Rush pin or lag screw metaphyseal fragment

Contraindication for different types of fixation
- IM pins
  - Infected or contaminated open fx
  - Fxs that can't be reconstructed
- External skeletal fixation
  - Intra-articular fxs
  - Avulsion fractures of ligaments & tendon attachments

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Proximal intertarsal subluxation or luxation SAP 1053; Sx-S-hb 609; Sx-S 1881; Sx4B 1248; X-Gr 100, 210(f) **	• Subluxation >> luxation • Cause: - Rupture of plantar ligament (75%) - Trauma to plantar ligament (25%) • 6+ yrs-old • Obese dogs • Breeds: Shetland sheepdog, Collie, Samoyed • Unilateral > bilateral	• **Lameness**: moderate to severe, semi-weight bearing • **Walks plantigrade** - Abnormal dorsiflexion • Thickening of joint capsule in chronic cases	• Hx, CS • Palpation - pain can't be elicited • Stress radiographs	• **Subluxation:** - Arthrodesis of proximal intertarsal joint . Curette off cartilage of the calcaneus & 4th tarsal bone, add cancellous bone . Pin (into calcaneus & 4th tarsal bone) & tension band wire (through drilled holes in calcaneus & 4th tarsal bones) - Doesn't respond to conservative Tx & splints • Luxation: - Arthrodesis w/ a bone plate . Curette cartilage of joint & add cancellous bone . 7 hole bone plate on lateral side of tarsus Prognosis: **Excellent** w/ reconstruction of partial arthrodesis
Plantar lig. **CS: Lameness, Plantigrade - Dorsiflexion** **Dx: Palpation, Stress radiographs** **Tx: Arthrodesis • Px: Excellent**				
Tarsometatarsal subluxation SAP 1055; E 2339; Cat 688; Sx-OL 165; Sx-S-hb 610; Sx-S 1883; *	• Less common than intertarsal subluxation • Cause: #1 trauma	• Signs of trauma • Resemble intertarsal subluxation • Moderate to severe semi-weight-bearing **lameness** • Abnormal dorsiflexion • Thickening of joint capsule in chronic cases	• Hx, CS • Palpation • Radiographs	• **Arthrodesis of proximal & tarsometatarsal joints** - Pin & tension band . Pin (through calcaneus, T4 & into distal 1/ 2 of Mt 4) . Tension band wire between calcaneus & base of Mt 4, 3 (2) • **Bone plate across tarsometatarsal joint** Prognosis: **Excellent**
Tarsocrural/ Tibiotarsal subluxation or luxation E 2340; SAP E 2340; Sx-S-hb 609; Sx-S 1880; Sx-S 1883; *	• Slightly more common than tarso-metatarsal subluxation • May or may not involve malleolar fxs • Usually result of rupture of medial & lateral collateral ligaments	• **Angular deformity** • **Lameness**	• Hx, CS • Palpation • Stress radiographs	• **Tarsal arthrodesis** - Remove cartilage from distal tibia & trochlea of talus, intertarsal & tarsometatarsal joints - Autogenous cancellous bone grafts - Dorsal bone plate • **Prosthetic sutures replacement of collateral ligaments** - Coadaptation splint for 2-6 weeks Prognosis: Good: collateral prosthesis • Good to Poor: arthrodesis

Fractures of pes Sx-S-hb 610; Sx-S 1883; Sx4B 890, 1252, 1264, 1283; Sx-OP 607; Sx-WW 257	• **Calcaneal fxs**: common in racing greyhounds, rare in other breeds. Associated w/ central tarsal fxs or plantar ligament tears, resulting in plantar intertarsal luxation - Tx: Steinmann pins, tension band wiring, lag screws, plates or cerclage wires used • **Talus fxs**: rare • **Central tarsal fx**: common in racing greyhounds, reported in other breeds. Right tarsus due to counterclockwise racetracks. Often with other tarsal fxs - Fxs graded from 1 to 5 and fixation depends on grade - lag screw to external coapted. Px: variable w/ grade • **Metatarsal fxs**: Nonweight bearing lameness. Swelling, crepitus & pain - Tx: Coaptation for 4-6 weeks, internal fixation of severe displacement or multiple bones • **Sesamoid bone fxs**: primarily in greyhounds. CS: mild swelling & pain over plantar aspect of metatarsophalangeal joint - Tx: Remove fragments. Prognosis: good for return to racing			
Tarsal OC, Osteochondrosis, Dyschondroplasia, Osteochondritis SAP 1085; H2B 866; Smin 888; O-L 189; O-D 271; Sx3B 728; Sx-S-hb 634; Sx-S 1962; Sx-WW 244;??302 *	• **Dog problem, not in cat** • **Endochondral ossification failure** • **Medial & lateral trochlea of talus** - **Less common than shoulder** - Unilateral or bilateral - Male:female - 5:1 • Breeds: Large & giant breeds (Rottweiler, Labrador) • **Cause- unknown** - **4-10 mo-old, rapidly growing, large breeds** . **Overnutrition,** genetics, low copper . Trauma: causing or affecting abnormal cartilage • **Pathophysiology**: cartilage outgrows its nutrition, cells die, trauma	• **Lameness** • **Hyperextension of tarsocrural joint** • **Swelling** (distention of joint/ synovitis) • ± Pain on flexion • Sequelae: **DJD** **DDx:** • Hip dysplasia • Panosteitis • Sprain - ligament damage • Fracture/luxation	• **Hx (age, sex breed)**, CS • **Manipulate for pain** • **Radiology:** (cartilage not seen) - Subchondral bone changes m/ indicate cartilage damage - Joint distention - Subchondral bone sclerosis (thickening) - Chronic: DJD (sclerosis, loss of joint space, periarticular osteophytes)	• **Conservative** - Rest (exercise on leash only for 6 months) - Restricted feed intake - NSAIDs (buffered aspirin or PBZ for comfort) • **Surgery - arthrotomy** - Debridement - **Curettage**, scrape to good clean bone - Remove" joint mice" - Postsurgery . Enforced rest for 6 weeks (leash) . Keep patient thin . Buffered aspirin • Prognosis: **Guarded to poor**; worst joint to have OCD, "large" piece usually found which, when removed, makes joint very unstable - DJD - arthrodesis

Breeds & skeletal dizs

Afghan: Bone cysts
Airedale: Panosteitis
Basset hound: HOD, Panosteitis, Elbow subluxation & anconeal fx
Boston terrier: CMO
Boxer: CMO
Cairn terrier: Craniomandibular osteopathy
Collie: HOD
Chondrodystrophic breeds: Elbow luxation
Dalmatian: HOD, Bone cysts
Doberman: Osteosarcoma, HOD, Panosteitis, CMO, Bone cysts
English bulldog: Elbow subluxation & anconeal fx
German shepherd: Panosteitis, Osteosarcoma, Chondrosarcoma, HOD, Bone cysts
German short haired pointer: HOD
Golden retriever: OCD - elbow, Osteosarcoma
Great Dane: Osteosarcoma, HOD, panosteitis, CMO
Greyhound: HOD
Irish setter: Osteosarcoma, HOD, Panosteitis
Irish wolfhound: HOD, Bone cysts
Labrador retriever: HOD, CMO, OCD - elbow
Large breeds: Osteosarcoma, Chondrosarcoma, HOD
Miniature breeds: Legg-Calve-Perthes diz
Miniature schnauzer: Panosteitis
Poodles (miniature & toy), Patellar luxation
Rottweiler: OCD - elbow
Saluki: Bone cysts
Scottish terrier: Craniomandibular osteopathy
Small breeds: Legg-Calve-Perthes diz
Spaniels: Condylar humeral fxs
St Bernards: Osteosarcoma, HOD, Panosteitis
Weimaraner: HOD, Bone cysts
West Highland white terrier: craniomandibular osteopathy
Yorkshire terriers: patellar luxation

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Endocrine Diseases

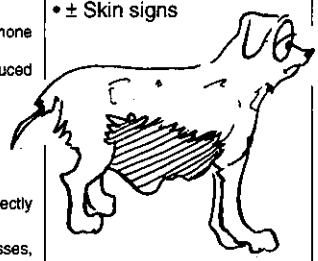
Condition	Facts/Cause	Presentation/CS	Diagnosis

Endocrine diseases

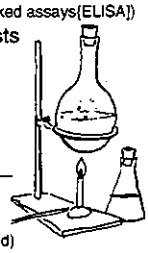
M8k 380; H3B 435, 438; H2B 495; I2M 671; IM 525; IM-WW 383; C12T 335; Cat 1403; Sx-WW 181

- **Incidence of endocrine diz - 7% of small animals seen**
- Causes of endocrine diz
  - Autonomy: hormone not modulated by negative feedback: neoplasia usually
  - 2° Dysfunction: hypersecretion by overestimulation due to trophic hormone or metabolic stimulus
  - 1° Hypofunction: developmental or degeneration resulting in reduced secretion
  - 2° Hypofunction: deficiently of stimulating hormone on organ
  - Ectopic hypersecretion: neoplasia
  - Failure of target organ to respond
  - Abnormal degradation of hormone
  - Iatrogenic hormone excess: excessive hormone administration
- **Endocrine system**: group of organs that secrete hormones directly into bloodstream to affect distant parts of the body
  - Hormones: maintain hemostasis, coordinate response to stresses, control growth, control reproduction
  - Control of hormone secretion; **negative feedback**: negative closed loop (A stimulates B secretion, B inhibits A secretion)
  - Positive closed loop only in ovary-pituitary loop (hormone A stimulates B secretion & B stimulates A)
- **Endocrine organs** (nonreproductive) & their major secretion
  - Hypothalamus: TRH (thyrotropin-releasing hormone), CRH (corticotropin-releasing hormone), GHRH (growth hormone-releasing hormone), Somatostatin (growth hormone-inhibiting hormone), ADH (antidiuretic hormone)
  - Hypophysis: TSH (thyrotropin/thyroid-stimulating hormone), ACTH (corticotropin/adrenocorticotropic hormone), Growth hormone
  - Thyroids: T4 (thyroxine), T3 (Triiodothyronine), Calcitonin
  - Parathyroids: PTH (parathyroid hormones)
  - Pancreatic islet & GI tract: Insulin, glucagon, gastrin
  - Adrenals: cortisol, aldosterone, epinephrine, norepinephrine
  - Kidney: Vitamin D3 (1,25- dihydroxycholecalciferol), erythropoietin
  - Heart: atrial natriuretic peptide

- Generally nonspecific
- Dysfunction of hormone's target organ
- ± Skin signs



- History
- Clinical signs
- Physical exam
- Concentration of hormone in blood stream (most secreted continuously, some fluctuate [weekly, monthly, circadian/diurnal rhythms])
  - Hormone transport in blood (thyroid & steroid hormone bind to plasma protein w/ a little free hormone to bind to receptors)
  - Immunoassay (radioimmunoassay, enzyme-linked assays[ELISA])
  - Dynamic stimulation or suppression tests
  - Inappropriate levels usually significant
- Response to therapy



Laboratory samples

- Adhere to methods recommended by reference laboratory
- Plasma or serum samples for hormone measurements (never whole blood or clotted blood)
  - Serum samples in **red-top** tubes allow to completely clot, centrifuge as soon as possible & collect serum
  - Plasma samples in **purple top** (EDTA [ethylenediaminetetraacetic acid]), centrifuge w/in 15 minutes, collect plasma
  - Place serum & plasm samples in snap-top plastic (polypropylene) tubes
  - Refrigerate or freeze until shipment
  - Try to avoid severe hemolysis or lipemia
- Do not mail in glass tubes; mail in protective containers
- Ship early in week by fast shipper

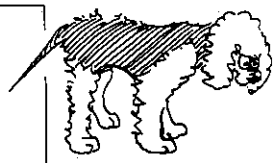
Lab - specific requirements for each hormone

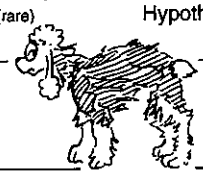
Hormone	Minimum size	Mailing package	Time to ship
• Cortisol	1ml of plasma (preferred) or serum	Refrigerated	2 day air
• Total T4 & T3	1 ml of plasma or serum	Refrigeration not required	Regular mail
• Gonadal steroids - Testosterone, progesterone	1 ml plasma or serum	Refrigerated	2nd day air
• Insulin*	1ml plasm or serum	Refrigerated	2nd day air

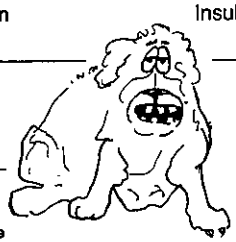
* Feline assays not always available, check w/ lab

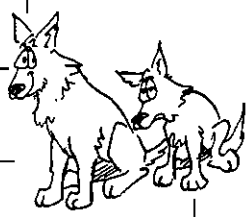
Age & onset of endocrine disorders

0-1 year old	1-5 years	5-10 years	More than 10 years
Familial diabetes mellitus	Hypoadrenocorticism	Hypothyroidism	Diabetes insipidus
Pituitary dwarfism	Hypercalcemia (lymphosarcoma)	Diabetes mellitus	1° hyperparathyroidism
Cretinism	Hypoparathyroidism	Hyperadrenocorticism	Hypercalcemia (anal sac tumor)
Nutritional 2° hyperparathyroidism			
Juvenile diabetes insipidus (rare)	Hypothyroidism	Insulinoma	2° hyperparathyroidism (renal diz)







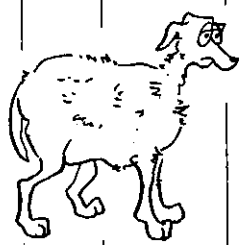


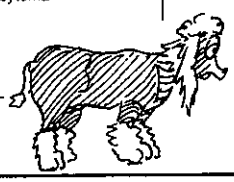
Canine - Endocrine dizs - Incidence

***Common - 1 per month**
- **Diabetes mellitus**
- **Hyperadrenocorticism**
- **Hypothyroidism**

** Uncommon - 1 per year**
- Hypoadrenocorticism
- Hypercalcemia (lymphosarcoma)
- Hypoparathyroidism/hypocalcemia
- Hyperparathyroidism
- Hypoglycemia
- DM - Diabetic ketoacidosis
- DM - Insulin resistant
- Diabetes insipidus

*** Rare - 1 per lifetime**
- Juvenile onset Diabetes mellitus
- Hyperthyroidism
- Juvenile hypothyroidism
- Acromegaly
- Pituitary dwarfism
- Cretinism
- Insulinoma
- Diabetes insipidus
- Hypercalcemia (anal sac tumor)
- Juvenile hyperparathyroidism
- 2° hyperparathyroidism - diet
- 2° hyperparathyroidism - renal
- DM - Nonketotic hyperosmolar diabetic syndrome
- DM - insulin resistant
- Hypoglycemia - Gestational
- Pheochromocytoma





Feline - Endocrine dizs - Incidence

***** Common - 1 per month**
- **Hyperthyroidism**
- Diabetes mellitus (DM)
- DM - insulin resistant

** Uncommon - 1 per year**
- Hypoparathyroidism
- DM - Diabetic ketoacidosis
- Hypoglycemia

*** Rare - 1 per lifetime**
- **Hyperadrenocorticism**
- Acromegaly
- Pituitary dwarfism
- Cretinism
- Hypoadrenocorticism
- Hypercalcemia (lymphosarcoma)
- Hypoparathyroidism/hypocalcemia
- Hypothyroidism (adult & juvenile)
- Insulinoma
- Diabetes insipidus
- 1° hyperparathyroidism
- Hypercalcemia
- 2° hyperparathyroidism - diet
- 2° hyperparathyroidism - renal
- DM - Nonketotic hyperosmolar diabetic syndrome
- Hypoglycemia - Gestational
- Pheochromocytoma (1 cat)

Not reported in cat
- Juvenile onset diabetes mellitus
- Juvenile hyperparathyroidism

Hyperadrenocorticism

Condition	Facts/Cause	Presentation/CS	Sequelae

Canine Hyperadrenocorticism, Cushing's syndrome, Cushing's diz,

Hyperglucocorticoidism

VetMed 710, 1997; M8k 387, 407; Mk 261, E-hb 585; SAP 240; H3B 473; H2B 534; I2M 775; IM 587; 5min 690, 40; IM-WW 404; Cat 1481; C12T 416,421, 336, 356, C11T 396t, 345, 349,1062, 310; E 1538, R&E-F 187; R&E-M 216; Derm 635, D-CT 273; D-Sy 102, 151, 192, D-Mi 275; Phys-B 905, 958, 970; Lab-S 338; Lab-C 220; Pa-T 258; Sx-S-hb 503, 758; Sx-S 1496, 2293; Sx4B 539; Sx3B 431; Sx-WW 181; NB 9. 7

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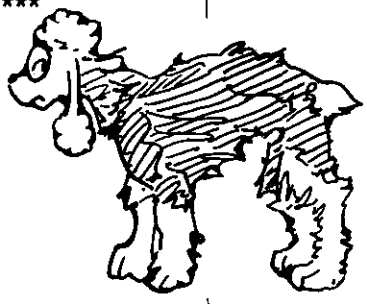
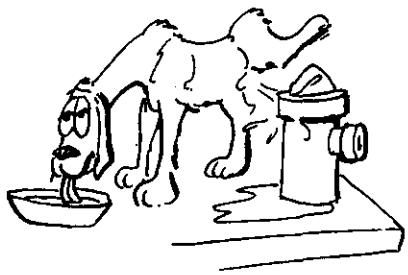


- **Chronic exposure to excess GCC** (glucocorticoids)
- Insidious onset, slowly progressive
- One of most common endocrine dizs in dogs
- Rare in cats
- **Causes:**
  1. **Pituitary dependent** (85%)(**PDH**): excessive ACTH - hyperplasia
  2. **Adrenal tumor** 15% (**AT**): excessive cortisol
  3. **Iatrogenic**: prolonged steroid Tx - adrenal atrophy
- **Breeds**: PDH: Boxer, Boston terrier, Dachshund, Poodle, terrier breeds, all breeds can be affected; AT: Ger. shepherd & toy poodle
- **Middle aged** (8-9 years, range 0.5-17 yrs)
- No sex predilection in PDH, 70% female in AT

Insidious & progressive

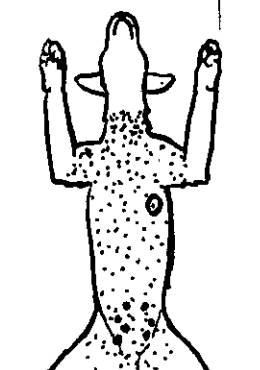
- **PU/PD** #1 CS >85% (polyuria/polydypsia)
- Polyphagia (PP) (ravenous appetite due to developing DM, cortisol interferes w/ insulin at cellular level)
- **"Potbelly"** 90%: muscular wasting, pendulous abdomen
- **Dermatologic changes:**
  - **Thin, wrinkled skin** (atrophy of skin due to catabolism, especially abdomen)
  - **Bilateral, symmetrical, nonpruritic alopecia** (thin, dry, broken hair)
  - **Hyperpigmentation** (cause unclear)
  - **Calcinosis cutis: uncommon**
  - Hematomas after venipuncture, bruising
  - Pressure necrosis
  - **Pyoderma** (immunosuppression)
- **Muscle weakness/wasting** 70% - trembling, weak, atrophy of limb muscles
- **Redistribution of fat:** neck & shoulder thickened
- **Mineralization** (lungs, skeletal muscles, adrenals, skin & stomach wall)
- Lethargy (CNS)
- **Immunosuppression**
  - Infections - skin, UTI, lungs
  - Poor healing of wounds
  - Rapid spread of corneal ulcers
  - Urinary tract infections/pyelonephritis
  - Bronchopneumonia
- **Panting**: respiratory system
  - Thromboembolism - uncommon sequelae
- Hypertension

- Sequelae/complications: average lifespan after diagnosis is 2 years due to complications:
  - Diabetes mellitus 80% of cases
    . PU/PD & polyphagia
    . Insulin-resistant
  - Pulmonary thromboembolism
  - Infection
  - Congestive heart failure
  - Recurrence of symptoms
  - Progression of pituitary tumor growth
  - Complication due to underdosage or overdosage of mitotane or ketoconazole
    . Must persistently monitor



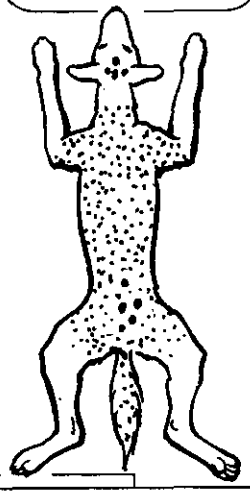
Pathogenesis:

- **1 - PDH/Pituitary dependent hyperadrenocorticism** 80%
  - Hypothalamic dysfunction
  - **Pituitary gland tumor: #1 Adenoma**, 85% (90% micoradenomas, < 10% macroadenomas, hyperplasia rare)
    . **Secretes excessive ACTH which is unresponsive to negative feedback**
    . Causes bilateral adrenal cortical **hyperplasia**
    . Adrenals secrete excess of cortisol (CCS)
  - Negative feedback not effective at resulting cortisol levels (high exogenous doses will suppress)
  - Small dogs
- **2 Adrenal tumors** 15% (ATs)
  - **50/50 rule** = 50% malignant (carcinomas: malignant, large locally invasive & metastasizes); 50% benign (adenomas - smaller); < 15% mineralize on radiographs
  - **Secretes excess cortisol, independent of ACTH** (autonomous)
  - ↓ ACTH due to negative feedback resulting in contralateral adrenal hypoplasia
  - Usually unilateral
  - Big dogs; female > Male
- **3 Iatrogenic**: prolonged exogenous GCC (glucocorticoid) administration (2° to Tx for atopy, immunological diz, eye, ear medicines)
  - **Bilateral adrenocortical atrophy**
- **Hormones involved:**
  - CRH (corticotropin releasing hormone from hypothalamus) stimulates release of ACTH
  - ACTH (from anterior pituitary): stimulates adrenal cortex to secrete glucocorticoids, mineralocorticoids & androgenic steroids
    . Negative feedback on CRH
  - Corticosteroids have negative feedback on ACTH

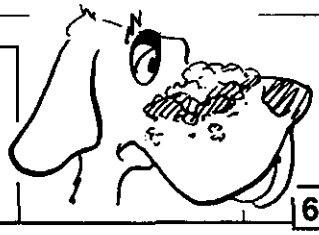


DDx:

- Diabetes mellitus
- Liver diz
- Renal diz
- Hypothyroidism
- Hypercalcemia
- Pyelonephritis
- Diabetes insipidus
- Hyperthyroidism
- Psychogenic polydipsia
- Acromegaly



Steroid excess
CS: PU/PD, Pot bellied, Alopecia
Dx: CS, PE, Lab, Rads; Tests
Tx: Pituitary: Mitotane or Depranil
Adrenal: Adrenalectomy



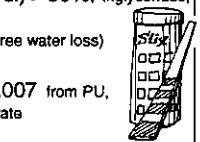
Glucocorticoid effects

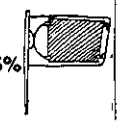
- Gluconeogenesis
- Lipolytic
- Protein catabolic
- Anti-inflammatory (suppresses phagocytosis, lympholytic & ↓ Ig)

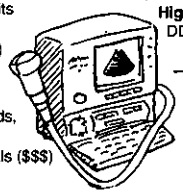
Diagnosis & treatment: following page

Diagnosis - Cushing's diz

- Hx (**steroid Tx**)
- CS: PU/PD/PP, weakness, skin, "pot bellied"
- Occasionally insulin resistant DM: 10% of cases
- Palpation: CS & hepatomegaly
- **Blood values**
  - **Stress leukogram** (↑PMNs & monocytes, ↓lymphocytes & eosinophils,)
  - ±↑ RBCs (PCV > 55)
  - **↑ALP, 80% dogs only** (alkaline phosphatase) > 1000 IU/dl common
  - ±↑ Blood glucose - overt diabetes mellitus (> 250 mg/dl in 10% of cases
  - ↑ Cholesterol (> 290 mg/dl) > 50%, triglycerides, ± ALT
  - ↓BUN from diuresis (↑ free water loss)
- UA (urinalysis):
  - Low specific gravity < 1.007 from PU, still maintains ability to concentrate
  - ± Proteinuria
  - Glycosuria in 10% = DM
- Hypertension
- Radiology:
  - Enlargement of adrenals can't be seen
  - **Calcification of adrenals - < 15%**
  - ± Calcification of bronchial wall
  - Distended abdomen w/out effusions
  - **Hepatomegaly**: ↑ fat & glycogen deposits
  - Distended urinary bladder
  - Osteoporosis (GCC increases bone resorption)
  - Ectopic calcification in lungs & skin
  - **. Calcinosis cutis**
- Ultrasound (look for tumors on adrenal glands, to differentiate from pituitary tumor) 50%
- CT (computed tomography) of pituitary & adrenals ($$$)





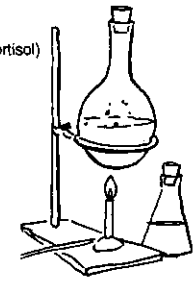


- **Presumptive diagnosis: CS, PE, Lab & rads**
- **Diagnostic tests (ACTH, LDDST, HDDST)**
  - Done if owner willing to consider surgery or interested in prognosis
  - If not willing - medical therapy for PDH (85% chance of being right)
  - None of tests are foolproof! Repeat if questionable in 1 month
- ACTH stimulation to diagnose Cushing's
  - PDH (85%), AT (50%): exaggerated response
  - Normal: normal or ↑ in cortisol
  - Iatrogenic: blunted or no increase
- LDDST: diagnose Cushing's - PDH or AT
  - < 1.5 µg/dl cortisol at 8 hrs = normal
  - > 1.5 at 8 hours: may be PDH or AT
  - < 1.5 at 4 hours & > 1.5 at 8 hours: suggests PDH
- HDDST: "differentiate" PDH vs AT
  - < 50% or pre-value at 4 hrs: PDH more likely
  - ≥ 50% of pre-value at 4 hrs: AT more likely
- Thyroid function tests
  - Serum T3 & T4 low in 50% of cases, but response to exogenous TSH parallels that of normal

Low - dose Dex	**4 hr-post**	**8hr-post**	µg/dl
	-	< 1.5	Normal
	< 1.5	> 1.5	PDH more likely
	> 1.5	> 1.5	AT more likely
High dose Dex	**Post Dex. cortisol**		µg/dl
DDx PDH vs AT	< 50% of pre-value		PDH most likely
	≥ 50% of pre-value		AT most likely

Pituitary-adrenal function tests

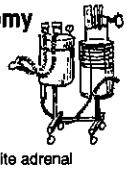
- Basal cortisol levels - 1-5 ug/dL: not very useful because of constant fluctuation throughout day (Cushing's dogs often fall w/in this range so use suppression & stimulation tests)
- **ACTH stimulation** (most commonly used, inexpensive & quick)
  - **Diagnoses Cushing's & differentiates from iatrogenic Cushing's**
  - PDH (85%) & adrenal tumors (50%): show an exaggerated response
  - Normal: normal or ↑ (but doesn't rule out Cushing's; if CS, do LDDST)
  - Iatrogenic (steroid Tx): "blunted" or no increase - "flat line"
  - Protocol: Obtain serum samples of cortisol analysis before & after IM injection of ACTH (Vedco®, Cortroxyn®)
- **LDDST** (**Low dose dexamethasone suppression test** - 0.01 mg/kg)
  - **Confirm Cushing's diagnosis**: separates normal from PDH & AT
  - Dexamethasone supplies negative feedback on ACTH production resulting in ↓ blood cortisol in normals
  - Normal: ↓ cortisol < 1µg/dL at 8 hrs
  - PDH & Adrenal tumors: no suppression > 1µg/dl at 8 hrs
  - . 1/3rd of PDH are suppressed at 2-4 hours, but "escape" & are > 1 ug/dl at 8 hours, "escape" doesn't happen w/ AT
- **HDDST** (**High dose dexamethasone** suppression test - 0.1 mg/kg)
  - **May** differentiate pituitary & adrenal tumors
  - . Adrenal tumors: ACTH independent, thus not suppressed, not diagnostic
  - . PDH threshold for steroid negative feedback on ACTH is higher than normal - suppression of cortisol diagnostic (75% of cases); 25% fail to suppress, especially large pituitary tumors
- ACTH plasma concentrations to separate PDH from AT
  - PDH: ACTH elevated (tumor producing ACTH)
  - AT: ACTH low (not producing)
  - Expensive & difficult to perform, not done often
- Cortisol:creatine ratio
  - New test, sensitive, but not specific (many causes of ↑ cortisol)
  - Creatine & cortisol in urine measured
  - Cortisol to creatinine ratio > 35 suggestive of Cushing's, < 35 normal



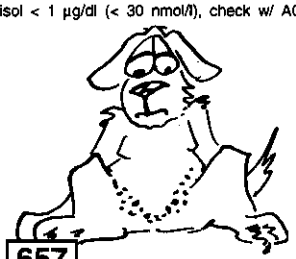
Treatment of hyperadrenocorticism

- **PDH**/Pituitary dependent hyperadrenocorticism
  - **Mitotane, Lysodren® (o,p'-DDD)**:
    - . Causes selective necrosis of adrenal cortices (zona fasciculata & zona reticularis)
    - . 2 phases: **initially dose to cause remission, PO 7-10 days**
    - .. Glucocorticoid (prednisolone or prednisolone) during induction to prevent 2° hypoadrenocorticism effects
    - . **Lifelong maintenance once normalized: Mitotane PO 1-2 x week**
  - **. Fludrocortisone acetate** or **DOCP** (mineralocorticoids): generally lifelong supplementation required
  - . Dramatic reversal of signs
  - . Side effects usually mild - stop & give prednisone or prednisolone if side effects (lethargy, vomiting, anorexia, CNS, ataxia & diarrhea)
  - . Monitor Tx w/ ACTH stimulation test every 5-10 days
  - .. Goal: basal & post ACTH cortisol between 1-5 µg/dl
  - .. If serum cortisol falls to < 1 µg/dl stop & supplement w/ GCC until normalized
  - . Owners carry prednisolone for times of major stress (2.2 mg/kg)
  - . M/ cause hypoadrenocorticism (5% of cases): tell owners to look for signs: vomiting & diarrhea
  - . Many relapse in 12 months & require reloading w/ ↑ dosage of mitotane for maintenance
  - **Selegiline (Deprenyl®**, L-deprenyl, Eldepryl®): for uncomplicated PDH
    - . ↑ Dopamine by ↓ metabolism of dopamine using monoamine oxidase (MOA) type B
    - . Avoid with other MAO inhibitors
    - . Decreases CS, monitor CBC, Chem & UA
  - **Ketoconazole** (Nizoral®) reversibly inhibits enzymes needed in GCC production (steroidogenesis)
    - . Start w/ 5 mg/kg & work up (↑ mg/kg every 7-10 days) to level that controls cortisol levels
    - . ACTH stimulation after 7-10 days
    - .. Goal 1-5 µg/dl cortisol
    - .. Once adequate control **lifelong BID Tx**
    - Disadvantages: cost & lifelong BID Tx
  - Radiation: PDH: for pituitary macroadenoma or macrocarcinoma
    - . Radiation delivered in fractions over a period of 4-6 weeks
    - . Disadvantages: cost & limited availability
  - Cobalt irradiation for pituitary macroadenoma

- **PDH + concurrent diabetes mellitus & PDH**
  - Mitotane - o,p'-DDD (Lysodren®)
  - . Induction 25-35 mg/kg/d 7-10 d
  - . ↓ insulin by 10% w/ each negative glucose (monitor urine glucose BID)
  - . Maintenance: follow above regime for PDH w/o DM
  - . Comment: Mitotane removes cause of insulin resistance so insulin dose reduced

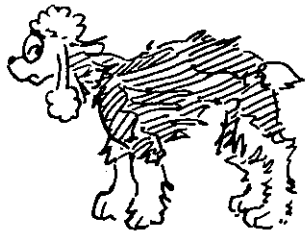


- **Adrenal tumor**
  - **Adrenalectomy** TOC, surgical removal of affected adrenal gland
  - . Check that not bilateral & for metastasis
  - . Post surgical: low cortisol due to atrophy of opposite adrenal
  - .. Ketoconazole to prepare for surgery (normalizes hypercortisolemia as well as removes negative feedback on contralateral normal adrenal allowing it to return to function sooner post-op)
  - .. DOCA, prednisolone (corticosteroid w/ hi mineralocorticoid) administrated 1-2 days before surgery
  - .. IV steroids during surgery
  - . Post surgical monitor Na:K levels & for shock, Tx w/ DOCA if necessary
  - . Continual steroid not necessary usually unless bilateral adrenalectomy
  - . Mineralocorticoids necessary if bilateral adrenalectomy
  - . Anatomical note: adrenal glands located under phrenicoabdominal vein, near cranial pole of kidney
  - Mitotane, Lysodren® (o,p'-DDD) for AT
  - . If surgery not acceptable to owner
  - .. Initially dose higher than for PDH to cause remission, PO 7-10 days
  - .. Goal: serum cortisol < 1 µg/dl (< 30 nmol/l), check w/ ACTH stimulation every 2 weeks
  - .. Prednisolone or prednisolone: during induction to prevent 2° hypoadrenocorticism effects
  - .. Lifelong maintenance once normalizes: High dose mitotane PO 1-2 x week
  - .. If side effects stop Tx & restart at lower dosage



- **Pulmonary thromboembolism**
  - General supportive care
  - Oxygen
  - Anticoagulants + time
- Monitor Cushing's patients
  - **Lifelong monitoring necessary** because mitotane overdosage or underdosage can complicate Tx
  - . ACTH stimulation test every 3-6 months to guide mitotane & ketoconazole adjustment

Drugs on horizon: Bromocriptine, Cyproheptadine, Metyrapone, Aminoglutethimide, Etomidate, Trilostane, Suramin



Prognosis:

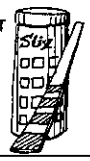
- **Always guarded at best**
- Pituitary tumors: good - life span 2 yrs
- Benign adrenal tumors: good
- Poor: malignant adrenal tumors: - metastasis
- PDH + CNS CS: grave

Adrenal Function

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Feline Hyperadrenocorticism, Cushing's syndrome, CCS Mk 261, E-hb 596; SAP 244, 373; E 1510; H2B534; I2M 792; IM 587; 5min 690; IM-WW 408; F2IM 129; Cat 1481, 1405; R&E-F 256; R&E-M 216; Phys-B 970; Lab-C 220; Pa-T 358; Sx3B 431; Sx-S-hb 503, 758; Sx-S 1496, 2293; NB 9.7 ★-★★	• **Rare in cats** • Chronic exposure to excess glucocorticoids • Strong correlation between Cushing's & Diabetes mellitus: in most diagnoses after documentation of insulin-resistant Diabetes mellitus • Insidious onset, slowly progressive • **Middle aged** & older (10+ years old) • Female > males • **Causes-like dogs:** **1. Pituitary dependent** (70% of spontaneous cases): - **Excessive ACTH - excess cortisol - adrenal hyperplasia** **2. Adrenal tumor** 20% (AT) - Excess cortisol **3. Iatrogenic:** uncommon - Prolonged steroid Tx - adrenal atrophy	• **PU/PD:** 2° Diabetes mellitus • Polyphagia/PP (ravenous appetite due to developing DM) • **"Potbelly", pendulous abdomen** • Dermatologic changes - **Thin skin, easily bruised** - **Bilateral symmetrical alopecia** . Dull, dry hair coat . Pinnal alopecia . Medial curling of ear tips - Hyperpigmentation - Skin infections (demodicosis) • Muscle weakness/wasting • Lethargy • Dyspnea/panting • Immunosuppression - **Recurrent bacterial infections** • Sequela: - **Diabetes mellitus 80% of cases** . PU/PD & polyphagia . Insulin resistant - Pulmonary thromboembolism - Congestive heart failure	• Hx (steroid Tx), CS • Insulin resistant DM common • Palpation: CS & hepatomegaly • **Blood values** - Stress leukogram not consistent in cats - ↑ ALP not a consistent finding in contrast to dog (alkaline phosphatase) - **↑ Blood glucose in 80%** - ↑ Cholesterol • UA (urinalysis) - **Glycosuria in 80% - DM** • Radiology: - ± Hepatomegaly • Ultrasound • **Presumptive Dx: CS, PE, Lab & Rads** • **Tests to establish diagnosis (ACTH, HDDST) w/ similar results to dog** • ACTH stimulation to diagnose Cushing's - PDH & ATs usually exaggerated response - Normal: normal increase cortisol - Iatrogenic: blunted or no increase • LDDST: not well standardized for cat & not recommended • HDDST: differentiate normal from Cushing's, PDH not suppressed in cat as in dog so can't be used to DDx PDH from AT - < 50% or pre-value = normal - ≥ 50% of pre-value = PDH or AT	• **Effective Tx in cat yet to be determined** - Few cases treated - Surgery may be best . Bilateral adrenalectomy for PDH . Unilateral for AT - Mitotane not recommended (poor tolerance & lack of efficacy) - Ketoconazole doesn't suppress plasma cortisol in cats & may not be effective in hyperadrenocorticism - Metyrapone (inhibits glucocorticogenesis, mixed results)

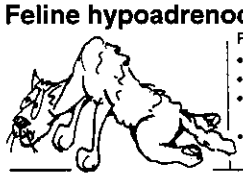
Rare, Steroid excess
CS: PU/PD, Pot bellied, Alopecia; DM
Dx: ACTH, HDDST, Glucose
Tx: ? Surgery ?

- CRH (cortropin releasing hormone from hypothalamus) stimulates release of ACTH
- ACTH (anterior pituitary) stimulates adrenal cortex to secrete glucocorticoids, mineralocorticoids & androgenic steroids
  - Negative feedback on CRH
- Corticosteroids have negative feedback on ACTH

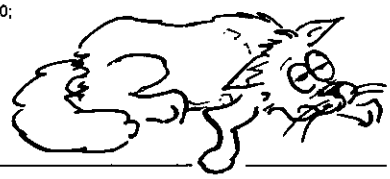


Prognosis:
- **Guarded to poor** in cat

Feline hypoadrenocorticism: ★ Mk 264; E-hb 602; C12T 421; IM 597; SAP 238; H2B531; 5min 716; IM-WW 404; E 1591; F2IM 129; Cat 1490; R&E-F 302; R&E-M 216; Phys-B 970; Lab-C 222; Pa-T 2259; Emrg 224, 255; Sx-S-hb 512, 758; Sx-S 2294; NB 9.11



- **Rare**. more being Dx lately, especially in insulin resistant diabetic cats; < 7 years old, Iatrogenic: steroid or Ovaban® Tx
- CS: **Similar to dog**: lethargy, weakness, hypothermia
- Dx: **Same method as dogs:** PE (dehydration), Auscultation: Bradycardia; ACTH stimulation ("Blunted" or no cortisol response); ECG: depends on ↑ of K; Radiology; Necropsy (small adrenal w/ thin cortex)
- Tx: **Emergency**: rapid IV normal saline (20-40 mg/kg), Dexamethasone (Azium®); then mineralocorticoids (Florinef® [fludrocortisone acetate]); ± Glucocorticoids maintenance (cats don't respond as quickly as dogs to fluids & steroids)



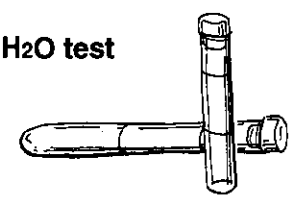
Hyponatremia, Ectopic vasopressin syndrome, Ectopic antidiuretic hormone production, Excess ADH syndrome, **Syndrome of inappropriate secretion of antidiuretic hormone,** **SIADH** H2B 820, 503; E-hb 551, 25, 244, 151; I2M 820; IM 617; IM-WW 386; 5min 276; C12T 530, 531t, 535; C11T 303t, 304 ★	• ***Rare*** • *ADH = antidiuretic hormone, vasopressin* • Ectopic production of ADH despite low serum sodium (**hyponatremia**), osmolality • Unable to secrete a dilute urine & therefore retain fluids • Pathophysiology: - ADH increases permeability to water in distal nephrons & collecting ducts - Expansion of extracellular volume - Hyponatremia (↑ secretion of Na, ↓ plasma osmolality, ↑ urine osmolality)	• **Asymptomatic** • CS of low sodium (< 120 mEq/l) - PU/PD - Edema - Anorexia, weakness - Nausea, vomiting - Confusion, stupor - Seizures, coma • ± Sudden ↑ body weight (water retention)	• CS • Lab - **Hyponatremia** - hallmark < 130 mEq/l - Persistent high urine osmolality, hypernatriuresis, & normal renal function - Low plasma osmolality (< 275 mOsm/kg) • Evidence of cancer or anticancer drug • Water loading test (give 20 ml of H2O by stomach tube & measure urine osmolality, should decrease to < 100 mOsm/kg in normal - Positive if urine osmolality remains higher than plasma • Bioassay for tumor • R/O outer cause of hyponatremia	• Manage underlying tumor • Stop anticancer drugs • Severe hyponatremia: **furosemide** diuresis + hourly replacement of sodium w/ hypertonic **saline solution** - Water restriction when normal Na level • Mild hyponatremia: - Restrict water intake - **Demeclocycline** (Declomycin®) PO bid to counteract action of ADH on distal tubules - **Lithium carbonate** (Lithotabs®) PO sid to antagonize renal action of ADH • Monitor so serum sodium ≥ 135 mEq/l of urine to plasma osmolality ration 2:5-5.8 • Sudden correction of hyponatremia may cause progressive spastic quadriplegia & death

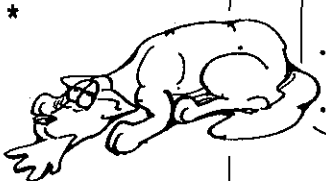
Cause: SIADH
- Paraneoplastic diz
  - **Bronchogenic carcinoma**
  - Thymoma
  - Leiomyosarcoma
  - Pancreatic adenocarcinoma
  - Mesothelioma
  - Lymphoma
- Anticancer drugs:
  - Vincristine
  - Cyclophosphamide
- Exogenous ADH administration

DDx: Hyponatremia
- Vomiting & diarrhea #1- GI loss
- Hypoadrenocorticism
- Renal insufficiency (nephrotic syndrome)
- Congestive heart failure
- Postobstructive diuresis
- Over hydration (1° polydipsia)
- Edematous states
- Iatrogenic
  - Diuretics
  - Fluid therapy - hypotonic fluids
- Myxedema coma
- Pseudohyponatremia
  - Hyperlipidemia
  - Hyperproteinemia (> 10 g/dl)
  - Hyperglycemia
  - Mannitol therapy
- Diz causing excessive release of ADH

Na < 130

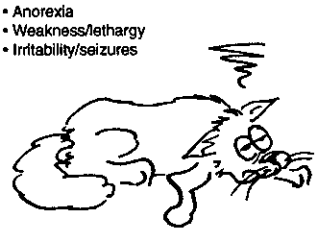
H2O test

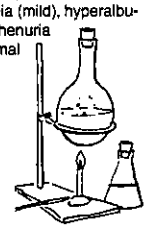


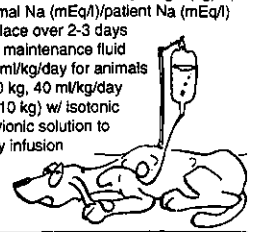


Adipsia, Hypodipsia SAP 270; IM-WW 386; C12T 953; C11T 303t, 304,1002 ★	• **Absent or reduced thirst** • Cause: ? idiopathic, resetting of osmoreceptor threshold or lesion of thirst center? • Young < 1 year old in idiopathic & congenital form • **Female miniature schnauzer** • Pathophysiology: - Normal: water loss, mild ↑ in plasma osmolality stimulates osmoreceptors in hypothalamus to ↑ drinking & ADH secretion - Adipsia: no extra drinking - hypernatremia & dehydration	• **Depression/stupor/coma** • **Personality change** • **Disorientation** • Anorexia • Weakness/lethargy • Irritability/seizures	• Hx (**miniture schnauzer**); CS • PE: dehydration & altered mentation • Lab: - Hypernatremia (profound) - Hyperosmolality (profound) - Hyperchloremia, azotemia (mild), hyperalbuminemia (mild), hypersthenuria • Radiographs: usually normal	• **Slowly correct or cerebral edema ≤ Na** • Sodium-restricted isotonic fluid IV (5% dextrose in water or 0.45% NaCl w/ 2.5% dextrose) • Water deficit = 0.6 x body weight (kg) x (1- normal Na (mEq/l)/patient Na (mEq/l) • Replace over 2-3 days • Add maintenance fluid (60 ml/kg/day for animals > 10 kg, 40 ml/kg/day if ≤ 10 kg) w/ isotonic polyionic solution to daily infusion

↓ Thrist: ?







Hypoadrenocorticism

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Addison's ** disease, Hypo-adrenocorticism

M8k 391; Mk 264; E-hb 597; SAP 238, 1175, 802; H3B 471; H2B 531; I2M 798; IM 600, 742; 5min 716; IM-WW 401; E 1579; Cat 1490; C12T 425; R&E-F 266; R&E-M 216; NS-W 203; NS-HB 332; NS-L 89, Phys-B 970; Lab-C 222; Pa-T 259; Emrg 224, 255; Sx-S-hb 512, 758; Sx-S 2294; NB 9.11

- **Uncommon endocrinopathy**
- **↓ Glucocorticoids &/or mineralocorticoids from adrenal cortex**
  - Usually due to adrenal atrophy
- **Young to middle aged, female dogs**
  - < 7 years (range 0.5-10 yr)
  - Any breed, black standard poodles

Causes of Addison's

1°: diz of adrenals (usually defc of both mineralo- & glucocorticoids)
- **Unknown/idiopathic #1**
- Destruction of adrenals
  - . **Autoimmune**
  - . Granulomatous fungus
  - . Hemorrhage/Infarction
  - . Metastatic tumors
- **Overdose of o,p'-DDD** (mineralocorticoids usually normal)

2°: **Pituitary ACTH deficiency** (glucocorticoid deficiency, mineralocorticoids usually remain normal)
- **Iatrogenic - termination of steroid Tx**: (sudden) prolonged or hi doses of glucocorticoids (ACTH suppressed)
- Megestrol acetate (Ovaban®) Tx in cats
- Destruction of pituitary or hypothalamus by tumors
- Idiopathic ACTH deficiency (rare)

Low steroids, Female dogs
CS: Great pretender - PU/PD, Weak
Dx: ACTH stim. - Blunting
Tx: Glucocorticoids, Mineralocorticoids

- **"Great pretender"**: CS mimic other dizs
- **Chronic**
  - **No pathognomonic signs**
  - Waxing & waning course
  - **Anorexia, weight loss**
  - **Dullness, lethargy**
  - **Muscle weakness** (exercise intolerance)
  - **Vomiting** & diarrhea
  - **PU/PD**
  - Stress often exacerbates CS
- **Acute, end-stage**: from similar but more severe CS
  - Weakness to collapse
  - Severe vomiting/ dehydration
  - **Bradycardia**
  - Cardiac arrhythmias (K+)
  - **Hypovolemic shock & death** w/o Tx

- **Difficult** - confused w/ other dizs
- Hx (history), CS (clinical signs)
- **Physical exam**
  - Weak femoral pulse
  - Dehydration, CS
- Auscultation: bradycardia
- **ACTH stim. for definitive Dx**
  - "Blunted" or no cortisol response
  - Takes time to get results back
  - < 1 µg/dl in 1°, > 2.5 µg/dl for 2°
- Plasma ACTH concentrations
  - > 500 pg/ml in 1° , < 20 pg/ml in 2°
- Blood values:
  - Na:K ration < 27:1
    hyponatremia:hyperkalemia, normal 27:1 - 40:1
  - ↑ K, Ca, ↓ Na, Cl
  - K & Na m/b normal in 2°
  - Hypercalcemia 25%
  - Prerenal/renal azotemia (BUN)
  - Mild acidosis
  - ↑ Lymphocytes, eosinophils
  - Anemia (normocytic, normochromic nonregenerative)
    - . ↑ PCV - dehydration
    - . ± Hypoglycemia (rare)
- UA: Specific gravity often increased, but m/b decreased due to medullary Na washout
- **ECG: depends on ↑ of K** (see box)
- Radiology:
  - Microcardia
  - Small aortic arch
  - Narrow caudal vena cava
  - ↓ Pulmonary vasculature
  - Megaesophagus (rare)

- Necropsy: Small adrenal w/ thin cortex

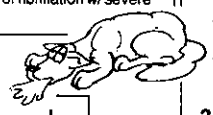
- **See below - expanded**
- **Acute: medical emergency** (life threatening hypercalcemia & hypoglycemic)
  - **Rapid IV normal saline** (40-80 ml/kg/h IV) w/o food or water for 24 hours past crisis
  - **Glucocorticoids**
    - . **Dexamethasone (Azium®)**
      - .. Repeat in 2-6 hours if needed
    - . Convert to SCC maintenance over following 3-5 days
  - **Hyperkalemia**
    - . NaCl 0.9% fluids usually enough
  - Acidosis: ± Na bicarbonate if total CO_2 < 12 mg/dl
- Chronic or subacute
  - **Fluid Tx**: normal saline
  - Maintenance
    - . **Mineralocorticoids:**
      - .. DOCP IM or SQ, monthly injections
      - .. Florinef® tablets DOC (drug of choice)
    - . ± Glucocorticoids maintenance not always required: Cortisone or prednisolone
  - **Steroids on hand** for crisis
- Monitor
  - Initially monitor serum electrolytes every 1-2 weeks until patient stable
  - Once stable check Na, K, BUN every 3 months

Prognosis:
- **Good** w/ diligent owner therapy

Pathophysiology:

- Glucocorticoids & cortisol deficiency
  - ↓ Gluconeogenesis & glycogenolysis, energy metabolism
  - Depletion of hepatic glycogen, ↓ fat metabolism, ↓ mentation, GI disturbances, impaired water excretion, impaired tolerance to stress
- **Lack of aldosterone (mineralocorticoid)**
  - **Loss of Na**, Cl, H2O & **retention of K+ & H+** leads to:
    - . Hypovolemic shock, ↓ cardiac conduction & output, ↓ blood press, ↓ renal perfusion
    - . Muscle weakness & nausea, mineralocorticoid deficiency
    - . Early: normal electrolyte levels, but can't deal w/ stress
- Glucocorticoids (CCS) can be deficient w/o aldosterone deficiency

ECG - life threatening hyperkalemia
- "Hold ECG at T wave & before P wave & stretch out"
- Peaked T wave
- Fattening of P wave
- Prolonged PR interval
- Widening & flattening of QRS complex
- ↓ or absent P waves as K+ rises
- Bradycardia
- Sinoatrial standstill (no P waves)
- Ventricular astole or fibrillation w/ severe hyperkalemia



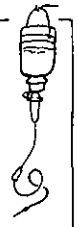
Memory aid: **Add** steroids to Tx **Add**ison's

DDx:
- 1° GI disturbance
- Renal failure
- Acute pancreatitis
- Ingestion of toxins
- Collapse or weakness
  - Cardiovascular diz
  - Neuromuscular dizs
  - Metabolic disorders
- Hyperkalemia
  - Chronic renal failure
  - Urethral obstruction
  - Ruptured urinary bladder
  - Severe acidosis
  - Surgical tissue destruction
  - Crush injury
  - Extensive infection
  - Massive hemolysis
- Hyponatremia
  - Renal tubular diz
  - Diuretic induced sodium loss
  - Urinary sodium loss from osmotic diuresis - Diabetes mellitus
  - Inadequate intake
  - Vomiting
  - Diarrhea
  - Polydipsia
- Other causes of hypercalcemia
- Crisis - life threatening
  - Diabetic ketoacidosis
  - Necrotizing pancreatitis
  - Septic peritonitis

TREATMENT:

- **Acute: medical emergency** (life threatening hypercalcemia & hypoglycemia), correct hypotension & hypovolemia, give immediate CCS, correct electrolyte imbalance & acidosis
  - Obtain blood & urine before initiating Tx, ACTH stimulation can be performed simultaneously

1. Hypovolemia IV catheter
- **Rapid IV normal saline** (40-80 ml/kg in 1st hr)(90% of time will take care of hyperkalemia)
- **Dexamethasone (Azium®)** (doesn't interfere w/ ACTH test) or Dexamethasone sodium phosphate
  - . Repeat in 2-6 hours if needed
- **Convert** to prednisolone, prednisone or cortisone acetate over following 3-5 days



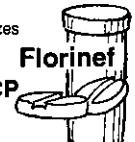
2. Hyperkalemia - Tx increased K if needed
- **Usually corrected w/ normal saline**
  - Indication for more aggressive Tx: severe bradycardia & sinoatrial standstill
  - . Insulin-dextrose Tx (Regular insulin IV bolus + Dextrose IV fluid over 4-6 hr)
  - Ca gluconate or Na bicarbonate, administer cautiously/serious side effects
  - . Antagonize K effect on heart
  - . Cautiously give Na bicarbonate over 10-20 min (temporary transcellular shift of potassium)

3. Acidosis: Na bicarbonate if pH < 7.1 or total CO_2 < 12
- 1/4 calculated dose IV during first 6 hr if serum bicarbonate < 12 mEq/L

4. Supportive care
- Correct hypothermia
- Hypoglycemia: 50% dextrose 0.5-1.5 ml/kg IV slowly

5. When stabilized Tx as for chronic Addison's

- **Chronic or subacute**
  - **Fluid Tx:** normal saline (60-80 ml/kg/d IV), decrease over 48-96 hours as normalizes
  - Maintenance therapy
    - . **Mineralocorticoids**
      - .. DOCP® (desoxycorticosterone) **monthly** injections; long acting mineralocorticoid, not approved for small animals, get a client waiver
      - .. Oral Florinef® (fludrocortisone acetate) tablets DOC (check w/ serial electrolyte values)
    - . **"Steroids"/glucocorticoids** maintenance not required by all
      - .. Prednisolone, prednisone or cortisone acetate
  - **Steroids on hand** for crisis (stress - owners should carry prednisolone tablets)
  - Salt supplementation may enable to decrease of DOCP or Florinef (which is expensive)
  - Monitor: Initially monitor serum electrolytes every 1-2 weeks until patient stable
  - . Once stable check Na, K, BUN every 3-4 months



Diabetes mellitus

Condition	Facts/Cause	Presentation/CS	Diagnosis

Diabetes mellitus, DM

M8k 394, 913; Mk 267; E-hb 576, 318; SAP 249, 1168; H3B 463, 281; H2B 523, 311; I2M 737, 734; IM 563, 573(!), 595, 798; IM-WW 394; 5min 520; E 1510, 706; Cat 1465, 1459, 1555; C11T 311; C12T 393, 403, 390, 384; R&E-F 339; R&E-M 194; NS-C 383; NS-W 202, 216, 228; NS3hb 194, 351; NS-hb 192, 331; NS-O 362, 270; NS-L 79; NS-Pa 462; Phys-B 851; Derm 706; Pa-T 276; Sx-S-hb 756, 66; Sx-S 2290, 140; NB 9.2

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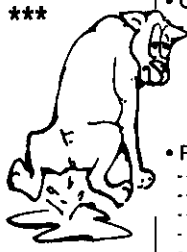


Facts/Cause

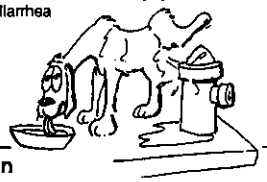
- Pancreatic islets inability to secrete insulin &/or impaired insulin action in tissues
- Incidence about 1:500 in dogs & cats
- **Insulin deficiency - metabolic disorder**
  - **CHO** (carbohydrate) intolerance
  - **Abnormal protein & lipid metabolism**
- Adult: 4-14 yrs (rare dogs < 1 yr)
  - Male cats & female dogs more commonly
- Breeds: pulis, cairn terriers, miniature pinschers, poodles, dachshunds, miniature schnauzers, beagles
- Types:
  - **Type 1 - Insulin dependent** (IDDM, Type 1) (ketosis prone) #1
    . Can't make insulin (β cells nonfunctional)
    . Irreversible, life long therapy
  - Type 2 - Non-insulin dependent (NIDDM)
    . Relative insulin deficit, insulin antagonism, abnormal carbohydrate metabolism, some function of β cells of pancreas
    . Cats 20%, less common in dogs
    . Some insulin secreted so mild hyperglycemia & ketoacidosis uncommon
  - Type 3 - 2° Diabetes: associated w/ other dizs (pancreatic diz, endocrine disorders, drug-induced (steroids, megestrol acetate), hyperadrenocorticism, acromegaly)
    . Requires insulin treatment
- Causes - multifactorial
  Genetic, drugs (steroids, megestrol acetate), immune-mediated destruction of beta cells, amyloidosis, hormonal abnormalities (excess growth hormone), hyperadrenocorticism (rare), pancreatic diz, obesity & hi CHO diets, infectious viral dizs
- Pathophysiology:
  - ↓ Insulin
  - ↑ Hepatic gluconeogenesis & glycogenolysis
  - ↓ Glucose utilization & impaired glycolysis
  - Ketoacidosis (↑ ketone bodies due to underuse of glucose)
  - Results in hyperglycemia & glycosuria (PU/PD [osmotic diuresis], polyphagia, weight loss, dehydration)

Presentation/CS

- **PU/PD** (polyuria/polydypsia)
- **PP** (polyphagia)
- **Weight loss**, many obese until late in untreated diz
- **Plantigrade walk** - cats (hocks touching ground); neuropathy?
- Cataracts (dogs common, cats uncommon)
- **Skin manifestation**: rarely or in 1/3rd cases
  - Bacterial pyoderma, seborrhea, thin, hypotonic skin, varying degrees of alopecia

Complications:

- **Hypoglycemia** (iatrogenic)
- Cataracts (not in cats)
- Infections (especially urinary tract)
- DKA (diabetic ketoacidosis)
- Lipidosis - hepatic
- Pancreatitis (dog, less common in cat)
- Peripheral neuropathy (common in cat [plantigrade walk], uncommon in dog)
- Uncommon sequelae: glomerulonephropathy, glomerulosclerosis, retinopathy, gastric paresis, diabetic diarrhea

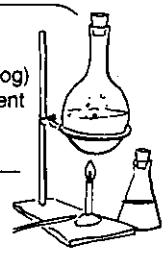


Diagnosis

- Hx, CS (**PU/PD, weight loss, PP**)
- Physical exam: unremarkable unless DKA
  - Hepatomegaly (hepatic triglycerides - "fatty liver")
- Persistent hyperglycemia & glycosuria
- **Fasting hyperglycemia** (Chemstrip®)
  - Dog > 200 - 250 mg/dl
  - Cat > 300 mg/dl
- R/O transient stress hyperglycemia (lasts only a few days), Cats: stress can raise glucose so leave overnight & test again
- Lab chemistries
  - **Hyperglycemia** > 300 mg/dl (Chemstrip®)
- UA (urinalysis)
  - **Glycosuria** (Ketodiastix®)
  - **Ketonuria** (Ketostix®, Ketodiastix) for DKA
  - ± UTI (urinary tract infection)(proteinuria, pyuria, hematuria)
- CBC: Stress leukogram, infec/inflam. if present
  - ↑ Cholesterol, triglycerides, ALT, AST, ALP
- Differentiate IDDM from NIDDM
  - IV glucose tolerance test (for β cell function)
    . IDDM = insulin within or below normal (≤20 µU/ml)
    . NIDDM = insulin > 20 µU/ml (some NIDDM cats don't respond)

DDx:

- 1° renal glycosuria
- Chushing's hyperglycemia (dog)
- Stress hyperglycemia (transient epinephrine-induced) (no glycosuria)



Insulin

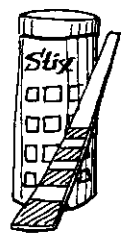
• Regular (crystalline zinc)	short acting (5-8 hr)
• **NPH** (Iosphane®), **Lente**	intermediate acting (8-16 hr)
• **Ultralente**	long acting (14-24 hr)

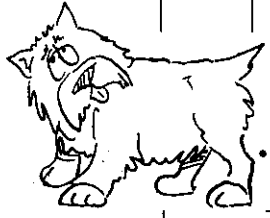
Treatment summary

- **Insulin**
  - Regular - short acting
  - **NPH, Lente** - intermediate acting
  - PZI, Ultralente - long acting
- **Balanced diet**, feed BID
- **Exercise** (↓ Insulin requirement)
- **Home monitor**: Keto-Diastix for morning urine
  - Adjust dose (see box)
  - Feed 1/2 of day's food
  - Feed other 1/2 in evening

Patient monitoring

- Home monitoring by owner
  - Subjective evaluation of water intake, urine output & normal body weight; good, not ravenous appetite; vomiting, diarrhea, anorexia, weight loss or weakness
  - Check urine daily for glucose & ketones prior to evening meal (not in morning) - (Test-Tape, Keto-Diastix, Clinitest®), urine monitoring not necessary in cat
  - Negative for glucose indicates correct response to injections
  - Persistent glycosuria: bring in for in-hospital serial blood glucose determinations
- Periodic serial blood glucose curves in hospital every 2-4 weeks to adjust insulin dose





Treatment nonketotic DM

- **Balanced diet**, feed **BID**
  - High-fiber, highly digestible, complex carbohydrate diets (Hill's r/d (reducing), w/d diets)
    . Nibblers: Free choice + 2 small meals of canned food; 2 meals for gluttons)
  - Obesity: gradually reduce over 2-4 months: Hill's r/d, Gaines cycle 3 or high-fiber, low calorie food
  - Thin dog & cats: high-caloric, low fiber diet (i/d or p/d); once ideal weight gradually change to high fiber
- **Exercise** (↓ Insulin requirement)
- **Ovariohysterectomy** of intact females: progesterone in diestrus complicates management
- **Insulin:** maintain blood glucose between 100-180 mg/dl in noncataract dogs & 100-250 mg/dl in cataract dog & cat (> 80 mg/dl glucose strip). Or, in cats, less then 200 mg/dl for ≥ 80% of day
  - Guard against hypoglycemia from overzealous insulin Tx
  - **Dogs: intermediate acting**: Lente or NPA - **sid** in morning
  - **Cat:** 75% require insulin twice a day (bid), tight regulation not as important as in dog because of lower complication rate & potential neurological damage
    - **Long-acting**: Ultralente or protamine zinc **sid** in morning
    - **Intermediate acting insulin**: Lente or NPH **bid**

Cats w/ Type 2 DM (NIDDM) non-insulin dependent may often be controlled w/o insulin

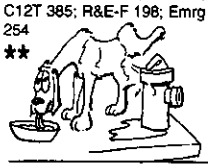
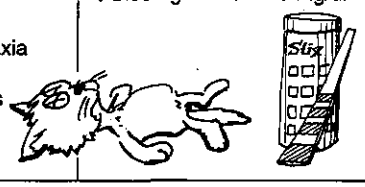
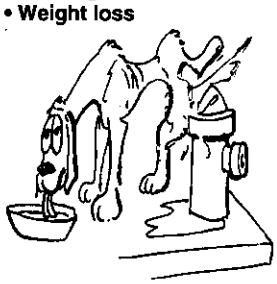
- Diet, Exercise, OVH as above
- **Glipizide (Glucotrol®)** (sulfonylureas): oral hypoglycemics (requires some functional β cells) control glycemia in some NIDDM cats when used w/ dietary Tx & obesity correction (duration from weeks to > 1 year), wait a month to see improvement in blood glucose; **little use in dogs.**
  - Discontinue & re-evaluate in 1 week if hypoglycemia or euglycemia (reinstitute if hyperglycemia returns, initiate insulin therapy if CS worsen or hyperglycemia over 2 months)
- **Hyperadrenocorticism in dogs**: control hyperadrenocorticism 1st then control DM
  - Conservative dose (0.5-1 U/kg) sid or bid to prevent ketoacidosis & severe hyperglycemia
  - Owners monitor urine glucose (strip); if negative decrease insulin 10-20% to avoid hypoglycemia
  - If persistent hypoglycemia stop mitotane Tx & do a ACTH stimulation test
  - As control Cushing's, insulin requirement usually decreases
  - Monitor ACTH response 3-4 x/year

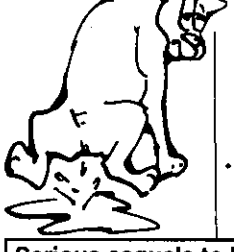
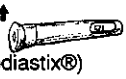
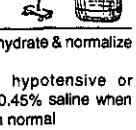
Prognosis:

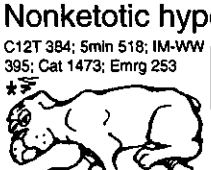
- **Cat: Guarded**
- **Dog: Good**

Insulin defc
CS: PU/PD, Polyphagia, Weight loss, Cataracts
Dx: CS, Hyperglycemia + Glycosuria
Tx: Diet, Exercise, Insulin

Hypoglycemia

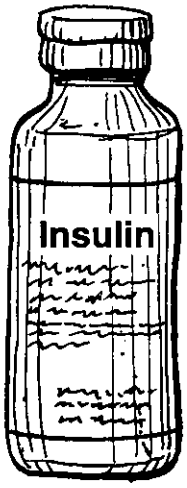
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Post-insulin hypoglycemia E-hb 583; H2B527; IM 572; C12T 385; R&E-F 198; Emrg 254 ** 	• **Decline in blood glucose < 70 mg/dl after insulin dose** • 13% of hospital cases • Causes: - Insulin excess - No food (anorexia, vomiting, malabsorption) - Cats that regain ability to make insulin months after insulin therapy started	• **Asymptomatic in most** • Weakness • Anxiety • Behavioral changes • Muscle twitching, ataxia • Head tilting • Generalized seizures • Coma	• **Hx & CS 2-6 hrs after insulin injection** • ↓ Blood glucose < 70 mg/dl 	• **Temporary withhold insulin** • If conscious - carbohydrates orally - **Karo syrup** (15 g /5 ml) 1.0 ml/kg PO • If unconscious: - 50% Dextrose 1 ml/kg IV & maintain on 5% dextrose sol. - Glucagon 0.03 mg/kg IM, IV • **Readjust insulin dose** Prognosis: **Guarded:cat; dog: good**
Somogyi overswing, Induced hyperglycemia, Posthypoglycemic hyperglycemia E-hb 584; H2B526 **	Overdose of insulin causes hypoglycemia w/ subsequent hyperglycemic compensatory response - Hyperglycemia due to ↑ secretion of glucagon, epinephrine, cortisol & growth hormone	• CS of hyperglycemia - Continued PU/PD - Weight loss	• Suspect in persistent morning glycosuria (1 gm/dl) • Demonstrate hypoglycemia (< 65 mg/dl) followed by hyperglycemia (> 300 mg/dl) w/in one 24 hours period following insulin administration	• **Reduce dose 25-30% or split dose** /2 Prognosis: **guarded:cat; dog: good**
Juvenile-onset DM (Diabetes mellitus) H2B 523; * C12T 348	• **Rare** < 1.5% of diabetic dogs; insulin dependent diabetes, (IDDM) in dog < 1 year old ; keeshond & golden; not recognized in cat; Cause: parvovirus? exocrine pancreatic insufficiency/pancreatic atrophy • CS: **PU/PD/ PP** evident at 2-6 months old, ± nocturia, stunted growth & weight loss, ± cataracts, ± soft stool, pelvic limb polyneuropathy • Dx: Fasting hyperglycemia (200 mg/dl) + glycosuria diagnostic, ± ketoacidosis; fat absorption test for pancreas • Tx: Emergency as in adult for KA: fluids, insulin; Maintenance: balanced diet bid; Tx concurrent PEI (pancreatic enzyme supplementation) • Px: Good if not DKA			
Transient insulin response E-hb 584; H2B526; SAP 254; IM 570 **	• **Short duration of action of insulin** - NPH & Lente (intermediate duration) usually & occasionally in Ultralente (long acting) in cats - Ideally duration from injection until blood glucose > 200-250 mg/dl at least 22-24 hours • Insulin works faster than normal: hypoglycemic then persistent hyperglycemia	• **Evening PU/PD** • **Weight loss** 	• **Hx (insulin Tx) + CS** • **Marked morning glycosuria** • Hypoglycemic episode 2-6 hours after injection • Confirm w/ blood glucose curve: - Hyperglycemia > 250 mg/dl w/ in 18 hours or less of insulin Tx, while lowest level > 80 mg/dl	- Tx: Reduce insulin 25-30% & split dose, or use longer acting insulin • Dog - Reduce insulin 25-30% & split dose, given 12 hours apart, or - If Lente or NPH, consider change to Ultralente - If Ultralente: consider supplementation w/ a dose of regular or Lente in evening or switch to Lente or NPH bid • Cat - Ultralente to short, switch from sid to bid & adjust dose to prevent hypoglycemia, or - Switch to Lente insulin **bid**

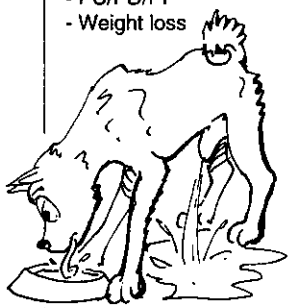
***DKA,* Diabetic ketoacidosis** Mk 267; E-hb 579; SAP 249; H3B 467; H2B527; I2M 759; IM 578; 5min 516; 1518; IM-WW 395, 396; Cat 1470; C12T 384, 394; C11T 359; E&R 392; Lab-S 330; Emrg 251 ** 	• **Severe stage of DM** (diabetes mellitus) - Undiagnosed IDDM • **Hyperglycemia, hyperketonemia & metabolic acidosis** • Pathophysiology: - Insulin defc causes peripheral **lipolysis** w/ massive influx of fatty acids into liver - Ketogenesis: excess FAs converted to ketones (acetoacetate & hydroxybutyrate or acetone) - Metabolic acidosis • 4 Factors involved in DKA (all 4 needed); therefore NIDDM/type 2 don't get because make some insulin 1. Insulin deficiency 2. Starvation/fasting 3. Dehydration 4. Diabetogenic hormones (GCC, glucagon, catecholamines, growth hormone) • Bacterial or viral infections sometimes precipitate onset	• Acute or chronic onset • Early signs of DM - **PU/PD** - **± Polyphagia** - **Weight loss** • DKA (diabetic ketoacidosis) - Depression, weakness - Vomiting, diarrhea - Acetone breath (Juicy Fruit odor) - Kussmaul respiration (slow, deep breathing due to acidosis) - Coma	• CS, DM, ketonuria, acidemia, glycosuria, ketonemia • Lab: as for DM - **Hyperglycemia > 250** mg/dl (Chemstrip®) - **Plasma pH < 7.3 w/ anion gap** - Plasma bicarbonate < 15 mEq/l, decreases total carbon dioxide - **Ketonemia** - **↑ Liver enzymes** (ALP, AST) - **BUN normal to ↑**  • UA (urinalysis) - Glycosuria (Ketodiastix®) - **Ketonuria** (Ketostix®) - ± Pyuria & bacturia (UTI infection) • CBC: stress leukogram, infec/ inflam. if present • Plasma pH < 7.3 w/ anion gap • Radiography: hepatomegaly • Physical exam: - Dehydration - Check for coexisting disorders (acute pancreatitis)	• **Emergency** • **Rehydrate & maintenance fluids** • **0.9% saline w/ KCl** over 24-48 hrs -Initially 1.5-2 x maintenance (60-100 ml/kg/d) - KCl sol. to IV maintenance fluids for hypokalemia, if no accurate K level add 40 mEq K/liter, not to exceed 0.5 mEq/kg/hr - Monitor electrolytes bid: if Na 140-155 mEq/l change fluids to lactated Ringer's, if 140 mEq/l keep on 0.9% saline, if > 155 mEq/l give hypotonic 0.45% saline • **Insulin** to lower glucose slowly to 200-250 mg/dl over 8-10 hours - Regular crystalline insulin if clinically ill (IV, IM or SQ) (depressed, dehydrated) . Rapid action (immediate IV or IM, SQ - 30-60 min) . Short duration - If patient alert: NPH, Lente or Ultralente • Treat concurrent illness: bacterial infections, pancreatitis, congestive heart failure, renal failure, hyperadrenocorticism & diestrus • Spay all intact females when diabetes is diagnosed  Prognosis: • **Guarded to poor**
Serious sequela to DM = Metabolic acidosis **CS: Depression, Sick, Acetone, Coma** **Dx: DM + Ketonemia** **Tx: Emergency, Saline w/ KCl, Insulin**		Replacement = % dehydration x kg (BW) x 1000 ml Maintenance - Normal urine output: 60 ml/kg/d - Oliguria: = amount of urine output + insensible loss (20 ml/kg/d) - Anuria: insensible loss (20 ml/kg/d)		

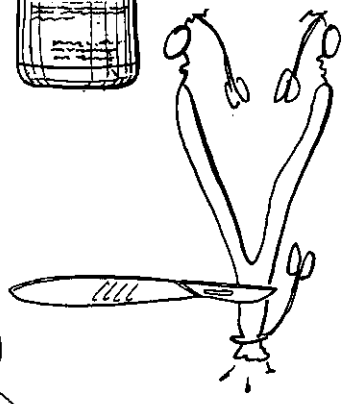
Nonketotic hyperosmolar diabetic syndrome (NKHDS) C12T 384; 5min 518; IM-WW 395; Cat 1473; Emrg 253 * 	• **Severe form of DM** • Hyperosmolar blood, no ketones • Pathophysiology: osmotic gradient between intracellular & extracellular compartments of brain - Causes: cellular dehydration & dysfunction	• Early: PU/PD - Weakness - Vomiting - Thirst may diminish even w/ increasing hyperglycemia • **CNS signs** - **Mental depression** - Grand mal seizures - Hemiparesis - Hyperreflexia - Muscle fasciculations - Nystagmus	• Hx, CS • Physical exam: dehydration, hypotension & mental depression • Hyperglycemia often above 800 mg/ml • Serum osmolality > **350** mOsm/kg body water (normal 290-310) • Most have renal or prerenal azotemia (BUN, creatinine) • **NO ketones**, but may be acidotic	• **Emergency**: objectives: rehydrate & normalize urine output • **Fluid**: 0.9% saline if hypotensive or hyponatremic, change to 0.45% saline when blood pressure & hydration normal - Monitor electrolytes bid: if Na 140-155 mEq/l change fluids to lactated Ringer's, if 140 mEq/l keep on 0.9% saline, if > 155 mEq/l give hypotonic 0.45% saline • **Regular crystalline insulin** (short acting) to avoid precipitous drop of blood glucose - Fear of brain edema 2° to rapid fluid appear unwarranted (C12T 385) • Potassium supplementation Px: **Poor**
Hyperosmoles - No ketones **CS: CNS** **Tx: Fluids, Insulin**			**DDx:** • Diabetic ketoacidosis	

Diabetes mellitus

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Insulin-resistant Diabetes mellitus E-hb 584; H2B526; SAP 254; C12T 390 **	• **Normal amounts of insulin result in subnormal response**	• CS of diabetes - PU/PD/PP - Weight loss	• Hx, CS • Suspect insulin resistance when: - Insulin dosage >1.5 U/kg (dog) or 6 U (cat) + blood glucose over 300 mg/dl - > 2.2 U/kg necessary to maintain blood glucose < 300 mg/dl • R/O problems w/ insulin activity or administration • R/O & Tx coexisting disorders: Infection, Cushing's (20%), progesterone [diestrus], exogenous steroids, Ovaban, acromegaly	• Treat all existing disorders • Spay all intact females after diabetes diagnosed • **Insulin: titrate to effect** as long as no hypoglycemia - Cats ≤ 2.2 µg/kg/day - Dogs > 2.2 µg/kg/day - **No maximum dosage**

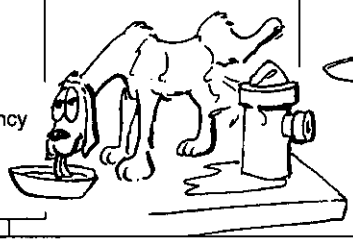






Causes of insulin resistance or ineffectiveness

- Insulin therapy
  - Inactive insulin
  - Dilute insulin
  - Improper administration
  - Inadequate dose
  - Somogyi phenomenon
  - Inadequate frequency of Tx
  - Impaired insulin absorption
  - Anti-insulin antibody excess
- Concurrent disorders
  - Diabetongenic drugs
  - Hyperadrenocorticism
  - Diestrus (bitch)
  - Acromegaly (cat)
  - Infections (esp. oral & urinary)
  - Hypothyroidism (dog)
  - Hyperthyroidism (cat)
  - Renal insufficiency
  - Liver insufficiency
  - Cardiac insufficiency
  - Chronic pancreatitis
  - Exocrine pancreatic insufficiency
  - Glucagonoma (dog)
  - Hyperlipidemia (?)
  - Pheochromocytoma (?)



↑ Dose until control

Gastrinoma, Zollinger-Ellison syndrome, APUDomas, Hypergastrinemia

M8k 398; E-hb 603; H2B380; 412; SAP 661, 662; I2M 771; IM 586, 297, 331; 5min 360, 614; IM-WW 410; E 1593; C11T 370; R&E-F 442, Cat 1464; Sx-WW 189

*

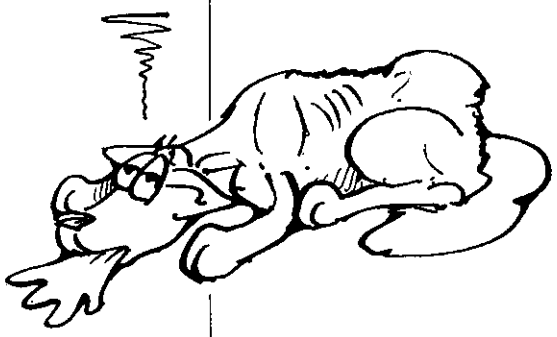
- **Rare**
- Gastrinomas (islet [APUD] cell tumors of **pancreas**)
  - **Malignant, gastrin**-producing tumor
  - Most in right lobe & body of pancreas
  - Small < 2 cm
  - **Metastasizes** (75% of cases) to liver before Dx
- Signalment: female:male 2:1, older animals, rare in cats (2 reported)
- Pathophysiology:
  - Excess gastrin, ↑ hydrochloric acid (HCl) - gastric **ulcers**
    - Gastric mucosal hypertrophy; delayed gastric emptying, esophagitis (reflux); diarrhea & steatorrhea
- Gastrin normally secreted by gastric & duodenal mucosa

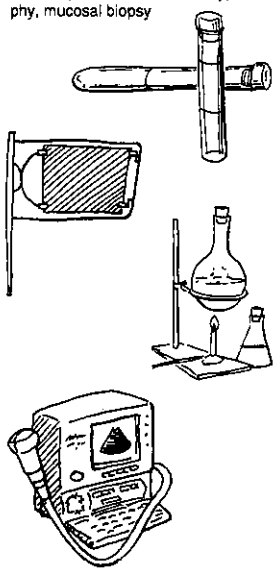
- **Severely ill**: fever, dehydration, tachycardia, abdominal pain, shock
- **Vomiting** (consistent CS)
  - Fresh & undigested **blood**
- **Weight loss** (thin to emaciated)
- Depression, lethargy, anorexia
- **Intermittent diarrhea**
- **Severe ulceration**: melena, blood loss, hematochezia, hematemesis, abdominal pain
- **Erosive esophagitis** & esophageal ulceration (anorexia, regurgitation, hematemesis)

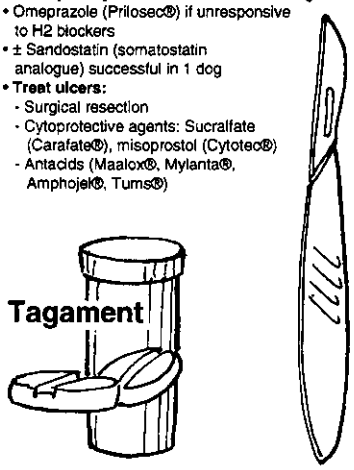
- Sequela: gastric perforation & peritonitis

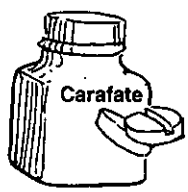
- Suspect if severe **ulcers** + gastric mucosa **hypertrophy**, or **responsive** ulcers that **relapse** when Tx stopped
- PE (physical exam) unremarkable
- Persistent serum gastrin levels (each lab has own normals) 3-100 x not routinely measured
- Provocative stimulation
  - High protein meal (Hill's p/d)
  - Normal: Double levels in 30 minutes, little response if hypergastrinemia
- **Regenerative anemia** (50% of cases) blood loss
- **Radiographs**: contrast - ulceration, esophagitis
- **Ultrasound**: pancreatic mass
- Endoscope: ulcer & mucosal hypertrophy, mucosal biopsy

- **Sx:** Right lobe pancreatectomy if tumor can't be located
  - Partial pancreatectomy & debulking if heavy metastasis
- Small low-protein meals frequently
- **H2-receptor antagonists** (cimetidine [Tagamet®], Ranitidine [Zantac®], Famotidine [Pepcid®], Nizatidine [Axid®] to control ulcers & clinical signs
- Omeprazole (Prilosec®) if unresponsive to H2 blockers
- ± Sandostatin (somatostatin analogue) successful in 1 dog
- **Treat ulcers:**
  - Surgical resection
  - Cytoprotective agents: Sucralfate (Carafate®), misoprostol (Cytotec®)
  - Antacids (Maalox®, Mylanta®, Amphojel®, Tums®)









Prognosis
- **Grave** for long term - many highly malignant
- Guarded to poor for short term

Rare; Malignant islet cell, Gastrin-producing, Metastases & Ulcers
CS: Severely ill, Vomiting, Emaciated, Diarrhea; Ulceration
Dx: Relapsing ulcers + Thick mucosa, Rads, US, Endoscope
Tx: Pancreatectomy, H2 blockers • Px: Grave for long term

Hypoglycemia

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Hypoglycemia M8k 397, 1437; Mk 939; H3B 485; H2B 548; 5min 228, 20; DDx 548; E-hb 243, 277, 575, 572; SAP 257, 726, 1168; I2M 735; IM 562; 5min 228; Emrg 254 ***	• **BG (blood glucose) < 65** (< 50-70) • Depends on glucose production & utilization • **CS - related to neuroglycopenia** • Pathophysiology: - Dietary intake (exogenous) - Glycogenolysis & gluconeogenesis (endogenous) . Gluconeogenesis - liver & a little in kidney - Stress hormones incr. BG (glucagon, glucocorticoids, catecholamines, growth hormone & progesterone) - Cells not requiring insulin for glucose uptake: CNS, renal, liver, RBCs - Minute to minute BG controlled by: . Glucagon (alpha cells of pancreatic islets) - ↑ BG . Insulin - ↓ BG • **Fasting:** - Glycogenolysis (liver) maintains for 24 hr., then body protein (muscles) & glycerol from fat for glycogenesis - Dogs & cats OK for days to weeks of fasting (unlike humans), adaptation to wild . **Exception: puppies & toy breed dogs**: hypoglycemia w/in hours of fasting	• **Hunger** • **Neuroglycopenia** - CS - Incoordination/ataxia - Weakness - Tremors - Collapse, seizures, coma • Epinephrine increase - Trembling, muscle fasciculations - Nervousness/anxiety	• Hx (age, overdose), CS - Insulin Tx - Old: suspect neoplasia • **Whipple's triad** - CS of hypoglycemia - BG < 65 mg/dl - CS reversed by IV glucose	• **Hypoglycemic seizure at home:** - **Feed animals that can eat**: frequently or ad libitum - **Rub Karo syrup** on pet's gums (don't stick fingers in mouth) - Corn syrup, fruit guices, honey • Orogastric intubation - 20% dextrose • **IV 20% dextrose** initially 1 ml/kg - Follow w/ 10-20 ml/kg/hr 10% dextrose until stable - Oral glucose: Corn/Karo syrup • Treat underlying cause - Surgery for hyperinsulinism or extrapancreatic neoplasia • **Chronic hypoglycemia** - Constant calories: protein, fats & complex carbohydrates), avoid simple sugars - Limit exercise - Steroids when diet no longer effective - Diazoxide (Proglycem®) - ± Thiazide diuretics (potentiates) • **Insulinoma** (see below)

DDx/Causes - hypoglycemia

- Juvenile-onset
  - **Puppies (neonatal)**
  - Transient juvenile hypoglycemia
  - Portosystemic anomalies
  - Glycogen storage dizs
- Adult
  - Insulinoma (common)
  - Insulin overdose (common) iatrogenic
  - Extrapancreatic neoplasia (esp. hepatic)
  - Severe liver diz
  - Cachexia
  - "Hunting dog" or exertional hypoglycemia
  - Gestational hypoglycemia
- Age independent
  - Sepsis/bacteremia
  - Malnutrition/starvation
  - Addison's diz
  - Drug related
    . Ethylene glycol
    . Salicylates, ethanol, sulfonylureas
  - Hypopituitarisms

See pg 421, 418, 581, 669 also

BG = blood glucose

Prognosis:
- Guarded to poor: cerebral hypoxia, insulinoma
- Good if responds to Tx

Low glucose - CNS
CS: CNS
Dx: Triad: CS, < 65, Tx reversal
Tx: Glucose

Hypoglycemia, malnutrition - neonate ***

- **See Repro pg 418**
- **Common cause of neonatal death**
- Neonates: less ability to use other energy sources than adults
- Higher glucose requirement than adults
- Problem at weaning: supplement w/ solid food 3-4 weeks after parturition

- **Persistent crying**
- Weakness, ↓ activity
- Decreased nursing
- Respiratory distress
- Convulsions, Coma
- Weight loss of > 10%

- Hx (failure to suckle), CS
- Physical exam
  - Bradycardia

- **Hypoglycemia: oral glucose**
- Correct hypothermia gradually
- Tube feeding: milk replacer + glucose
- Supplemental before weaning
- Adequate diet for lactating dam

Prognosis: **Good**

Gestational hypoglycemia **

- **See Repro pg 421**: **Rare**; Bitch's diets deficient during pregnancy, hypoglycemic last of gestation; ↑ in dead puppies at birth & 1st 3 days, ± hypocalcemia (failure to respond to Ca Tx)
- CS: ↓ Food intake & activity, Vomiting, Rapid respiration, Abdominal straining, Prostration, Acetone breath
- Dx: Hx (last gestation), CS, Acetone breath, Ketonuria, glucose levels < 70 mg/dl, Response to Tx, Check for concurrent hypocalcemia
- DDx: Hypocalcemia
- Tx: IV glucose in normal saline solution, Frequent feeding, Parturition or cesarean section alleviates problem
- Prevention: proper nutrition throughout gestation

Insulinomas, Islet cell neoplasia; Beta cell neoplasia, Pancreatic neoplasia, Beta cell carcinoma, Islet cell adenocarcinoma
M8k 397, 906; H2B 548; E-hb 572, 321; IM-WW 400; E 1501; SAP 257, 1168; I2M 766; IM 562, 745; Cat 1464, 1535; 5min 734, 930, 162; R&E-F 422; R&E-M 198; NS-W 202; NS3hb 194, 353; NS-HB 192, 333; NS-O 269; NS-L 328, 89 NS-Pa 246, 472 Phys-B 872; Pa-T 279; DDx 553; Sx-S-hb 515, 683, 756; Sx-S 1536; Sx-G 206; Sx-WW 188
**

- **Older dogs** (> 6 yr) & ferrets, rare in cats
- **Malignant beta cell tumor**
  - Secretes insulin: hypoglycemia doesn't inhibit
  - Results in hypoglycemia
- Often have "mets" in liver at time of Dx (lymphatics & lymph nodes, liver, mesentery & omentum; rarely lungs)
- Breeds: Standard poodle, Fox terrier, G. shepherd, Irish setter, Boxer, Collie
- Fasting, exercise, excitement & eating often bring on episodic signs

- **Episodic in nature**
  - Weak in hind limbs to seizures
  - See CS of hypoglycemia
- **Seizures** (0.5-5 min) > syncope & coma (see Nero pg 581)
- ± Weight gain
- CNS: proprioception deficits, depressed reflexes, muscle atrophy
- Sequela to surgery:
  - Diabetes mellitus

- **Whipple's triad**
  - CNS CS w/ hypoglycemia
  - Fasting BG ≤ 40 mg/100 ml
  - Glucose relieves CNS CS
- Physical exam: unremarkable
- ↑ or "normal" serum insulin in face of **hypoglycemia** (should suppress)
- CBC & UA usually normal
- Radiography usually normal, rarely metastasize to lungs
- Ultrasound for pancreatic mass
- Exploratory for Dx & Px

- **Emergency: Karo syrup or IV 50% dextrose**
- **Sx**: remove mass or half of pancreas
  - Tx for pancreatitis for 36-48 hrs after Sx
  - NPO (fast 8-12 hours) maintain BG by 5% dextrose drip as monitor BG
  - Diabetes mellitus m/ develop, usually transient (days to 6 months)
- Medical:
  - **Frequent meals** (calories), high protein & complex carbohydrates, avoid simple sugars
  - **Steroids:** Prednisone until Cushing's
  - **Diazoxide** (Proglycem®): inhibits secretion of insulin PO
  - **± Thiazide diuretics** (potentiate diazoxide) hydrochlorothiazide (HydroDiuril®)
  - Somatostatin analog decreases insulin in some insulinoma dogs
- ± Phenobarbital to control seizures

Karo syrup
50% Dextrose
Proglycem
HydroDiuril
Steroids

Prognosis: **Guarded short term**
- **Poor** for long term survival > 4 years
- Recurrence nearly 100%

Old dogs, Hypoglycemia
CS: Seizures, CNS
Dx: Hi insulin w/ low glucose
Tx: Medical or Surgery?

Diabetes insipidus

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Diabetes insipidus, DI

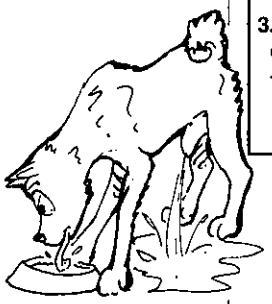
M8k 412; H3B 443; H2B 502; E-hb 549; SAP 268; I2M 673; IM 458, 527; 5min 514, 130, 274; IM-WW 384; E 1428; Cat 1410; R&E-F 2; R&E-M 251; Phys-B ; Psy-R 195; Lab-C 219; Pa-T 254; DDx 68

**

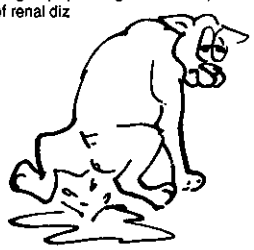
- **See Urinary pg 378**
- Disorder of water metabolism: characterized by polyuria/polydipsia (PU/PD, low specific gravity of urine

3 basic types see pg 378

1. **Nephrogenic DI (NDI):** inability of renal tubules to respond to ADH
   - Causes: 2° to renal & metabolic disorders (endocrine & electrolyte) see pg 378 for list
2. **Pituitary/Central DI (CDI):** deficiency of ADH
   - Cause: **Idiopathic** (#1), head trauma or neoplasia
3. **Psychogenic/D psogenic DI:** excessive water intake
   - Cause: disorder of thirst centers, behavior problem, pharmacological agents



- **PD/PU** (polyuria/poolydypsia)
- **Nocturia**
- ± CNS signs (expanding brain tumor)
- ± CS of renal diz



DDx:
- Diabetes mellitus
- Hyperadrenocorticism
- Hyperthyroidism
- Hypertension (severe)
- Liver diz
- Hypercalcemia
- Chronic renal failure
- Pyelonephritis
- Hypokalemia
- Hyperviscosity syndromes

- **Hx, CS (PU/PD)**
- Physical exam: usually unremarkable, m/b thin (thirst overshadows hunger)
  - Dehydration if water unavailable for 4-6 hours
- **Water deprivation** if not azotemic
  - Central or nephrogenic: neither concentrates (< 1.025)
  - Psychogenic: concentrates (> 1.025) unless medullary washout
- **Water deprivation + ADH**
  - **Central: concentrates w/ ADH (>1.025)** unless medullary washout
  - Nephrogenic: no response to ADH (< 1.025)
- **Gradual water deprivation** to check for medullary washout
  - Psychogenic: concentrate (> 1.025)
  - Central or Nephrogenic: no response (< 1.025)
- **Gradual H_2O deprivation + ADH**
  - Central: concentrates (> 1.025)
  - Nephrogenic: no response (< 1.025)

- **Central DI**
  - Idiopathic: Tx not mandatory if unlimited water
    - Repositol vasopressin (Pitressin® tannate) IM
    - Synthetic vasopressin (Desmopressin acetate DDAVP) drops intranasal or conjunctival
    - Chlorpropamide (Diabinese®) (sulfonylurea - potentiates renal tubular effect of ADH)
    - Diuretic w/ salt restriction
  - Tumors: Cobalt teletherapy, Carmustine (BCNU)
- Nephrogenic DI
  - Tx predisposing cause
  - Not mandatory if unlimited water
- Psychogenic
  - Nothing, behavior modification, slow restriction

Prognosis:
- Central: good for idiopathic or congenital
  - Guarded if trauma induced
  - Guarded to grave: tumor
- Nephrogenic: depends on response of underlying cause
  - 1° NDI (rare) guarded to poor
- Psychogenic: good

3 types: NDI, CDI & Psychogenic
CS: PD/PU, Nocturia, ± CNS signs or Renal diz
Dx: Water deprivation + ADH
Tx: CDI (ADH, Diabinese®), NDI (Tx cause, H_2O), Psychogenic (none)
Prognosis: CDI: Good, NDI: Varies, Psychogenic: Good

Hyperlipidemia, Hyperlipoproteinemia

M8k 1640; E-hb 543, 544, 151, 652, 249; SAP 1199; H3B 481; H2B 543; IM-WW 410; 5min 240, 725; E 1410, 1414; I2M 813; IM 613, 436

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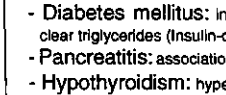
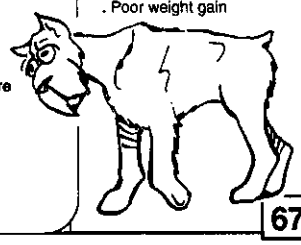


2° to diz or meal, Tx 1° diz

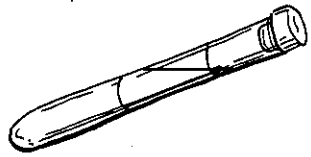
DDx/Causes: Hyperlipidemia
- **2° to underlying metabolic abnormalities** cause in most
  - **Postprandial hyperlipidemia: #1** - high lipids 1/2-12 hours after a fat meal
  - Diabetes mellitus: insulin deficiency or resistance, insulin helps clear triglycerides (Insulin-dependent Diabetes mellitus)
  - Pancreatitis: association w/ hyperlipidemia, incompletely understood
  - Hypothyroidism: hypercholesterolemia in 2/3rds of cases, atherosclerotic-type lesions occasionally reported
  - Nephrotic syndrome (glomerulonephritis or amyloidosis): protein- losing nephropathy - hypercholesterolemia
  - Cholestatic liver diz: hypercholesterolemia
  - Hyperadrenocorticism: hypercholesterolemia that doesn't cause CS
  - **Drug induced hyperlipemia:**
    - **Progesterone** Tx (megestrol acetate [Ovaban®]) - DM: cats
    - Estrogens, glucocorticoids
  - Obesity
  - Late pregnancy
- 1° (familial) defect of lipoprotein metabolism - **rare**
  - Idiopathic canine hyperlipoproteinemia
    - **Miniature schnauzers**
    - ≥ 4 years old
    - Pancreatitis: high frequency in these dogs
  - Juvenile hyperchylomicronemia
    - Rare: 3 kittens & 1 puppy up to 1984

- **Increase of any lipid in blood**
  - Hypertriglyceridemia or hypercholesterolemia
  - Hyperlipoproteinemia: hyperlipidemia from increased production or reduced degradation of lipoproteins
    - Chylomicrons (rich in triglycerides)
    - Very low density lipoproteins (VLDL)
    - Low density lipoprotein (LDL): rich in cholesterol
    - High density lipoproteins (HDL): cholesterol-rich
- Lactescence (opacity of serum due to high triglycerides)

- **Secondary:**
  - CS of cause
  - Asymptomatic
  - Hypertriglyceridemia
    - Vomiting, diarrhea
    - Abdominal pain, ↓ appetite
    - Seizures
    - Lipid-laden aqueous humor
    - Cutaneous xanthomata: lipid accumulations in macrophages forming lipid granulmata
  - Hypercholesterolemia
    - Atherosclerosis (rare)
    - Lipemia retinalis: milky appearing retinal vessels
    - Crystalline corneal opacification
- **1° hyperlipidemia/idiopathic**
  - **Miniature schnauzers**
    - Vomiting, Diarrhea
    - Nonlocalizing abdominal pain, pancreatitis?
    - Recurrent seizures
    - Depression, behavioral changes
    - Episodes of polydipsias
  - Juvenile hyperchylomicronemia
    - Most asymptomatic
    - SQ Xanthomas: yellow papule, nodule or plaque (lipid deposits)
      - Peripheral paralysis (compression from xanthomas), sensation spared
      - Spinal nerve at vertebral foramina
      - Greater ischiatic notch: sciatic nerve
      - Other sites: SQ, liver, spleen, kidney, heart, muscle & intestine
    - Lipemia retinalis: vision not affected
    - Poor weight gain

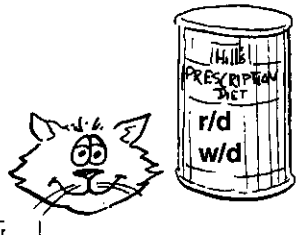


- **Finding of milky blood sample**
- R/O postprandial sample 1st (fast for 12 hours)
- R/O pancreatitis: rads, US, Lab
- R/O secondary cause: CBC, chemistries, UA, Rads
- Hyperlipidemia can alter biochemical data - consider
- Labs:
  - Fasting hyperchylomicronemia/hyperlipidemia always indicates abnormal lipid metabolism
- Ultracentrifugation: massive elevation of plasma triglyceride (> 10,000 mg/dl) > 500 are considered candidates for treatment
  - ↑ Chylomicrons, ↑ cholesterol (CH), small ↑ in VLDL, ↓ HDL
- **"Cream of tomato" soup:** positive chylomicron (CM) test in most: cream layer of chylomicrons of plasma stored over night (lactescence)
- Electrophoreses: for shifts in lipoprotein distributions
- Reduced lipoprotein lipase (LPL) activity: in vivo measurement of LPL activity before & after heparin administration



Lab classification of lipids
- Chylomicron (CM) test: store serum plasma overni_ chylomicrons float to top (cream layer) over clear layer
  - Diffuse serum lactescence signifies VLDL
  - Quick assessment of hypertriglyceridemia
- Electrophoresis: for shifts in lipoprotein distributions
- Ultracentrifugation: quantitative measurement of cholesterol (CH), triglycerides (TGs) & lipoproteins by density
- Lipoprotein lipase (LPL) activity: in vivo measurement of LPL activity before & after heparin administration
- Serum samples should be refrigerated, but never frozen

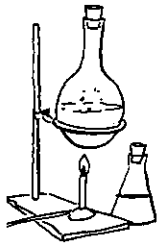
- **Secondary**: resolves if underlying diz adequately treated & diet changed
- **Primary:**
  - If gastroenteritis: NPO (nothing per os)
    - Antiemetics to control vomiting - phenothiazine tranquilizers (chlorpromazine [Thorazine®], prochlorperazine [Compazine®], anticholinergics (may cause ileus); combined phenothiazine/anticholinergic (prochlorperazine/isopropamide [Darbazine®])
  - **Low fat diet (r/d or w/d** Hill's or homemade [low fat cottage cheese, lean beef, or skinless poultry]) (lower triglycerides below 500 mg/dl & normal CH level) for life
    - Peripheral nerve paralysis resolves in 2-3 months
  - Monitor lipemia; if still high in 2 months use drugs
  - **Lipid-lowering drugs** if unresponsive to diet, not approved for dogs & cats (advise Client)
    - Clofibrate (Atromid-Se®), nicotinic acid (Nicotar tablets®), gemfibrozil (Lopid®), n-3 polyunsaturated fatty acids from marine/fish oil (Formula Plus®)

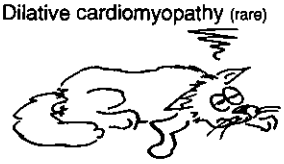


Prognosis:
- Secondary: good if control cause
- Miniature schnauzer: good can usually lower triglycerides w/ diet - lifelong
- Cats; good, diet will lower lipid & reverse peripheral neuropathy over 2-3 months, lifelong Tx

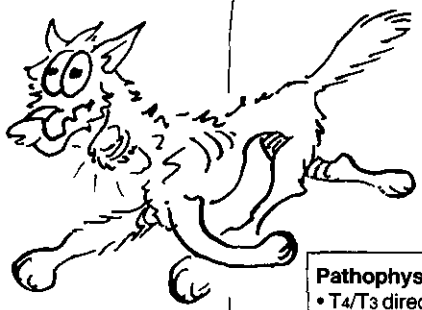
Hyperthyroidism

Condition	Facts/Cause	Presentation/CS	Diagnosis
Thyrotoxicosis, Feline hyperthyroidism, Thyrotoxic myocardial diz, 2° hypertrophic cardiomyopathy, HCM M8k 419; Mk 284; SAP 221; E-hb 561, 417; H3B 451; H2B511; 5min 708, 98; IM-WW 392; I2M 720; IM 552; E 1466; C11T 756, 334; F-N 401; F3IM 155; F2IM 143; H-T/M 295; H-F 734, 255, 459, 565; Cat 1416; R&E-F 118; R&E-M 274; Phys-B 902; Lab-C 222; Pa-T 266; Sx-S-hb 508; Sx-S 1517; Sx-WW 183; Sx4B 542 ***	• Excessive T3 & T4 in blood • **Multisystemic disorder** - **#1 feline endocrine disorder** - > 10 years-old 95% - Usually bilateral 70% - Uncomplicated cases common - Cardiac involvement fortunately uncommon • Cause: - Thyroid hyperplasia/adenoma: functional > 95%, benign - Thyroid carcinoma rare < 2% • Mechanism of PU: unknown - Medullary washout &/or thyrotoxic psychogenic polydipsia	• **Common CS** - Looks healthy - **Weight loss** (95%) - Polyphagia - Unkept hair coat (50%) - Excellent appetite & active (hyperactive) - **Frantic, anxious, aggressive** (70%) • CNS: hyperactivity, weakness • Respiratory: dyspnea, panting ± breathlessness • **PU/PD (50%): renal** • GI: vomiting (40%), diarrhea (40%), anorexia (10%) • **Apathetic hyperthyroidism** > 10% (opposite what would expect) - Depression, lethargy, anorexia & weakness - Weight loss - Cardiac abnormalities • Sequelae: - Cardiovascular failure (10-15%) - Hypertension - **Hypertrophic cardiomyopathy** - **Congestive heart failure** (15% of hyperthyroid cats) . **Weakness, dyspnea, lethargy** . Dilative cardiomyopathy (rare)	• Hx (history), CS (clinical signs) • Physical exam (PE): - **Goiter (thyroid enlargement) (90%)**, normally can't be palpated - Aggressive behavior during PE • Laboratory: - CBC: stress response (leukocytosis & eosinopenia), ↑ PCV (50%) - ↑ Liver enzymes (ALT, AP, LDH - 80%), BUN (30%) • ↑ **Resting T4** (multiple samples) (normal = 15-55 mmol/l; 12-43 ng/ml) • ↑ Free T4 in early cases • Nuclear imaging (technetium-99 pertechnetate) taken up in thyroid - shows thyroid involvement & metastasizes (rare) • T3 suppression test - give T3 for a couple of days then check T4 - Normal cats: T4 suppressed - Hyperthyroid cats: T4 not suppressed • UA: ± low SG, ± ↑ BUN & creatinine • Thyroid stimulating hormone (TSH) response test not recommended • Thyrotropin-releasing hormone (TRH) stimulation test - Normal cats: causes rise in T4 of 60% - Mildly hyperthyroid cats: causes rise less than 50% • **Cardiac involvement** - Physical exam: weak pulse, muffled heart & lungs (effusions), tachycardia, apical systolic murmur (50%) - Bounding arterial pulse, mildly distended jugular veins, jugular venous pulse - Echocardiography . **Lt ventricular hypertrophy** (70%) . **Thick ventricular septum** (40%) . **Lt atrial dilation** (70%) . **Ventricular dilation** (45%) . Myocardial hypercontractility (20%) - Radiology: . **Cardiomegaly** (50%) . **Pulmonary edema/pleural effusion** (10%) - ECG (electrocardiography): . **Sinus tachycardia** (70%) . Large R waves (30%) . APCs/Atrial fibrillation (10%) . VPCs (2%) . Conduction defects (10%), left anterior fascicular block





Multisystems, #1 Endo & Geriatric diz
CS: Thin & gluttonous, Frantic, Cardiac
Dx: Large thyroid, TSH, Rads, Echo, ECG
Tx: Sx - Excision



Pathophysiology - heart
- T4/T3 direct effects on heart (↑ HR & contractility)
- Increased sympathetic ANS: ↑ heart activity
- Indirect effects: increase demand on heart (↑ metabolism)

DDx:
- Weight loss + good appetite
  - Malassimilation (GI infiltration, neoplasia, inflammation, pancreatic exocrine insufficiency)
- Other 1° dizs
  - Chronic renal failure
  - Hepatic diz
  - Cardiomyopathy

Treatment: minimal for uncomplicated cases
- NO spontaneous remission
- **Methimazole** (Tapazole®): chronic antithyroid drug, safer than propylthiouracil (PTU): prevents iodination of thyroglobulin: does not treat adenoma itself (side effects = anorexia, blood dyscrasias, allergic dermatitis, possible lupus development). Daily Tx for life.
- **Surgical thyroidectomy** stabilize w/ methimazole 1st for 1-3 weeks, ß-blocking drugs (propranolol or atenolol) to protect from cardiac complications, calcium channel blockers (diltiazem) for HCM
  - Complication: hypoparathyroidism & hypocalcemia, death, Horner's syndrome, laryngeal paralysis
  - Bilateral thyroidectomy: monitor serum calcium daily until stabilizes in normal range, start T4 supplementation 1-2 days after surgery, usually only needed for 2-3 months
- Radioactive iodine ^{131} TOC if available: least evasive, curative; into thyroid tumor, kills benign adenoma; not widely available, often expensive

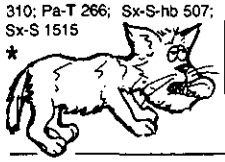
Cardiac complication
- Stabilize before above Tx
- **Arrhythmias**
  - Propranolol (Inderal®)
    . ß blocker for sinus tachycardia, supraventricular or ventricular arrhythmias
- **CHF clinical signs:**
  - Hypertrophic cardiomyopathy
    . **Diuretic** (furosemide [Lasix®])
    . **Diltiazem (Cardizem®), digoxin** or **propranolol** (Inderal®) carefully
  - Dilatative (rare)
    . Furosemide (Lasix®)
    . Digoxin (contractility)
    . Thoracocentesis (effusions)
    . ± ACE inhibitors (captopril [Capote®] or enalapril [Vasotec®])
    .. Antithyroid Tx

Prognosis:
- Uncomplicated cases: good
- After correction of hyperthyroid state
  - Good: hypertrophic cardiomyopathy usually partially reversible
  - Poor: dilative cardiomyopathy usually not reversible

Feline hypothyroidism: SAP 220; H3B 447; H2B507; 5min 726; IM-WW 390; I2M 719; Cat 1452; F3IM 147; F2IM 150; R&E-F 111; R&E-M 68; Phys-B 935; Lab-C 227; Pa-T 266; Sx-S-hb 507; Sx-S 1515; *

- **Extremely rare in cat**, Cause: #1 Tx of hyperthyroidism (usually transient)
- CS: Asymptomatic, dwarfism/cretinism, lethargy, mental dullness, seborrhea sicca, dry haircoat, obesity, bilaterally symmetrical alopecia does not occur
- Dx: Hx, CS, subnormal resting serum T4 level that fails to respond to TSH stimulation
- Tx: **T4 supplementation**
- Px: Adult - good, Congenital - guarded

Hyperthyroidism

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Canine hyperthyroidism, Thyroid neoplasia Mk 284; SAP 224; E-hb 567; H3B 454; H2B 514; I2M 729; IM 558; 5min 708; IM-WW 394; E 1484; R&E-F 166; R&E-M 74; Phys-B 932, 945; Lab-C 227; Sx-S-hb 509; Sx-S 1522; Sx-WW 183; Sx4B 542 * **Mass, 90% Malignant** **CS: Cervical mass** **Dx: Biopsy** **Tx: Sx • Px: Poor**	• **Rare** • **Tumors** large, invasive carcinomas - Usually not hyperfunction (no hyperthyroidism) - **90% malignant tumor** - Metastasize to lungs • 10-15% of all head & neck tumors: dog - Old - 9+ years • Cause: unknown, iodine deficiency? • Pathophysiology: malignant carcinoma (90%) - 2/3rd unilateral, ectopic sites (cranial mediastinum base of tongue rarely, most in thyroid gland) - Locally invasive, high metastases at time of diagnosis (lungs, lymph nodes) - Boxers, Old Eng. sheepdogs, Shelties, Golden retrievers - Medullary carcinoma: rare - Benign adenomas: less common, little clinical importance, usually incidental finding at necropsy: boxers - rare	• **Enlargement in neck** • **Goiter** - ventral cervical mass - Usually nonfunctional • Pressure or infiltration of adjacent areas - Dysphagia (difficult eating), weight loss - Cough, hoarseness - Vomiting, anorexia - Dyspnea (difficult breathing) - Precaval syndrome (edema of face, neck, forelimbs) - Horner's syndrome • Rare: hypocalcemia if medullary carcinoma; usually eucalcemic • Rare: 10% hyperfunction (PU/PD, weight loss, w/ increased appetite, weakness, heat intolerance, nervousness) • Cardiac signs - insignificant compared to tumor importance 	• Hx (histyory), CS (clinical signs) • Physical exam: **easily palpated** • PE (physical exam): cervical mass, regional lymph node assessment • Radiology: cervical region, thoracic for metastasis (33%) • Fine needle aspiration: • **Excisional biopsy** & histology (wedge) - bleeding problems • Nuclear medicine: not common because tumors often nonfunctional, ^{99m}Tc or ^{131}I • Thyroid function test **DDx:** • Other malignancies (chemodectoma, carotid body tumors, lymphosarcoma, metastatic tonsillar squamous cell carcinoma, regional soft tissue neoplasia - Miscellaneous 1° or metastatic tumor types • Benign tumors - Abscess - Granuloma - Salivary mucocele - Thyroglossal duct remnants	• **Treatment rarely curative** • **Surgical excision** if possible (TOC) - Complications: Horner's syndrome, unilateral laryngeal paralysis - Monitor for hypoparathyroidism - Thyroid supplementation may be required • Chemotherapy: inconsistent, indicated if incomplete surgical removal: doxorubicin, cisplatin or mitoxantrone • ± 131 Iodine therapy, minimal value Prognosis: • **Poor** for carcinoma or large masses (majority of cases) - survival < 12 months • Good for adenomas & small tumors (minority)
Juvenile Hypothyroidism, Cretinism Mk 280; SAP 218; I2M 703; IM 544; E-hb 568; 5min 726; E 1487; F3IM 151; H-T/M 300; Neo 243, 385; C12T 346; C11T 310; Pa-T 266; Sx-S-hb 507; Sx-S 1515 * 	• **Rare** • **Slows cellular metabolism** • < 1 year old • Causes: - Thyroid dysgenesis - #1 in dog - Dyshormonogenesis: rare cause in kittens - Transport abnormalities - Goiterogens - Severe iodine deficiency • Pathophysiology: - ↓ Metabolic rate - **Growth plate problems** **DDx:** • Pituitary dwarfism (also epiphyseal dysgenesis) • Panhypopituitarism	• **Stunted growth** - **Disproportionate dwarfism** - Broadened skull - Protruding tongue (macroglossia) - Lateral strabismus exophthalmos - Distended abdomen - **Delayed dental eruption** • Gait abnormalities • Dysphagia & dyspnea 2° to goiter • **Mental dullness & depression** • **Muscular weakness** • **Constipation** (especially in kittens) • Skin changes: - Retention of puppy hair - Alopecia - Myxedema (dry, waxy swelling w/ mucin deposits in skin, nonpitting edema)	• **Hx (neonate), CS** (clinical signs) • Physical exam: ± goiter • Low T3/T4 before & after TSH stimulation - Normal: 15-25 µg/dl may be 10-20 x higher than adult • Radiography: - Ragged epiphyses w/ scattered foci of calcification (epiphyseal dysgenesis): pathognomonic • Blood values - Nonregenerative anemia - ↑ Cholesterol - Hypoglycemia - ± ↑ CK (creatinine phosphokinase) • Cardiovascular CS: Bradycardia	• **Thyroid replacement** - lifelong - **Synthetic L-thyroxine** (Levothyroid®, Synthroid®) DOC, usually required for life **L-thyroxine** Prognosis: • Poor: most die before weaning • Mental retardation likely if Tx started after 3-4 weeks old • Nervous disturbances usually reversible, skeletal malformations may be reversible if animal treated aggressively before 8-10 months old

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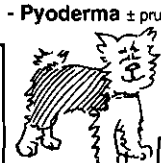
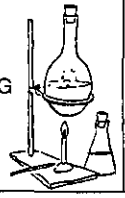
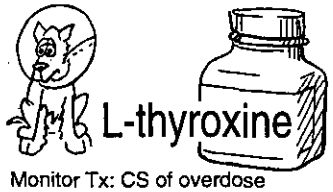
Canine **Adult onset** **hypothyroidism** M8k 415, 913; Mk 280; SAP 218, 1168; H3B 447, 282; H2B 507, 312; IM 544; E-hb 568, 321; IM-WW 390; 5min 726, 40, 80; E 1487, 710; C12T 346; C11T 310; H-T/M 300; R&E-F 70; R&E-M 68; NS-C 285; NS-W 205; NS3hb 194, 351; NS-hb 191; NS-O 270; NS-L 79; NS-Pa 462; Phys-B 930, 935; Lab-S 344; Lab-C 228; Pa-T 266; Sx-S-hb 507; Sx-S 1515; NB 9.15 *** Heart relationship not proven **#1 Endo - Dog, Slow metabolism** **CS: Tiring, Heat seeker, Skin, Wt. gain, Low libido** **Dx: CS, No TSH response,** **Tx: L-thyroxine (T_4)**	• **#1 canine endocrinopathy** maybe • **Also see pg 674 & 673** • **Slows cellular metabolism** • 4-10 yrs, medium to large breeds • Breeds: goldens, Irish setters, min. schnauzer, dachshund - Spayed > intact bitches, bitches > dogs - Rare in toys & miniatures - Extremely rare in cats (Sx removal of thyroids in hyperthyroid) • Causes: - **1° - thyroid problem**, no T_4 or T_3 (95% of cases) . **Lymphocytic thyroiditis**: probably immune-mediated . **Idiopathic atrophy** of thyroid . Neoplastic: 1° > metastasizes . Iatrogenic: radiolodine (^{131}I, surgical thyroidectomy or antithyroid drug (hyperthyroid cat) - 2° - pituitary problem, no TSH . Rare < 5% . Pituitary tumors - 3° - hypothalamic disorder (no TRH) rare • Pathophys.: ↓ **metabolic rate** **DDx: < T_3, T_4** • Obesity • Exercise intolerance • Skin problems	• **Dullness, lethargy** • **Tiring** (exercise intolerance) • **"Heat-seekers": cold** intolerant • **Skin changes** - **Alopecia**: symmetric nonpruritic truncal alopecia - "Rat tail", Flakes - Hyperpigmentation - "Tragic" facial expression (thickening of skin on face, puffy - myxedema [thickening of dermis]) • **Weight gain** w/o increase in appetite • **Reproductive**: - Male: ↓ libido, testicular atrophy, hypospermia, infertility - Female: anestrus, sporadic cycling, infertility, abortion, poor litter survival - Galactorrhea (25% of intact bitches) • Bleeding disorders - Exacerbation of Von Willbrand's diz? • CNS: peripheral neuropathy rare - Dragging of front feet - Lateral head tilt - Facial nerve paralysis - Myxedema coma • Cretinism/dwarfism: see congenital above • Eye (rare): corneal lipid deposits, Chronic uveitis, 2° glaucoma, Keratoconjunctiva sicca • **Other pituitary signs** - Hyperadrenocorticism - Hypoadrenocorticism - Diabetes mellitus - Hypogonadism • **Sequela:** - **Pyoderma** ± pruritus 	• **1 of most over diagnosed dizs** • Hx (history), CS (clinical signs) • **Best: unresponsiveness to TSH stimulation test** - Resting level, TSH stimulation, 4- 6 hr later level - < 2.0 µg/dl ↑ of T_4 • **Very low resting T_3/T_4** with CS & no other illness highly suggestive, but not diagnostic as other dizs & drugs can lower - If normal basal levels, not hypothyroid • Differentiate from euthyroid sick syndrome (low T4) & T4 lowering drugs: respond normally to TSH suppression test • Biopsy: differentiate 1° from 2° (histo) • UA: NSF (no significant findings) • Blood values: - Anemia: nonregenerative (normochromic, normocytic) 25-40% - ↑ Cholesterol (≥ 75%) - ± Triglycerides - ± ↑ CK (creatinine phosphokinase) • Cardiovascular CS - Bradycardia - Weak apical beat - Low amplitude ECG 	• **Thyroid replacement** - lifelong - **Synthetic L-thyroxine** DOC (Levothyroid®, Synthroid®) . Usually required for life . Gradually introduce & ↑ 25% increments daily over 4-8 wks to desired level . CS resolve in a few months - Other products (not recommended) . Desiccated thyroid: cheapness outweighed by short shelf life & variable contents . Synthetic L-triiodothyronine . Synthetic combination of L-T4 & L-T3 • Myxedema stupor or coma - IV L-thyroxine, IV steroids, broad spectrum ABs, passive rewarming w/ blankets  Monitor Tx: CS of overdose - PU/PD, nervousness, wt. loss, ↑ appetite, panting, fever - Dx: Elevated T4 &/or T3, amelioration of CS by discontinuance of Tx • Access 1-2 months after Tx started - Haircoat & body weight Prognosis: **Good**

DDx: low T4 levels

- **Canine "euthyroid sick" syndrome**
  - Nonthyroidal illness causing ↓ T3/T4
    - . Cushing's
    - . Addison's
    - . Diabetes mellitus
    - . Chronic renal failure
    - . Hepatic diz
    - . Other critical medical illnesses
  - Calorie or protein deficiency
  - Surgery or anesthesia
- Drugs suppressing T3, T4
  - Glucocorticoids, anabolic steroids
  - Anticonvulsants (phenytoin & phenobarbital)
  - Salicylates, flunixin, phenylbutazone
  - Ipodate (radiographic contrast agent)
  - Furosemide (Lasix®)
  - Thipental, methoxyflurane, halothane
  - Mitotane
  - Fatty acids

Condition	Facts/Cause	Presentation/CS	Diagnosis

Hypercalcemia

M8K 400; H2B 1384, 518, 1277, 263; I2M 826; IM 623, E-hb 552; SAP 230, 518, 1277; 5min 204; E 1437; C12T 378; C11T 301; H-T/M 316; H-hb 60; H-F 575; Cat 1458; R&E-F 455, 473, 474; R&E-M 142; NS-W 203; NS3hb 352; NS-hb 332 Lab-C 237; Pa-T 273; Sx-S-hb 512, 8; Sx-S 1528; NB 9.17

**

- **Uncommon in dog & rare in cat**
- **Repeated high serum calcium**
  - Young may be elevated due to bone growth < 13.0 mg/dl
  - Lipemia or hemolysis may elevate levels falsely
  - Concurrent hyperphosphatemia
  - Mineralization of soft tissues if concurrent azotemia (kidney not clearing)
- **Malignancy** #1 cause of symptomatic hypercalcemia
  - Lymphosarcoma #1

Cause of hypercalcemia (see below)

- Nonpathological conditions
  - Young age
  - Laboratory error, hemolysis, lipemia
  - Hyperproteinemia
  - Hemoconcentration
- Pathological conditions
  - **Malignancy**
    - **. Lymphosarcoma #1**
    - . Adenocarcinoma (apocrine) of anal sac (female dogs)
    - . Multiple myeloma
    - . Less common malignancies: carcinoma, squamous cell carcinoma, metastatic bone tumors, lymphocytic leukemia, fibrosarcoma, pancreatic adenocarcinoma, testicular interstitial cell tumor, mammary carcinoma (rare), lung carcinoma, thyroid adenocarcinoma, osteosarcoma, squamous cell carcinoma
  - Hypoadrenocorticism
  - Chronic renal failure (± mild hypercalcemia)
  - 1° Hyperparathyroidism - parathyroid tumor #1
  - Bone lesion: metastasis, sepsis, disuse osteoporosis
  - Acute renal failure
  - Hypervitaminosis D
    - . Cholecalciferol-containing rodenticides (Rampage®, Quintox®, Rat-Be-Gone®)
    - . House plants: Cestrus, jessamine, Solanum, Triestrum
    - . Granulomatous diz - blastomycosis, tuberculosis
    - Severe hypothermia
    - Nutritional 2° hyperparathyroidism

Malignancy - Lympho
CS: PU/PD, CNS, GI
Dx: > 12 mg/dl, P, BUN, Biopsy
Tx: 9% NaCl

- **PU/PD**
- CNS depression, seizures
- GI: anorexia, vomiting, constipation
- **Muscular weakness**
- Fine muscle fasciculations

- Sequelae:
  - Cardiac arrhythmias (rare) see Cardio pg 240
  - Soft tissue mineralization
  - Renal tubular damage

- Laboratory (fasted animal)
  - Hypercalcemia
    - **. Dog > 12.0 mg/dl**
    - **. Cat: > 11.0 mg/dl**
    - . < 15 mg/dl may not be associated w/ CS
    - . > 18.0 mg/dl often life-threatening signs
- R/O causes - fortunately short list
  - 1st rule out young age & error due to hemolysis or lipemia
  - High K & low Na - hypoadrenocorticism
  - High Ca & P & normal BUN - Vit. D toxicity
  - High P & BUN & variable Ca - renal diz
  - High serum globulin - myeloma
- **Malignancy Dx**
  - Biopsy & cytology of enlarged lymph node
  - Radiograph: cran. mediastinal mass
    - . Soft tissue mineralization
  - Rectal exam (apocrine gland adenocarcinoma, 30% normal)
- Hypoadrenocorticism - ACTH test
- Hyperparathyroidism
  - No neoplasm found
  - Chloride:phosphate ratio greater than 33
  - Marked phosphaturia
  - ↑ PTH w/ normal kidneys
- Vitamin D3 intoxication - history
- Renal diz
  - Azotemia (BUN + creatinine)
  - Usually normocalcemia or mild hypocalcemia, may be hypercalcemic
    - . Hypophosphatemic if 1° renal
    - . If hyperphosphatemia, Hi Ca not due to 1° renal failure
- ECG:
  - Prolonged P-R interval
  - Shortening of Q-T interval
  - Cardiac arrhythmias (ventricular fibrillation)

- **Pseudohyperparathyroidism: malignancy #1 cause of hypercalcemia (paraneoplastic syndrome) in dogs & cats**
  - **Lymphosarcoma**
    - . #1 cause of hypercalcemia in dogs
    - .. 20% of affected dogs
    - .. 40% of lymphoma, hypercalcemia dogs have anterior mediastinal mass
    - .. Biopsy of lymph node, organs or bone marrow to diagnose
    - . Documented in cats, but at much lower frequency
    - . Tx: steroids will lower serum calcium, but makes subsequent identification of lymphoma difficult
  - **Multiple myeloma**: 15% hypercalcemic; Tx: chemotherapy, long term survival recorded
  - **Adenocarcinoma (apocrine) of anal sac**: old female dogs, 90% hypercalcemic, usually malignant, metastasized to regional lymph nodes at time of diagnoses
    - . Tx: surgical excision, radiation & chemotherapy
    - . Prognosis: Poor for long term survival, tumor usually recurs - 2-21 months survival time

- **Hypervitaminosis D3**: Causes: iatrogenic vitamin D intoxication (dietary supplementation, post-vitamin D therapy for hypocalcemia); cholecalciferol-containing rodenticides (Rampage®, Quintox®, Rat-Be-Gone®): gaining popularity over anticoagulants because no resistance & no secondary toxicities it rodent ingested
  - CS: Vague, related to hypercalcemia, sequela: renal damage, duration ± weeks
  - Dx: Hx of exposure, hypercalcemia often severe 15-20 mg/dl, associated with hyperphosphatemia; ± azotemia (renal damage)
  - Tx: Stop supplementation or therapy; Rodenticide toxicosis: low calcium diet (Hill's k/d, u/d & s/d, restrict milk products); phosphate binders that don't contain calcium (aluminum hydroxide [Amphojel®]); avoid sunlight; if severe, aggressive IV fluids, furosemide, prednisolone &/or calcitonin for several weeks
  - Prognosis: Good if aggressive, complete recovery if early Tx

- **Hypoadrenocorticism**: 20% mild hypercalcemia (< 15 mg/dl), ionized fraction usually normal
  - Prognosis: correction of hypoadrenocorticism resolves hypercalcemia rapidly

- **Chronic & acute renal failure**: see 2° renal hyperparathyroidism

- Nonpathological conditions:
  - **Young age**: have a mild hypercalcemia (< 13.0 mg/dl) due to skeletal growth
  - Laboratory error: hemolyzed or lipemic blood samples ± false elevation

Treatment:

- Aggressive Tx if azotemic, hyperphosphatemia or dehydrated
  - **0.9%% sodium chloride** (NaCl), volume expansion & diuresis
  - . Furosemide (Lasix®) requires high dosages to increase secretion of Ca
  - . **Thiazide diuretics contraindicated** (↓ Ca excretion)!
  - Steroids helps, but make definitive diagnosis difficult
  - Sodium bicarbonate may help when combined w/ diuresis
- Lymphosarcoma: chemotherapy
- Hyperparathyroidism: surgical removal
- **Nutritional PTH: confinement, diet**
- Multiple myeloma: chemotherapy
- Adenocarcinoma of anal sac: surgical excision, radiation & chemotherapy
- Hypervitaminosis D3: stop Ca
- Rodenticide toxicosis: low calcium diet, phosphate binders, avoid sunlight, IV fluids, furosemide, prednisolone
- Hypoadrenocorticism: supplement
- Renal failure: k/d diet, fluids, restrict Na

Prognosis:

- **Lymphosarcoma - guarded to good**
- **1° PTH:** Good, most tumors benign
- Multiple myeloma: Guarded, long term survival recorded
- Adenocarcinoma of anal sac: Grave for long term survival
- Hypervitaminosis D: Good if early
- Hypoadrenocorticism: Good
- Chronic renal failure: Poor

Hi Ca + Low P =	Hi Ca of malignancy, 1° Hyperparathyroidism
Hi CA + Hi P + normal BUN =	Vit. D toxicity
Hi Ca + Hi P + Hi BUN =	1° renal failure

Hyperparathyroidism

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Primary hyperparathyroidism, **Hypercalcemia** M8K 401; Mk 481; E-hb 555, 558(F), 645; SAP 233, 236; H3B 459; H2B519; I2M 693; IM 537; 5min 696, 204; IM-WW 288; E 1444; C12T 351, 963, 1000; C11T 376; Cat 1452; R&E-F 455; Phys-B 885, 894; Lab-C 235; Pa-T 272; X-T 34, 25; Sx-S-hb 511; Sx-S 1527; SX-WW 187; NB 9.17 **	• Excessive unregulated production of PTH (parathyroid hormone) - **Hypercalcemia, but malignancies** much more common cause • Uncommon in dog, rare in cat (7 reported cases) • Breeds: Keeshond, Siamese • **Middle to older - 10 yrs (5-13)** • Pathogenesis: - Excessive PTH secretion despite high serum Ca+ (PTH usually secreted due to low Ca & inhibited by high Ca) - Solute & water diuresis - Kidney: . ↑Ca due to ↓excretion . ↑PO4 retention . ↑Bone resorption (osteoclast activity) . ↑Ca & P absorption from intestine because of ↑Vit D - Results in: . ↑Calcemia & normal to ↓phosphorus & bone resorption . Inhibits neuromuscular activity, direct cellular toxicity (calcium nephropathy), soft tissue mineralization . Renal damage in time Causes: **• #1: Solitary parathyroid adenoma** • Cystadenoma: occasionally in cat • Parathyroid carcinoma (infrequent) • Parathyroid hyperplasia (rare) • Ectopic parathyroid adenomas (usually cranial mediastinum) • Hereditary neonatal parathyroid hyperplasia (rare) **Solitary parathyroid adenoma** **CS: None, PU/PD, Nervous** **Dx: Hi Ca+, PTH** **Tx: Surgery**	**• Many asymptomatic** • Renal - PU/PD (ADH inhibition) - ± Urinary tract calculi CS **• Listlessness, depression** **• Anorexia** • GI - Vomiting - Constipation, obstipation - Pancreatitis (rare) • Neuromuscular - Muscle weakness - Drowsiness, obtundation, coma - Lameness - stiff gait - Shivering - Seizures • Cardiovascular: ECG abnormalities • Skeletal (uncommon) - Demineralization (maxilla & mandibular lamina dura) - Fibrosa osteodystrophy - Pathological fractures • Facial swelling • Sequelae - 2° Renal failure	• Hx **(older dog)** **• Suspect in older dogs w/ hypercalcemia w/o evidence of malignancy** • Physical exam: - Often normal in dog, no palpable mass . ± Calculi w/in urinary tract - Cat: palpable cervical mass - 50% • Blood values: **- Persistent hypercalcemia** (> 12 mg/dl) hallmark . Corrected for albumin: Ca + measured Ca - albumin + 3.5 for dogs . Ionized calcium (biologically active): .. Raised in 1° PTH & 2° to tumor .. ↓or normal in renal failure .. Normal: hypoalbuminemia .. Decreased: 1° hypoparathyroidism, eclampsia, pancreatitis - Hypo- or normophosphatemia - ± Azotemia (BUN, creatinine), ± ↑ALP, ALT - High PTH values suggestive, w/o azotemia - diagnostic . PTH low w/ tumors . High PTH & azotemia PTH or renal failure • Urinalysis (UA) - Low SpG <1.015 (Can interference w/ ADH) - ± 2° bacterial cystitis/cystic calculi: hematuria, pyuria, bacturia, crystalluria (uroliths - calcium phosphate, calcium oxalate or combo of two) • Radiology: usually normal, except for possible urinary calculi - ± Loss of lamina dura line around teeth - Rule out malignancy - hypocalcemia also • Ultrasound: normal parathyroids not visualized, if adenomas > 5 mm seen **• R/O other causes, esp. malignancies** - CBC, Chem, U/A, radiographs, lymph node or bone marrow biopsy • Exploratory cervical surgery (IV methylene blue to help find parathyroids)	**• Symptomatic: fluids ± furosemide** (Lasix®) if dehydration, azotemia, arrhythmia, CNS signs or weakness • Surgical removal of affected parathyroid tumor - Reduce Ca 1st: normal saline, diuretics (Lasix®), not thiazide . Prednisolone if not lymphosarcoma - Almost all solitary adenoma, check all 4 parathyroid glands 1st, tumor should be large & others atrophied, making them hard to find • Remove 3 of 4 glands in hyperplasia - Most will become hypocalcemia w/in 96 hours of tumor removal . CS: Nervousness, excitement, muscle tremors & cramping, stiff gait, tetany &/or convulsion . IV or SQ Calcium treatment • Monitor - Prophylactic Vit D3 ± calcium after surgery if presurgery levels > 14 mg/dl Ca - Monitor Serum Ca bid: OK if above 8 mg/dl, most hypocalcemic between 2-6th day after surgery, supplement until stabilized then gradually withdraw - May recur after surgery so periodically check Ca levels Prognosis • Good, most tumors benign

Juvenile * hyperparathyroidism C12T 351	• Hereditary neonatal parathyroid hyperplasia (rare); **German shepherd** • CS: Stunted growth, PU/PD, muscle weakness • Dx: Hx, CS, **hypercalcemia**, hypophosphatemia, high PTH values; Rads (± ↓bone density) • DDx: Hyper- or hypovitaminosis D3, bone neoplasia & osteomyelitis • Tx: **????**			
1° hyperparathyroidism in cats E-hb 558, SAP 233; 5min 696; E 1456; R&E-F 494 *	• **Rare** • CS: Anorexia & lethargy, vomiting • Dx: Palpable parathyroid mass in 3 of 7 cats; Serum Ca levels 11-23 mg/dl; Radiographs: thin cortices • Tx: Surgically remove parathyroids			
Nutritional 2° hyperparathyroidism, Metabolic bone diz E-hb 745; 5min 696 Lab-C 236; Pa-T 271; X4T 101; Neo 516 **	**• Skeletal disorder** • Puppies & kittens > adults • Diet with a low calcium/phosphorus ratio or low in calcium or excess phosphorus **(all meat diet)** • Pathophysiology: - Low calcium causes secretion of PTH & ↑ osteoclastic resorption of bone - Prevents mineralization of bone - ↓Renal absorption of phosphate & ↑ resorption of calcium - ↓Intestinal absorption of calcium - Progressive development of bone disorder	**• Lameness** • Weak bone & lax ligaments - Reluctance to stand or move - Abnormal gait • Skeletal pain **All meat diet** • Sequela: - Pathological bone fractures - Constipation - narrow pelvis - Collapsed vertebrae - CNS signs	**• Hx (all meat diet),** CS • Calcium usually low normal range due to compensatory action of PTH **• SAP** (alkaline phosphatase) usually elevated • High PTH (rarely done) • **Radiographs:** - ↓Bone densities & thin cortices/wide medullary cavities - ± Epiphyses wide & moth-eaten - Loss of lamina dura around teeth - Multiple fractures (compression, folding or complete) - Bowing deformities of long bones	**• Close confinement for 4-8 wks** - Avoid trauma **• Good-quality, commercial growth diet** • Avoid Ca or Vit D3 supplementation • Nursing care to prevent decubital ulcers, constipation, additional fractures • Treat any fractures Prognosis: • Good unless skeletal deformities
Renal 2° hyperparathyroidism (RSHP), Rubber jaw, Renal osteodystrophy, Renal rickets Mk 835; SAP 230, 806; IM 490, 624; 5min 698, 204; H2B573, 1281; E-hb 554, 746; E 1093; C11T 644, 853, 857; Lab-C 236; Pa-T 272; Sx-S-hb 512; Sx-OP 723, Pa-T 439 NB 16.20 **	**• See Urinary pg 346** **Can develop 2° to chronic renal failure,** less commonly to acute renal failure • 10-20% have mild hypercalcemia, the rest have less or normal levels; associated with hyperphosphatemia • Pathophysiology: - **Hyperphosphatemia** from ↓renal excretion, inhibits Vit D formation - Low Vit D = ↓gut Ca absorption - Low Ca = ↑PTH secretion . Increased mobilization of Ca from bone . Generalized osteoporosis, commonly seen in cancellous bones of skull • High phosphatemia + hypercalcemia leads to **soft tissue mineralization** **- Exacerbates progression of renal failure**	**• GI signs** - PU/PD, vomiting, oral ulcers **• Bone demineralization** - Osteopenia & potential pathologic fractures **- "Rubber jaw":** replacement of bone by fibrous tissue • Sequela: - Neuropathy - Bone marrow suppression - Mineralization of soft tissues - Myopathy - Insulin resistance - Pruritus	**• Diagnostic challenge** if high Ca due to renal failure or if it caused failure • Hx (history), CS (clinical signs) • Blood values: **- Hyperphosphatemia** - Calcium: normal, decreased or **increased** - Azotemia (↑BUN, creatinine) - ± Nonregenerative anemia - ↑PTH + azotemia - Check Ca + P (normally below < 50-70 mg/dl • Urinalysis: **isosthenuria - low SpG**, proteinuria • Radiology - Small irregular kidneys **- Soft tissue mineralization**	**• CRF therapy - fluids + protein restricted diet (k/d, u/d) + Vit C & B + avoid stress** **• Phosphorus restricted diet** (k/d, u/d) **• Intestinal phosphorus binders** Aluminum hydroxide (AmphoGel®, Tums®) • Monitor serum P every 10-14 days until normalized & then monthly as needed • ± Calcitriol/vit D3 (Rocaltrol®) to inhibit PTH, only if P normal Prognosis: **Poor**

Hypocalcemia

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Hypocalcemia

I2M 698, 829; IM 626, 540, 541; E-hb 277, 558; SAP 234, 72; H2B 1384, 517, 1277; 5MIN 206; E 1457; C12T 370, 378; C11T 301, 305, 376, 1062; H-F 577; H-T/M 313; Cat 1463; R&E-F 497; R&E-M 163, 173; Sx-S-hb 8, 514, 509, 558; Sx-S 1457

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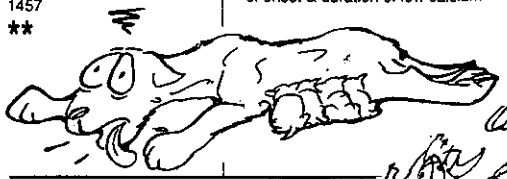


Neuromuscular excitability
CS: Tremors, Tetany, Panting
Dx: Hx, CS, PE, < 6.5 mg/dl, ECG
Tx: Ca+, Eliminate cause

See also pg 240, 421, 581 & 681

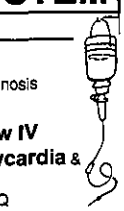
- **Low serum Ca ⁺ < 6.5 mg/dl**
- Clinically significant hypocalcemia uncommon in cat
- Protein bound & ionized fractions
  - In hypoalbuminemia, the ionized fraction is assumed to be normal
  - Adjust calculation in low serum total protein or albumin concentrations
- Severity of signs due to magnitude, rapidity of onset & duration of low calcium

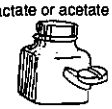
- Asymptomatic to severe neuromuscular dysfunction
- **Neuromuscular excitability**
  - Tremors, twitches (face & ears)
  - Tetany, muscle spasms
  - Stiff gait & ataxia
  - Seizures (no loss of consciousness or incontinence)
  - Hypersensitivity to stimuli
  - Disorientation
- Behavior changes
  - Restlessness, aggression, panting, facial rubbing
- ± Bradycardias
- ± PU/PD, vomiting
- ± Hyperthermia
- "Splinted" abdomen
- ± Cataracts

- Hx (histyory), CS (clinical signs)
- Physical exam: complete
- Auscultation
- **Serum calcium < 6.5 mg/dl** (< 8.5-9.0 mg/dl), if normal serum albumin/protein total & ionized if possible
  - Asymptomatic - 7.5-9 mg/dl dog & 7.5-8.5 cat
  - **CS if < 7.5 mg/dl**
  - Hypoalbuminemia & alkalosis may falsely lower levels
- CBC
- Chemistries
- **ECG:**
  - **Prolonged Q-T interval**
  - VPCs (ventricular premature contractions)
- Other specific test for specific causes
  - Vit D3 response test - hypoparathyroidism

Dogs: Adjusted calcium = Ca (mg/dl) - albumin (g/dl) + 3.5
= Ca (mg/dl) - 0.4 (total protein) + 3.3

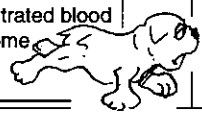
- **Eliminate cause**
- Supportive Tx, pending diagnosis
  - **Calcium gluconate or calcium chloride slow IV**
    - **Toxicity signs: bradycardia** & shortening of Q-T interval
    - Ca gluconate may be given SQ
    - Not added to fluids containing lactate or acetate or precipitation
  - Oral calcium (Tums® 1-2 tablets divided tid or qid)
  - Vitamin D supplementation (calcitriol [Rocaltrol®] to ↑ Ca absorption in GI
- Eclampsia: Ca gluconate 10% IV slowly
  - SQ Calcium
- 1° hypoparathyroidism
  - Supplement Ca for life
  - ↓ Phosphorus: kidney diet, oral phosphate binders
- 2° hypoparathyroidism: supplement until resolves
- **Maintenance**
  - Short term hypocalcemia & tetany
    - SQ injection of Ca gluconate usually enough
  - Prolonged state - hypoparathyroidism
    - SQ Ca gluconate every 6-8 hours until oral calcium & vit D_2 supplements effective (monitor Ca serum concentrations SID, stop SQ once Ca > 8 mg/dl
- **Chronic maintenance** Tx - idiopathic hypoparathyroidism & bilateral thyroidectomy in cats
  - **Oral Vit D + oral calcium**
  - Maintain calcium levels between 8-10 mg/dl





DDx - hypocalcemia

- Severe hypocalcemia
  - **Puerperal tetany/eclampsia #1** w/ CS
  - **Hypoparathyroidism**
    - Spontaneous (lymphocytic parathyroiditis)
    - Iatrogenic - bilateral thyroidectomy
      - Parathyroid tumor removal
    - Phosphate enema (hyperphosphatemia causing calcium decrease) in small dogs & cats
- **Mild asymptomatic hypocalcemia**
  - **Laboratory error** (use of EDTA-coagulated blood)
  - Hypoalbuminemia/hypoproteinemia (#1, no CS)
  - Primary renal diz (Chronic or acute renal failure)
  - Acute pancreatitis
  - Nutritional 2° hyperparathyroidism
  - Dilution (P or Ca free fluids)
  - Idiopathic hypocalcemia
  - Hypovitaminosis D
  - Hypomagnesemia
  - Osteoblastic bone tumor
  - Massive blood transfusion w/ citrated blood
  - Intestinal malabsorption syndrome
  - Cancer chemotherapy



Calcium chloride is caustic outside vein

Prognosis
- Good, guarded if severe

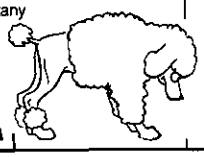
Hypoparathyroidism, Hypocalcemia

M8K 405; E-hb 558; SAP 234, 235; H3B 457; H2B 517, 263; I2M 698; IM 540, 754; 5min 722, 206; E 1457; C12T 370, 378; C11T 305, 376, 1062; Cat 1460; R&E-F 299; R&E-M 159; NS-W 203; NS3hb 260, 350; NS-HB 332; NS-O 259; Phys-B 885, 895; Lab-C 237; Pa-T 270; Sx-S-hb 8, 514, 509; Sx-S 1457

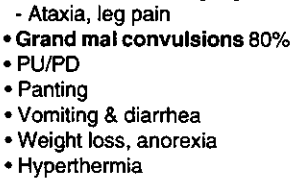
**

Low PTH - Neck surgeries
CS: Tetany
Dx: Low Ca+, Low PTH
Tx: Vit D & Ca supplementation

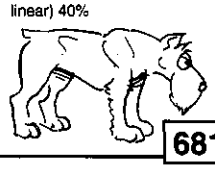
- **Failure of parathyroid to produce PTH** or failure of tissues to respond to PTH: pseudohypoparathyroidism: not reported in dog & cat
- Hypocalcemia & hyperphosphatemia w/ normal renal function
- Female dogs, any age
- Small breeds of dogs (toy poodle, min. schnauzer, Lab, G. shepherd & terrier)
- Cats: young to middle aged
- Cause:
  - Neck surgeries - iatrogenic
    - Post-thyroidectomy: common in cats, in 1 -5 days, may be transient
    - Post - parathyroidectomy: dog (parathyroid adenoma)
  - Idiopathic/spontaneous: immune-mediated?
    - Lymphocytic parathyroiditis: destruction of parathyroid gland
    - Very rare - dog & not reported in cat
  - Neck injury, neoplasia, thyroid irradiation, agenesis (St. Bernard): all *rare* causes
  - Severe hypomagnesemia (DM or gentamicin toxicity)
  - Canine distemper
- Pathophysiology: lack of PTH (parathyroid hormone)
  - Kidney: ↑ Ca & ↓ phosphorus & magnesium excretion
  - Impaired bone resorption
  - Reduced Vit D synthesis, thus ↓ Ca & P resorption from intestine
  - Hypocalcemia ↓ nerve cell stability - hyperexcitability & tetany



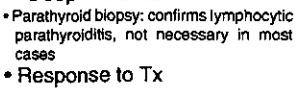
- CS when Ca < 6-7 mg/dl
- Episodic (hrs - days between)
- **Nervousness**
- Muscle tremors & twitching
- **Behavioral changes**
  - Pruritus (facial rubbing, feet biting) 50%
  - Aggression, disorientation
  - Depression & listlessness
- Cramping
- Lameness:
  - Rigid limb extension (tetany)
  - Stiff, hunched or rigid gait
  - Ataxia, leg pain
- **Grand mal convulsions** 80%
- PU/PD
- Panting
- Vomiting & diarrhea
- Weight loss, anorexia
- Hyperthermia



- Sequela:
  - ± Cataracts (small punctate to linear) 40%



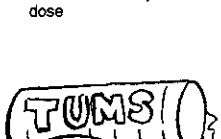
- Hx (**recent Sx**), CS
- PE: extensor rigidity
  - Weak pulse
- Blood values
  - **Severe hypocalcemia** (< 6 mg/dl)
  - **Hyperphosphatemia** usually
  - **Low PTH values**
- Urinalysis: normal renal function
- ECG:
  - Prolonged Q-T & S-T interval
  - Tachyarrhythmias
  - Deep T waves
- Parathyroid biopsy: confirms lymphocytic parathyroiditis, not necessary in most cases
- Response to Tx



DDx - hypoparathyroidism

- Neuromuscular & behavior abnormalities
  - Hypoglycemia
  - Hypercalcemia
  - Severe K+ & Na+ disturbances
  - Liver failure
  - Renal failure/uremia
- Cardiac diz
  - Tachy - or bradyarrhythmias
- 1° neurologic diz
  - Cerebral diz
  - Polyneuropathy or polyneuritis
- Toxicity
  - Metaldehyde
  - Caffeine
  - Organophosphate & carbamates
  - Ethylene glycol
- Other cause for hypocalcemia

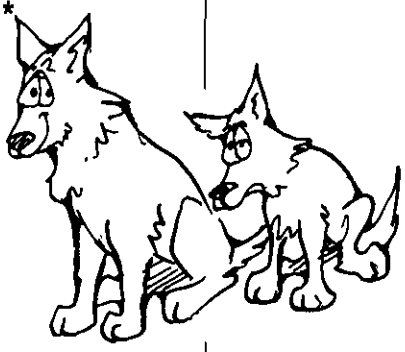
- **Supplement for life to low-normal calcium levels** (8-9.5 mg/dl)
  - Dihydrotachysterol (Vit D) Hytakerol®, Vit D2 (ergocalciferol), Vit D3, Calcitriol®
  - Oral calcium - Tums® calcium carbonate, Ca lactate, Ca chloride, Ca gluconate
- ↓ Phosphorus
  - Kidney diet (k/d)
  - Oral phosphate binders (aluminum hydroxide, Tums®)
- ± Thiazide diuretics promotes calcium resorption in renal tubules
  - Monitor weekly at first then monthly
- 2° hypoparathyroidism due to parathyroid tumor surgery or thyroidectomy
  - Transient: hypocalcemia resolves once atrophied parathyroid glands regenerate
  - Supplement w/ Vit D3& calcium after surgery until resolves w/o production iatrogenic hypercalcemia
  - Usually can be withdrawn w/in 8-12 weeks for hypocalcemia due to thyroid/parathyroid Sx
    - Occasionally life long supplementation necessary
- Monitor Ca daily until stabilizes (8-10 mg/dl for several days, then weekly, then every 1-3 months indefinitely until Tx not needed)
- Monitor serum P weekly until normal & Ca x P products remain < 70, then every 1-3 weeks
- Monitor PTH in iatrogenic cases monthly & taper Ca & Vit D
- Owners monitor PU/PD as a sign of hypercalcemia
  - If hypercalcemia results, stop medication until Ca normal for 2-3 days, then reinstitute Vit D at lower dose

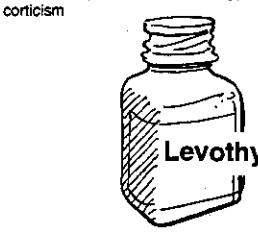


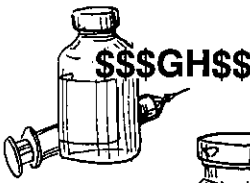
Prognosis: **Guarded**

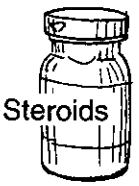
Dwarfism

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Pituitary hypofunction, Hypopituitarism, Pituitary dwarfism, **Juvenile panhypopituitarism, Pituitary cyst** M8k 411; H3B 440; H2B 499, 851; SAP 266; E-hb 547; 5min 724; I2M 689; IM-WW 383; E 1422; C12T 349; R&E-F 40; R&E-M 38; Phys-B 871, 914; Lab-C 218 *	• **Deficiency of pituitary hormones** (cortisol, T4, GH) • Young animals: deficiency of GH - pituitary dwarfism - Germ. shepherd, spitz, toy pinscher, Carnelian bear dog, immunodeficient weimaraners • Adult onset: 1° pituitary neoplasia • Rathke's pouch development	• **Short** stature compared to littermates, proportionate • **Skin abnormalities** - Soft woolly hair coat (retention of puppy hair & no guard hairs) - Gradual bilateral, symmetrical alopecia sparing head & extremities - Progressive hyperpigmentation - Thin, hypotonic scaly skin • Musculoskeletal abnormalities - Delayed closure of **growth plates** - Delayed eruption of permanent teeth, retention of deciduous teeth • **Reproductive problems** - Hypogonadism, small testicles, azoospermia, flaccid penile sheath; female: absence of heat, infantile external genitalia • Shortened life expectancy • **± Shrill, puppy bark** • Sequela: - 2° Hypothyroidism - 2° Hypoadrenocorticism	• **Presumptive: Hx, CS, insulin response test** • Definitive GH assay not available • R/O other causes of dwarfism (CBC, US, chem., fecal flotation) • Lab usually normal in uncomplicated pituitary dwarfism • **Insulin response test** (GH is anti-insulin, so deficiency results in hypersensitivity of hypoglycemic affects of insulin) - Fast for 12 hours & give insulin, collect blood at 15, 30, 45, 60 & 90 min. - Pituitary dwarfism: glucose falls ≤ 50% & returns to normal more slowly - Causes severe hypoglycemia & hard to interpret • Endocrine progfiles - Xylazine response test: ↑ glucose 2° to ↑ GH • Radiographs: - Delayed closure of growth plates - Delayed calcification of os penis	• GH replacement: SQ, expensive & hard to obtain • **Thyroid replacement** (thyroxine [Levothyroid®, Synthroid®] PO if 2° hypothyroidism for life, will reverse many of dermatologic & skeletal consequences of TSH deficiencies if client can't afford GH therapy • Cortisone replacement - for 2° hypoadrenocorticism Prognosis: • GH replacement usually effective, repeat if alopecia returns, expensive & unavailable • Short stature usually permanent because growth plates closed soon after GH therapy started









Deficiency of GH, Germ. shepherd
CS: Dwarf; ± Shrill, puppy bark; Puppy hair; Alopecia
Dx: Hx, CS, R/O other causes of dwarfism, Rads
Tx: GH SQ ($), T4

DDx - Dwarfism
- Malnutrition
- Maldigestion/malabsorption
- Heavy intestinal parasitism
- Congenital heart of kidney diz
- Congenital liver diz (portosystemic shunts)
- Congenital hypothyroidism (cretinism)
- Hyper- or hypoadrenocorticism
- Diabetes mellitus
- Metabolic storage diz
- Skeletal dysplasia
- Cretinism (juvenile hypothyroid)

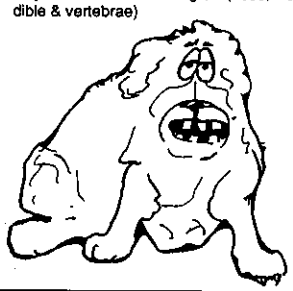
Acromegaly,

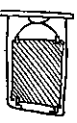
Hypersomatotropism (GH) - Dog & cat

M8k 413(F), E-hb 549, SAP 264; I2M 686(F)IM 535; H3B 442; H2B 501 986; E-hb 548; IM-WW 387; 5min 318; E 547; CAT 1405; F3IM 169; C12T 393, 356, 855; C11T 322, 310; R&E-F 55; R&E-M 41; DDx 191; Phys-B 871, 914; Lab-C 218

*

	• ***Chronic excessive of GH*** (growth hormone/ somatotropin) - Overgrowth of soft tissue (heart) & bones • Cause: - **Cat: pituitary tumor** (rare in dog) . Old male cats (8-14 years) - **Dog: progesterone** from diestrus or progesterone Tx of estrus (megesterol acetate [Ovaban®]), exogenous somatotropin for hormonal-responsive dermatosis- no heart problems . Old female dogs • Pathophysiology: - GH: anabolic & catabolic effects - necessary for normal growth . Hypertrophic cardiomyopathy - cats . Anabolic affects: proliferation of bone cartilage & soft tissue & organomegaly . Catabolic affects: insulin resistant Diabetes mellitus ↓ number of insulin receptors - If GH over secretion after growth plates close = acromegaly . Only membranous bones grow (nose, mandible & vertebrae)	• **Conformation changes:** ↑ body size, weight gain - Large head, prognathism (long mandible), enlarged interdental spaces, large paws - Lameness: arthropathies proliferation of cartilage (cats > dogs) - Enlarged abdomen - organomegaly (heart, kidney, liver & tongue) • **Skin:** - Thickened, myxedematous skin w/ prominent folds - face & neck - Hypertrichosis (thick coat) - Hyperpigmentation - Thick hard nails • **Diabetes mellitus** (some dogs & all cats) - PU/PD, Weight loss • **Inspiratory strider** (thickened mucosa) • Cardiomyopathy in cats (45%) - CHF **- Weakness, dyspnea** • Renal failure (50% of cat cases) • Reproduction/Dogs: pyometra, mucometra & mammary gland nodules • Sequelae: - CNS - tumor invasion (rare): head pressing, dullness, anorexia - Tissue compression . 2° hypothyroidism, adrenal insufficiency, hypogonadism	• **Hx (dog: progesterone Tx or diestrus or DM; Cat: insulin resistance DM), CS** • Tentative: conformation alteration in poorly controlled DM (weight gain & PU/PD) • Physical exam: ± papilledema: ophthalmic exam, cyanosis • Auscultation - cat **- Systolic murmur (65% of cats), Gallop rhythm** **- Pulmonary effusion, edema** • Laboratory: - Hyperglycemia, glycosuria - Mild elevation of SAP (serum alkaline phosphatase) & alanine transaminase - ± Hyperphosphatemia (renal) - ± Stress leukogram - Hypercholesterolemia, hyperproteinemia, mild erythrocytosis (cats) • Cat: normal adrenal & thyroid tests • ECG abnormalities not observed • Urinalysis (UA) cats w/ renal failure - proteinuria & dilute specific gravity (1.015-1.025) • Radiology: **- Cardiomegaly (86% of cats), hepatomegaly, renomegaly** **- Pleural effusions, edema** - Soft tissue proliferation in cervical region - Bony changes : spondylosis, periarticular reactions - Pituitary mass • Echocardiography: **ventricular hypertrophy in cat** • **Persistent elevation of GH definitive, but assays not available** • **CT scans for pituitary tumor** • **Skin biopsy** - Orthokeratotic hyperkeratosis - Epidermal, dermal hyperplasia - Myxedema	• **Cat: no successful therapy reported** - Surgical excision of pituitary tumor not done - Control diabetes: high insulin doses (NPH bid) - Heart diz . Diuretic for mild-to-moderate heart diz . Beta blockers (propranolol, atenolol); ACE inhibitors (captopril, enalapril) or calcium antagonists (diltiazem) - Renal diz: low protein diet, low phosphorus diet • **Dog:** **- Withdraw progesterone** &/or ovariohysterectomy - GH concentration normalize & soft tissue abnormalities resolve Prognosis: • Cat: Good - short term: survival 4-42 months **- Grave** - long term: die or euthanized because of CHF, renal failure or expanding pituitary tumor • Dog: **Good**





↑ GH, organomegaly, Cat - tumor, Dog - progesterone
CS: PU/PD, Weight loss; Large head, Cardiomyopathy
Cat: insulin-resistant DM
Dx: Hx, CS, Hyperglycemia, Rads
Tx: Cat: no successful therapy
Dog: stop progesterone

DDx:
- Other causes of inspiratory stridor
  - Elongated soft palpate
  - Laryngeal paralysis
  - Upper airway neoplasia
  - Foreign body
- Simple Diabetes mellitus
- Hyperadrenocorticism

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Pheochromocytoma M8k 421; Mk 288; H-T/M 311; C11T 307t, 310; H3B 478; H2B119, 538; SAP 245; I2M 803; IM 87, 604; IM-WW 409; 5min 938; E-hb 51t, 3; R&E-F 306; Phys-B 972, 976; SX-WW 183 ★	• **Catecholamine-secreting tumor** of **adrenal gland** (chromaffin cells) • **Rare in dog**, reported in 1 cat - Older dog - 11 years old • Pathophysiology: **Catecholamines** - Hypertension - Myocardial irritability, necrosis • Metastasizes: lungs, regional lymph nodes, heart, spleen & kidney; invasive; caudal vena cava **DDx:** • Other causes of systemic hypertension - Chronic renal diz - Hypothyroidism - Hyperadrenocorticism • Other metabolic or systemic disorders - Cardiovascular diz - Neurologic disorder - Pulmonary diz	• Vague & episodic: CS < 50% of cases • **Weakness - episodic** • Vomiting • Weight loss, anorexia • Panting, tachypnea • PU/PD • Distended abdomen • Lethargy • Erythema w/o pruritus • Collapse, Acute death • Sequelae: - Hypertension: mydriasis, blindness, retinal detachment, epistaxis - Thrombosis of caudal vena cava . Ascites . Peripheral edema, caudal limbs	• **Most incidental finding postmortem** • Hx, CS vague, rarely diagnosed antemortem • Palpable abdominal mass (10% of cases) • Laboratory data usually normal • Radiography/Ultrasound - **Cranial abdominal mass** (33% of cases) • **Hypertension** (50% of cases) • Surgical exploration definitive • ECG: - **Arrhythmias** (VCPs, ventricular tachycardia) - Nonspecific S-T segment & T wave changes • Hemorrhagic diathesis	• **Adrenalectomy** TOC (Tx of choice) - Control catecholamine-induced arrhythmias & hypertension before & during surgery • Long-term alpha- & beta-adrenergic blockers if inoperable - control cardiac arrhythmias & hypertension - Phenoxybenzamine to reduce hypertension - Propranolol or atenolol for tachyarrhythmias Prognosis: • **Poor if inoperable** • **Guarded if operable**

Catecholamine Adrenal tumor Tx: Adrenalectomy

Erythropoietin abnormalities
H2B 546; C12T 1435t, 345t; C11T 484

- **See Cardio pg 325: Glycoprotein hormone**: regulates normal erythopoiesis of bone marrow; Origin? juxtaglomerular apparatus in kidney? Renal hypoxia: major stimulus for secretion
- 1. Reduced erythropoietin, 2. Normal ↑ (hypoxia), 3. Inappropriate ↑ (tumors, renal diz)
- CS: Chronic renal failure or polycythemia vera, Cardiopulmonary diz, hyperviscosity; Neoplasia, renal diz
- Dx: < PCV, > PCV, ± > RBCs; R/O dehydration, check for causes
- Tx: Treat cause

Endocrinological conditions that are not covered in this text:

Hyposomatotropism,
Acquired growth hormone responsive dermatosis
Estrogen responsive dermatitis
Testosterone responsive dermatitis
Hyperandrogenism
Atrophic hypogonadism
Male feminizing syndrome
Adrenal sex hormone imbalance

Systemic Diseases

Anaphylaxis 706
Anorexia 708
Anthrax 699
Aspergillosis 703
Blastomycosis 704
Cachexia 709
Canine distemper 686
Cat plague 699
Cerebellar hypoplasia 690
Circulatory shock 707
Continuous fever 711
Cryptococcosis 703
Distemper
  canine 686
  feline 690
Ehrlichiosis 700
Encephalitis - distemper **522**, 687
Fading kitten syndrome 690
Feline panleukopenia 690
  distemper 690
  immunodeficiency virus 694
  infectious peritonitis 688
  leukemia 692
  lymphosarcoma 692
  panleukopenia 690
  Parvovirus 690
FeLV 692
Fever 711
Fever of unknown origin 712
FIP 688
FIV 694
Francisella tularensis 699
Frostbite 715
Fungus 702-5
Heat stroke 714
Hepatozoonosis 696
Histoplasmosis 705
Hypersensitivity reaction 706
Hyperthermia 714
Hypothermia 715
Immunodeficiency virus 694
Infectious peritonitis 688
Leishmaniasis 698
Leptospirosis 695
Leukemia 692
Lupus erythematosus 699
Lymphoma 692
Malignant hyperthermia 714
Malnutrition 708
Multifocal encephalitis 687
Mycotic lung disease 704
Neosporosis 696
Obesity 710
Old dog encephalitis **522**, 687
Pancytopenia 700
Panleukopenia 690
Parvovirus 690
Plague 699
Postvaccine canine distemper
  encephalitis **552**, 687
Pyrexia 711
Ricketsia - Ehrlichia 700
Rickettsia rickettsia 701
Rocky Mt. spotted fever 701
San Joaquin Valley fever 702
Shock 707
SLE 699
Systemic lupus erythematosus 699
Toxoplasmosis 697
Tularemia 699
Typhus 700
Valley fever 702
Wasting disease 692
Weight gain 710
Weight loss 708
Yersinia pestis 699

Canine Distemper

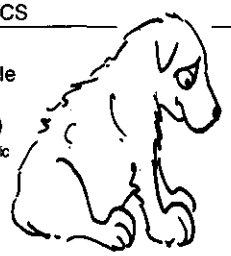
Condition	Facts/Cause	Presentation/CS	Diagnosis

Canine distemper, CDV

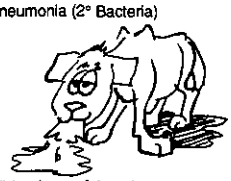
M8k 548; Mk 548; E-hb 143, 198, 240; 52; SAP 107; H3B 1127; H2B 1187; IM-WW 557, 222; 5min 528; IM 772, 277; I-B 51; Pa-T 14, 128, 549; NB 11.7

**

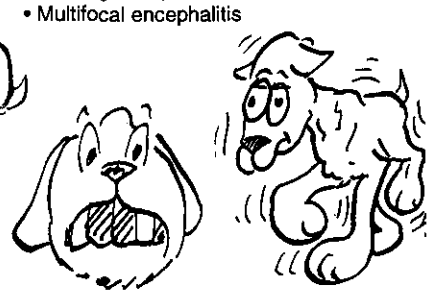
- **Severe, highly contagious multisystem viral diz**
- Dogs & other carnivores - worldwide
- Virus (CDV)/ morbillivirus family
  - Paramyxoviridae (closely related to measle virus)
- Most susceptible are unvaccinated weaned puppies - 3-6 months old
- Transmission: primarily aerosol, transplacental rare
- Pathogenesis:
  - Airborne to tonsil then systemic lymphoid tissue, viremia, dissemination to epithelial tissue
  - Immunosuppressive



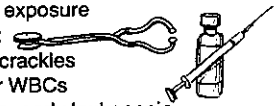
- **Subclinical in 50%**
- Multisytemic & extremely variable
- Systemic (general)
  - Malaise (anorexia, depression)
  - Fever of 104-106° F (40-41° C) diphasic (CS usually coincide w/ 2nd fever spike)
  - Weight loss, debilitation
- Respiratory CS:
  - **Rhinitis & conjunctivitis**
  - **Pneumonia** - interstitial to bronchopneumonia (2° Bacteria)
  - Cough, dyspnea



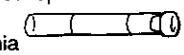
- GI tract:
  - **Vomiting**
  - **Diarrhea**
- Eye:
  - Keratoconjunctivitis sicca
  - Chorioretinitis, "gold medallion" lesion of fundus
  - Optic neuritis (**blindness**)
- **CNS** - wks - months after apparent recovery
  - Acute to subacute encephalitis
    - . **"Chewing-gum" seizures**, pacing, circling, behavior changes
  - Midbrain, cerebellar & vestibular
    - . **Ataxia & gait disturbances**
    - . **Circling**
  - Spinal cord
    - . **UNM signs**: gait disturbances, abnormal spinal reflexes, paresis, abnormal proprioception
  - Myoclonus (rhythmic, repetitive, motor movement or muscle twitches)
  - Hyperesthesia, cervical rigidity
- **Miscellaneous:**
  - Dental enamel hypoplasia (pitted teeth if infected before eruption)
  - Hyperkeratosis of foot pads (**"hard pad" diz**)
  - Abdominal pustules/rash
  - Transplacental: abortions, stillbirths, weak puppies ± CNS signs
- Old dog encephalitis
- Multifocal encephalitis



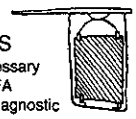
- **Hx (young unvaccinated dog [2-6 months]), CS**, & possible exposure
- Physical exam:
  - Auscultation: crackles



- Blood count for WBCs
  - **Lymphopenia**, early leukopenia later ↑ PMNs



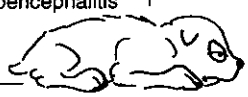
- Radiology for pneumonia (interstitial or alveolar)



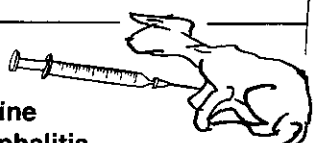
- CSF analysis if neurologic CS
- Virological techniques usually not necessary or practical (inclusions in buffy coat - FA
- Serology: rising titers suggestive not diagnostic

DDx:

- Respiratory dizs
  - Kennel cough
  - Bacterial pneumonia
  - Adenovirus (CAV & CAV_2)
- GI
  - Parvovirus
  - Garbage or toxin ingestion
- Lymphopenia
  - Parvovirus
- Cardiomyopathy
- CNS
  - Other causes of seizures
  - Other causes of meningoencephalitis
    - . Toxoplasmosis
    - . Rickettsial dizs

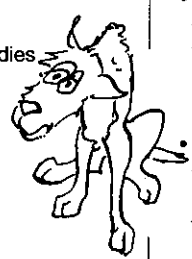


See also GI 54, Resp pg 144 & Neuro 552



Postvaccine canine distemper encephalitis

- **See Neuro pg 552: Rare**, < 6 months; ? associated w/ **MLV** distemper + parvo vaccines in pups < 6-8 weeks old
- CS: **W/in 1-2 weeks of vaccination**: anorexia, listlessness, CNS
- Dx: Hx, CS, absence of inclusions bodies
- Tx: Symptomatic: ???
- Prognosis: guarded
- Prevention: Measles vaccine then parvo vaccine in 7-10 days



Multifocal encephalitis, Encephalomyelitis

- **See Neuro pg 552: Chronic progressive diz 2°** to distemper virus, 4-8 years-old
- CS: **Incoordination, Weakness**, Head tilt, Facial paralysis, Head tremors w/ myoclonus, BAR, **No seizures or personality changes**
- Dx: Hx (age) CS; Necropsy
- Tx: **No treatment**
- Prognosis: **Poor**

Old dog encephalitis, ODE

- **See Neuro pg 552: Extremely rare**, Progressive disorder - **fatal, > 6 yr**
- CS: **CNS CS + personality changes**
- Dx: Hx, CS, Necropsy
- Tx: **Unrewarding - always fatal**
- Px: **Grave - all die**

Prevention:

- **Vaccinate** bitch before breeding, don't use MLV in pregnant bitch
  - Passive maternal antibodies
    - . Protective for 9-12 weeks in puppies that received colostrum
      - .. Protects for 1-4 weeks if colostrum not received, 8-14 weeks if colostrum received
    - . Interferes w/ response to vaccinations
- Vaccination:
  - **MLV CDV** (modified live vaccine) 2 doses nearly 100% protective
  - Normal puppies: vaccinate at 6-8 weeks of age
    - . Repeat every 3-4 weeks until 14-16 weeks old
  - Colostrum deprived puppies
    - . Vaccinate at 4 weeks old, Repeat in 2-4 weeks
  - Dogs older than 16 weeks
    - . Vaccinate twice 2-4 weeks apart
  - Measles virus vaccine, recommended for 1st vaccine if puppy less than 8 weeks old w/ or w/o CDV because it partially protects pups in face of interfering maternal antibodies, follow w/ at least 2 CDV vaccines later
  - Annual boosters recommended
    - . Immunity is solid & prolonged, but not necessarily lifelong
  - MLV vaccination w/in 4 days of exposure may be effective in preventing distemper
- Postvaccinal complications
  - Encephalitis associated w/ MLV vaccines
  - High environmental temperature & humidity can reduce effectiveness of vaccine
  - Concurrent parvo may reduce response

Treatment:

- No specific antiviral drugs
- **Broad-spectrum ABs** for 2° bacterial infections
- Humidification of airways
- Pneumonia
  - Expectorants
  - Bronchodilators
- GI (vomiting & diarrhea)
  - Antiemetics
  - Antidiarrheals
- Seizures:
  - Anticonvulsants (phenobarbital)
- **Good nursing**
  - Keep eyes & nose free of discharge
  - Nutritional support
  - Clean, warm, dry
  - Fluids
  - B-complex vitamins
- Isolate animal
- Euthanasia if severe, incapacitating, progressive neurologic signs

Prevention: Wait 1 week before bringing another dog onto the premises

- Vaccines (see box)

Prognosis:

- **Guarded**: mortality from 1-100% depending on virulence & age of animal
  - Pessimistic even for mild cases
  - Disease is often progressive despite therapy
  - Some recover & then exacerbate

Condition	Facts/Cause	Presentation/CS

Feline infectious peritonitis, FIP, Coronavirus

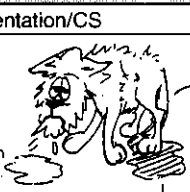
M8k 551; E-hb 207, 282, 53, 88; E 421; SAP 94; H3B 1136; H2B 1196; 5min 586; I2M 1290; IM 774, 981, 372, 231, 410, 678, 214; IM-WW 558, 223; I-B 66; Cat 449, 333, 833, 1071; F-N 352; Pa-T 173; NB 11.20

**

Cattery diz, Fatal
CS: Wet & Dry forms
Dx: Hx, CS, PE, Lab, Rads, Serology
Tx: Unrewarding
Px: Grave

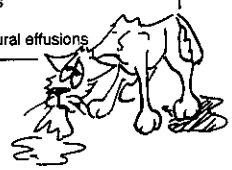
- **Progressive & fatal systemic immune-mediated diz**, cats & wild cats
- **Uncommon in general practice, relatively common in catteries**
- Causes pyogranulomatous enteritis & other systemic signs
- **Coronavirus** (FIP virus strains [FIPV]), antigenically related to feline enteric coronavirus (FECV)
- Pathophysiology:
  - Systemic infection of **macrophages**
  - Immune complex-mediated **vasculitis - effusions**
  - Necrosis & **pyogranulomatous** inflammation
- Transmission: oral or respiratory
- 6 months - 5 years (all ages), Clinical FIP < 3 yrs-old or > 11 yrs
- Low morbidity (20%), but high mortality (90%)
- Risk factors: crowding, FeLV or FIV concurrent infections
- Incubation: days to weeks to months

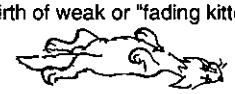
- **Initially nonspecific**
  - Chronic fluctuating fever (unresponsive to ABs)
  - Anorexia, weight loss, inactivity
  - Vomiting, diarrhea
  - Dehydration, depression & pallor (anemia)
- **"Wet" (effusive) form** (acute) more common form
  - **Peritonitis/abdominal effusions** (85%)
    - Progressive, nonpainful distension of abdomen
    - Scrotal swelling m/b from direct extension
    - GI: vomiting diarrhea
    - Hepatic (jaundice)
    - Pancreas (vomiting) uncommon
    - Adhesions: large mass of guts
  - **Pleuritis**: thoracic effusions - 35%
    - Dyspnea, tiring, sternal recumbency or sitting posture
  - Ocular & CNS rare
- **"Dry" form** (noneffusive) (slow, insidious & smoldering)
  - **Pyogranulomatous lesions** - organ-specific
    - Kidney - PU/PD
    - Icterus, hepatomegaly
    - **CNS**: pyogranulomatous meningoencephalomyelitis: incoordination, posterior paresis, nystagmus, convulsions, intention tremors, cranial & peripheral nerve paralysis, hyperesthesia, generalized ataxia, head tilt, behavior changes, urinary incontinence, tetraplegia
    - **Anterior uveitis** - pyogranulomatous (iridocyclitis, chorioretinitis, corneal edema aqueous flare, hypotony, iritis, hyphema, hypopyon)
    - Splenomegaly
    - Mesenteric lymphadenopathy
    - Pyogranulomatous pneumonia infrequent & dyspnea uncommon
- **Combination of both wet & dry form**
- **All forms progressive & fatal**
- Reproductive - suspected: infertility, stillbirths, abortions, congenital malformations, fetal resorption, birth of weak or "fading kittens"
- Sequela: DIC (disseminate intravascular coagulation)



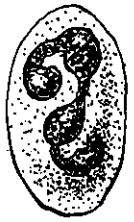
DDx:
- FIV infections
- FeLV infections
- Lymphosarcoma
- Visceral tumors
- Cardiomyopathy
- Pyothorax
- Chylothorax
- Diaphragmatic hernia
- Chronic bacterial peritonitis
- Cholangiohepatitis complex
- Pansteatitis
- Toxoplasmosis
- Cryptococcosis
- Tuberculosis

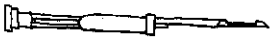
CNS:
- More frequent in dry (noneffusive) than wet form
- Progressive focal, multifocal or diffuse involvement of spinal cord, brain, & meninges
- Cats < 2 years & aged cats
- Rarely have abdominal or pleural effusions





Diagnosis:
- **Strong circumstantial evidence of CS, PE, Hx, Lab, rads, fluid analysis, cytology & biopsy**
- Hx, CS (AB resistant fever)
- Physical exam
  - Auscultation: muffled heart & lung sounds in 25% of wet form
  - Palpation & percussion of a fluid wave
  - Palpation of lymphatic, hepatomegaly, enlarged firm kidneys - dry form (pyogranulomatous)
  - Fundic exam (± flame- or boat-shaped hemorrhages
- Lab: unspecific - strong circumstantial evidence
  - CBC ± anemia, leukocytosis, lymphopenia
  - Chemistry: noneffusive FIP to pin down organs involved azotemia, liver enzymes + bile acids
  - UA: Proteinuria - kidney, bilirubinuria
- Radiology & Ultrasound
  - **Confirm body cavity effusions**
  - Organ enlargement (kidney liver)
  - Organ infiltration (lungs)
- **Fluid analysis** - strongly supportive (centesis)
  - Clots on standing- pale yellow, translucent
  - High cell count - 1000-10,000 /µl, PMNs)
  - Tenacious, sticky - fibrin
  - Foamy - high protein content 4-10g/dl
  - Protein electrophoresis (gamma globulin ≥ 32% of fluid protein
    - Albumin < 48% of fluid protein
    - Albumin to globulin ration (A/G) < 0.81
  - **Nonseptic exudate** (pyogranulomatous) predominantly nonregenerative PMNs & macrophages w/ some plasma cells & lymphocytes
- CSF or aqueous humor of eye: ↑ WBCs (especially PMNs) in neural & intraocular FIP, & elevated protein
- Corona virus serology - FIP antibody often nondiagnostic
  - Not definitive because doesn't differentiate FIP coronavirus from non-FIP coronavirus or distinguish between carrier & active infection
  - Use as a diagnostic aid not definitive diagnosis
    - Low titer - FIP possible
    - High or rising titer - FIP probable
    - Negative titer - FIP unlikely
- Specific ELISA, IFA, antigen-antibody & DNA probe tests are being developed
- Biopsy - only definitive Dx in live cat, valuable in some cats
  - Vasculitis & pyogranulomatous inflammation
- Check FeLV
- Postmortem: pyogranulomatous: multiple, gray-white nodular masses of variable size on surface & in parenchyma of organs





Treatment:

NO CURE

- **No known cure for FIP, no viral treatment**
- **No Tx effective in prolonging life**
- Palliative chemotherapy: beneficial response in < 10%
  - High dosage of corticosteroid w/ cytotoxic alkylating agents (chlorambucil, cyclophosphamide or mephalan)
- Tx of ocular FIP:
  - Topical ophthalmic corticosteroids & topical atropine for mydriasis
  - Subconjunctival or retrobulbar injections or long acting corticosteroids recommended by some
- Supportive Tx, may improve quality of life
  - Intermittent body cavity drainage
  - Parenteral fluid therapy
  - Nutritional support (tube feeding)
  - Blood transfusion (anemia)
  - ABs (if 2° bacterial infection suspected)
- Experimental treatments: Antiviral drugs & immune mediating drugs

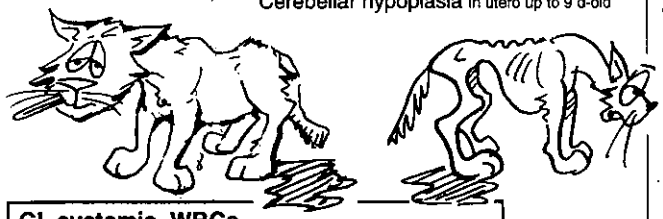
Prognosis:
- **Grave**: Wet form: survival from days to 2 months
  - Dry form: survival time up to 1 year
- Once clinical signs develop - nearly always fatal regardless of treatment
  - Rare remissions in mildly affected or only ocular involvement

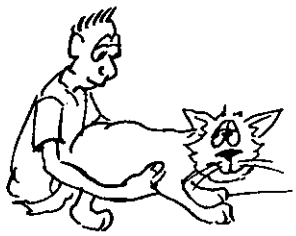
Prevention:

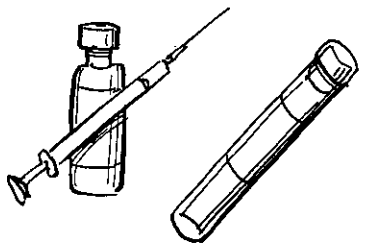
IN Vaccination

- **Vaccination** in catteries
  - Intranasal (IN) vaccine (Primucell FIP®) 1991
    - 2 doses of 0.5 ml each intranasally 3-4 weeks apart at 16 weeks of age or older
    - Annual booster: survival of 71-85% for vaccinates vs 17-20% for unvaccinates when challenged w/in 6 months
- **Cattery management**
  - Isolate cats w/ FIP signs
  - Control FeLV (vaccination, testing & removal)
  - Replace only w/ cats of negative FIPV-Ab titers
  - Use only proven queens in breeding program
  - Good husbandry (hygiene, feeding & density)

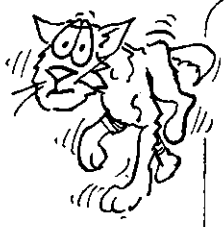
Condition	Facts/Cause	Presentation/CS	Diagnosis
FPV, Feline panleukopenia, Feline parvovirus enteritis, Feline distemper M8k 559; IM 336; SAP 114, 700; E-hb 211; E 433; 5min 592; H3B 1135; H2B 1194; IM-WW 293; Cat 479; Pa-T 50; NB 11.17 **	• Severe, highly contagious infection • **Viral gastroenteritis** • 3-4 mo-old highest incidence, at risk throughout life • **Parvovirus**: relatively rare now because of vaccinations - Occasionally seen in unvaccinated kittens • **Contagious** - Direct contact of cats & secretions - Ubiquitous in environment, persistent - Shed in urine & feces weeks after recovery - Transplacental - Dilute Chlorox (1:32) kills virus • Destroys rapidly dividing cells - Intestinal epithelium: Acute enteritis - Stem cells of bone marrow: panleukopenia thymus & - Lymphoid tissue - lymphoid depletion - Transplacental: abortion Cerebellar hypoplasia in utero up to 9 d-old	• **Adults - subclinical** • **Perinatal infection - neonate** - **Normal or weak** - **Cerebellar damage at 3 wks of age** . Hypermetria, intention tremors (disappear at rest), symmetrical incoordination, rolling & tumbling, ataxia all persist for life - **Fading kitten syndrome** . Invasion of thymus, thymic atrophy & early neonatal mortality - Retinal dysplasia if invades retina • **Severe - older kittens** - **Like parvo in dogs** - **104-106°F** (pyrexia) - **Persistent vomiting** (bile stained) - **Severe, fetid diarrhea** (watery, mucoid or bloody) . ± **Blood & fibrin casts** - Other less common signs: Iritis, 2° infection, cutaneous hemorrhages, necrosis & sloughing of ear tips, ulcerative or necrotic stomatitis, mild icterus • **In utero infections** - Early embryonic resorption (infertility) - Fetal death/mummification - Abortion & stillbirth • Sequela: - **Severe dehydration** - Endotoxic shock (gram neg.) - DIC - Death in 1-2 d if untreated	• Hx (**unvaccinated**), CS (gastroenteritis/ systemic/panleukopenia) • Previous vac. doesn't R/O • Lab: - **Transient leukopenia** (↓ WBCs) in most cats <500 /µl, lasts 2-4 days - **Rebound leukocytosis** w/ marked lt. shift upon recovery (500-2000/µl) - Prerenal azotemia - dehydration - Thrombocytopenia if DIC - Hypoproteinemia ? - Serological testing & Viral isolation rarely done • Serum chemistries nonspecific & inconsistent • Necropsy: severe necrosis of intestinal crypts





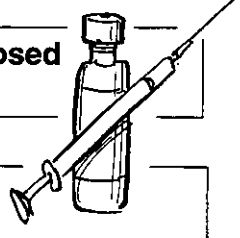


GI, systemic, WBCs
CS: Severe diarrhea/vomiting/ dehydration
Dx: Hx, CS, WBCs
Tx: Fluids & ABs, Vac

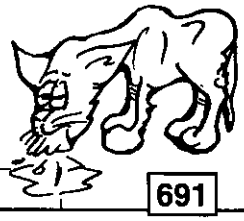


DDx:
- FeLV (persistent leukopenia)
- Other viral enteritides
- Acute bacterial enteritis
  - Salmonella
  - Campylobacteriosis
- Toxoplasmosis
- Cryptosporidiosis
- Toxicosis,
- Linear foreign bodies/peritonitis
- Pancreatitis

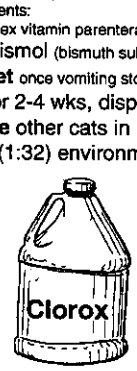
Vaccinations very effective as apposed to parvo vaccination in dogs

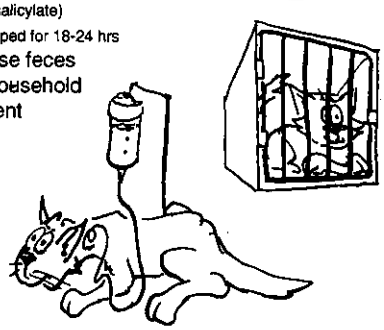


Vaccination schedule:
. 8-9 wks-old - 1st dose
. Revaccinate 2-4 wks until 12-14 weeks old
. At least 2 doses for MLV & 3 doses for killed vaccine
. Booster annually, even though immunity probably lifelong, money maker?
- **Active immunization**
  - **MLV vac** (not for pregnant or cats < 4 weeks old)
    . Longer lasting & more effective than inactivated vac., breaks through maternal immunity
  - **Inactivated vaccine**
    . For pregnant cats & kittens <4 wks-old or debilitated kittens
    . M/ cause injection irritation (formalin)
    . 2 doses probably lifelong immunity but annual boosters w/ MLV recommended
- Passive immunity
  - Only in **exposed** cats & last for 2-4 wks
  - Wait 2-4 wks & revaccinate w/ MLV



Treatment
- **Emergency** - start treatment before lab results
- Symptomatic & supportive (as for canine parvovirus)
- **Aggressive fluids (IV catheter)**
  - Add K+ (potassium)
  - Overzealous fluids m/b problem in severe hypoproteinemia, sepsis or intussusception
- **Broad spectrum ABs** to control 2° bact. sepsis
  - Gentamicin to hydrated patient 5 days
    Prevent gram-neg. sepsis & endotoxemia
- **NPO** (nothing per os) if vomiting until antiemetics drugs not needed
- **No** anticholinergic antiemetics/antidiarrheal Rx (antimotility) contraindicated, ↑ risk of endotoxin absorption
- Moribund or severe anemia or hypoproteinemia
  - Plasma/whole blood transfusions form health donor cats
  - Check for DIC 1st (Platelet & activated coagulation time)
- Other treatments:
  - Vit B complex vitamin parenterally
  - Pepto-Bismol (bismuth subsalicylate)
- **Bland diet** once vomiting stopped for 18-24 hrs
- **Isolate** for 2-4 wks, dispose feces
- **Vaccinate** other cats in household
- **Chlorox** (1:32) environment





Prognosis:
- **Guarded to grave: young kittens (mortality 50-90%)**
  - Guarded until impending recovery indicated by cessation of vomiting & diarrhea and return of appetite
- Cerebellar hypoplasia persists for life, (party entertainment is not a valid reason to keep alive, love is!)
- Guarded for septic shock or hemorrhagic diarrhea
- Survival may give long-standing (years) immunity

Condition	Facts/Cause	Presentation/CS	Diagnosis
Feline lymphosarcoma, Feline leukemia, FeLV M8k 555, 53, 37; Mk 39; E-hb 204, 704; 5min 588; H3B 1138; H2B 1197; SAP 82; I2M 1292; IM 876, 954, 903, 827; IM-WW 559; Cat 263; Pa-T 129, 226, 319 ***	• **#1 neoplastic associated diz of cats** • **#1 cause of severe illnesses & death in cats** • Feline leukemia virus (FeLV) - FOCMA (Feline oncornavirus cell membrane antigen) antigen on surface of FeLV-induced neoplastic cells . Anti-FOCMA antibody involved in immunity to tumor development - Demonstrated in 90% of mediastinal, 70% of multicentric & 35% of GI cases - Doesn't survive in environment • **Forms:** - **Lymphoma:** . **Mediastinal form** (young cats) . **Multicentric form** (kidney, liver, spleen, mesenteric lymph nodes) . **Alimentary form** (older cats), Ileum - Leukemia & myeloid leukemia less frequent - Nonregenerative anemia - Immunosuppression . ↑ Susceptibility to FIP & FIA . Chronic Infections - Immune mediated & autoimmune dizs • Associated dizs: - Enteritis - Fetal resorption or abortion • **Pathophysiology**: - Transmission: contact, milk & transplacental . Lymphoid tissue of nasopharynx to bone marrow - Subclinical = immunity or persistently infected (contagious) - Kittens exposed in utero or < 8 weeks old become viremic - Older cats less susceptible - Viremia (FeLV +) predisposes to neoplasia or other nonmalignant manifestations	• **Unaffected** • **Wasting diz** - Anemia, lethargy, anorexia • **Anterior mediastinal lymphosarcoma** pg 164, 165 - Dyspnea or dysphagia (regurgitation) - Horner's syndrome • **GI form**:pg 42, 51 - Gastritis (vomiting, anorexia, weight loss) - Enteritis (diarrhea, weight loss, obstruction) - Malabsorption • **Kidney**: see pg 359 - Uremia & renal failure - Urinary incontinence • **Liver** pg 93 (anemia, jaundice, weight loss, vomiting) • **Spleen** (diffuse splenomegaly) pg 318 • **Leukemia** - **bone marrow suppression** pg 315 • **Eye**: - Retrobulbar mass - Third eyelid mass - Corneal infiltration - Uveal infiltration & hemorrhage • **CNS**: pg 527, 548 - Brain: seizures, ataxia, blindness, behavior aberrations, motor deficits - Spinal cord: paresis or paralysis • **Cutaneous form**: multiple firm, nonpainful cutaneous nodules • Reproduction system: fading kittens, infertility, stillbirths & abortions • Others: lung, heart, urinary bladder, nasal etc.	• Anterior (cran.) mediastinal lymphosarcoma - Hx, CS - Radiology: . **Anterior mediastinal mass** . Dorsal displacement of tracheal . ± Pleural effusions - Thoracocentesis: immature lymphocytes in pleural effusion, Histo/cytology • GI: - Palpation: abdomen - Radiology • Bone: - Bone marrow aspirate . > 40% of nucleated cells are lymphoblasts • Liver: abnormal liver tests • Laboratory: - Nonregenerative anemia, persistent leukopenia or lymphocytosis or circulating lymphoblasts • FeLV test for core antigen - IFA (indirect fluorescent antibody test) - ELISA (enzyme-linked immunosorpent assay) . More sensitive than IFA . In clinic test kits . More false-positive results - Both ELISA & IFA show if viremic, don't Dx leukemia, lymphoma or any diz • **Exploratory laparotomy** (m/b only way to get definitive Dx)

DDx
- Anemia
  - Haemobartonellosis
  - Immune-mediated hemolytic anemia
- Panleukopenia & panleukopenia like syndromes

Treatment:
- **Lymphosarcoma**
  - Chemotherapy can extend life,
  - **COP (Cytoxan, oncovin, prednisolone)**
- **Myelosuppressive dizs**
  - Blood transfusions for nonregenerative anemia
  - Steroids (glucocorticoids) may ↑ life span, useful if thrombocytopenia
  - Interferon

Eradicate from cattery
- Remove positive cats
- Vaccinate all negative cats
- Retest & remove positive cats every 3 months
- FeLV free once all cats negative on 2 successive testing 3 months apart

Control FeLV negative catteries
- Replacement cats form FeLV negative source
- Screen w/ ELISA & vaccinate negative cats, reject positive cats
- Isolate & retest in 3 months
- Disinfection not necessary, virus doesn't survive in environment

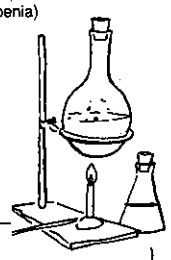
Management of FeLV + cats
- Keep indoors to protect from contact (other dizs)
- Keep other vaccines current (MLV panleukopenia & respiratory vaccines OK, use inactivated rabies)
- Closely monitor for onset of systemic diz

Prevention: Vaccines available
- Efficacy controversial <100% (80%)
- MLV's recommended
  . 2 initial doses & annual boosters
  . Little benefit in FeLV +, retest in 2-3 months & only vaccinate if n
- Vaccinate or not?: IM 959
  - Vaccinate all outdoor & indoor/outdoor cats & FeLV-negative cats in multiple cat houses that have FeLV positive cats
  - Don't vaccinate strictly indoor cat in a single-cat household, FelV -negative, strictly indoor cats in multicat households

Cat: #1 neoplasm & severe diz, FeLV, many forms
CS: Unaffected, Wasting diz, Mediastinal, GI form etc.
Dx: Hx, CS, Lab, Rads, FeLV test
Tx: Lympho: chemo can extend life, vaccines available
Px: Guarded to poor

Prognosis: **Guarded to poor**
- Lymphosarcoma
  - Long-term remission (> 1 year) in 10-15%
  - Median remission 6 months
- FeLV related nonregenerative anemia & myeloproliferative diz: poor

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
FIV, Feline immunodeficiency virus, Immunodeficiency diz M8k 586; SAP 91; E-hb 202, 285, 697; H3B 1139; H2B 1198; 5min 584; I2M 1294; IM 955, 904, 861; IM-WW 558; Cat 433; C12T 280; C11T 216, 244, 275, 1010, 1069; E 411	• Retrovirus (**Lentivirus** subfamily), isolated in 1987, formerly T-lymphotropic virus, subfamily of human **AIDS** virus • Worldwide, 7% of cats infected w/ FIV, 13% w/ FeLV, 2% w/ both • Low risk <2% infected (indoor cat in single-cat house & purebred catteries) • High risk: catteries & rooming cats • **Male**:female 3:1 (fights), all ages incidence w/ age, due to latency CS in cats > 6 years old • Transmission: cat bites, why more males, transfusion, contact rare • Pathophysiology: - **Destroys T-lymphocytes** over years until immunodeficiency syndrome - Chronic & recurrent infections • **Phases:** - **Acute phase**: 4-6 wks post exposure - Asymptomatic latent phase: up to years - Chronic terminal phase: immunodeficiency	• **Acute phase: goes unnoticed** usually (± fever, diarrhea, lymphadenopathy) • **Asymptomatic latent phase**: up to years • **Chronic: immunodeficiency** - **Chronic recurrent infections**, waxing & waning, progressively worsen over months to years - **Chronic wasting** (weight loss & debilitation) - Recurrent fever of unknown origin - **Generalized lymphadenopathy** . **Oral** (>50%): stomatitis, gingivitis, periodontitis . **Respiratory** (30%): purulent rhinitis & conjunctivitis, pneumonia . **GI** (20%): diarrhea (ulcerative, necrotizing or pyogranulomatous) . **Skin** (15%): pustular dermatitis, abscesses, purulent otitis, generalized notoedric & demodectic mange . **Urinary**: recurrent urinary tract infections (cystitis, pyelonephritis) . **CNS**/encephalopathy: behavioral changes, dementia, compulsive wandering, licking motions, facial twitching, seizures . **Neoplasia**: lymphoid & myeloproliferative neoplasia & other . **Reproductive**: abortion, infertility reported - **Eye**: uveitis, pars planitis, glaucoma	• Hx (high risk), CS, PE • **ID anti-FIV antibodies** - means infected for life - **ELISA: in-office screening** (CITE-FIV [FIV], CITE-Combo, Probe-Combo [FIV & FeLV]) > 99% accuracy - IFA or Western blot to check ELISA + low risk cats • Lab: anemia, lymphopenia, neutropenia, hyperglobulinemia • Thrombocytopenia uncommon in FIV, common in FeLV • FIV antigen tests not yet reliable • Researchers: virus isolation • Terminal stage: persistent anemia or m WBCs (leukopenia)	• **Incurable** (infected for life) but asymptomatic cats can live for years before CS • **NO current antiviral Tx** for cats, Human drugs for HIV are either toxic for cats (AZT) or being evaluated • Supportive for ill cats - Antibiotics for bacterial infections, sometimes dramatic response - ± Fluid & nutritional support - Prevent exposure to other infections - Continue vaccination, killed products . Don't use griseofulvin (dermatophytic drug) risk of neutropenia • Isolate infected cats **No antiviral Tx** **Prevention:** • Neuter male cats • Don't allow cats to roam • No vaccine developed (difficult to make vaccine for lentivirus) **Prognosis:** • Asymptomatic cats can live for years before CS • Mortality rate FIV+ 6 months after diagnosis - 15% • A large number of FIV+ cats are asymptomatic & do not die form FIV-related causes



DDx:
• Other causes of:
- Anemia
- Leukopenia
- Immunosuppression

Lentivirus, male fights, destroys T-lymphocytes
CS: Immunosuppression - multisystems, wasting
Dx: ELISA: in-office screening
Tx: Incurable, No antiviral, supportive
Px: Can live for years

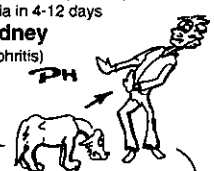
Leptospirosis

M8k 476; E-hb 186, 182, 516; SAP 128; 5min 768; H3B 1149; H2B 1207, 911, 1190, 561, 18t; I2M 1275; IM-WW 544; Cat 534; ID 143; E 373; Pa-T 292; NB 11.15

★-★★?

See also pg 92, 351, 592

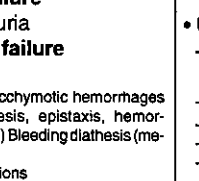
• **Bacterial diz: dogs & humans**
- Cats: clinical diz not seen
• *Leptospira interrogans*:
L. icterohaemorrhagiae
- *L. canicola*
- *L grippotyphosa*
• **Filamentous, motile spirochete**
• Public health - zoonosis
• Spread by shedding in urine for months to years
- Penetrates abraded skin or mucosa
- Wild animal reservoir (rodents)
- Leptospiremia in 4-12 days
• Targets **kidney** (interstitial nephritis) & **liver**



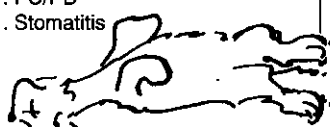
DDx:
• Other causes of anterior uveitis
• Other causes of persistent fever
• Other causes of acute renal failure
- Ethylene glycol toxicity
- Pyelonephritis
- Toxins
• Other causes of acute hepatitis
- Infectious canine hepatitis
- Toxins
- Bacterial infections

Spirochete, Urine
CS: Septicemia, hepatitis, nephritis, abortions
Dx: CS, Serology (MA)
Tx: Pen, Dihydrostreptomycin

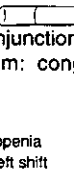
• **Subclinical** in vaccinated dogs & **all cats**
• **Peracute: leptospiremia**
- Fever
- Shock, vascular collapse
- Death
• **Acute to subacute**
- Fever, anorexia
- Depression
- Vomiting, dehydration
- Thirst
- Reluctance to move (pain- kidneys, muscle or meningitis), myalgia (muscle tenderness)
- Acute renal failure
. Oliguria or anuria
- Acute hepatic failure
. Icterus
- ± DIC: petechial & ecchymotic hemorrhages (melena, hematemesis, epistaxis, hemorrhagic gastroenteritis) Bleeding diathesis (melena, epistaxis)
• Occasional manifestations
- Abortion or stillbirths
- Uveitis (immunologic)
- Meningitis
• Chronic (most cases)
- Fever, anterior uveitis
- Anorexia, weight loss
- Frequently subclinical



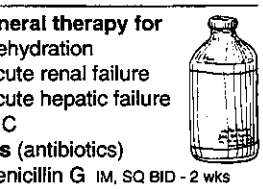
• Sequela:
- Chronic renal failure
. PU/PD
. Stomatitis

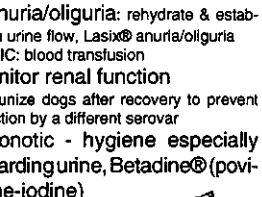


• Hx, CS
• Serology in conjunction w/ CS
• Physical exam: congested mucosa
• Blood values:
- ↑ WBC (leukopenia early), PMNs w/ left shift
- ± Thrombocytopenia
- ↑ Fibrinogen products
• Chemistry:
- **Azotemia** - ↑ BUN & creatine
. Hyperphosphatemia
- ↑ **Liver enzymes** (ALT, AST, LDH) & bilirubin
- Electrolyte imbalances (renal & GI effects)
• UA (urinalysis)
- Microscope of leptospires (darkfield)
- Culture
- Proteinuria
- Pyuria
- Cylindruria (granular casts)
- Bilirubinuria (liver)
- Isosthenuria (SpG 1.010)
• Serology: microscopic agglutination test (MA)
- 4 fold increase in paired sera over 2-4 weeks (to differentiate from previous infection or vaccination)
. Single titers never diagnostic but ≥ 1:300 suggestive, ≥ 1:1000 highly indicative
- IgM-IgG (ELISA) titers - less available than MA
• Urine or blood culture: definitive but difficult & difficult to identify so use serology w/ CS
• Histo of silver stained biopsy of kidney or liver



• **General therapy for**
- Dehydration
- Acute renal failure
- Acute hepatic failure
- DIC
• **ABs** (antibiotics)
- Penicillin G IM, SQ BID - 2 wks
- Dihydrostreptomycin (once azotemia resolved to eliminate carrier state)
- Doxycycline, tetracycline
• Supportive Tx
- Fluids: shock, dehydration, renal failure
- Anuria/oliguria: rehydrate & establish urine flow, Lasix® anuria/oliguria
- DIC: blood transfusion
• Monitor renal function
• Immunize dogs after recovery to prevent infection by a different serovar
• Zoonotic - hygiene especially regarding urine, Betadine® (povidone-iodine)





Prevention:
• **Vaccination**: reduces incidence & severity but doesn't prevent subclinical or urine shedding
- Bivalent Leptospira bacterin component of most polyvalent canine vaccines
- 9, 12, 15 wks (3 doses required)
- Revaccinate annually (endemic areas every 4-6 months)

Prognosis: **Guarded** if severe, renal & hepatic damage may be permanent

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Neospora, Neosporosis, Neosporum infection M8k 482; E-hb 193, 608; SAP 145; 5min 870; H3B 1180; H2B 1235, 910, 260, 1121t, 1080; I2M 1317; IM 775, 738; IM-WW 553; C11T 263; Pa-T 381 *	• *Neospora caninum* • Protozoal/coccidial parasite - **Recently recognized**, formerly confused w/ Toxoplasma • Natural infection in dogs, experimental in cat • Puppies transplacentally infected • Puppies mainly, hunting dogs overrepresented	• **Puppies > 4 weeks old** - **Progressive ascending weakness to death** (stiffness, ataxia, muscle atrophy, progresses to rigid contracture of hind limbs, ± retina, choroid & extraocular muscles involvement) • Adult: localized or generalized diz - CNS (seizures, tremors), polymyositis, myocarditis, chorioretinitis, iridocyclitis, hepatitis, dermatitis, multifocal dissemination; abortion	• Hx, CS • Positive serology & negative T. gondii serology • Neospora tachyzoites or tissue cysts in nervous tissue occasionally found • Abortion: organism in aborted fetus or paired sera of dam 2 weeks apart	• **Clindamycin**, sulfadiazine, trimethoprim & pyrimethamine used, successful treatment not reported Prognosis: **Poor** • To few treated to give prognosis, but no successful Tx reported
Hepatozoonosis M8k 50; E-hb 194; H3B 1179; H2B 1234; 5min 672; SAP 142; I2M 1320; Pa-T 416 *	• **Polysystemic protozoal diz** of dogs & cats • *Hepatozoon canis* in dogs & *Hepatozoon* spp in cats (1 cat reported) • Gulf coast, Okl. • Brown dog **tick**, *Rhipicephalus sanguineus* • Pathophysiology: eat tick, cyst develop - **pyogranulomatous** response • Concurrent infection w/ other parasites carried by tick (Babesia, Ehrlichia) may exacerbate	• **Asymptomatic** in most dogs • Chronic intermittent fever, weight loss • Pain (hyperesthesia) rear limb or lumbar spine • Anorexia, depression • Oral lesions, bloody diarrhea • Cough, oculonasal discharge • PU/PD (polyuria polydipsia) • CNS	• History (Hx), Clinical signs (CS) • ↑ WBCs, eosinophilia, **anemia** of chronic diz, hypoalbuminemia, hypoglycemia ↑ SAP • Radiographs: ± **periosteal bone reaction** on most bones except skull • Definitive: gamonts in PMNs or monocytes (Giemsa or Iesihman's stain blood smear, or organism in muscle biopsy	• **So few cases**, potentially useful drugs (all toxic): - Diminazene aceturate IM once - Imidocarb dipropionate SQ once - Primaquine phosphate SQ once - Toltrazuril PO • NSAIDs: **aspirin** PO bid for discomfort Prognosis: **Infection often asymptomatic**, no effective treatment reported

DDx:
- Puppies: toxoplasmosis, distemper, progressive polyradiculomyositis, neuromuscular diz, peripheral multifocal neurological dizs
- Adults: fungus, rabies, pseudorabies, toxicity (lead, organophosphates, carbamates, chlorinated hydrocarbons, strychnine) nonsuppurative encephalitis, meningitis, granulomatous meningoencephalitis, metabolic diz (hypoglycemia, hepatic encephalopathy)
- Other ocular dizs: neoplasia, systemic fungi, distemper

DDx:
- Causes of fever
- Causes of muscle hyperesthesia
- Periosteal reaction: immune mediated polyarthritis, immune mediated myositis, neoplasia, infections
- Leishmaniasis, babesiosis, ehrlichiosis, endocarditis, Chagas' diz

Toxoplasmosis M8k 488; E-hb 192, 283, 305; SAP 141; 5min 1110; H3B 1181; H2B 1236, 910, 122, 910, I2M 1313; IM 774, 94, 103, 806, 738; IM-WW 554; Cat 565; C12T 271	• ***Toxoplasma gondii***, obligate intracellular coccidian parasite - Worldwide, ubiquitous - Cat definitive host, many species intermediate hosts (dog & man) • Transmission: eating infected tissue, oocysts in cat feces, transplacental (including women) • **Cats** more than dogs • **Opportunist** so FIV, FeLV, FIP, canine distemper or steroid tax increases risk	• **Asymptomatic** in most • **Nonspecific**: anorexia, depression, unresponsive fever, weight loss • **Respiratory**: acute necrotizing pneumonia - progressive dyspnea • **Eye**: anterior uveitis [iridocyclitis, chorioretinitis] - aqueous flare, keratic precipitates, hypopyon or fundic lesions (rare in dogs) • **CNS**: encephalomyelitis: seizures, ataxia, tremors, weakness/paralysis, cranial nerve deficits • **Muscle**: myositis - hyperesthesia, stiff gait, muscle atrophy • **GI**: diarrhea, vomiting, icterus, pancreatitis, ascites, mesenteric lymphadenitis, hepatitis, cholangiohepatitis • **Cardiac**: myocarditis, cardiac arrhythmias or heart failure • **Reproductive**: stillborn or kitten die of lung, liver or CNS infection • **Dog**: usually asymptomatic, multisystem diz: severe & often fatal: respiratory & GI, rapidly fatal (<1 yr-old) reported w/ distemper or - CNS & PNS diz: LMN diz, spastic rigidity in hind limbs (especially puppies), adults (hyperexcitability, depression, tremors, paresis, paralysis, seizures)	• Hx (History), CS • ↑ Creatine kinase (muscle damage), ↑ liver enzymes, bile acids, bilirubin, amylase or lipase (pancreas); leukopenia or leukocytosis • **Radiographs**: diffuse interstitial to alveolar pattern, ± patchy, ascites, hepatomegaly • CSF: ↑ protein, lymphocytic pleocytosis, ± PMNs • **Definitive antemortem diagnosis difficult** • Serum IgM antibodies for active or recent infection ≥ 1:256 • Paired IgG titers - 4 x ↑ = active, single titer not diagnostic of active • Difficult to find tachyzoites in cytologies, smears or biopsies • Oocytes in feces, small hard to see, shedding ends before CS	• **Clindamycin** (Antirobe®) (DOC) for dogs & cats - Also used: trimethoprim-sulfa, sulfonamides • Anterior uveitis: topical or parenteral steroids Prognosis: • **Guarded**, no Tx consistently effective • 60% recover w/o treatment • Mortality highest in neonates & immunosuppressed **Prevention in cats**: no raw meat, roaming, or eating cockroaches, flies or earthworms (sure!)

DDx:
- Cats
  - Ocular: FIP, FeLV, FIV
  - Systemic mycoses (cryptococcosis)
  - Other polysystemic dizs
    - . FIP, FeLV, FIV
    - . Haemobartonellosis
    - . Immune-mediated dizs
    - . Neoplasia
- Dog:
  - Neospora: neuromuscular diz, eye
  - Viral GI diz
  - CNS: distemper, systemic mycosis, protothecosis

Protozoan, Cat> dog; PH
CS: Asymptomatic, multisystems
Dx: Difficult, Hx, CS; Lab; Rads, IgM, IgG
Tx: Clindamycin. Px: Guarded
PH: Pregnant women

Public Health:
- **Pregnant women**: avoid soil, cat litter or raw meat, empty cat litter daily (24 hours to sporulate), gloves when gardening
- Touching & caring for cats unlikely to transmit to humans
- Positive toxoplasmosis antibody titer cat safer than negative (nonimmune) cat

Leishmaniasis & SLE — SYSTEMIC DISEASES

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

Leishmaniasis

M8k 566, 2170; E-hb 195, 182, 247; SAP 142t, 154; H3B 1175; H2B 1231, 943, 957; 5min 766; I2M 1321; IM-WW 553; C11T 266, 271, 280t, 1067; C12T 270; Derm 479; D-Mi 186

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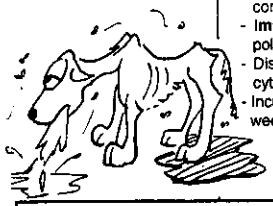
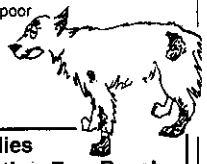




- Serious **protozoal** infection: group of cutaneous, mucocutaneous & visceral dizs
- *Leishmania* spp.
  - Flagellates (promastigotes [flagellated form]) in sand fly
  - Amastigotes (nonflagelate form - round to oval 2-4 µm, contain round basophilic nucleus & small, rodlike kinetoplast w/ Giemsa stain in macrophages)
- Humans & dogs (< 5 years old) > cats
- Worldwide distribution, usually from **travel outside USA (Greece, Italy, Spain)**
  - Endemic in Tx, Ok, Ohio, Mich, Ala
- Vertebrae & invertebrate host
  - Bloodsucking **sand flies** (Lutzomyia & Phlebotomus)
  - Rodents & dogs 1° reservoir, cats & man probably incidental hosts
- Pathophysiology: **extreme immunological response**
  - Organism survive in macrophages (amastigotes)
  - Extreme humoral & cell mediated response (polyclonal gammopathy, proliferation of macrophages, histiocytes, lymphocytes, & immune complexes
  - **Immune complexes** can cause vasculitis, polyarthritis or glomerulonephritis
  - Dissimilated diz if cell-mediated (T-lymphocytes) function is poor
  - Incubation period weeks to 7 years

Protozoan, Humans & dogs, Sand flies
CS: Visceral/systemic, Skin - ulcerative, Eye, Renal
Dx: Hx; CS; ID organism
PH: human at risk, prevent: destroy infected animals
Tx: Reportable diz, Euthanasia

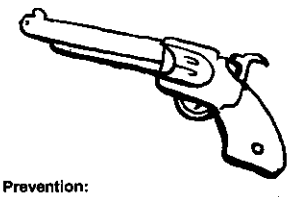
- **Dogs: visceral & skin**
- **Cat: usually subclinical, skin nodules of ear**
- **Visceral/systemic signs**: many & varied:
  - Weight loss w/ normal to ↑ appetite or anorexia
  - PU/PD (polyuria, polydipsia)
  - Weakness, depression
  - Sleepiness (somnolence - 50%)
  - Generalized lymphadenopathy & hepatosplenomegaly
  - Muscle wasting, cachexia
  - Intermittent fever
  - Polyarthritis, lameness
  - Cough, sneezing
  - Epistaxis, bleeding
  - Vomiting, diarrhea, melena
  - Icterus
- **Skin lesions** (90% of cases) muzzle, pinnae, & footpads most commonly
  - Alopecia
  - Silvery white, asbestos-like scales: head, pinnae & extremities
  - Alopecic to hypotrichotic
  - Nasodigital hyperkeratosis
  - Periorbital alopecia ("lunettes")
  - Nasal depigmentation w/ erosions & ulcerations
  - Long brittle nails, onychogryposis, paronychia
  - Ulcerations (especially limbs)
  - Generalized nodular diz (boxers)
  - Sterile pustular dermatitis, generalized (trunk, abdomen, axillae, groin)
- **Ocular signs** associated w/ general diz or isolated (keratoconjunctivitis, keratouveitis, "spectacle blepharitis", granulomatous & nongranulomatous choriotetinitis, focal & diffuse retinal atrophy)
- **Renal failure**: due to immune complex, major cause of death

- **Hx (endemic area), CS**
- CBC:
  - Hyperglobulinemia, hypoalbuminemia, proteinuria
  - Thrombocytopenia, lymphopenia ↑ leukocytosis w/ left shift
  - ↑ liver enzymes, azotemia
- **Organism ID**
  - Lymph node or bone marrow aspirate, skin imprint: amastigotes (nonflaggelate form: round to oval 2-4 µm, contain round basophilic nucleus & small, rodlike kinetoplast w/ Wright's- or Giemsa stain in macrophages)
  - Culture from skin lesions or tissue aspirates
  - Serological testing: multiple tests available, IgG
    . Anti-Leishmania antibodies indicate infection
    . Indirect immunofluorescence test most commonly used - false negatives in 10-

DDx:
- Immune mediated dizs:
  - Pemphigus foliaceous
  - SLE
  - Neoplasia
  - Infections dizs: Ehrlichia
- Causes of focal dermatitis
  - Zinc responsive dermatitis
  - Necrolytic migratory erythema
  - Sebaceous adenitis
  - Lymphoma
- Immune-complex diz
- Causes of polyclonal gammopathy
- Causes of weight loss
- Causes of muscle wasting

Public Health: Human at risk, prevent destroy infected animals

- **Reportable diz, untreatable**
- **Euthanasia** recommended because of human risk
- Organism sensitive to ketoconazole
  - Meglumine antimonate (Glucantime®) IV, SQ 3-4 weeks
  - Sodium stibogluconate (Pentostam®) IV, SQ 3-4 wks
  - Surgical excision of skin nodules usually recurs



Prevention:
- **Control sand flies:** insecticides & moisture control
- Keep dogs in at night in endemic areas

Prognosis: varies, most cases recurrent
- **Grave** if euthanasia used
- Guarded to poor for cure
- Fair to good for remission

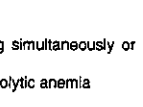
Systemic lupus erythematosus, SLE, Lupus erythematosus

M8k 579; SAP 316; H3B 791; H2B 120, 839, E-hb 779, 839, 107; I2M 1229; IM 972; 5min 782; IM-WW 537; E 211; Derm 578, 574; D-Sy 117, 152, 153; D-Mi 24, 145; D-Clin 64; D-hb 115; D-Plc 75; D-Dx 166; Pa-T 226, 498

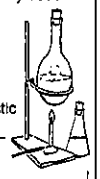
*

- **Rare polysystemic immune-mediated diz**
- Type 3 hypersensitivities
  - **Ag/Ab complexes** lodge in small vessels & basement membrane zone of the **skin** & various organs
  - Complement fixing
- Great imitator (polysystemic)
  - ± Inflammatory myocarditis, epicarditis/pericarditis
    . ± Pericardial effusions/tamponade
- Both cat & dog
- Collies, Shetland sheepdogs
- May be precipitated by virus, drugs

- Acute or insidious CS
- Often CS wax & wane
- **Multi-organ diz**: showing simultaneously or randomly
  - Thrombocytopenia, hemolytic anemia
  - Glomerulonephritis
  - **Polyarthritis: gait** abnormality #1 sign
    . Stilted gait or shifting lameness
    . Joint swelling
  - Fever, lymphadenopathy
  - Muscle pain
  - CNS signs
  - Cardiopulmonary (myocarditis, pleuritis)
- Variable pruritus
- **Skin manifestations 20-50% of cases**
  - Periorbital alopecia
  - Seborrhea
  - Oral ulceration (stomatitis)
  - Mucocutaneous ulcerations
  - Footpad separation/ulceration
  - Panniculitis (lupus profundus)
  - Urticaria, Purpura



- CS, History
- Heart murmur
- **Skin biopsy:** variable: leukocytoclastic vasculitis & mononuclear panniculitis
- Laboratory: variable depending on system involved: anemia, proteinemia, thrombocytopenia, leukopenia
- DIT or peroxidase: deposition of immunoglobulin or complement at basement membrane
- LE prep unreliable & not routinely used
- **ANA** positive 85-90%
- Appropriate clinical signs
- **Direct immunofluorescence**
- Positive Coombs
- IFA & IPS positive
- Direct smears are nondiagnostic



DDx
- Canine ehrlichiosis
- Multiple myeloma
- Subacute bacterial endocarditis

- **Immunosuppressive drugs**
  - **Prednisolone + azathioprine** (Imuran®)
    . Every other day w/ steroid
    . Use cautiously in cats
- Supportive care
- Gold salts contraindicated (potential to cause glomerulonephritis)
- Severe anemia & thrombocytopenia: splenectomy

Prognosis: ????

Plague, Cat plague

M8k 485; H3B 1152; H2B 1210; SAP 129t; I2M 1273; 5min 942; Cat 533; F-H 294, 660

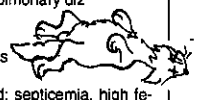
*

- **Bacterial zoonotic** (animal diz that may be transferred to man)
- Cats > dogs in W USA (N Mex, Az, Co, Ca, Hw)
- High mortality rate in cats (50%)
- ***Yersinia pestis*** (family Enterobacteriaceae)
- Eating infected rodents, flea bites, inhalation
- Pathophysiology: incubation period 2-6 days
  - 3 forms: bubonic form, septicemia, pneumonic

DDx:
- Cat fight abscess
- Other causes of bacterial pneumonia
- Other causes of sepsis
- Tularemia

PH: Main concern as possible source of human plague

- **Cats**:
  - Fever, anorexia, lethargy, lymphadenopathy
  - **Draining abscesses: submandibular& limb - Buboes** (inflammatory swelling of lymph glands), rupture = fistulous tracts (creamy, purulent discharge)
  - **Respiratory**: drooling or sneezing, 1° pneumonic plague not reported
  - Splenic, hepatic or pulmonary diz
  - **Death** in 7 days or
  - Chronic emaciation w/ death in 2-4 weeks
- Dogs:
  - Not well documented: septicemia, high fever, lymphadenopathy



- Hx (area), CS
- Contact public health officials
  - **Lymph node aspiration:** Gram's or Giemsa stains: small gram-negative, bipolar coccobacillus or direct fluorescent antibody (**IFA**)
  - Blood: neutrophilia w/ left shift, **culture** (liquid blood culture medium), **serology** (convalescent-phase titers within 10-14 days)
  - Thoracic radiographs recommended to access possibility of aerosol transmission to humans

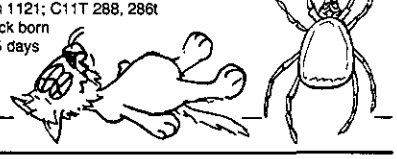
- **Consider euthanasia?**
- **ABs: streptomycin** IM (DOC), tetracyclines, chloramphenicol
- **Topical insecticides** for fleas whether present of not (5% carbaryl dust)
- **Protect humans**: isolate, wear gowns gloves masks, parenteral not oral ABs
- Once recovers animal no risk to humans

Prognosis: **Grave**, 4 of 5 kittens died w/in 4-7 days

Tularemia, Rabbit fever, Deerfly fever, Market men's diz, M8k 494; H3B 1156t; SAP 129t; IM-WW 547; I2M 1336; F-H 296; Cat 532; 5min 1121; C11T 288, 286t

*

- **Rare** in cats, dogs relatively resistant; *Francisella tularensis*: gram-neg. coccobacillus; eating many dead, sick rodents or rabbits; tick born
- CS: Anorexia, No diarrhea or vomiting, Lymphadenopathy, Draining abscesses, Rapid weight loss, Bacteremia, Fever, Death in 2-5 days
- Dx: Hx, CS, Autopsy: white foci on liver & spleen
- Tx: isolate, no Tx successes reported, streptomycin • Px: poor
- Public health: circumstantially implicated, wear gloves, masks & gowns



Anthrax: M8k 432; H-F 296, H3B 1156t *

- Rare, Carnivores resistant, eating infected meat

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Ehrlichiosis, Tracker dog diz, Tropical canine pancytopenia, Canine hemorrhagic fever, Canine typhus M8k 562; E-hb 189; SAP 124; IM-WW 555; I2M 1282; H3B 1163; H2B 1219; IM 960; 5min 538; E 378, 380; Cat 545; Pa-T 303; NB 11.8 **	• Rickettsial diz of **dogs** • ***Ehrlichia canis***, *E. equi* *- E. platys (intermittent thrombocytopenias, see Circulation)* • Worldwide, enzootic in SE & SW USA • Year round (chronic & insidious) • Transmission: **Brown dog tick** *(Rhipicephalus sanguineus)*, blood transfusions • Pathogenesis: - In acute phase: organism replicates in monocular cells of the mononuclear phagocytic system (MPS) in lymph nodes, spleen, liver & bone marrow = hyperplasia & organomegaly, thrombocytopenia, widespread MPS (lymphoreticular) hyperplasia & hematologic abnormalities - Subclinical phase: follow acute, resolves or becomes chronic - Chronic phase: 1-4 months after inoculation, immune system ineffective & can't eliminate infection . More severe in G. shepherd & Dobies	• **Acute phase** 2-4 weeks - **Fever** - Dyspnea, tiring, (pneumonitis) - **CNS:** ataxia, seizures, vestibular, generalized or localized hyperesthesia - **Lameness** from joint pain - Intermittent limb or scrotal edema • **Subclinical** (variable time, occasionally years) - Asymptomatic, apparent recovery • **Chronic phase**: may resemble multiple myeloma or chronic lymphocytic leukemia - Mild to severe signs - **Weight loss**, fever - **Spontaneous bleeding** (petechiae, ecchymoses, epistaxis, retinal hemorrhages) - Pallor - Eye: anterior or posterior uveitis - CNS: (meningoencephalomyelitis) - Signs of specific organ failure (kidney, liver) • Sequela: **Sepsis**	• **Hx (ticks, endemic areas)**, CS • **+ Indirect immunofluorescence test (IFT) definitive** • Physical exam: - **Generalized lymphadenopathy, splenomegaly** • Lab: - **Thrombocytopenia** - **Nonregenerative anemia** &/ or ↓ **WBCs** (leukopenia) - Hyperproteinemia, hyperglobulinemia, hypoalbuminemia - Polyclonal gammopathy, ± monoclonal gammopathy - ↑ ALT (alanine aminotransferase & SAP (serum alkaline phosphatase, hyperbilirubinemia - ± Azotemia, proteinuria - Hyperplastic to hypoplastic bone marrow - ↑ Protein && mononuclear pleocytosis in CSF - Positive blood cultures in severe chronic diz • Organism in mononuclear cells definitive but seldom possible	• **Doxycycline** or **tetracycline** (TOC) PO tid 10-21 days • Chloramphenicol effective, but questionable w/ cytopenias, used in puppies < 5 months • Enrofloxacin (Baytril®) • Imidocarb (Imzol®) anticholinesterase parasympathomimetic SC repeated in 14 days effective in refractory ehrlichiosis (not available in USA) • Supportive: blood, fluids, ABs, ± steroids in immune component **Prevention: tick control** in endemic areas, low dose tetracycline or doxycycline PO for 6 months Prognosis: • **Excellent** w/ Tx unless bone marrow severely hypoplastic • Poor in severely chronic infections • Infection doesn't provide immunity

Rickettsia; Dogs; Tick; Acute, subclinical & chronic phases
CS: Fever, Bleeding, Dyspnea, CNS, Weight loss, Eye
Dx: Ticks, CS, + IFT, Thrombocytopenia
Tx: Doxycycline, Supportive
Px: Excellent

DDx:
- Rocky mountain spotted fever
- Multiple myeloma
- Chronic lymphocytic leukemia
- Lymphoma
- Other causes of:
  - Fever of undetermined origin
  - Thrombocytopenia
  - Nonregenerative anemia
  - Leukopenia
  - Lymphadenopathy
  - Splenomegaly

Doxycycline

Rocky Mt. spotted fever, RMSF M8k 564; I2M 1280; IM 94, 962; SAP 125, 497; E-hb 188, 181, 284; H3B 1165; H2B 1221; 5min 1042; E 376; NB 11.9	• **Rickettsia** (*Rickettsia rickettsia*) • **Tick-born** (Dog tick [*Dermacentor variabilis*], wood tick [*D. andersoni*]) - 3 host ticks: definitive - humans, dogs & cats; reservoir - rodents, rabbits & dogs (purebreds: G shepherd, Siberian husky) - Need to be attached for 5-20 hours to infect host - Transmission also through blood transfusions - Incubation period 2-14 days (**acute**) • All USA; Endemic areas: east coast, Midwest & plains • **Spring, summer**: tick season April- September • Pathophysiology: - **Widespread vasculitis**: organism invades & replicates in vascular endothelium = necrosis & vascular permeability - DIC/Disseminated intravascular coagulation - Immune mediated - Edema & vascular collapse - Multisystem dysfunction	• **Most inapparent (subclinical)** • **Acute CS** - illness < 2 weeks • **Multisystem signs** • **Depression, listlessness** • **Fever** (pyrexia) • **Anorexia, weight loss** • Conjunctivitis w/ scleral injection • **CNS** (meningoencephalitis & myelitis) - Altered metal status - Vestibular: nystagmus, ataxia - Stupor, seizures, coma • **Lameness**: myalgia (muscle pain), arthralgia (joint pain) • **GI**: vomiting &/or diarrhea • **Respiratory** - Mucopurulent oculonasal discharge - Lungs (pneumonitis) - edema . Dyspnea . Tiring (exercise intolerance) . Nonproductive cough • **Lymphadenopathy** • **Skin/mucous membranes** - Rash, petechial & ecchymotic hemorrhages (<20%), common in humans, confers name to diz) - Edema of limbs & face - Gangrene of distal limbs, scrotum, mammary glands, nose or lips • **Eye**: anterior uveitis & retinal hemorrhage & edema • ± **Bleeding**: epistaxis, melena, hematuria, petechial to ecchymotic • **Sequelae:** - Myocarditis - DIC (disseminated intravascular coagulation) - Shock - Acute death	• **Hx** (season, tick, region), **CS** • Splenomegaly • **Laboratory:** - Leukopenia followed by **leukocytosis** - **Thrombocytopenia** - ± Anemia - Azotemia (BUN, creatinine) - ↓ Na, Ca, Cl, protein, albumin - ↑ Liver enzymes, bilirubinemia, cholesterolemia - Metabolic acidosis - ↑ **ACT, APTT & OSPT** - ↑ **FDPs** • **Response to doxycycline Tx**: dramatic improvement in 48 hours • Isolation of agent not frequently done, biopsy of skin • Serological 4 fold rise in titer of antibody to confirm - Micro-IFA (immunofluorescent antibody) > 1:128 west, 1:1024 east - IgM titers - acute infections • Direct IF (DIF) - skin • CNS fluid: elevated protein, PMNs or mononuclear cells • Synovial fluid analysis - PMNs	• **ABS** for minimum of 10-14 days - **Doxycycline or tetracyclines** - Chloramphenicol (< 6 months old) to prevent yellow discoloration of teeth - Enrofloxacin (Baytril®) • **Supportive** especially if shock or bleeding disorders - Fluids (carefully due to vasculitis), blood transfusions • Endemic areas + CNS or systemic signs, CS, fever: **IV doxycycline** until definitive Dx made Prevention: • Tick & rodent control in enzootic areas Prognosis: • **Excellent** if early Tx, recovery in 48-96 hours • **Poor** if delayed Tx, high fatality if left untreated • If CNS signs may die w/in hours • Recovery: immune for 6-12 months, likely for lifetime

Zoonotic diz (#1 human rickettsial diz)

Rickettsial, Tick, Summer, Vasculitis,
CS: Fever, Multisystems (GI, CNS, Skin, Lung, Lame, etc.)
Dx: Hx, CS, Lab, IF, Tx
Tx: Doxycycline or Tetracycline, Support

DDx:
- Canine ehrlichiosis
- Canine distemper
- Other causes of
  - Fever
  - Splenomegaly
  - Lymphadenopathy
  - Other CS

Doxycycline

Doxycycline

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Ehrlichiosis, Tracker dog diz, Tropical canine pancytopenia, Canine hemorrhagic fever, Canine typhus M8k 562; E-hb 189; SAP 124; IM-WW 555; I2M 1282; H3B 1163; H2B 1219; IM 960; 5min 538; E 378, 380; Cat 545; Pa-T 303; NB 11.8 **	• Rickettsial diz of **dogs** • ***Ehrlichia canis***, *E. equi* - *E. platys (intermittent thrombocytopenias, see Circulation)* • Worldwide, enzootic in SE & SW USA • Year round (chronic & insidious) • Transmission: **Brown dog tick** *(Rhipicephalus sanguineus)*, blood transfusions • Pathogenesis: - In acute phase: organism replicates in monocular cells of the mononuclear phagocytic system (MPS) in lymph nodes, spleen, liver & bone marrow = hyperplasia & organomegaly, thrombocytopenia, widespread MPS (lymphoreticular) hyperplasia & hematologic abnormalities - Subclinical phase: follow acute, resolves or becomes chronic - Chronic phase: 1-4 months after inoculation, immune system ineffective & can't eliminate infection . More severe in G. shepherd & Dobies	• **Acute phase** 2-4 weeks - **Fever** - Dyspnea, tiring, (pneumonitis) - **CNS:** ataxia, seizures, vestibular, generalized or localized hyperesthesia - **Lameness** from joint pain - Intermittent limb or scrotal edema • **Subclinical** (variable time, occasionally years) - Asymptomatic, apparent recovery • **Chronic phase**: may resemble multiple myeloma or chronic lymphocytic leukemia - Mild to severe signs - **Weight loss**, fever - **Spontaneous bleeding** (petechiae, ecchymoses, epistaxis, retinal hemorrhages) - Pallor - Eye: anterior or posterior uveitis - CNS: (meningoencephalomyelitis) - Signs of specific organ failure (kidney, liver) • Sequela: **Sepsis**	• **Hx (ticks, endemic areas)**, CS • **+ Indirect immunofluorescence test (IFT) definitive** • Physical exam: - **Generalized lymphadenopathy, splenomegaly** • Lab: - **Thrombocytopenia** - **Nonregenerative anemia** &/ or ↓ **WBCs** (leukopenia) - Hyperproteinemia, hyperglobulinemia, hypoalbuminemia - Polyclonal gammopathy, ± monoclonal gammopathy - ↑ ALT (alanine aminotransferase & SAP (serum alkaline phosphatase, hyperbilirubinemia - ± Azotemia, proteinuria - Hyperplastic to hypoplastic bone marrow - ↑ Protein && mononuclear pleocytosis in CSF - Positive blood cultures in severe chronic diz • Organism in mononuclear cells definitive but seldom possible	• **Doxycycline** or **tetracycline** (TOC) PO tid 10-21 days • Chloramphenicol effective, but questionable w/ cytopenias, used in puppies < 5 months • Enrofloxacin (Baytril®) • Imidocarb (Imzol®) anticholinesterase parasympathomimetic SC repeated in 14 days effective in refractory ehrlichiosis (not available in USA) • Supportive: blood, fluids, ABs, ± steroids in immune component **Prevention: tick control** in endemic areas, low dose tetracycline or doxycycline PO for 6 months Prognosis: • **Excellent** w/ Tx unless bone marrow severely hypoplastic • Poor in severely chronic infections • Infection doesn't provide immunity

Rickettsia; Dogs; Tick; Acute, subclinical & chronic phases
CS: Fever, Bleeding, Dyspnea, CNS, Weight loss, Eye
Dx: Ticks, CS, + IFT, Thrombocytopenia
Tx: Doxycycline, Supportive
Px: Excellent

DDx:
- Rocky mountain spotted fever
- Multiple myeloma
- Chronic lymphocytic leukemia
- Lymphoma
- Other causes of:
  - Fever of undetermined origin
  - Thrombocytopenia
  - Nonregenerative anemia
  - Leukopenia
  - Lymphadenopathy
  - Splenomegaly

Doxycycline

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
***Rocky Mt.* spotted fever, RMSF** M8k 564; I2M 1280; IM 94, 962; SAP 125, 497; E-hb 188, 181, 284; H3B 1165; H2B 1221; 5min 1042; E 376; NB 11.9	• ***Rickettsia*** (*Rickettsia rickettsia*) • **Tick-born** (Dog tick [*Dermacentor variabilis*], wood tick [*D. andersoni*]) - 3 host ticks: definitive - humans, dogs & cats; reservoir - rodents, rabbits & dogs (purebreds: G shepherd, Siberian husky) - Need to be attached for 5-20 hours to infect host - Transmission also through blood transfusions - Incubation period 2-14 days (**acute**) • All USA; Endemic areas: east coast, Midwest & plains • **Spring, summer**: tick season April- September • Pathophysiology: - **Widespread vasculitis**: organism invades & replicates in vascular endothelium = necrosis & vascular permeability - DIC/Disseminated intravascular coagulation - Immune mediated - Edema & vascular collapse - Multisystem dysfunction	• **Most inapparent (subclinical)** • **Acute CS** - illness < 2 weeks • **Multisystem signs** • **Depression, listlessness** • **Fever** (pyrexia) • **Anorexia, weight loss** • Conjunctivitis w/ scleral injection • **CNS** (meningoencephalitis & myelitis) - Altered metal status - Vestibular: nystagmus, ataxia - Stupor, seizures, coma • **Lameness**: myalgia (muscle pain), arthralgia (joint pain) • **GI**: vomiting &/or diarrhea • **Respiratory** - Mucopurulent oculonasal discharge - Lungs (pneumonitis) - edema . Dyspnea . Tiring (exercise intolerance) . Nonproductive cough • **Lymphadenopathy** • **Skin/mucous membranes** - Rash, petechial & ecchymotic hemorrhages (<20%), common in humans, confers name to diz) - Edema of limbs & face - Gangrene of distal limbs, scrotum, mammary glands, nose or lips • **Eye**: anterior uveitis & retinal hemorrhage & edema • ± **Bleeding**: epistaxis, melena, hematuria, petechial to ecchymotic	• **Hx** (season, tick, region), **CS** • Splenomegaly • **Laboratory:** - Leukopenia followed by **leukocytosis** - **Thrombocytopenia** - ± Anemia - Azotemia (BUN, creatinine) - ↓ Na, Ca, Cl, protein, albumin - ↑ Liver enzymes, bilirubinemia, cholesterolemia - Metabolic acidosis - ↑ **ACT, APTT & OSPT** - ↑ **FDPs** • **Response to doxycycline Tx**: dramatic improvement in 48 hours • Isolation of agent not frequently done, biopsy of skin • Serological 4 fold rise in titer of antibody to confirm - Micro-IFA (immunofluorescent antibody) > 1:128 west, 1:1024 east - IgM titers - acute infections • Direct IF (DIF) - skin • CNS fluid: elevated protein, PMNs or mononuclear cells • Synovial fluid analysis - PMNs	• **ABS** for minimum of 10-14 days - **Doxycycline or tetracyclines** - Chloramphenicol (< 6 months old) to prevent yellow discoloration of teeth - Enrofloxacin (Baytril®) • **Supportive** especially if shock or bleeding disorders - Fluids (carefully due to vasculitis), blood transfusions • Endemic areas + CNS or systemic signs, CS, fever: **IV doxycycline** until definitive Dx made Prevention: • Tick & rodent control in enzootic areas Prognosis: • **Excellent** if early Tx, recovery in 48-96 hours • **Poor** if delayed Tx, high fatality if left untreated • If CNS signs may die w/in hours • Recovery: immune for 6-12 months, likely for lifetime

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- **Sequelae:**
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  - Shock
  - Acute death

DDx:
- Canine ehrlichiosis
- Canine distemper
- Other causes of
  - Fever
  - Splenomegaly
  - Lymphadenopathy
  - Other CS

Doxycycline

Doxycycline

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Coccidioidomycosis, Valley fever, San Joaquin Valley fever, Coccidiosis M8k 140; SAP 136; H3B 1119; H2B 1175, 202; IM 217; IM-WW549; E-hb 216; 5min 460; Cat 561; C12T 330; E 444; Pa-T 166; NB 11.12 ** - ***	• ***Coccidioides immitis*** - Soil: mycelia/arthrospores - In tissue: large spheres releasing hundreds of endospores • **Transmission: inhalation arthrospores**, cutaneous inoculation rare, not contagious • Forms: - **Cutaneous**: local inoculation - **Pulmonary**: acute or chronic granulomatous pneumonia & tracheobronchial lymphadenopathy - **Extra-pulmonary**: chronic • **Dry, desert SW USA** • **80% 1-2 yr-old dogs**	• **Asymptomatic: common** • **Disseminate form** (#1) - **Coughing** & dysphagia - **Weight loss** - **Fever, lethargy** - **Lameness** & painful swelling of bones & joints, . Draining tracts . Metaphyseal end of bones - Orchitis, prostatitis - Lymphadenopathy - Ocular lesions - CNS signs - Abdominal organs - Heart & pericardium • **Pulmonary form:** - **Cough** - Fever & malaise - ± Dyspnea • **Cutaneous form:** - Painless, firm indurated nodule + central ulcer - Lymphadenitis & lymphadenopathy in area - No pulmonary signs	• Hx (**SE USA**), CS (**cough, weight loss & lameness in 1-4 yr-olds**) • Auscultation: crackles on inspiration & wheezing on expiration (lower airway narrowing of compression) - Loss of breath sounds w/ consolidation or pleural effusions • **Radiology (thorax) 80%** - 80% mixed interstitial, bronchial or alveolar pattern, 50% nodules, 75% hilar lymphadenopathy, 50% pleural effusion, ± Cavitary lesions - Dissemination to long bones: multifocal osteoproliferations • **Serology**: #1 method to confirm: fairly reliable, precipitation test - IgM, complement fixation (CF) test - IgG; both weeks after infection • Cytology for spherules form draining skin lesion or pleural fluids, lnn., TTW • Biopsy/histopathology: m/b necessary for diagnosis • **Culture: hazardous**, only in commercial labs, Sabouraud's medium, growth in 4 days	• **Amphotericin B** IV initially every other day followed by - **Ketoconazole** PO 8-12 months, m/b indefinitely • Itraconazole: doesn't seem to be superior to ketoconazole • **Monitor**: TX 1 month past resolution of clinical dlz, CF ≤ 1:16 - Check at 3,6 & 12 months after Tx stopped for recurrence, retreat - Liver panel bimonthly for ketoconazole toxicity **Ketoconazole** **Prognosis:** • Good: Tx effective in 90% • Poor if not treated, usually die

Desert - SW USA
CS: Asymptomatic, Disseminate; Pulmonary; Skin
Dx: Hx, CS, Rads, Serology
Tx: Ketoconazole • Px: Good

Cryptococcosis M8k 145; H3B 1121; H2B 1182, 202, SAP 137; E-hb 218; C12T 330; 5min 488; IM-WW 550; I2M 1302; E 450; Cat 554; Pa-T 385; NB 11.13 ** - ***	• ***Fungal/mycotic systemic infection*** • *Cryptococcus neoformans*: budding yeast w/ thick, protective capsule • Forms: -Nasal form in **cats** - Disseminate form (extra-respiratory): CNS (local extension through cribriform plate = granulomatous meningoencephalitis or myelitis), Eyes, Skin • **General geographic distribution, no true endemic areas** • Infection: inhalation of soilborne organism or pigeon excreta • **Cats** > dogs	• **Asymptomatic** • **Nasal form** (cat 50%, rare: dogs) - Mucopurulent to bloody nasal discharge • **CNS** (dog: 50%, cat: 25%), seizures, circling, head pressing, blindness, dementia, ataxia, weakness, cranial nerve deficits (2, 7, 8) • **Eye** (cats: 25%, dog: 50%): granulomatous (exudative) chorioretinitis, anterior uveitis & optic neuritis • **Skin** (cat & dog: 25%): rapidly enlarging firm nodules that ulcerate & ooze (head, near nose) • Others: peripheral lymph nodes (submandibular), pharynx, & oral cavity, kidney, liver, spleen, heart & skeletal m. • **Fever** (<25%) • Clinical pulmonary diz rare but 50% have lung lesion at necropsy	• Clinical signs • CBC: often normal • **Radiology**: nasal bone lysis or tissue density • Serology: presumptive: latex agglutination or compliment fixation (CF) for capsular antigen, false negative occur • **Cytology:** ID capsulated organism in nasal exudate, CSF, skin, Lnn, urine, eye - Gram's, PAS, new methylene blue or India ink • Biopsy: organism - mucicarmine, H&E, PAS or silver stains • Culture on Sabouraud's media **DDx:** • Nasal form: nasal tumor • CNS: Toxoplasmosis • Ocular: Optic neuritis from toxoplasmosis, lymphosarcoma etc. • Skin lesions: Cryptococcal diz (nodular panniculitis, lipomas)	• **Fluconazole**: superior to itraconazole long term 1-2 months after resolves • Itraconazole: for refractory to fluconazole, relatively safe in cats • Combo of flucytosine & amphotericin B - Flucytosine (Ancobon®) + Amphotericin B, IV • Ketoconazole: PO x 3 mo, effective in cats • Monitor: clinical parameters & antigen titers, capsular antigen monthly - Amphotericin, flucytosine: BUN, creatine 2 x wk - Ketoconazole, fluconazole itraconazole: liver profile once a month Fluconazole **Prognosis: Poor to guarded**
Aspergillosis M8k 460; H3B 1269; H2B 1184, 203, SAP 576; E-hb 220; 5min 368; IM 168; IM-WW 548; E 455; C12T 329, 330; Cat 562; Pa-T 129, 169, 303 ** - ***	• **Fungal systemic infection** • *Aspergillosis fumigatus, A. terreus, A deflectus. A. flavipes & many others* - Common, ubiquitous saprophytic fungus • Pathophysiology: Pets constantly inhale spores, immunosuppression results in infection (FeLV & panleukopenia in cats) - Systemic diz associated • Forms: - **Nasal** most common in dogs (medium to large dolichocephalic or mesocephalic: large nasal cavities), occasionally in cats - **Disseminate form: rare** & associated with immunosuppression (steroid or cytotoxic drugs) skin, pulmonary, CNS, eye, GI, bone or cardiovascular - **Cats**: pulmonary & GI most frequently - associated w/ immunosuppression (FeLV & panleukopenia)	• **Asymptomatic** • **Nasal** (#1 dog, occasionally: cat) - Mucopurulent to bloody nasal discharge: chronic rhinitis - ± CNS & seizures if later invades brain case • **Disseminate**: - **Pulmonary diz** (common in cat) . Coughing, weight loss, . No fever usually • **GI** (most frequently in cat), chronic diarrhea, weight loss, depression . ± Pulmonary form - CNS - Eye - Skin - Bone - Cardiovascular - Urinary	• Suggestive: CS, cytology, radiographs • Hx, Clinical signs • **Cytology:** difficult to find because of low # in exudates • Tissue biopsy: better than cytology, H&E stains • Fungal culture: contamination common • Serology: immunodiffusion gel precipitin test • Work up for systemic dizs: chest radiographs, FeLV **DDx:** • Nasal form: 1° nasal tumor • GI form: lymphocytic plasmacytic enteritis, other infiltrative dizs	• **Systemic:** - **Itraconazole**: improved prognosis since amphotericin caused renal toxicity; maintains but doesn't cure - Ketoconazole: PO x 3 mo, resistance - Flucytosine (Ancobon®) PO, x 3 mo - Attempt to correct any underlying diz (immunosuppression) • **Nasal: difficult to treat**, 3 months - **Enilconazole** (Clinafarm-EC®) nasal flush in surgically implanted tubes, 1-2 wk (Sterwin labs), fungicide in hatcheries - Clotrimazole (Canestran®, Lotrimin®) topically - Amphotericin B + Itraconazole - Ketoconazole effective 50% of time - **Surgical debridement** + ketoconazole or povidone-iodine sprays Prognosis: **Guarded**: Improved since itraconazole, maintains but rarely cure

Systemic Mycoses

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Blastomycosis, Gilcrist diz, Chicago diz, **North Amererican blastomycosis** M8k 469; H3B 1113; H2B 1177, 202, SAP 135; E-hb 213; 5min 394; I2M 1305; IM-WW 548; C12T 330; E 439; Cat 559; Pa-T 443, 149, 410; NB 11.13 ** = ***	• *Blastomyces dermatitidis*: dimorphic fungus, mycelial, chlamydospores in soil, parasitic yeast form in tissue • Forms: - **Pulmonary** 85%: pneumonitis, bronchitis - **Peripheral lymphadenopathy** 60% - Eyes, skin, bones & other organs • **Fungal/mycotic infection** • **River valleys of central USA** (Ohio, Missouri & Mississippi rivers & Great lakes) similar to histoplasmosis • Infection: airborne spores or skin inoculation, discourage backyard burial • Dogs (1-5yrs, > 40 lb) > cats • Dogs 10 x more frequently than humans	• **Asymptomatic** • **Acute CS**; usually may persist for 1 week to 3 years • **Nonspecific signs: fever, weight loss, cachexia, anorexia, depression 50%** • **Pulmonary form** 85% - **Cough** - Fever & malaise - ± Dyspnea • **Lymphadenopathy** - Skin lesion & SQ draining tracts (13%) - No pulmonary signs • **Eye:** 41%, epiphora (tearing), pain, anterior uveitis, cloudy cornea, granulomatous retinitis, blindness 26% • **Skin form:** 26%, ± ulceration & draining • **Bone:** osteomyelitis, periosteal & soft tissue swelling 26% • **Prostatitis** -4%, orchitis	• Hx (**Mid USA, age, male > 40 lb**) • CS • CBC: ↑ WBCs, PMNs, monocytes • Auscultation • **Radiology (thorax) 80-%** - 80% mixed interstitial/ & alveolar pattern, ± hilar lymphadenopathy - Bones: proliferative > lytic or lesions • **Cytology:** most effective to confirm: exudates, aspirates or impression smears of skin, eyes, SQ masses or lymph nodes • Biopsy/histopathology: m/b necessary for diagnosis, especially in chronic cases • Serology: agar gel diffusion not often used because of acuteness of diz usually	• **Itraconazole**: ≥ 2 mo., as effective as amphotericin alone or w/ ketoconazole • **Amphotericin B short course + long course of ketoconazole** - **Amphotericin B** (Fungizone®) IV (nephrotoxic) so give with ketoconazole PO for 2-4 weeks initially for quick reduction in organisms numbers - **Ketoconazole** maintenance for several months or • **Ketoconazole** • Monitor: - Disappearance of organism in exudates - Radiographs - Creatine levels if amphotericin B, stop if > 3 mg/dl - Monitor every 30 days & at 3 & 6 months after Tx stopped

DDx:
- Pulmonary lesions
  - Distemper
  - Other systemic mycosis
  - Diffuse pulmonary metastasis
- Ocular lesions
  - Other causes of uveitis
  - Other causes of retinitis
- Lymphadenopathy
  - Lymphosarcoma
  - Other systemic mycoses
  - Regional bacterial infections
- Skin lesions
  - Many dizs
  - Actinomycosis
  - Nocardiosis
- Bone lesions
  - 1° bone tumors
  - Bacterial, fungal or algae osteomyelitis
- Prostate enlargement
  - Bacterial prostatitis
  - Benign prostatic hypertrophy

Central USA
CS: Lungs, Eye, Skin, Bone
Dx: Hx, CS, Rads, Cytology
Tx: Amphotericin B + ketoconazole

Prognosis:
- Poor: if untreated most die
- Guarded in sever respiratory - frequently die in a few days
- Good if survive first week of Tx
- Ocular: poor, less responsive, resulting in enucleation

Histoplasmosis

M8k 467; SAP 133, 690; H3B 1116; H2B 1180; E-hb 217; C12T 330; 5min 680; I2M 1307; IM-WW551; E 448; Pa-T 33, 64, 96, 167, 322; NB 11.12

* = ** regional

- Systemic fungal diz
- ***Histoplasma capsulatum***
- **River valleys of central USA** (Ohio, Missouri & Mississippi rivers)
- Infection: airborne spores or ingestion
  - Yeast form in body, mold in soil, intracellular infection of macrophages
- Cats: 1° pulmonary & generalized disseminate diz
- Dogs: frequently, <5 years
  - Severe GI diz
  - Diffuse granulomatous enteritis of the bowel & mesenteric lymph

- **Pulmonary diz (cats)**
  - **Asymptomatic** (mostly)
  - **Unproductive cough**, tiring, **fever, weight loss,** lethargy anorexia
- **GI form (dogs)**
  - **Asymptomatic** (usually)
  - **Diarrhea, intractable**
    - Large bowel: bloody-mucoid diarrhea, tenesmus
    - Small bowel: watery diarrhea, malabsorption, watery diarrhea, weight loss
  - ± Pulmonary signs: dyspnea, coughing, pale gums, **fever**
- Disseminate (w/ or w/o lung signs)
  - Icterus, ascites
  - Peripheral or abdominal lymphadenopathy
  - Lameness associated w/ proliferative or lytic bone lesions
  - Oral ulcers
  - Peritoneum - masses, mesenteric adhesions, nodular or granular serosal surfaces
  - Eyes - exudative anterior uveitis, multifocal granulomatous chorioretinitis, optic neuritis
  - CNS - ataxia, seizures, etc.

- Hx (**area**), CS
- Lab: variable & nonspecific
  - Anemia (nonregenerative)
  - ± Organisms in monocytes or PMNs, blood smears (especially if buffy coat examined)
  - Absorption tests in intestinal form
  - Delayed xylose absorption, ↑ fecal fat
- Intestinal form: palpable thickened intestines
- **Radiology**:
  - Diffuse interstitial pattern
  - Hilar & mediastinal lymphadenopathy
  - Irregularities of mucosa & thickening of bowel wall (diffuse infiltrate)
  - **Hepatomegaly, splenomegaly,** ascites
  - Bone lesions are rare
- Cytology: **organisms in monocytes/macrophages**
  - **Bone marrow aspirates/buffy coat smears of peripheral blood:** best for diagnosis
  - Lungs: transtracheal lavage, bronchoscoptic alveolar lavage, needle aspiration
  - Intestine: smears or fecal mucosal scrapings, impression smears or endoscopic biopsies
  - Liver, spleen, or lymph node aspirates
  - Abdominal or thoracic effusions
  - Skin lesion impression smears
- Biopsies for GI & liver forms (periodic acid-Schiff stain (PAS), H&E stain: Round to oval bodies w/ "pseudocapsule"
- Culture: hazardous, difficult , done w/in 1 hours of collection, Sabouraud's media, 10-14 days for growth

- **Itraconazole**: ≥ 3 mo, preferred Tx
- Amphotericin B + itraconazole: for dog refractory to itraconazole, amphotericin B initially
- Ketoconazole: PO minimum of 3 months, maybe indefinitely
- Ketoconazole in combo w/ amphotericin B
- Remissions rather than cures expected - retreat
- **Monitor**: radiographs, CBC & malabsorption tests every 30 days during Tx, 3,6 & 12 months after Tx stopped for recurrence; liver panel monthly for ketoconazole & itraconazole toxicity

Prognosis: **Guarded**
- Grave: if untreated most die
- Remission. not cures expected

DDx:
- Other pulmonary fungal dizs
- Bony: 1° bone tumors or other fungal dizs
- Malabsorption: lymphocytic or plasmacytic enteritis & infiltrative bowel disorders

Systemic fungal diz: Central river valleys
CS: Cats: 1° pulmonary & disseminate diz
Dogs: frequently - severe GI diz
Dx: Hx (area) CS, organisms buffy coat , Rads, biopsy
Tx: Itraconazole

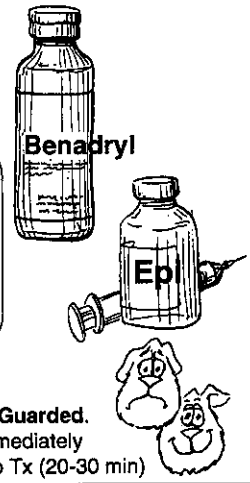
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Anaphylaxis, Hypersensitivity reaction M8k 571, 574; Mk 423; H3B 787; H2B 835; E-hb 726, 169, 724; 5min 700, 398; IM-WW 535; E 2004	• **Acute, severe, systemic type 1 hypersensitivity** • **Life-threatening** • **Rare in dog** • **Extremely rare in cat** • Anaphylactic reactions - type 1 - Allergic reaction to allergen - Occurs immediately after introduction of an antigen (allergen) into circulation of a sensitized animal • Anaphylactoid reactions: similar to anaphylaxis w/ same treatment, but non-allergenic mechanism • Both reactions cause release of chemical mediators from **mast cells** & basophils (histamines, serotonin kinins etc.) - Alters vascular permeability, smooth muscle contractions, compliment activation • Target organs: dogs differ from other domestic species as the liver is main target organ; cat: splanchnic vasculature & smooth muscles of lungs;	• **W/in minutes of exposure** • **Pruritus of head &/or injection site** • **Facial urticaria & angioedema** (more common than actual anaphylactic shock) • **Salivation & lacrimation** • **Anxiety** • **Tachycardia** • **Cat: Resp. distress,** dyspnea, stridor, cyanosis • **Sweating** • Piloerection • **Vomiting, colic, diarrhea**	• **Hx (exposure)** • **CS: especially skin reactions are suggestive** • Radiographs: **pulmonary edema in cat**	• **Emergency:** immediate Tx • If respiratory distress: patent airway & give O2 • **Epinephrine IV** (1:10,000) 0.2-1.0 ml - Epinephrine IM or subQ : for less acute cases or if IV can't be administered - Epinephrine injected into offending site - **Repeat 15 min** - epinephrine at 20 min. intervals if necessary • **Shock doses of IV fluids:** 5% dextrose/water or lactated Ringer's 50-100 ml/kg/hr for 1-2 h • **Steroids**: fast acting corticosteroids: Dexamethasone (0.25 - 1 mg/kg IV or IM) • **Antihistamine**: Diphenhydramine (Benadryl®) 0.25 - 1 mg/kg IV or IM • Ice on site

Acute type 1, Rare
CS: Itching, GI, Resp.
Dx: Hx, CS
Tx: Epinephrine, IV fluids, steroids
Px: Guarded

Cause of anaphylaxis
(parenteral introduction usually not orally)
- Venom (hornets, wasps, ants)
- Blood products: transfusions
- Tetanus & venom antitoxins
- Vaccines
- Allergenic extracts
- Drugs: ABs, local anesthetics, vit K, asparaginase, radioactive dyes, sulfomophthalein

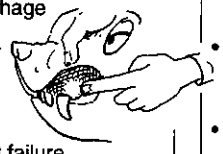
Life threatening
Epinephrine IV

DDx:
- Other causes of shock
- Certain toxicosis
- Feline asthma
- Canine hemorrhagic gastroenteritis
- Urticaria & angioedema of nonimmunological causes



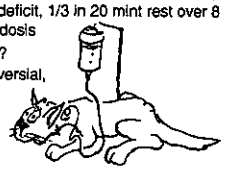
Prognosis: Guarded.
Good if immediately responds to Tx (20-30 min)

Shock, Circulatory shock, Cardiogenic shock M8k 1235; I2M 391; IM 94, 302; H3B 1295; H2B 1353; E-hb 150, 144; 5min 150; IM-WW 107 ***	• **Acute severe circulatory failure** - ↓ O2 & nutrients to vital organs - ↓ Removal of wastes - Leads to progressive & possibly fatal derangement of organs • **Multifactorial syndrome** • **Severe insufficiency in capillary perfusion**	• **Rapid, weak pulse** • **↓ Heart sounds** • **Pale, cold & dry mucous membranes** • **Muscle weakness,** depressed sensation • **Cold skin**, especially extremities • Oliguria or anuria	• **History, Clinical signs** • **Prolonged CRT (≥ 3 sec)** (capillary refill time) • CVP (central venous pressure) - Water manometer in jugular vein • Metabolic acidosis • Postmortem: widespread hemorrhage	• **Emergency** • **Replace fluid volume** - **Restricted volumes in cardiac failure** - **Large volumes for others** - **Lactated Ringer's** (electrolyte solution) . Dog: 40-90, cat: 20-60 ml/kg initially - Blood transfusion - Plasma or plasma expanders • **Cardiovascular stimulants**/inotropic support after fluid volume loading - Dopamine (Intropin®) safe - Dobutamine (Dobutrex®) safe • **Vasopressors**: persistent low blood pressure - Dopamine (Intropin®), constriction dose - Methoxamine (Vasoxyl®) IV - Phenylephrine (Neo-Synephrine®) IV • **O2**: nasal catheter, cage, face mask • **Broad spectrum ABs** for septic shock . Penicillin G + aminoglycosides??? • **Steroids** after fluid volume corrected for early hypovolemic shock - Dexamethasone, prednisolone, or methylprednisolone IV **once** • **NSAIDs: Banamine®** (flunixin meglumine) fight endotoxins early • ± Naloxone IV narcotic antagonist may ↑ cardiac output & blood pressure & m mortality & acidosis • **Sodium bicarbonate**: mEq =0.3 x body weight (kg) x base deficit, 1/3 in 20 mint rest over 8 hrs; to minimize acidosis - Empirically ?????? • Glucose IV : controversial, may help



Classification of shock

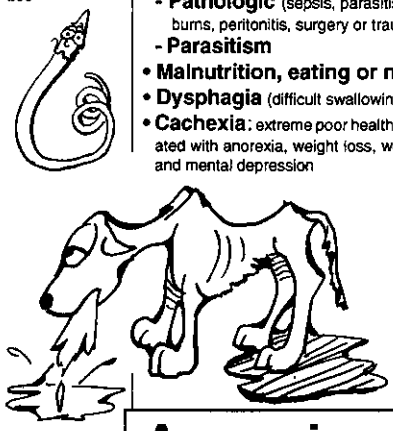
- **Hypovolemic**: marked depletion of extracellular volume
  - Fluid loss (exogenous)
    . Hemorrhage (internal or external)
    . Vomiting
    . Diarrhea
    . Burns (massive)
    . Anaphylaxis
  - Obstructive blood flow
    - Aortic embolism
    - Caval syndrome of heartworm diz
- **Vasculogenic**: circulatory disturbances of distribution
  - **Endotoxemia** (early sepsis)
  - Peritonitis
  - Pneumonia
  - Septicemia/sepsis
  - Anesthetic overdose
  - Surgical trauma
- **Cardiogenic:**
  - Myopathic:
    . Cardiomyopathy
    . Congestive heart failure
    . Myocarditis
    . Myocardial infarction
  - Valvular:
    . **Vegetative endocarditis?**
    . Ruptured chordae tendineae
  - Intracardiac obstruction:
    . Intracardiac tumors
    . Hypertrophic obstructive cardiomyopathy
    . Aortic stenosis
  - Dysrhythmias:
    . Sustained ventricular tachycardia
    . Prolonged atrial or supraventricular tachycardia
    . Uncontrolled atrial fibrillation/flutter
    . Complete heart block or atrial standstill
    . Severe bradycardia
  - Drug overdoses:
    . Vasodilators
    . Calcium entry blockers
    . ß adrenergic blockers
  - Extracardiac obstruction:
    . Pericardial tamponade
    . Heartworm diz
    . Massive pulmonary embolism
    . Other causes of pulmonary hypertension

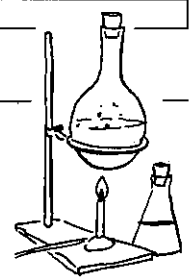


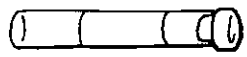
Low tissue perfusion - #1 Endotoxins
CS: Rapid pulse, Pale, Weak, Cold, Anuria
Dx: CRT ≥ 3 sec, Acidosis
Tx: Emerg.: Fluids, Steroids, ABs, Bicarb

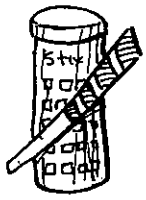
Monitor: PCV, Hg, blood gasses, central venous pressure, blood lactate, D O2 & V O2

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Weight loss E-hb 1; I2M 810; IM 275; C11T 316; 5min 178; IM-WW 45, 258, 266	• **Anorexia - usually 2° to a 1° diz** - Loss of appetite (desire to eat) - Differentiate from dysphagia (difficult swallowing) by observation • ↑ **Nutrient demands** - Physiologic (colds, weather, growth, exercise, pregnancy & lactation) - **Pathologic** (sepsis, parasitism, burns, peritonitis, surgery or trauma) - **Parasitism** • **Malnutrition, eating or not?** • **Dysphagia** (difficult swallowing) • **Cachexia**: extreme poor health, associated with anorexia, weight loss, weakness and mental depression	• **Weight loss** • **Dehydration**	• **Note other CS** - diarrhea, dysphagia, coughing & polyuria • **History:** - Amount of weight loss (acute loss of 5-10% significant) - Dietary Hx, quality of feed, feeding practices - Deworming Hx • **Physical exam:** - CS of concurrent diz (diarrhea), fever, dysphagia (difficult swallowing), abnormal dentition, melena, icterus, dyspnea, tachycardia - Abdominal palpation - Weigh - Check for lice • **Analyze diet:** - Adequate intake - Inadequate intake . Adequate feed: anorexia due to 1° diz . Inadequate feed: malnutrition	• **Treat 1° cause** • **Good quality food** • **Fecal exam:** - Microscopic for parasites - Fecal occult blood for melena - Diarrhea • Lab - CBC, PP (plasma proteins) & fibrinogen - Inflammatory process (↑ WBCs, ↑ PMNs, ↑ fibrinogen, ↓ PP: fibrinogen ratio) - Chemistry: hypoalbuminemia • Cats: FeLV antigen & FIV antibodies; T4 • Urinalysis, thoracic & ± abdominal radiographs • Serological tests: viral, rickettsial, fungal dirofilariasia, ANA • ± Echocardiography, Ultrasound • ± GI endoscopy • ± Exploratory laparotomy w/ biopsies









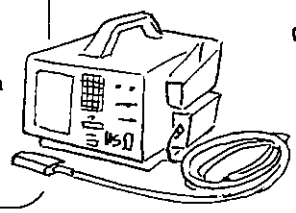
Anorexia

IM 276, 276t; 5min 16

- Inappetence
- Causes similar to weight loss
- Diagnostic approach similar to weight loss as many causes the same

DDx - Anorexia

- Psychologic
- Cancer cachexia
- High temperature
- Inflammation
  - Bacterial
  - Viral
  - Fungal
  - Rickettsial
  - Immune mediated
- Loss of smell especially in cats
- GI dizs
  - Dysphagia due to pain
  - Nausea
  - Gastric diz
  - Intestinal diz
  - Peritoneal diz
  - Pain
- Metabolic dizs
  - Organ failure
    . Kidney
    . Renal
    . Liver failure
  - Hypercalcemia
- Toxic agents
- Anosmia
- CNS diz

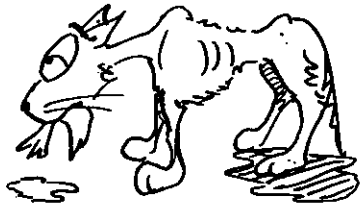


Weight loss - DDx

- **Malnutrition**
  - Inadequate amount
  - Poor quality
  - Inedible
- **Anorexia** (see pg 708)
- Physiologic
  - Growth
  - Exercise
  - Pregnancy & lactation
  - Extreme cold weather
- **Parasites**
- Dysphagia
  - Neurological
  - Oral dysphagia
  - Pharyngeal dysphagia
- Protein losing enteropathy
- Malabsorption
  - Small intestinal diz
- Maldigestion: Exocrine pancreatic diz
- Diabetes mellitus
- Hyperthyroidism (old cats)
- Portosystemic shunts (young dogs)
- Regurgitation/vomiting
- + Fever (↑ catabolism)
  - Infections
  - Inflammation
  - Neoplasia: cachexia
  - Toxins
- W/o fever
  - Metabolic disorders
    . Renal
    . Hepatic diz
    . Cardiac diz
    . Adrenal failure
  - Cancer cachexia syndrome
- Loss of muscle mass
  - Immune mediated neuromuscular diz
  - Degenerative joint diz
- Exudative skin dizs
  - Burns
  - Pyoderma
- Lower motor neuron diz
- Loss of smell especially in cats

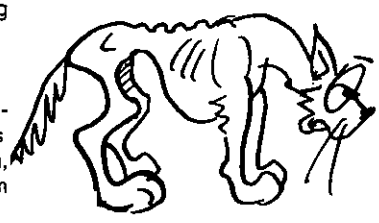
Difficult to diagnose causes of weight loss or anorexia

- Feline hyperthyroidism w/ normal T4
- Gastric diz w/ no vomiting
- Intestinal diz w/ no vomiting or diarrhea
- Hepatic diz w/ normal ALT or SAP
- Hypoadrenocorticism w/ normal electrolytes
- Occult cancer
- Occult inflammatory diz
- "Dry" feline infectious peritonitis
- Occult CNS dizs



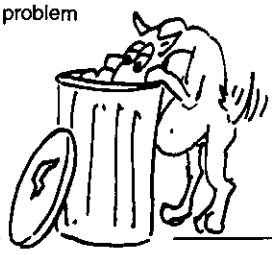
Cachexia, Cancer cachexia, Anorexia-cachexia complex M8k 1638; H3B 765; H2B 817; SAP 191, 447; E-hb 240; E 513

- **Phenomenon** of severely reduced or stopped eating = progressive emaciation & debility; cachexia with eating w/ severe metabolism alterations; common in cancer
- CS: Anorexia, cachexia/weight loss, anemia, debility
- Dx: Hx/CS; Find neoplasm (PE, radiographs, cytology, biopsy)
- **DDx**: Starvation; Parasites; Endocrine (hypoadrenocorticism, hyperthyroidism, hypopituitarism), CNS (diencephalic syndrome); Chronic infectious dizs (FIP, systemic mycosis); Malabsorption/maldigestion syndromes
- Tx: **Specific anticancer therapy**; **Dietary** (special diets, tube feeding, parenteral nutrition, ↑ palatability [warm, flavor w/ meat, fat, onion, garlic, multiple feedings], ± Shark cartilage diets; **Appetite stimulants - cat** (diazepam [Valium®], Oxazepam [Serax®])



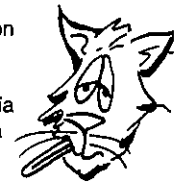
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Weight gain, Obesity M8k 1641; E-hb 2, I2M 811; IM 612; E 4; H3B 1237; H2B 1287; Cat 172; NB 13.2 ****	• Caloric intake exceeding use • **A most common problem** • Overindulgent owners, often overweight themselves, feed table scrap treats • Boredom • Females more than males • Breed predilection: lab, cocker spaniel, collies, some terriers	• **Obesity** • Owners often not aware of problem	• Check nonobese weight at 1-3 years in the pets record - Cats obese if > 12 lb/5.5 kg, put on a diet if >15lbs • PE: should be able to feel the ribs without seeing them in most breeds • CBC, chemistry, urinalysis • Endocrine: TSH stimulation, ACTH stimulation, insulin: glucose	• **Treat cause**: overeating #1 • **Overeating** - **Owners commitment** = success, explain health risks - **Reduce calories** . **Stop table scraps & treats** (diet treats if necessary) . **1/2 & weight program**: cut what feeding in half; weigh in 2 weeks; if no loss, cut in half again & repeat until weight is lost ; or . **r/d diet** (low calorie, high fiber, low fat) 40 kcal/kg of ideal weight divided TID initially, weigh in 1 month & reduce 40% more if no loss .. (kcal/day divided by calories in food), reduced palatability so heat or sprinkle w/ onion or garlic powder. Gradually replacing regular diet may be necessary. Expect more frequent stools & flatulence - ↑ **Exercise in dogs**: daily walks • Failure due: owner compliance, dog's genetics, stealing food, other cause in DDx • If overweight owner compliance a problem: "a fat dog may not be a healthy dog, but it may be a happy family dog"

Obesity - DDx
- **Overeating** (polyphagia)
- Reduced exercise
- Neutering (correlated)
- Genetic predisposition
- Hypothyroidism
- Hyperadrenocorticism
- Hyperinsulinemia
- Acromegaly
- Hypothalamic dysfunction
- Hypogonadism
- Ascites or peripheral edema (hypoproteinemia, cardiac diz, hepatic diz, abdominal disorders, posthepatic dizs)
- Hypotension (water retention)
- Anabolic steroids



Very common, Overindulgence
CS: Obesity
Dx: Fat, PE
Tx: Treat cause, Diet, r/d, ↑ Exercise

Fever, Pyrexia M8k 726; IM 974; IM-WW 59; 5min 68; H2B 819; E-hb 19, 170, 246; E 520	• **Fever: higher than normal temperature** - Protective response to inflammation (infectious or non-infectious) • Normal: dog & cats: **100-103°F** (102.2-102.8) - 103°F can be caused by stress - > **104°F** usually important - > 107°F usually due to 1° hyperthermia • Types of fever: - Continuous fever- days to weeks - bacterial endocarditis, CNS lesions, tuberculosis & some malignancies - Intermittent fever: returns to normal but raises for 1 or 2 days - brucellosis & some malignancies - Remittent fever: variation of temperature each day but always high - bacterial infections • Pathophysiology: exogenous or endogenous pyrogens cause release of endogenous substances (interleukin-1 & -6, prostaglandins, tumor necrosis factor (TNF)) which reset hypothalamic thermoregulatory center (preoptic nucleus)	• **Fever**: over 104°F usually important • Dehydration • Anorexia • Lethargy • Tachycardia • Hyperpnea	• Fever: clinicians assume fever due to an infection until proven otherwise • **Response to nonspecific AB treatment**, most respond promptly & no lab work is performed • If fever persists see FUO below	• **Nonspecific AB treatment**, most respond promptly & no lab work is performed • Monitor: temperature q12h Prognosis: **Good**, most promptly respond to nonspecific ABs



DDx: Fever
- **Stress & anxiety**
- **Infectious agents**
  - Viruses
    . FeLV (Feline leukemia)
    . FIP (feline infectious peritonitis)
    . FIV (Feline immunodeficiency virus)
    . Parvo virus
    . Distemper
    . Herpes virus
    . Calici virus
  - Bacteria:
    . Gram-positive & gram negative endotoxins
  - Systemic fungi
    . Histoplasmosis
    . Blastomyces
    . Coccidioidomycosis
    . Cryptococcus
  - Rickettsia
    . Ehrlichia
    . Rocky Mt. spotted fever
    . Hemobartonella
  - Parasites & protozoa
    . Babesia
    . Toxoplasma
    . Aberrant larva migrans
    . Dirofilaria thromboembolism
    . Leishmania
  - Hepatic tumors
  - Mastocytoma
  - Plasma cell neoplasm
  - Mast cell tumor
  - Metastatic diz
  - Any actively necrosing tumor
  - Secondary infected neoplasn
- **Other inflammatory processes**
  - Inflammatory bowel diz
  - Cholangiohepatitis
  - Hepatic lipidosis
  - Toxic hepatopathy
  - Cirrhosis
  - Pancreatitis
  - Peritonitis
  - Pulmonary thromboembolism
  - Pleuritis
  - Granulomatous diz
  - Hypertrophic osteodystrophy
  - Infarction
  - Blunt trauma
  - Pansteatitis
  - Panniculitis
  - Cyclic neutropenia
  - Intracranial lesions (encephalitis, trauma)
- **Drugs & toxins**
  - Tetracycline (#1 in cat)
  - Penicillins (#1 dog)
  - Cephalosporins (#1 dog))
  - Sulfonamide
  - Nitrofurantoin
  - Enrofloxacin
  - Amphotericin B
  - Barbiturates
  - Iodine
  - Atropine
  - Procainamide
  - Salicylates (high dose)
  - Cimetidine
  - Antihistamines
  - Heavy metals
- **Vaccines**
- **Immune mediated**
  - SLE (systemic lupus erythematosus)
  - Immune-mediated hemolytic anemia
  - Immune mediated thrombocytopenia
  - Pemphigus
  - Polyarthritis
  - Polymyositis- Vasculitis
  - Hypersensitivity reactions
  - Transfusion reaction
  - Infection 2° to immune defects
- **Endocrine & metabolic**
  - Hyperthyroidism
  - Hypoadrenocorticism) rare)
  - Pheochromocytoma
  - Hyperlipidemia
  - Hypernatremia
- **Neoplasia**
  - Lymphoma
  - Leukemia
  - Myeloproliferative diz
  - Intracranial tumors

Condition	Facts/Cause	Presentation/CS	Diagnosis

Fever of unknown origin, FUO

I2M 1231, 141; IM 974; 5min 68; H3B 767; H2B 819; E-hb 19, 170, 246; E 520

- **Prolonged fever or unknown cause**
  - Fever unresponsive to ABs that is not diagnosed by a minimum data base or
  - Continuous or intermittent fever ≥ 103°F (39.7°) ≥ 3 weeks
  . Remains undiagnosed after 1 week in-hospital
- Clinicians assume fever due to an infection until proven otherwise
- Pathophysiology: exogenous or endogenous pyrogens cause release of endogenous substances (interleukin-1 & -6, prostaglandins, tumor necrosis factor (TNF)) which reset hypothalamic thermoregulatory center (preoptic nucleus)
  - ↑ Metabolic demands, muscle catabolism, bone marrow suppression, and possibly DIC & shock

- **Fever**: over 104°F usually important
- Weight loss in time
- Dehydration
- Anorexia
- Lethargy
- Tachycardia
- Hyperpnea
- Sequela:
  - Shock, DIC

- **FUO + Failure to respond to antibiotics** (ABs)
- **Workup:**
  - **Hx** (thorough): ticks? tetracycline to cat? travel to mycotic areas?
  - **Complete physical exam**: lymphoreticular organs, auscultate chest
  - **CBC**: leukopenia or leukocytosis, left shift, monocytosis, lymphocytosis & thrombocytopenia or thrombocytosis
  - **Urinalysis** (pyuria - kidney infection)
  . Urine bacterial culture & susceptibility
  - **Chem** (hyperglobulinemia & hypoalbuminemia: infectious, immune-mediated, neoplastic?)
  - **FNA** (fine needle aspiration) of enlarged organs, masses or swellings
- **Other tests depending on findings & suspected causes**
  - **Serial blood cultures** if infectious suspected
  - **FeLV & FIV test**
  - **Serology**: toxoplasma, Lyme diz, systemic mycoses, rickettsia, brucellosis
  - Fecal if GI signs, tracheal wash if respiratory signs, occult heartworm
  - **Arthrocentesis-multiple**
  - **Immune tests**: cytologic, synovial fluid, Coomb's, antinuclear antibody (ANA), rheumatoid factor (RF), serum protein electrophoresis
  - **Radiographs**
  . Abdominal: for tumors
  . Thoracic: for tumors, pneumonia, pyothorax
  . Survey bones: bone tumors, multiple myeloma, osteomyelitis, diskospondylitis, panosteitis, hypertrophic osteodystrophy
  . Skull: dental abscesses, sinus infections, neoplasia
  . Contrast: GI excretory urography: for neoplasia or infections
  - **Ultrasound:**
  . Abdominal: ± guided FNA biopsy: neoplasia, abscess or infection(pyelonephritis or pyometra)
  . Echocardiography if murmur: endocarditis
  - **Bone marrow aspiration** (cytology & bacterial/fungal cultures)
  - **Biopsy** any lesion or enlarged organ
  - CSF tap if neurological signs
  - Leukocyte scanning
- **Exploratory laparotomy**: last resort if not improving
- **Therapeutic trials: antipyretics, antibiotics, steroids**

DDx: FUO - cat

- **Idiopathic (10-15%)**
- **Viral #1**
  - FeLV (Feline leukemia)
  - FIP (feline infectious peritonitis)
  - FIV (Feline immunodeficiency virus)
- **Occult bacteria** (bite wounds)
  - Yersinia (plague)
  - Mycobacteria (tuberculosis)
  - Nocardia
  - Actinomyces
  - Brucellosis
  - **Localized abscesses of organ or tissue**
  . Pyothorax
  . Abscess (liver, lung, kidney)
  . Dental abscess
  . Stump pyometra
  . Peritonitis
  . Pyelonephritis
  . Septic arthritis
- **Systemic fungi**
  . Histoplasmosis
  . Blastomyces
- **Protozoal**
  - Hemobartonellosis
  - Cytauxzoonosis
- **Neoplasia**
  - Lymphoma
  - Leukemia
  - Myeloproliferative diz
  - Intracranial tumors
  - Plasma cell neoplasm
  - Mast cell tumor
  - Metastatic diz
  - Necrotic solid tumor (liver, kidney, bone, lungs, lymph node)
  - Multiple myeloma
- **Miscellaneous**
  - Drugs (tetracycline)
  - Tissue necrosis
  - Hyperthyroidism
  - Blunt trauma
- **Rare causes in cats**
  - Immune disorders (polyarthritis)
  - Endometritis
  - Endocarditis
  - Diskospondylitis
  - Pneumonia
  - Prostatitis

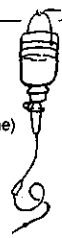
DDx: Fever of unknown origin - dog

- **Idiopathic (10-15%)**
- **Recurrent bacteremia**
  - **Endocarditis**
  - **Localized abscesses of organ or tissue**
  . Abscess (liver, pancreas, prostate, lung, kidney)
  . Chronic prostatitis
  . Stump pyometra
  . Peritonitis (retroperitoneal space)
  . Pyothorax
  . Chronic pyelonephritis
  . Osteomyelitis
  . Septic arthritis
  . Diskospondylitis
  . Meningitis
- **Systemic infections** (early, chronic or latent)
  - Brucellosis
  - Systemic mycoses (histoplasmosis, blastomycosis, coccidioidomycosis)
  - Ehrlichiosis
  - Rocky Mt. spotted fever
  - Lyme diz
  - Salmon poisoning
- **Protozoal**
  - Hemobartonellosis
  - Babesiosis
  - Hepatozoonosis
  - Chagas' diz
  - Leishmaniasis
- **Immune mediated**
  - SLE (systemic lupus erythematosus)
  - Immune-mediated hemolytic anemia
  - Polyarthritis
  - Vasculitis
  - Steroid-responsive fever
  - Meningitis
  - Infection 2° to immune defects
  - Immune mediated thrombocytopenia
  - Pemphigus
  - Polymyositis
  - Hypersensitivity reactions
  - Transfusion reaction
- **Neoplasia**
  - Lymphoma
  - Acute or chronic leukemia
  - Myeloproliferative diz
  - Intracranial tumors
  - Plasma cell neoplasm
  - Mast cell tumor
  - Metastatic diz
  - Necrotic solid tumor (liver, kidney, bone, lungs, lymph node)
  - Malignant histiocytosis
  - Multiple myeloma
- **Miscellaneous**
  - Chronic granulomatous diz
  - Chronic hepatic dizs
  - Metabolic bone disorders (hypertrophic osteodystrophy)
  - Drugs (tetracycline, sulfa, penicillins, enrofloxacin)
  - Tissue necrosis
  - Hyperthyroidism

Most common causes of UFO

- Infectious diz (viral #1 in cat)
- Immune mediated (rare in cat)
- Idiopathic
- Miscellaneous
- Neoplastic

Treatment



- Restrict activity
- High caloric diet
- Fluids: isotonic (lactated Ringer's or 0.9% saline)
- Inform owner diagnosis can be extensive, expensive & not always definitive (10-15% never diagnosed)

- **If definitive diagnosis treat specifically**

- **Idiopathic** (no definitive diagnosis) & already treated w/ ABs
  - **Steroid trial** (warn owner death can occur if undiagnosed infectious cause)
  . If Immune mediated or steroid responsive: fever resolves in 1-2 days; taper dose to every other day

- **No response to steroids: aspirin or continued ABs**
  - **Aspirin** [salicylates] & return to clinic in 1-2 weeks (bid in dogs, q3d in cats)
  . Other antipyretic drugs: dipyrone [Novaldin®], flunixin meglumine [Banamine®], use w/ caution, hypothermia, ulcerogenic, blood cytopenias, nephrotoxic if dehydrated

  - **Continue ABs trials** (cephalosporin + aminoglycoside combo for minimum of 5-7 days)

- Monitor: temperature q12h, CBC every 2 weeks for leukopenia or sepsis, weigh weekly

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Heat stroke, Hyperthermia M8K 726; Mk 442, 631; H-T/M 326; E-hb 29; H3B 1311; H2B 1369; I2M 991; IM 974; IM-WW 59; 5MIN 640 **** - ****** regional	• **Acute elevation of body temperature > 106°F (41°C)** - Temperature > 110°F = death • Predisposition: - Brachycephalic - Young or old animals - Obesity - Concurrent cardiopulmonary diz - Previous heat stroke • Pathophysiology: - Tachycardia - Respiratory alkalosis (tachypnea) - Vasodilation = hypotension & ↓ organ perfusion: myocardial hemorrhage, ischemia & necrosis	• **Panting**, Cyanosis • **Fever** • ± Watery diarrhea - bloody • Vomiting • ± Stupor, seizures, coma • Respiratory arrest • Sequelae: - **DIC** (disseminated intravascular coagulopathy) - Renal failure - **Shock**	• **Hx (in car in summer)**, CS (Temp > 106°F) • Physical exam - **Brick red mucous membranes** - Prolonged CRT (capillary refill time) - Generalized petechiae (pinpoint bleeding) • Auscultation - **Tachycardia** • **ECG** - **Tachycardia** (fast HR) - S-T segment & T wave abnormalities	• **Emergency**: patent airway, IV catheter - fluids • **Rapidly reduce body temp** - Submerge in cool (not cold) water - Wet extremities w/ rubbing alcohol (groin & axilla) - Take rectal temperature every 5-10 minutes, stop Tx when temp drops below 103°F (39.5°C) to avoid hypothermia - Ice baths & cold water enemas for unresponsive cases only • **Isotonic fluids** (0.45% saline or half-strength Ringer's solution w/ 2.5% dextrose) • **Supportive:** - **Oxygen** - **Diazepam** (Valium®) for seizures - ABs if evidence of infections • Treat DIC • Contraindicated: NSAIDs (nonsteroidal antiinflammatory drugs) (aspirin, flunixin meglumine [Banamine®]) • Glucocorticoids controversial, but used if cerebral edema suspected • ± Diuretic: mannitol for cerebral edema if stupor or coma develops to promote urination & reduce renal shutdown (ischemia) • Shock - corticosteroids • Monitor for several days for DIC or renal failure (anuria, BUN) or hypothermia Prognosis: • **Guarded to good** if Tx early • Coagulopathy & renal failure worsen Px
Malignant hyperthermia Mk 448; H-T/M 326; SAP 1174 * Anesthesia	• **Rare response to anesthetic agents** - Described in dog & one cat • Cause - Halothane - Quaternary amide muscle relaxants • Pathophysiology: Vasodilation = hypotension & ↓ organ perfusion: myocardial hemorrhage, ischemia & necrosis	• **Acute, profound temperature rise during surgery** • Tachycardia • ± Skeletal muscle rigidity	• **Hx (surgery)**, CS • **ECG** - **Tachycardia** (fast HR) - S-T segment & T wave abnormalities	• **Stop anesthetic (gas & relaxants)** • **Hyperventilate w/ 100% oxygen** **Prognosis: Guarded?**

Cause:
- Exposure to high environmental temperature
  - **Left in unventilated car on hot day,** high humidity exacerbates (reduces water evaporation)
  - Heating pads
- Malignant hyperth
- Thyrotoxicosis
- Exercise
- Drug reactions
- Seizures

High body temp, Hot car
CS: Panting, Fever, Stupor, Shock
Dx: Hx, CS, PE, ECG
Tx: Rapidly cool, Fluids, Support

Hypothermia & Frostbite

M8k 727; Mk 443, 627; E-hb 17; SAP 519t; H3B 1315; H2B 1373; IM 681; 5min 80, 163; C12T 157; E 26; H-T/M 328

****

- **Low body temperature**
  - Mild: 89 - 96°F (32-35°C)
  - Moderate: 82- 88°F (28-32°C)
  - Severe: < 82°C (< 28° C)
- Regional: greater in Arz. than Alaska
- Cause:
  - External cold
  - Drugs
  - Interference w/ thermoregulatory centers - anesthesia
  - Neonate (common cause of death)
- Pathophysiology: slows body metabolism, blood shunted from extremities to core if < 93° F, ↓ Renal perfusion; Cardiac dilation w/ microinfarcts, ↓ CO (cardiac output, Q); CNS diminished
- **Frostbite**: avascular necrosis as temperature falls below 93°F or
  - Simple freezing of body area
  - Necrosis increased if refreezing after thawing
  - Cats: ears, tail, footpads
  - Dog: external genitalia, footpads

- **↓ Consciousness**
- Lethargy
- Shallow, infrequently respirations
- Ataxia
- **Stupor**
- **Shivering**, disappears if severe hypothermia
- Dilated pupils
- Cyanotic or pale frozen parts
- Sequelae:
  - **Pneumonia** common
  - Respiratory arrest
  - **Cardiovascular collapse** (terminal ventricle fibrillation)
  - Shock

- Hx (cold), CS
- Low body temperature - < 95°
  - Standard thermometers only record as low as 94°F
- Weak or absent pulse
- Auscultation: bradycardia
- Anesthesia of frozen part
- ECG: mild hypothermia: prolongation of P- R interval, QRS interval, APCs (atrial premature contractions), inverted T wave
  - Moderate: atropine resistant bradycardia & ventricular arrhythmias
  - Severe: cardiac arrest 2° to ventricular fibrillation or astole

- **Hypothermia**
  - Intubate if unconscious, O2
  - **Minimize heat loss**: dry body, wrap in blanket, put on blanket
  - **Warm patient**
    - **IV catheter**: rapid infusion normal saline (warm to 104-109°F (40-43°C in water bath or incubator) +
    - **Mild to moderate**: warm water heating pad, water bottle, electric heating pad (monitor for thermal burns), immerse in warm water
    - **Severe**: internal (core) warming <90F° (<32 C°), prolonged hypothermia or unstable cardiovascular
      - .. Peritoneal dialysate (109°F/43°C): rapidly infuse & immediately remove, repeat until > 96°F (>36°C)
      - .. Colonic lavage w/ warm saline
      - .. Gastric lavage w/ warm saline
- **Frostbite**: remove from cold
  - Warm compresses applied
  - Immerse in warm water (102-104°F/39-40°C)
  - Prevent refreezing: IV infusion of low-molecular weight dextran (Dextran 40) to prevent peripheral sludging
  - Delayed debridement: demarcation of nonviable tissue occurs between 4-20 days
- **Supportive care**
  - IV fluids (warmed)
  - Ventilation, Oxygen
  - **Treat any atrial fibrillation** & ventricular tachycardia
  - Analgesia for painful thawing: morphine sulfate, oxymorphone (Numorphan®), butorphanol, pentazocine (Talwin®)
  - Elizabethan collar: prevent self trauma
  - ± ABs for infections
  - High-protein, high calorie diet, vitamin supplements
- **Monitor**
  - ECG continuously for 24-36 hours for arrhythmias
  - Urine output - watch for anuria
  - Pneumonia
  - CBC every 24-48 hours blood gases, electrolytes, BUN, creatine, PCV
    - . Maintain pH at 7.4, do not administer bicarbonate for respiratory acidosis, maintain hydration

Prognosis:
- Depends on degree, promptness of Tx & vigilante monitoring
- Frostbite
  - Good: rapid return to sensation, warmth & redness
  - Guarded: persistent cold, pale, insensitive

Low body temp, Slow metabolism, Cardiac microinfarcts
CS: Stupor, Shivering, Cardiovascular collapse
Dx: Hx, CS, ECG
Tx: Warm up, Support, Antiarrhythmics, Monitor

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Poisoning

TOXICOLOGY

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment

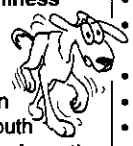
Toxicology, Poisoning

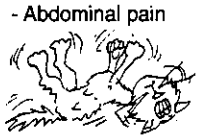
JAVMA 205(3)p417, 1994; Tox-X 392; H2B 1301; C12T 210, 211; %min 126; Cat 215; NM 20.2; Tx 7, 660

**

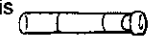
- **Toxicology**: study of poisons (toxicants)
- **Poisons**: solid, liquid or gas that interferes with life processed of cells
  - Toxins/biotoxins: poisons originating from biological processes
- **Owners frequently suspect poisonings,** which usually are other sicknesses
- **Relatively uncommon since:**
  - Pets, especially cats, are finicky eaters
  - Vomit readily if harmful material ingested
  - Cats eat small portions
  - Dogs poisoned more than cats
- Licking accidental contaminated coats (pesticides, paint, or disinfectants) can inadvertently poison a pet
- Aspirin and other drugs that are ok for dogs may be lethal to cats
- Eating a poisoned rodent or leaves of a toxic plant
- #1 household cleaners (drain cleaner, solvents, paint stripper) wrongly used to clean a pet

- **CS similar to several illness**
- Pain
- Vomiting
- Diarrhea
- Salivation
- Slimy mouth
- Redness of mouth
- CNS
  - Trembling
  - Incoordination
  - Fits
  - Coma
  - Panting
  - Abdominal pain





- History (exposure), CS
- Physical exam
- Serum enzyme profiles: liver or kidney damage
- Coagulation tests (PT & PTT)
- Urinalysis
- CBC



  - Electrolyte analyses
  - Blood pH, bicarbonate, anion gap

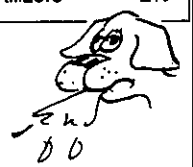
- Hair for chronic exposure
- **Stomach contents**
- Postmortem: lesions, organs & tissue samples in 10% formalin
- Chemical analysis: blood, organs

Types of poisonings

• Pesticides	30%
• Drugs	25%
• Plants	12%
• Foreign bodies	3%
• Fertilizers	2%

Common poisonings in dogs & cats

- Metaldehyde
- Lead
- Strychnine
- Warfarin (Brodifaxoum)
- Tylenol, Ibuprofen et al.
- Pyrethrins -
- Chlorphyrifos
- Organophosphates
- Petroleum distillates - ethylene glycol
- Cholecalciferol (Vit D)



- **Induce vomiting** if poison not on the contraindication list (**see page 271**)
- **Do not induce vomiting when:**
  - An unconscious or convulsing animal, may aspirate into lungs
  - If caustic or petroleum poisoning (see box)
  - Severely depressed
  - If the poisoning happened over 4 hours ago
- Gastric lavage: best w/in 2 hours (see box)
- **Activated charcoal** (make slurry): followed in 30 minutes with:
- **Cathartic**: hastens removal of toxicant-charcoal complex
  - Sodium sulfate (Glauber's salt®)
  - Magnesium hydroxide (Milk of Magnesium®)
  - Magnesium sulfate (Epsom salt®)
- **Treat shock** or unconscious: open airways, ± CPR
- **Reduce dermal exposure:**
  - Wash w/ warm water & soap or mild detergent
  - ± Clip long haired animal

- **Reduce ocular exposure**: immediately flush eyes w/ water, repeat many times up to 30 minutes
- **Emergency supportive care**: respiratory, cardiac, CNS, vomiting or diarrhea, hyperthermia, hypothermia
- **Antidotes**: if specific toxicosis is known, give test dose & monitor first, relatively few cleared for vet use, infrequently used (see box)
- ± Diuresis may help speed elimination in urine - mannitol, furosemide
- Ion trapping:
  - Sodium bicarbonate: promotes alkaline urine good for removal of acidic compounds (aspirin, acetaminophen, barbiturates, phenoxy herbicides)
  - Ammonium chloride: promotes acidic urine good for removal of alkaline compounds; Basic (amphetamines & most alkaloids)
- Peritoneal dialysis

Often blamed but uncommonly seen
CS: Similar to several illness
Dx: Hx, CS, Lab
Tx: Induce vomiting?, lavage, charcoal, cathartic, antidotes?

Do not *induce* vomiting for corrosive poisons!

- Petroleum products
- Acid products
- Alkaline products
- See box for complete list **on pg 721**

Induce vomiting: best when stomach contains food

- **Dog: apomorphine** IV or IM or SQ. not readily available, Naloxone (Narcan®) reverse if excessive CNS or respiratory signs
- **Cat: xylazine** (Rompun®) IM, IV, Yohimbine reverses respiratory depression
- **Hydrogen peroxide** (1 tablespoon (2-5 ml/kg) per 15 lb, do not exceed 40-50 ml
- **Syrup of ipecac** (dog 1-2 ml/kg, cat 3 ml/kg) by syringe. Emesis expected in 15 min. 1 repeated dose may be given. Ineffective in 50% of dogs,

Gastric lavage: used when emesis in ineffective or contraindicated. Must be performed in an unconscious or lightly anesthetized animal

- Place an endotracheal tube to prevent aspiration
- Stomach tube, lavage warm water or saline be gravity flow, aspirate back after a few minutes repeat 10-15 times
- Enterogastric lavage: "through & through enema" gastric tube & endotracheal tube in place. Give enema fluid gently until it comes out gastric tube

National Animal Poison Control Center
ph # (900) 680-0000 (NAPCC) Urbana, Il, $20.00/5 min, $2.95/min there after
(800) 548-2423 - **$30.00/call**
Oregon Poison Control Center (humans) (800) 452-7165

Antidotes

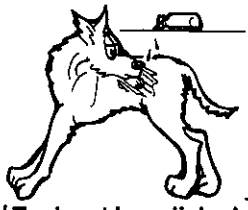
Toxicity	antidotes	
Acetaminophen	Acetylcysteine	PO
Anticholinesterase poisoning	Atropine sulfate	
Antifreeze (ethylene glycol)	Ethanol (20%)	IV
	4-methylpyrazole	
Arsenic	Dimercaprol (BAL)	IM
	DL-6,8-Thioctic acid	IM
Copper (hepatotoxicity)	Ascorbic acid	PO
Coumarin & indandione anticoagulants	Vit K1 (phytonadione	PO, SQ
Cyanide	Sodium nitrite	
	Sodium thiosulfate	
Lead	Calcium disodium EDTA	IV then SQ
	D-Penicillamine	PO
Methemoglobinemia in cats	Ascorbic acid	PO
Organophosphate insecticides	Pralidoxime chloride 2-PAM	IV, SQ
Snake (crotalid) venom	Antivenins	IV
Zinc	Calcium disodium EDTA	IV then SQ

Emergency supportive care for toxicities:

- **Respiratory depression or failure**
  - Endotracheal tube: a patent airway for comatose or anesthetized animal
  - Mechanical ventilation or oxygen for apnea, anoxia or severe anemia
  - Respiratory stimulants controversial (doxapram, naloxone for opiate exposure)
- **Cardiac arrhythmias**: lactated Ringer's sol., ± Na bicarbonate, ± antiarrhythmics
  - Bradycardia: atropine
- **Shock**: Lactated ringer's solution (40-50 mg/kg IV or SQ) or plasma expanders
  - ± Whole blood
- **CNS dysfunction**
  - Seizures: **diazepam** (Valium®) for seizures IV, **phenobarbital** IV if diazepam ineffective or prolonged Tx required, pentobarbital IV if phenobarbital ineffective - lightly anesthetize
  - CNS excitation: doxapram (Dopram®) IV
  - Phenothiazine tranquilizers not recommended
  - Depression: analeptics (doxapram), not recommended due to possible rebound depression
  - Opiates: Naloxone (Narcan®)
- Prolonged vomiting or diarrhea: may be beneficial, but if it leads to problems - histamine-2 blockers (cimetidine)
- Metabolic acidosis: most common: sodium bicarbonate or sodium lactate (monitor)
- Hyperthermia: cold baths, ice packs
- Hypothermia: blankets, warm water bottles, monitored heating pads

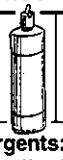
Corrosive, Caustic Poisons — TOXICOLOGY

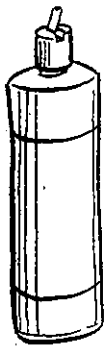
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Coat contamination JAVMA 205(4)p558, 1994; H2B 1332; Tox-WW 143, H3B 1275	• **Wrongly used substances to clean a pet or** • **Inadvertently contamination w/ toxic substances such as:** - Paint, paint remover, petroleum products, motor oil, bleach, disinfectant, antifreeze or tar • **May burn the skin or** • **Poison when licked off or** • **Burn mouth**	• **Dermatitis** (red) • Mucous membrane damage • **Stomatitis,** pharyngitis if ingested - (hypersalivation, gagging, respiratory distress), vomiting, nausea, diarrhea, GI distention; • ± Depression, collapse, seizure, coma	• Hx (**exposure**), CS	• Muzzle dog or wrap cat in a towel so they can't lick off contaminate • No emesis if on list below • Immediately remove contaminate - **Wash & rinse coat** thoroughly & repeatedly w/ soapy water, - Petroleum jelly, vegetable oil or mineral oil softens paint or tar & then they can be removed. Use rubber gloves* (do not use paint stripper, paint thinner, turpentine, or mineral spirits or paint brush cleaner) - Cut off any heavily contaminated fur or hardened paint or tar • **Activated charcoal + cathartic** • Check skin for chemical burns • ± Analgesics & demulcents if protracted • Supportive care

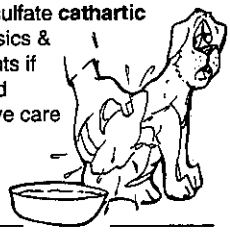


Toxic: skin or licked off
CS: Dermatitis, Stomatitis, ± Depression, collapse, seizure, coma
Dx: Hx (exposure), CS
Tx: No emesis, wash & rinse, Activated charcoal + cathartic, Supportive

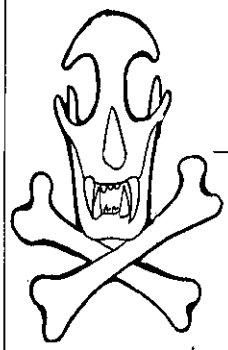
Detergents JAVMA 205(4)p558, 1994; H2B 1332; Tox-WW 322, 143	• #1 cause of poisoning • Mechanism: household detergents wrongly used to clean a pet **Types of detergents:** • **Anionic detergents: Usually not fatal** - sulfonated or phosphorylated hydrocarbons; sodium, potassium or ammonium salts of fatty acids; sodium phosphates; sodium carbonates; or sodium silicates - Dishwasher soaps, shampoos, laundry soaps • **Cationic detergents: Extremely toxic** - quaternary ammonium compounds w/ alkyl or aryl substituent groups (benzethonium chloride or banzalkonium chloride, methalbenzathonium & cetylpyridinium chloride) - Diaparene, Zephiran, Phemerol • **Nonionic detergents: Essentially nontoxic** - alkyl or aryl polyether sulfates, alcohol or sulfates, polyglycol ethers, polyethylene glycol & aryl ethers monostearate. • **Hexachlorophene soaps:** pHisoHex	• **Dermatitis** (red) • Mucous membrane damage • **Ingestion:** stomatitis, pharyngitis if ingested - (hypersalivation, gagging, respiratory distress), vomiting, nausea, diarrhea, GI distention; • ± Depression, collapse, seizure, coma • Hexachlorophene: vomiting, hypersalivation, tachypnea, depression & generalized tremors corrosive damage to esophagus **DDx:** • Phenolic compounds • Corrosive & caustic compounds • Paint thinner • Turpentine	• Hx (**exposure**), CS	• Patent airway if laryngeal edema • **Do not induce vomiting or lavage stomach** • **Wash the skin** thoroughly with soapy water, rinse thoroughly • **Milk or activated charcoal** • Sodium sulfate **cathartic** • ± Analgesics & demulcents if protracted • Supportive care

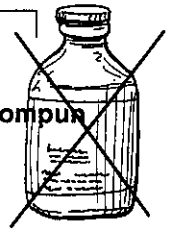






Corrosive & caustic agents, **Acid or alkali poisoning,** **Petroleum products,** **Aromatic hydrocarbons,** **Industrial & commercial toxicants** JAVMA 205(4)p558, 1994; M8k 2097; H3B 1275; H2B 1333, 1334; Cat 241; Tox-WW 213, 321, 143, 10	• **Household cleaners or petroleum products** (drain cleaner, solvents, paint stripper) wrongly used to clean a pet • **Do not induce vomiting for corrosive poisons** - Petroleum products (crude (raw) oil, - Acid products - Alkaline products - See box for complete list	• **Pain** • **Salivation** • **Redness of mouth** • **Vomiting** • **Diarrhea** • **Trembling** • **Slimy mouth** • **Incoordination** • **Fits/convulsions/seizures** • **Coma** • **Panting** • **Abdominal pain** • **Respiratory failure**	• Hx (**washing w/ corrosive agent**) • CS	• **Do not** induce vomiting or lavage stomach (will re-expose esophagus to corrosive agent, burst stomach or aspiration pneumonia) • **Wash the skin** thoroughly with soapy water, rinse thoroughly • Activated charcoal • **Dilute**: water or milk to dilute poison (3 tbsp/10 lbs) - For acids: milk of magnesia (4 tbsp/10 lbs) - For lye: vinegar, lemon juice or orange juice (2 tbsp lbs) - For petroleum products: vegetable or mineral (2 tbsp/10 lbs), poorly absorbed by charcoal





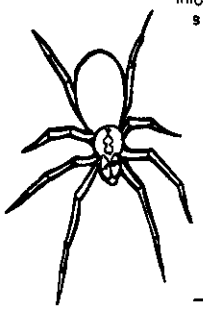
Do not induce vomiting for these Poisons

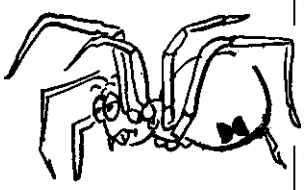
- Aliphatic hydrocarbons
- Aromatic hydrocarbons
- Automatic dishwasher detergents
- Benzene
- Bleach
- Butane
- Car battery liquid
- Carbon tetrachloride
- Caustic soda
- Chlorinated aliphatic hydrocarbons
- Chlorine bleach
- Chloroform
- Clay pigeons (shooting)
- Coal tar products
- Creosote
- Degreasing solvents
- Detergents: laundry, dishwasher
- Dinitroorthocresol
- Dishwasher granules
- Disinfectants
- Drain cleaner
- Dry cleaning solvents
- Ethane
- Gasoline
- Glues
- Hexachlorophene
- Kerosene
- Lacquers
- Lye
- Methane
- Mineral seal oil
- Mothballs
- Naphthalene
- Oven cleaner
- Paint stripper
- Paint thinner
- Paints
- Petroleum distillates
- Phenol
- Pine tar
- Plastics
- Polishes: furniture, shoe, floor
- Polyurethane
- Potassium hydroxide
- Propane
- Quick drying paints
- Resins
- Sanitizers
- Sodium hydroxide
- Sodium hypochlorite
- Solvents
- Stoddard solvent
- Tetrachloroethylene
- Toilet cleaner
- Toluene
- Trichloroethylene (TCE)
- Turpentine
- Varnishes
- Wood preservatives
- Xylene

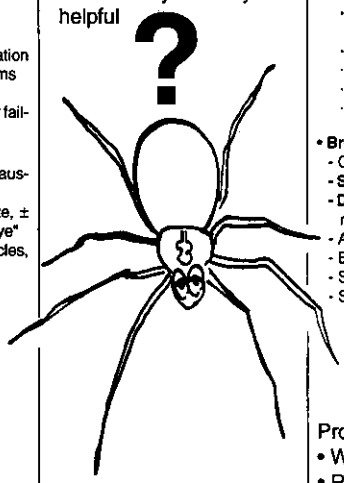
Corrosives to wash pets
Petroleum, acid or alkaline products
CS: Similar to other dizs
Dx: Exposure, CS
Tx: Do not vomit!! Wash, dilute

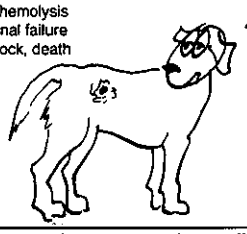
Spiders & Snakes

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Arachnids, Spiders M8k2155; Mk1731; 5min1070; Cat231; E-hb165; SAP331; C12T 631; Derm 443; Tox-WW 438 **	• **Difficult to recognize probably under diagnosed** • **Black widow** (*Latrodectus mactans*): red hourglass on ventral abdomen; L. hesperus. SW & E USA . Venom: neurotoxin: causes release of neurotransmitters at neuromuscular junctions • **Brown recluse** (*Loxosceles reclusa*): ± violin-shaped mark on dorsal thorax - Venom: potent dermonecrotic toxin, vasoconstrictive, thrombotic, hemolytic & necrotizing properties **s commonly on face & forelegs**	• **Acutely: bite very painful, little swelling** • Pruritus, erythema & local discomfort usually later than snake bites • **Widow spiders** - Intense pain - Restlessness, anxiety, apprehension - Salivation - Shock; rapid, shallow, irregular respiration - Painful muscle rigidity - clonus, spasms - ± Ascending motor paralysis - ± Death: respiratory or cardiovascular failure • **Brown spider** (fiddle backed) - Delayed, may not feel bite, indolent (causing little pain) - Red (erythematous) area around bite, ± blanched zone around red = "bulls-eye" - **Necrotizing skin lesions,** ± into muscles, last for weeks if not treated - Rarely fever, nausea, seizures • Sequelae: - IV hemolysis - Renal failure - Shock, death	• Difficult to diagnose • Hx, CS suspect • Confirmatory evidence is rare • Laboratory usually not helpful	• **Local infusion w/ 2% lidocaine & triamcinolone acetamide** (Vetalog®) intermediate steroid • **Widow spiders** - **Symptomatic usually enough** . **Methocarbamol** (Robaxin®), diazepam (Valium®) muscle relaxants . **Meperidine (Demerol®)** or morphine IV for pain . Atropine for salivation . Recovery may be prolonged . Antivenin (equine origin) available but reserved for confirmed bites of high risk very young or old • **Brown recluse spider** - Cold packs immediately - **Steroids** early to protect necrosis & systemic signs - **Dapsone** PO: inhibits leukocytes, reduces envenomation at site, DOC - ABs for 2° infections - Excise bite wound if early - Supportive care: fluids & bicarbonate - Surgical care of ulcers Prognosis: • Widow: good in dogs, guarded in cats • Recluse: good, may be delayed for weeks Prevention: clean up wood piles etc., & spraying







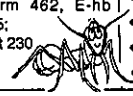


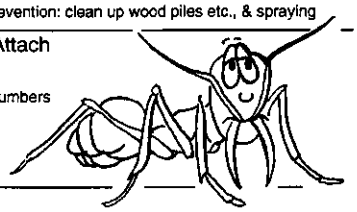
Widow spiders, Brown spiders
CS: - Widow spiders: CNS: severe, painful cramping
- Brown recluse: Skin necrosis
Dx: Difficult, Hx, CS; Confirmatory rare
Tx: - Widow: IV, Demerol, Diazepam
- Recluse: Cold packs, steroids, Dapsone, ABs

Ants,

Fire ants
Derm 462, E-hb 165; Cat 230
*

- Fire ants (*Solenopsis invicta*) S. Amer. & SW USA: predaceous carnivores like Vespids; Urban & rural settings; Attach by jaws & pivot in a circle administering stings
- CS: Initially painless, then redness, itching swelling, regress in 48 hours; anaphylaxis (hypersensitivity), death if large numbers
- Dx: Hx (ant exposure), CS
- DDx: Mechanical punctures, snakebite, angioneurotic edema
- Tx: None if mild; antihistamine &/or steroids if moderate to severe; Epinephrine if anaphylaxis





Snakes, Venomous snake bites

M8k2152; Mk1729; E-hb164; SAP330, 152; H3B 1289; H2B 315; E 321; 5min1066; Cat230, 260; Derm 873, 874A; Tox-WW 440; 57, 75t
**

- **Pit vipers,** crotalids, viperines (Crotalidae family): S. USA
  - **Copperhead** (*Agkistrodon contortix*)
  - **Cottonmouth** (*Agkistrodon pascivorus*)
  - **Rattlesnake** (Crotalus)
  - Massasauga or pygmy rattlesnake
  - Water moccasins (Agkistrodon)
  - Fer-de-lance; true vipers: puff adder, Russell's viper, common European adder
  - **Identification:** Pit vipers
    . Pit organ between eye & nostril
    . Broad triangular head, distinct neck
    . Vertical elliptical pupils (round in nonpoisonous)
    . Prominent curving, hinged fangs, strike & inject venom, rattlesnakes: rattle
  - **Toxic principle:** hemotoxic, necrotizing & anticoagulant, neurotoxic
- **Elapines** (Elapidae family): SE USA, W Texas
  - **Coral snakes** (Eastern or Texas coral snakes *(Micrurus)*, Arizona or Sonoran coral *(Micruroides)*
  - Cobra & mamba: not indigenous to USA
  - Identification: coral snakes:
    . Bands of yellow, red & black (yellow bands in contact w/ red bands)
    . Short fangs (hang on & "chew" venom into victim)
    . "Pseudo" coral snakes: black bands bordering both sides yellow bands
  - **Toxic principle:** neurotoxic: respiratory paralysis, surviving animals rarely have sequelae
- **Dogs & horse > cats & cows**
- **Bitten on muzzle or legs** (curiosity)
- Spring & summer
- **More common in SW & SE USA**
- < 50% cause envenomation & clinical signs

- **Pit vipers/**rattlesnakes
  - Extreme pain
  - Distinct fang marks
  - Rapid swelling, local hemorrhage, hematoma, necrosis & sloughing
  - **Dyspnea,** swollen nasal passages or throat (head bite)
  - Salivation
  - Dilated pupils, shock
  - 2° clostridial infections
- **Coral snakes:**
  - Small fang marks
  - Pain & swelling minimal
  - CNS: weakness, disorientation, paralysis, respirator failure
    Cranial n. paralysis of eyelids, eyeball
  - Parasympathetic CS: salivation, vomiting, defection or diarrhea

- Hx (see bite, dead snake [bring to vet for identification])
- CS
- Physical exam
  - Bite wounds
  - Vipers: Tachycardia
  - Elapines: CNS CS
- Lab: hemoconcentration, hemolysis, ↑ or ↓ coagulation times, DIC

DDx:
- Polyradiculoneuritis
- Tick paralysis
- Botulism
- Myasthenia gravis
- Fracture
- Abscesses
- Spider envenomation
- Allergic reactions to insect bites or stings
- Nonpoisonous snake bites

"Red on Yellow, kill a fellow
Red on black, friend of Jack
or venom lack"

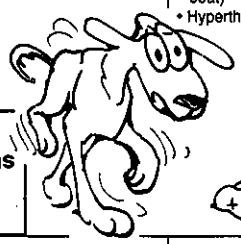
- **Pit vipers/rattlesnakes**
  - Debride, clean, disinfect & irrigation
  - Incise through fang marks (don't cross) use snake bite kit suck or encourage to bleed (do under 30 min. of bite)
  - Ice on site, tourniquet controversial
  - **Antivenin:** polyvalent crotalid (Micrurus) w/in 2 hr of bite, bind specifically to venom, poison control centers may help locate, 5-10 ml injected into tissue & rest IV
  - Have epinephrine (1:1000) for anaphylactic shock ready
- Diphenhydramine (Benadryl®) reduces anxiety & helps prevent allergic reaction to antivenin
- Tracheostomy if dyspnea from swollen nose
- No NSAIDs early (aggravate possible thrombocytopenia) OK in later stages for pain & edema
- **Antibiotics for 2° infections**
- Treat shock: IV fluids (careful for pulmonary edema)
  - Corticosteroids: controversial, may buy time
- **Coral snakes:**
  - Antivenin: availability limited (get from hospital emergency room)
  - Supportive care, anticonvulsants if necessary
  - ± Ventilation assistance
  - Atropine

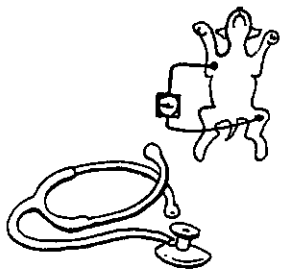
Prognosis:
- Pit vipers: depends on site of bite, size of animal & amount of venom
  - Acute phase (1st 2 hr): poor, usually die if not treated
  - 1st day phase: good if no shock or depression
  - Convalescent phase (10 d): good for life
- Corral snake: envenomation rare, recovery expected if prompt aggressive Tx

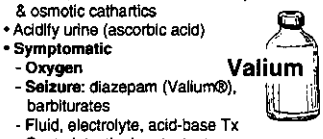
Viperines (Pit vipers & Elapines)
CS: Pit vipers: necrosis & sloughing
Elapines: CNS
Dx: Hx, CS, Physical exam
Tx: Elapine: Antivenin, Supportive, Tetanus antitoxin
- Pit viper: Antivenin, IV fluid, Steroids, ABs

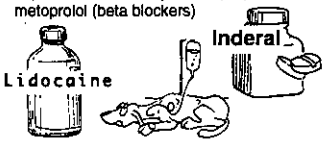
Chocolate, Toads & Gas

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Xanthines, **Methylxanthines alkaloids,** **Chocolate toxicity,** * Theobromine toxicity, Caffeine/coffee, Theophylline/tea toxicity JAVMA 205(4)p557, '94; M8k 2029; H3B 1281; H2B 1337; 5min 440; IM-WW 186, H-T/M 332; SAP 465t; E-hb 167; C9T 191; Tox-WW 307	• Methylated xanthines - caffeine, theophylline & theobromine found in coffee, caffeine pills, tea & chocolate respectively • Baking >>> dark >> milk chocolate: most to least potent • **Theobromine** - toxic component of chocolate • Pathophysiology: - CNS stimulants - Cardioarrhythmias - Increased heart rate & force of contraction	• **CNS** - **Excitement,** hyperactivity - Chronic movements (involuntary, jerky) - Delirium, muscle twitching - Seizures, tonic to tetanic convulsion • **Cardiac arrhythmias: sudden death** • Urinary incontinence • Vomiting & diarrhea • Polypnea (rapid breathing & heart beat) • Hyperthermia	• **Hx** (exposure, eating chocolate) • Auscultation: tachycardia, rarely bradycardia • ECG: - Sinus tachycardia - Ventricular arrhythmias • Lab: stomach content - alkaloids	• **Emesis, activated charcoal** every 3-4 hours & osmotic cathartics • Acidify urine (ascorbic acid) • **Symptomatic** - **Oxygen** - **Seizure:** diazepam (Valium®), barbiturates - Fluid, electrolyte, acid-base Tx - Gastrointestinal protectants • Ventricular arrhythmias - **Lidocaine** in dog, propranolol, metoprolol, then add beta blocker (propranolol) if needed • Supraventricular tachycardia: propranolol or metoprolol (beta blockers) Prognosis: Guarded if signs severe



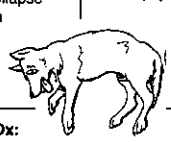


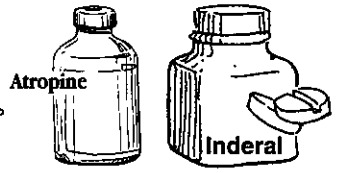




Theobromine
CS: Excitement, Seizure, Arrhythmias
Dx: Hx, ECG
Tx: Symptomatic, Antiarrhythmics

Toad (Bufo) toxicity M8k 21259; SAP 465t; E-hb 165; H3B 1288; H-T/M 330; Tox-WW 443 * - **	• **Rare** most of USA, uncommon in Florida & Hawaii • All toads irritating to mouth • Marine toad (*Bufo marinus*), *Colorado* river toad (*B. alvarius*) - **Toxic glands in skin** - **Digitalis-like toxin**	• **Hypersalivation:** mouth irritation w/ • **Vomiting & diarrhea** • **Shaking head** • Cyanosis • Depression, weakness, collapse • Blindness or disorientation • Convulsions, seizures • Death in 30 minutes	• **Hx (playing w/ toad),** CS • Auscultation/ECG: Cardiac irregularities leading to **ventricular fibrillation** • Monitor w/ ECG • Necropsy: Toad parts in stomach	• **Instruct owner to flush mouth w/ garden hose** • **Activated charcoal, + cathartic** • **Propranolol (Inderal®)** immediately IV - Repeat dose in 20 min if needed • Intubate & flush mouth w/ water • ± Atropine for salivation • Pentobarbital anesthesia for seizures Prognosis: **Good to guarded,** depending on severity of signs & treatment speed





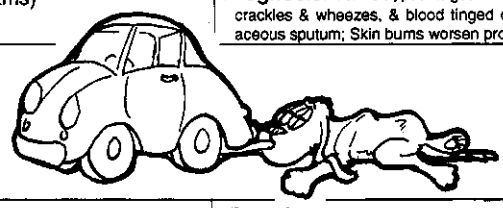
Digitalis-like toxin
CS: Vomition, Diarrhea, Weakness
Dx: Hx, CS, ECG
Tx: Flush mouth, Propranolol

DDx:
- Cardiac glycoside plants (oleander)
- Iatrogenic digoxin
- Snakebite
- Carbon monoxide
- 2° cardiac diz
  - Gastric torsion, anemia, shock, pancreatitis

Smoke inhalants H3B 1300; H2B 1358; 5min 1064; Cat 251, 1036; Tox-WW 127 **	• **House fires** • Pathophysiology: direct thermal injury, & inhalation of noxious substances - **CO toxicity** (carbon monoxide poisoning) most common cause of death • Alveolar damage, interstitial edema, hypoxia & 2° bronchopneumonia	• Oral & facial burns • Conjunctivitis • Smoke smell • Laryngospasms • **Respiratory problems** (dyspnea, cough, stridor, tachypnea) • ± Cyanosis • Weakness, collapse • Shock, respiratory or cardiac arrest • Sequela: pneumonia	• **History,** CS • Brick red gums form CO • Auscultation • Bronchoscopy/Transtracheal wash: soot, damage • Bradycardia late • Radiographs: findings in 16-24 hrs, film every 12-24 hrs: patchy interstitial edema, diffuse peribronchial densities, edema (interstitial & alveolar patterns with air bronchograms)	• **Patent airway** (intubation, tracheostomy) • **O2 therapy** (up to 100%), care of O2 m lung damage, wean to 40% rapidly • **IV fluids** (monitor for pulmonary edema) • **ABs** for 2° pneumonia • **Bronchodilators**: aminophylline, theophylline, relieve soot-induced bronchospasms • ± **Steroids**: for shock only in first 12-24 hrs • ± **Humidification** • ± **Diuretics**: furosemide (Lasix®) to hydrated patient for pulmonary edema • ± **Analgesics** for painful dyspnea: morphine sulfate, butorphanol **Prognosis: varies,** poor to guarded if early crackles & wheezes, & blood tinged carbonaceous sputum; Skin burns worsen prognosis

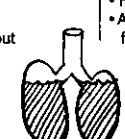
DDx:
- Other cause of oral & facial burns
  - Electric cord
  - caustic chemicals
- Other cause of pneumonia

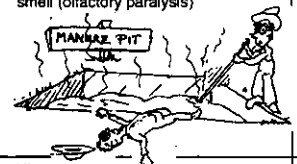
Carbon monoxide * H3B 1300; 5min 415; Cat 243; H-T/M 330; Tox 374; Tox-WW 68, 171, 172, 22	**See Cardio pg 246: Competes w/ O2** for binding to hemoglobin **& wins** **CS: Cardiac hypoxia (sudden death); Brain hypoxia** (convulsion, disorientation, coma); Listless & weak; Twitching Dx: Hx, CS; PE:: **hot, bright red gums**; Lab.: **cherry red blood**; ECG Tx: **No heroics, air out area,** move into fresh air; CPR if necessary; Move; **100% O2**; Treat any arrhythmias; Supportive Px: **Good** if treated early			



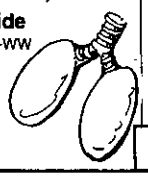
Hydrogen sulfide, H_2S Tox 372; Tox-WW 75t	• Toxic gas, **"Rotten egg" smell** • **Liquid manure holding pits** - Underneath animal housing - Gas released when pits pumped out	• Pulmonary edema • Hyperpnea • Asphyxia follows if not immediate artificial respiration	• Smell in air at low levels, HI levels can't smell (olfactory paralysis)	• **Fresh air** • Artificial respiration Public Health

Manure pits
CS: Asphyxia
Tx: Fresh air



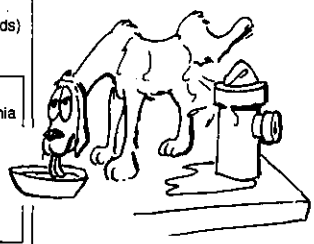
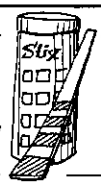
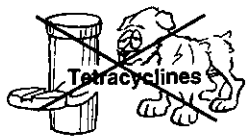


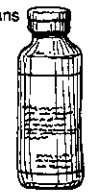
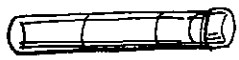
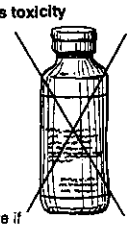
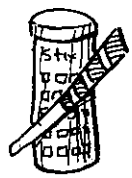
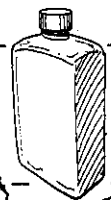
Smog, SO_2, **Sulfur oxide** Tox 376; Tox-WW 127, 144	• **Smog**, Sulfur oxides + H_2SO_4 smog major factor in air pollutants; deaths of man & animal • Urban environments	• Eye irritation • Salivation • Emphysema, • Respiratory distress	• History • Clinical signs	• **No specific Tx, supportive** Prevent: Keep in on moderate to high s days



Eyes - Respiratory

Antibiotics - Toxicity

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Aminoglycoside toxicity E-hb 138, 170, 274; H3B 1291; H2B 566, 1161, 1165, 1348, 1349; E 332; IM 767; IM-WW 491; Cat 235; NS3hb 190, 225; NS-hb 216; NS-L 249; Tox 208, 212; Tox-WW 153, 235, 84, 82t ** **Gentamicin**	• **Broad spectrum ABs** used mainly against **gram negative** bacteria that are resistant to ß lactam drugs. Bactericidal: bacterial protein synthesis inhibitors - Good for acute, overwhelming sepsis • **Nephrotoxicity** is major concern • **Ototoxicity & vestibulotoxicosis**: may result from long term use; incidence unknown; may cause neuromuscular blockade, acoustic nerve degeneration, cardiovascular depression • **Neuromuscular blockade**: when administered concurrently with certain anesthetic agents • Related to **high doses** & **prolonged use** (> 7 ds) especially if impaired renal function Predisposing factors • Dehydration & hypovolemia • Renal insufficiency • Metabolic acidosis • Concurrent furosemide (Lasix®) Tx • Severe sepsis or endotoxemia **Broad spectrum ABs** **CS: Renal failure & ototoxicity** **Dx: Hx, CS, UA** **Tx: Stop Tx, Tx renal failure**	• **Nephrotoxicity: nonoliguric renal failure**: - PU/PD (polyuria, polydipsia) - Uremia • **Ototoxicity**: - Unilateral or bilateral peripheral vestibular signs: ataxia, incoordination, nystagmus - Hearing loss 	• Hx (exposure), CS • Proteinuria • Sediment changes due to tubular injury  **Aminoglycoside ABs** • Gentamicin (Gentocin®) • Tobramycin (Nebcin®) • Kanamycin (Kantrim®) • Dihydrostreptomycin (Ethamycin®) • Amikacin (Amiglyde®) • Neomycin (Biosol®) 	• Stop administration • Treat renal failure • Prognosis: **Good** if stop early, Deafness may persist
Tetracyclines E-hb 138; H3B 1291; H2B 1348, 1389, 566; Tox 214 **Tetracycline**	• **Bacteriostatic**, bacterial protein synthesis inhibitors • For gram-negative & positive bacteria & Chlamydia, rickettsia, spirochetes, Mycoplasma, bacterial L-forms & some protozoa (Hemobartonella) **Bacteriostatic ABs** **CS: Teeth staining in young** **Dx: Hx** **Tx: Irreversible, Prevent: don't give to young**	• **Tooth discoloration young animals** • Inhibit bone growth in young • Renal injury in high doses, emesis, hepatotoxicity 	• Hx (given drug), CS **Tetracyclines:** • Chlortetracycline • Oxytetracycline (Terramycin®) • Doxycycline (Vibramycin®) • Minocycline (Minocin®)	• Irreversible once teeth stained  **Prevention:** **No tetracycline to young growing dogs**

Chloramphenicol toxicity E-hb 690; SAP 155; H3B 1291; H2B 725, 1348, 1349; 5min 91; Cat 235; Tox 209 * 	• **Broad spectrum antibiotic** • **Reversible bone marrow suppression may occur** - Not bone marrow aplasia as in humans • **Cats** especially susceptible - If use, limit to smallest dose & shortest duration possible • Do not use in dogs or cats w/ nonregenerative anemias • Chloramphenicol: Chloromycetin®. 	• CNS depression • Dehydration & dull hair coat • GI signs • Anorexia (vomiting, diarrhea) • Weight loss • Death 	• Hx (exposure), CS • CBC: Mild anemia - **Aplastic anemia** - ± Neutropenia • Thrombocytopenia & neutropenia precede anemia • Bone marrow: vacuolation of hematopoietic precursors 	• **Stop drug - reverses toxicity**  Prognosis: Good, grave if aplastic anemia
Ketoconazole toxicity C12T 328; SAP 138; E-hb 514t, 516; H2B 1179; 1409t, 691 **Nizoral** 	• 1st **oral**, antifungal imidazole for **systemic mycoses** • Clinical response may take 10 days - 2 weeks • **Hepatotoxic**, especially in cats • Useful after short course of amphotericin B, used in more chronic infections that don't need rapid onset, useful in cats w/ cryptococcosis • **Advantage is cost** - so used for coccidioidomycosis as long term Tx required • **Cats especially sensitive**, tolerate itraconazole better than ketoconazole	• **Anorexia** • **Vomiting** • ± Jaundice 	• Hx (taking drug), CS • ↑ ALT activity 	• Stop Tx until appetite returns or ulcers heal • Restart drug at half the dose Prevention: • **Don't give to cats**, substitute triazole (itraconazole or fluconazole) • Give w/ food to enhance absorption • Monitor anorexia for toxicity • Monitor ALT activity monthly during Tx
Trimethoprim-sulfadiazine (Tribrissen®) E-hb 516; H3B 1291; H2B 1348	• Cholestatic hepatopathy in dogs reported; acute onset of jaundice & ↑ serum liver enzymes, Hypersensitivity? • Also: keratoconjunctivitis sica, gastroenteritis, pustular dermatitis, erythema multiforme, blood dyscrasias, hepatic necrosis, seizures in cats			
Other Antibiotics/ antibacterials H3B 1291; H2B 1348, 1349; Cat 235 	• Amoxicillin (Amoxi-Tabs®, Amoxi-Drops®, Clavamox®), ampicillin (Omnipen®, Principen®, Polyflex®), cephalexin (Keflex®), cephalothin (Keflin®), clindamycin (Antirobe®, Cleocin®), erythromycin (many), griseofulvin (Fulvicin®, Gris-PEG®), hetacillin (Hetacin-K®), lincomycin (Lincocin®), potassium penicillin G (many), procaine penicillin G (many), sulfasalazine (Azulfidine®, Salazopyrin®)			

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Amphotericin B toxicity C12T 327; SAP 1135t, 139; IM 218; H2B 1348	• **"Gold standard" for antimycotic drugs** • **Amphotericin B (Fungizone®) IV** polyene antibiotic, fungistatic & fungicidal, protect from light • Excellent for initial Tx of fulminating life threatening infections - Restrict to **first few days** of life threatening systemic infections or unresponsive fungal infections • Must be given **intravenously**, thus expense comparable to new triazoles • Usually produces **renal toxicity** - More toxic to dehydrated, sodium-depleted animal • **Don't use in cats**: more sensitive- toxicity w/ single dose, rare that amphotericin should be used in cats since new drugs	• **Fever** • **Vomiting**	• Hx (tasking drug), CS • Renal toxicity: ↑ **BUN** • ↓ Serum potassium	• **Stop treatment** if CS or ↑ BUN or creatinine stop Tx if > 3 mg/dl • Metoclopramide for vomiting • ± Potassium supplementation
	Prevention: • **Rehydrate** animal before giving • **Dilute amphotericin B in 5% dextrose** - If normal renal function: dilute in 60-120 ml of 5% dextrose, give over 15 minutes - If compromised renal function: dilute in .5-1 liter over 3-6 hr. • **Measure BUN** before each dose to prevent irreversible renal damage - If BUN remains below 50 mg/dl give amphotericin B every other day - If BUN > 50 mg/dl stop amphotericin B until ≤ 35 mg/dl - If Creatinine stop Tx if > 3 mg/dl • Other suggestions: mannitol concurrently, saline loading, furosemide, aminophylline, antihistamine diphenhydramine (Benadryl) IM to prevent vomiting			
Triazole (itraconazole, fluconazole) toxicity C12T 329; SAP 138; H2B 179;	• **Triazole** - **Itraconazole** (Sporanox®): latest triazole, given w/ food to enhance absorption . Spectrum of activity equals or exceeding amphotericin B: effective against aspergillosis, blastomycosis, coccidioidomycosis, cryptococcosis, histoplasmosis, & some Zygomycetes. Improves some prototheca infections - **Fluconazole** (Diflucan®): a new triazole effective against Candida & Cryptococcus sp • **Hepatotoxic** (both) • Other bizarre effects reported for itraconazole: dermatitis & limb edema (due to vasculitis) • Cats tolerate itraconazole & fluconazole better than ketoconazole (cats readily eat food laced with drug)	• **Anorexia** usually develops during 2nd month of Tx, returns 3-4 days after Tx stopped • **Ulcerative dermatitis**	• Hx (tasking drug), CS • ↑ ALT activity	• **Stop Tx until appetite returns or ulcers heal** • Restart drug at half the dose Prevention: • Monitor anorexia for toxicity • Monitor ALT activity monthly during Tx

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Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Steroids **Glucocorticoid/GCC, Corticosteroid/CCS** E-hb 85; SAP 307, IM 968; DDx 68; Tox-WW 154, 111, 299t ****	• **Beneficial in a myriad of dizs** - Also adverse effects • Suppresses hypothalamic-pituitary-adrenal axis (HPAA) - Last longer than antiinflammatory effect - Steroid myopathy, hepatic damage • Adverse effects are seen if: - Long-term high doses - Not given on alternate day regimen - Activation or worsening of diabetes mellitus • Cats generally require higher doses than dogs, but tend to develop fewer side effects	• **Steroid Tx excess** - **PU/PD** - **Polyphagia/PP** - Weight gain - Uncommon signs: see above Cushing's - **Immunosuppression** . **Infections** - **GI ulcers** - **Bizarre behavior changes** • **Abrupt stoppage of GCS** - **See Addison's above + PU/PD** • **Abortions, teratogenic** • **Hepatotoxicity** see pg 94	• **Hx (steroid Tx)**, CS • Stress leukogram (leukocytosis w/ neutropenia, eosinopenia, monocytosis) • ↑ ALP (alkaline phosphatase • ± Alanine aminotransferase, glucose & cholesterol	**Prevention:** • **Avoid in pregnancy** • **Avoid long term hi dose Tx** - Use alternate day Tx if long term Tx required (prevent Addisonian signs) • Change steroid if problems - Methylprednisolone (depo-Medrol®) has minimum mineralocorticoid activity - will eliminate PU/PD/PP & weight gain • Wean off gradually to prevent hypoadrenocorticism due to atrophied adrenal gland • Stop drug if bizarre behavior • Do not give ultra long acting (Depo-Medrol®) more frequently than q 6-8 weeks

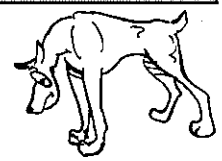
Glucocorticoids (inhibit inflammation & promote gluconeogenesis)
- 'Corticosteroids' generally assumed to refer clinically to glucocorticoids (actually it refers to both glucocorticoids & mineralocorticoids)

• Short acting:	Prednisone & prednisolone
• Intermediate acting:	Triamcinolone (Vetalog®)
• Long acting:	Dexamethasone (Azium®)
• Ultralong acting:	Methylprednisolone acetate (Depo Medrol®)

Beneficial drug
CS: PU/PD? PP
Dx: Hx
Tx: Limit use, Alternate day Tx

Digitalis intoxication **

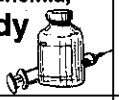
- **See Cardio pg 244 - Heart medication: digoxin, digitoxin**; + inotropes, **narrow margin of safety, Cats & Dobies**
- CS: **GI** (anorexia, vomiting, diarrhea); **Cardiac** (arrhythmias, dyspnea); **CNS**
- Dx: **Hx (digitalis), CS**, ECG: bradycardia, **arrhythmias**
- Tx: **Stop digoxin, Lidocaine or phenytoin**, supportive; **reinstitute 50% digitalis**
- Px: **Good to guarded**



Doxorubicin (Adriamycin) cardiomyopathy *

- **See Cardio pg 247** - Dogs, cats resistant, **anticancer chemotherapy;** Cardiac toxicity relatively frequent & potentially life threatening
- **CS: Dilative cardiomyopathy** (tiring, dyspnea & cough, distended abdomen), Anorexia, weight loss, Cold extremities, Anemia, GI toxicities, Urticaria, Alopecia, Sudden death
- **Hx (Tx)**, CS, **ECG**, Radiology, Echocardiology
- Tx: **Refractory to treatment**
- Prevention: Monitor Tx w/ ECG, if arrhythmias develop, stop treatment
- Prognosis: **Poor**

Drug oxidative injury to RBCs, Hemolysis & methemoglobinemia, Heinz body anemia



See Circ 282: Oxidation of RBCs causing hemoglobin denaturation - **Methemoglobinemia** (reversible) or **Heinz body formation** (irreversible), **Cats predisposed**

Causes: Methylene-blue, spontaneous Heinz bodies, Onion poisoning, **Acetaminophen** (Tylenol®), phenazopyridine, benzocaine topicals, propylene glycol, vitamin K3, DL-methionine

CS: **Lethargy, weakness, anorexia, depression**, fever, ± icterus

Dx: Hx, CS, PE, Lab: **methemoglobinemia: chocolate brown, Heinz bodies**, Bilirubinuria

Tx: **Stop any drug or toxin**, supportive, ± Blood transfusions see pg 382

Prognosis: **Good**

Drug & toxin induced **, aplastic anemia

E-hb 690; SAP 155; H2B 725

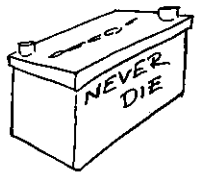
See Circ pg 286: **Nonregenerative - reduced erythropoiesis & aplastic anemia:** cytotoxic antineoplastic drugs, chloramphenicol, estrogen, benzene, phenylbutazone, trimethoprim-sulfa, neclofenamic acid, thiacetarsamide, quinidine, lead, levamisole

CS: **Thrombocytopenia & neutropenia CS take precedence over chronic anemia**, sepsis

Dx: Hx, CS, CBC: anemia then **pancytopenia**

Tx: **Stop drug or toxin**, supportive care

Px: Depends on severity & offending toxin; pancytopenia: poor to grave



Drug-induced hepatitis

E-hb 512; E 1320

**

- **See GI pg 94** - Anticonvulsants, Analgesics, Gas anesthetics, Antimicrobials; Antihelmintics, Steroids - see pg 91 for full list
- CS: Usually acute hepatitis except in anticonvulsants & steroid
- Dx: Presumptive diagnosis usually, cannot be proven
- Tx: Withdraw drug, supportive care, no antidotes

Tylenol, acetaminophen anemia

E-hb 167; H3B 1279; H2B 1335, 1347, 1348; SAP 152; 5min 312, E 323; Cat 233; Tox-WW 303; NB 20.5

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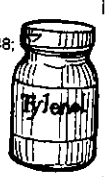
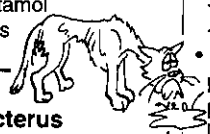


- ***#1 drug toxicity in cats***
  - Cats > dogs (10x)
  - 1/2 human dose may kill a cat
  - **DO NOT give this drug to cats!!!!**
- Target organs: liver (dog) & RBCs (cat)
- Tylenol, Excedrin, Anacin-3, Datril, Tempra, Paracetamol
- Toxic metabolites



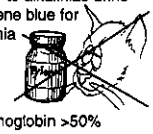
NOT TO CAT!!!!
CS: Cyanosis, salivating, vomiting, icterus
Dx: Hx, CS, Heinz bodies, UA, Lab
Tx: Prompt, emesis, charcoal, Acetylcysteine, Vit C

- ***Cat:***
  - **Anorexia, depression**
  - **Salivating**
  - **Vomiting**
  - **Sever cyanosis (dark gums)**
  - **Icterus** in 2-7 days
  - **Dyspnea**
  - Swollen face & paw, itching
  - Death in 18-36 hrs
- Dog: depression, abdominal pain, anorexia, vomiting, hepatic necrosis, icterus, weight loss & death (few days)

- Hx (exposure), CS
- **Methemoglobinuria** (chocolate brown urine), hematuria
- **Heinz body anemia**, methemoglobinemia, ↓ PCV
- ↑ Hepatic enzymes & ↑ bilirubin
- ± Serum acetaminophen levels
- Postmortem: dark, chocolate-colored blood, mottled liver, centrilobular hepatic necrosis, edema

DDx:
- Phenol compounds
- Detergents
- Soaps
- Nitrites
- Phenacetin
- Nitrobenzene
- Sulfites

- Prompt Tx - w/in 4 hours in cats
- **Induce vomiting** (xylazine in cat)
- **Activated charcoal + cathartic**
- **Acetylcysteine** (Mucomyst®) PO, antidote
- Transfusions, fluids, O2 (oxygen)
- **Vitamin C** PO (250 mg) immediately to reverse methemoglobinemia
- Na bicarbonate PO to alkalinize urine
- Do not use methylene blue for methemoglobinemia in cats

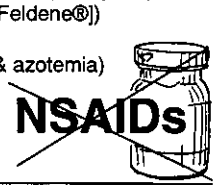


Prognosis:
- **Grave** if methemoglobin >50%
- Prompt Tx can result in recovery

Other NSAIDs: Phenylbutazone, Ibuprofen, Naproxen, Piroxicam

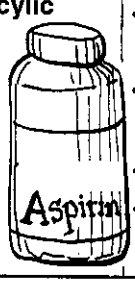
H3B 1280; H2B 1336, 1347, 1348; E-hb 863; C12T 1440t; Cat 233; Tox-WW 306; NB 20.5

- **Analgesics: NSAIDs** = nonsteroidal antiinflammatory drugs, (ibuprofen [Advil®, Medipren®, Midol®, Motrin®, Nuprin®], naproxen [Naprosyn®, Naxen®, Aleve®], phenylbutazone [Butazolidin®, Bute, PBZ], indomethacin [Indocin®], piroxicam [Feldene®])
  - Cause: **prostaglandin deficiency**
- CS: Inappetence, nausea, vomiting, colic, weight loss, ataxia, weakness, dark tarry stools, renal failure (oliguria & azotemia)
- Dx: Hx, CS, anemia, leukopenia, thrombocytopenia, ↑ bleeding times, ↑ hepatic enzymes, azotemia, acidosis, ± hyperkalemia if oliguria, radiography & gastroscopy, UA, necropsy: gastric ulcers
- Tx: **Emesis, charcoal, cathartic,** misoprostol, **IV fluids + Na bicarbonate, sucralfate, cimetidine,** ± Dopamine (Intropin®) for blood pressure & urine output, treat hyperkalemia if oliguria, treat acute renal failure



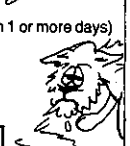
Aspirin, Acetylsalicylic acid

J A V M A 205(4)557,'94; E-hb 167, 145; H3B 1280; H2B 1336, 1347, 1348; 5min 369; Cat 232; Tox 395; Tox-WW 304; 74t, 174; NB 20.5



- **More toxic to cats**, do not give adult aspirin or enteric-coated
- Buffered, baby aspirin uses: Control fever, pain, inflammation (DJD), anticoagulation (lower doses)
- Pathophysiology: interferes w/ prostaglandins: low dose - GI, high dose - renal effects; inhibits platelet aggregation = prolonged bleeding times, gastric irritation &/or ulceration
- Therapeutic dosage: cat: 25 mg/kg daily; Dog: 25 mg/kg TID
- Toxic dose: cats: 80-129 mg/kg daily; 100-300 for 1-4 weeks = gastric ulcer

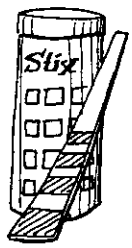
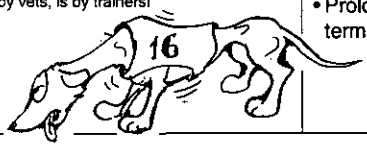
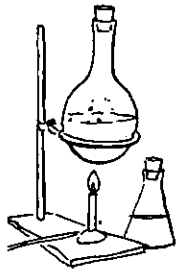
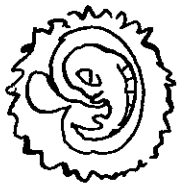
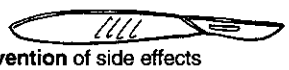
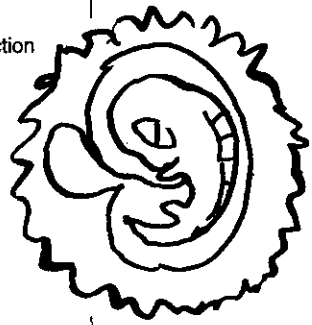
- **Vomiting**
- Abdominal cramps
- Depression
- Inappetence
- Hyperventilation
- ± Ataxia, ± Stupor
- Fever (pyrexia)
- ± Coma & death (in 1 or more days)



- **Hx (history)**, CS
- Heinz body anemia, thrombocytopenia
- ↑ Hepatic enzymes
- Azotemia
- Acidosis & hypokalemia
- Necropsy: gastric ulcers

DDx:
- Other gastritis
- Other acidosis
- Antifreeze
- NSAIDs

- **Induce vomiting** if conscious
- **Activated charcoal & saline cathartic**
- **IV fluids** - continuous
- **Sodium bicarbonate** to alkalinize urine & for acidosis
- Cooling baths
- ± Blood transfusions
- Sucralfate for gastric ulcers
- Cimetidine, ranitidine or omeprazole (↓ gastric acid)
- Misoprostol (Cytotec®) exogenous prostaglandin) to prevent gastric ulcers

Condition	Facts	Presentation/CS	Diagnosis	Treatment
Ovaban/ toxicity, Megestrol acetate toxicity C12T 1074, 1104, 583; E-hb 612, 543, 96t; H3B 1291; H2B 1348, 1349, 702, 1246t, 1072, 930, 338, 1263, 1255, 1259, 1263; SAP 893, 1205, 340, 869, 339, 340, 329, 914, 735t; IM 651, 708 Ovaban	• **Megestrol acetate (Ovaban®): oral drug that is widely abused in vet med** - More potent & longer lasting Antiinflammatory & adrenal suppression than steroids • Uses - **Dog:** . Progestin to suppress estrus in bitch . Benign prostatic hyperplasia . Aggressive behavioral problems - **Feline:** . Feline dermatoses; i.e., allergic dermatitis, symmetrical alopecia (not approved but used) . Behavioral problems, aggression, urine spraying . ECG lesions . Plasma cell gingivitis, feline eosinophilic keratitis 	• Polyphagia • **Cystic endometrial hyperplasia** • Mammary hyperplasia/neoplasia • ± False pregnancy signs when Tx stopped • **Diabetes mellitus** • Acromegaly • Adrenocortical suppression in cats • **Injection site:** alopecia, thinning of skin, discoloration of hair • Masculinization of fetus if give to pregnant • Post Tx lactation in bitch	• Hx (given), CS • ± Glucose in urine 	• Stop Tx if CS • Monitor urine glucose for diabetes mellitus Prevention: • Cat: warn owners, exhaust other options before try, then every other day Tx & wean to every 7-14 days maintenance • Not recommend for estrus suppression in bitches intended for future breeding . Don't suppress more than 2 cycles in a row (may cause CEH) . Only give to postpuberty bitches & queens
Mibolerone/ Cheque toxicity E-hb 613; H3B 1291; H2B 1348, 1349, 702, 1263; SAP 930, 735t; IM 651, 708; C12T 1439t; C11T 954, 966, 1074 Cheque	• **See Repro pg 406:** mibolerone (Cheque®): androgen for suppression of estrus in bitch (infertility in bitches due to short estrus cycles) • **Androgens** (mibolerone & testosterone) injections in greyhounds to prevent estrus & enhance racing performance - not an acceptable reason to use by vets, is by trainers! 	• **Clitoral hypertrophy ± ossification** • Mucopurulent vulvar discharge, vaginitis • Masculinization of female fetuses, ± teratogenic • ↑ Muscle mass & aggressiveness • Prolonged anestrus after long term use (greyhounds)	• Hx (use), CS • ± ↑ Liver enzyme activity 	• **Side effects usually reversible once Tx stopped** • Do not use for longer than 24 months . **Do not use in cats!** (hypertrophy of the glans clitoris & hepatotoxic) • Not recommended on insert for use in bitches intended for future breeding Prognosis: **Good**, resolve when Tx stopped, but may persist for years
Estrogen toxicity, ECP, DES, Hyperestrogenism C12T 1075; E-hb 613; SAP 899, 155; H3B 1291; H2B 725, 702; IM 677, 661; 5min 570; E 1632, 1075, 1079; Cat 236; F-N 460, 463; R-M 530, 811 (F); R-R 691, 707, 715; E&R 592; Tox-WW 22, 134, 299t, 155 DES	• **See Repro pg 407** • Testicular Sertoli cell or ovarian granulosa cell produce estrogen • **Endogenous estrogens: ECP/Estradiol cypionate** (Depo-Estradiol®) or Diethylstilbestrol (DES®) • **Commonly used to terminate unwanted pregnancies but not recommended** due to side effects • Other uses: treatment of infertility, urinary incontinence & perianal adenomas - Depends on dose & age of animal (worse in older dogs) • **Fatal irreversible aplastic anemia & blood dyscrasias** • Most common cause of **pyometra** in young bitches	• **Blood:** pale mucous membranes, petechial hemorrhages, dark stools, hypothermia • **Exercise intolerance** • **Pyometra**/cystic hyperplasia-pyometra complex (25%) • Prolonged behavioral estrus • Cystic follicles • ± Future infertility 	• Hx (estrogen given), CS • PE: if testicular tumors: cryptorchidism, feminization • CBC: Moderate to severe anemia - Thrombocytopenia: w/in 2-3 weeks - Leukopenia w/in 4 weeks • Bone marrow: early ↓ megakaryocytes, granulocytic hyperplasia - Late: generalized hypoplasia/aplasia • Surgical removal of tumor + recovery from anemia	• Fluids • Blood transfusion • Steroids for shock • Surgical removal of tumor + recovery from anemia  **Prevention** of side effects • **Don't use estrogens for pregnancy termination, prostaglandins better (see below)** • If use ECP - IM given once in estrus to prevent pregnancy - If given - Never during diestrus (vaginal cytology - decline in cornified cells) - Never exceed 1 mg - NEVER repeat dose
Prostaglandins F2a toxicity, Lutalyse toxicity C12T 1075; E-hb 613; SAP 899; H2B 702; IM 677; E 1632, 1075, 1079; Cat 1871; F-N 460, 463; R-M 530, 811 (F); R-R 691, 707, 715; E&R 592; C12T 1443t; C11T 947, 954, 969; C10T 1305; Tox-WW 154 Lutalyse	• **See Repro pg 407** • **Best method of termination of unwanted pregnancy, IM shots 1 month (dog)/40 days (cat) after mating if pregnant (diagnose with US)** • Contraindicated if preexisting cardiovascular or respiratory problem, use only in young healthy bitches • Mechanism: cause luteolysis of CL so prostaglandin level drops & can't maintain pregnancy. Resistant to effect until after day 25 of gestation in dog & 40 days in cat	• Minimum signs often • Vomition • Urination • Tachypnea • Trembling • Salivation after injection 	• History (Hx) • Clinical Signs (CS)	• Often well tolerated & side effects usually becomes less severe as Tx progresses • Return to normal reproductive cycle after Tx

Heavy Metals

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Thallium toxicity M8k 2146; H2B 1308; Tox-WW 207	• **Currently illegal in USA** (1965) • Rodenticides & insecticides • Necrotizes tissues	• **Pneumonia** (dyspnea, cough, nasal discharge) • **Necrotizing GI** (hematemesis, hemorrhagic diarrhea, abdominal pain, anorexia) • **CNS** (trembling, ataxia, convulsions, paralysis, coma) • **Brick red mucous membranes** in 2-4 days • **Kidney damage** • **Dermatitis** (red skin, pustules, redness, hair loss, scaling)	• Hx (exposure), CS • PE (**brick red mucous membranes**) • Thallium in urine (mix w/ Na iodide & Na bismuth in nitric acid = brick red ppt.) • ↑ Thallium concentration in urine, feces or tissue **DDx:** • Distemper • Heavy metals • GI diz • Bullous skin diz	• **Tx ineffective when clinical signs** • Dithizone® (diphenylthiocarbazone) chelates, PO tid • Potassium chloride (Kaon®, KayCiel®) • Ferric cyanoferrate (Prussian blue®) PO tid Dithizone
Ethylene glycol, Antifreeze toxicity **	**See Urinary pg 352:** Good sweet taste, Fall & spring, Nephropathy CS: **Acute: drunk** (ataxia, knuckling, depression), PU/PD, hyperpnea, ± death - Stage 2: 12-24 hr: **Nondescript - seems to be recovering** - Stage 3: 24-72 hr: **Renal signs,** depression, oliguria/anuria, anorexia & vomiting, oral ulcers, death Dx: **Hx**, CS, Lab (oxalate crystals), US Tx: **Emergency**; emesis, lavage, charcoal, **20% Ethanol IV, 4-methylpyrazole**, Supportive/fluids Px: **Grave if renal failure**			
Copper associated hepatitis of Bedlington terriers, Westies, Dobies, Sky terriers *	**See GI pg 97:** Metabolic defect causing accumulation of copper in liver; **Bedlington, West highland white, Dobie, Skye terriers** CS: **Asymptomatic** until critical level reached, Depression, lethargy, Anorexia, Vomiting, **Jaundice**, ± Hemolytic anemia; Hepatic encephalopathies; PU/PD in dobies - Chronic: **Weight loss, Ascites**, Small liver Dx: Hx (**breed**), CS, Lab, **Rads, Liver biopsy** - definitive Tx: Supportive, **Chelate copper (D-penicillamine or zinc)** - **Doby: no effective treatment established** **Prognosis: Bedlington: Good, Doberman: poor**			
Lead toxicity **	**See Neuro pg 579: Chronic; paint, batteries**; < 1 year-old CS: **GI** (vomiting & diarrhea), **CNS** (blind, seizures, behavior), PU/PD Dx: Hx, CS, lead levels **> 0.4 ppm**, Nucleated/Basophilic RBCs Tx: Stop exposure (emetics, lavage, charcoal etc.), Chelate (**Ca EDTA, D-penicillamine**) Supportive (fluids etc.) Px: Good if early Dx & Tx			

Zinc toxicity * E-hb 163; SAP 152; H3B 1273; H2B 719; 1282t; C12T 238; 5min 1164; Cat 239; Tox-WW 61t, 59, 204; NB 20.14	• **IV hemolysis** in dogs • Source - Galvanized wire - Kennel cage nuts - Pennies minted after 1983 - Fungicides, zinc oxide medications - High copper or calcium diets	• **Anorexia** • **Vomiting** • Lethargy, diarrhea, icterus, red urine • ± Death if not treated	• Hx (zinc exposure) • **Regenerative anemia** • Radiograph - metallic foreign bodies • Coombs' negative • Postmortem: gastroenteritis, kidney tubular necrosis, hepatocyte necrosis • Lab: ↑ AP & bilirubin, zinc concentrations (metal free blood tubes)	• **Remove** source by surgery or endoscopy • **Symptomatic & supportive** for gastroenteritis & anemia • **Chelating agents:** Calcium disodium EDTA or D-penicillamine • ± Blood transfusions EDTA Prognosis: Excellent
Arsenic poisoning; Arsenicals M8k 2024, 2043; Mk 163; E-hb 164; H3B 1272; H2B 1317, 566; 5min 361; Cat 219, 238; NS-hb 361t; NS-O 265t; NS-Pa 252; Tox 72, 80; Tox-WW 181 *	• Inorganic: **insecticides**: ant & roach poisons; herbicides: crabgrass killer; preservatives for wood - Organic: **Heartworm medication** (caparsolate), Filaricide (organic), silvisar 510, arsanilic acid (feed additive) • **Use greatly reduced** because of live stock losses & environment persistence • **Hazardous when used as recommended** • Mechanism: binds to - **SH enzymes - disturbs cellular respiration** **DDx:** • Thallium • Lead poisoning • Garbage intoxication • Ethylene glycol • Hemorrhagic gastroenteritis • Viral gastroenteritis	• **Acute (30 min to hours)** - **Restlessness, salivation, nausea** - **Repeated vomiting** . Dogs: vomit repeatedly & recover . Cats: often die despite vomiting • Whining, severe colic (abdominal pain) • Anorexia, depression • ± Bloody diarrhea w/ mucosal tags • Weakness, trembling, ataxia, staggering • Oliguria • Polyuria (PU) may precede anuria • Paraparesis, stupor, coma, death • Sequela: - Shock - Renal failure	• **Hx (exposure), CS** (rapid bloody diarrhea) - **No other heavy metal has this rapid of GI signs (severe)** • Stomach content & urine levels >10 ppm • Urinalysis: - Proteinuria, casts, RBCs, WBCs - Fixed specific gravity - Hematuria • Blood values - Azotemia (↑ BUN, creatinine) - Anemia • Postmortem: analysis of liver, kidney at postmortem	• **Prevent further absorption** - Induce vomiting - Gastric lavage - Activated charcoal, cathartic (mineral oil or saline purgatives) • **BAL®** (dimercaprol, British Anti-Lewisite) chelates arsenic, hastens elimination, maximum of 4 days (toxic) • D-Penicillamine (Cuprimine®) • **Sodium thiosulfate**, safer but less effective than BAL • Symptomatic (fluids, electrolytes, acid-base for shock) - Blood transfusions Digestive tract protectants BAL **Prognosis:** • **Poor to guarded** for acute toxicosis

Insecticides, SH enzymes - disturbs cellular respiration
CS: Acute GI, staggering, stupor
Dx: Hx, CS, Levels >10 ppm
Tx: induce vomiting, Lavage, Charcoal, BAL, Thiosulfate, Fluids
Px: Poor to guarded

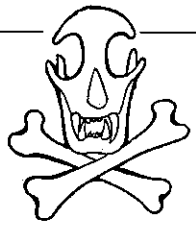
Other metals or minerals M8k 2073; Mk 1676; H2B 1282t; Cat 239 Tox 121; Tox-WW 189, 197

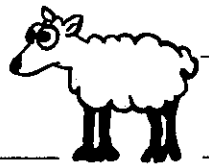
• Mercury toxicity
- **Rare**, mercurial salts & alkyl mercurials; Horses: Inorganic Hg containing **blistering agents** (if horse licks or used w/ DMSO), Mercuric fungicide treated grains historically but banned for years
- CS: Stomatitis, vomiting, diarrhea, dehydration, shock, death in hours, CNS, dermatitis, blindness, coma, death
- Tx: Egg white or activated charcoal, oral sodium, thiosulfate, saline cathartic, D-penicillamine PO, DMSA

• Molybdenum toxicity
- Trace mineral poisoning in cattle & swine

• Selenium toxicity
- Poisoning of cattle, sheep & horses grazing selenium containing plants

• Cadmium toxicity
- **Rare, pets eating cadmium-nickel batteries**
- CS: Chronic & degenerative (anemia, retarded growth, testicular necrosis, arthropathy, osteoporosis), acute poisoning rare (vomiting, diarrhea)
- Tx: No antidotes; supportive, selenium, vitamin D

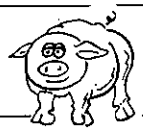




• Antimony toxicity
- In batteries, alloys, rubber, paints, old tartar emetic
- Signs similar to arsenic toxicosis

• Barium toxicity
- In alloys, paints, soap, obsolete pesticides
- CS: gastroenteritis, ventricular fibrillation
- Tx: GI detoxification + potassium

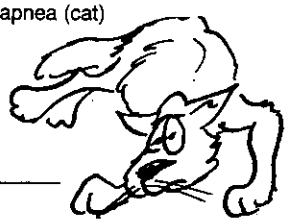
• Chromium toxicity
- Trivalent chromium essential nutrient, hexavalent is toxic; paints, leather tanning, wood preservatives
- CS: contact dermatitis, gastroenteritis, nasal irritation



• Iron toxicity
- Seen mainly in newborn pigs given supplemental iron
- CS in small animals: anorexia, weight loss, hypoalbuminemia, death in excess given to young especially if vit E -or selenium deficient

Central nervous system depressants H3B 1290; H2B 1347, 1348

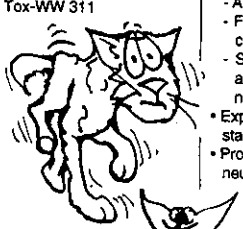
Acetylpromazine	- Atypical behavior, aggression, urination, defecation, seizures, cardiac effects, injection site pain, hyperactivity (cat)
Halothane	- Cardiac effects, hyperthermia leading to myocardial damage, nystagmus, torticollis, vomiting, hepatitis, apnea (cat)
Lidocaine	- Facial & laryngeal edema, seizures, tremors, ataxia
Ketamine	- Ineffective anesthesia, seizures, cardiac arrest, death (liver & kidney damage), apnea
Methoxyflurane	- Dog (cardiac arrest, renal damage, hepatic damage); Cat (ataxia, death)
Xylazine (Rompun®)	- Vomiting, aggression, bradycardia, cardiac arrest, seizures, apnea



Prescription drugs, Narcotics - CNS H2B 1338

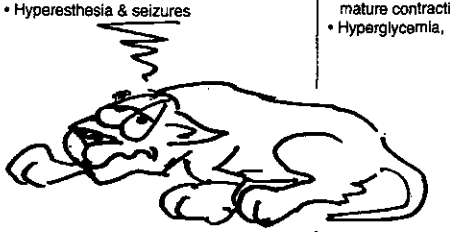
Human prescription drugs (tricyclic antidepressants, amphetamine [dextroamphetamine, methamphetamine])
CS: Vomiting, depression, staggering, restlessness or hyperexcitability, tremors, seizures, rapid HR or palpitations, coma
Dx: Hx (exposure) - have client bring in Rx bottle; CS
Tx: Emesis (cat-xylazine, dog-apomorphine/hydrogen peroxide), activated charcoal, keep warm, diazepam (Valium®) or barbiturates for hyperexcitability; treat any cardiac arrhythmias, acidify urine for amphetamines (NH4Cl)

Cocaine
Tox-WW 311



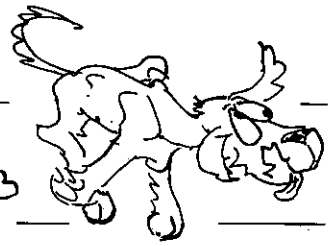
- Derived from coca plant (Erythroxylon coca or E. monogynum
  - Alkaloid (benzoylmethylecgonine
  - Freebase: chemically extracted pure cocaine
  - Street cocaine: often "cut" w/ amphetamine, caffeine, lidocaine, quinine, strychnine
- Exposure: pets getting into owner illegal stash
- Promotes catecholamine release & inhibits neuronal uptake of catecholamines

- **CNS: alternating stimulation & depression**
- Hyperesthesia & seizures



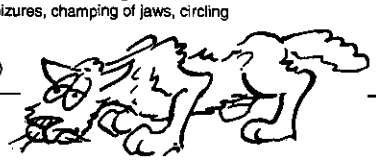
- Hx (exposure), CS
- Tachycardia, tachyarrhythmias, ventricular premature contractions,
- Hyperglycemia, ↑ ALT

- Detoxification usually useless because absorbed so fast
- Supportive: respiratory, chlorpromazine for cardiac & seizures
- Cool water baths or enemas



Phencyclidine PCP, "Angel dust", "Hog"
Tox-WW 312

- **Analog of ketamine**, nonbarbiturate anesthetic; taken off market in 1978 because of side effects: delirium, agitation, hallucinations
- CS: Variable, alternating excitation & depression, hypersalivation, mydriasis, tonic-clonic seizures, champing of jaws, circling
- Dx: Hx (exposure). CS; tachycardia, arrhythmias, hypertensions
- Tx: Rapid decontamination: emesis, activated charcoal & cathartics TID; keep cool & isolated, diazepam (Valium®) IV fluids, acidify urine, diuresis (furosemide)



PCP, Pentachlorophenol
Mk 1696; Tox 239; Tox-WW 273

- **See Resp pg 163: Rare.** Wood preservative, fungicide
- Livestock lick leaky wood
- Not street drug called PCP ((see above)

Lick "leaky" wood"

Rodenticides

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Metaldehyde **	**See NS 577: Molluskicides**, Southern lowlands, Pacific coast & Hawaii **CS: "Shake & bake"/continuous seizures, Hypersalivation, Severe fever, Death** **Dx:** Hx, CS, **Lab,** Postmortem: **formaldehyde odor** **Tx:** Emesis & **lavage, charcoal,** Relax/Valium, cooling **bath** **Px:** depends on amount ingested, time & Tx			
Strychnine **	**See Neuro pg 578: Illegal in USA**, malicious poisonings CS: **Tetanic seizures**, Rapid onset, Saw horse stance Dx: Hx, CS, Lab Tx: **Stop absorption, Control seizures** (diazepam/phenobarb), **Hasten elimination** (diuresis, NH_4Cl) Px: **Guarded** until seizures controlled, **Good** - early treatment & support for 48 hrs, **Poor** - late Tx & seizures			
Vit D rodenticide poisoning JAVMA 205(3)p416, 1994; M8k 2144; 5min 1156; Cat 225; Tox-WW 279; NB 20.11 **	• **Cholecalciferol-containing rodenticide** recently put on market - **"Place packs"** • Cause **hypercalcemia** in 18 hours, conduction dysfunction of heart, cardiac failure, tissue mineralization, renal tubule necrosis	• Depression, Weakness • Anorexia, vomiting, constipation • Seizures • Nephropathy - PU/PD	• Dx: Hx (exposure), CS • **Lab: serum Ca > 12.5 mg/dl** • Bradycardia; ECG: prolonged PR interval, shortened QT interval, ventricular fibrillation, • UA: Sp. Gr: 1.002-6 • Necropsy: gastric ulcers, mineralization of soft tissue • Serum vit D levels	• Prompt emesis & gastric lavage • Activated charcoal + cathartic TID • IV saline sol., furosemide • ± Calcitonin SQ, may take more than 2 weeks (fat soluble)
Vitamin K deficiency, Anticoagulants (Warfarin, coumarins) **	**See Circ pg 295 - #1 clotting factor deficiency**; Source: **Rodenticides #1 (warfarin), inhibition of Vit. K** CS: **Dyspnea, Bleeding** Dx: Hx, CS, **Response to vit K1**, Lab (anemia) Tx: **Emetic, remove source, Vitamin K1,** ± Transfusion Px: Good			
Other rodenticides M8k 2143; Mk 1721; H2B 1309; Cat 223; Tox 332, 357; Tox-WW 290	• **Alph-chlorohydrin**: sold only to exterminators, uncommon in USA; CS: infertility in males; Tx: not described • **ANTU** (alpha naphthyl-thio urea): See Resp pg 163 - rarely used; Strong emetic (protects some animals that vomit), rodents unable to vomit, not used much - CS: Pulmonary edema "drowns in own fluid", Death w/o convulsions, vomiting, salivation - Tx: Ineffective: emesis, lavage, steroids, diuretics, antibiotics • **Vacor** (Pridymethyl, Pyrimilin): taken off market in 1979; but m/ be on premises, Mech.: **Vit. B antagonism**, destroys pancreatic cells & depresses glucose uptake by cells - CS: Vomiting, apprehension, mental confusion, abdominal pain, trembling, ataxia, weakness, blindness, coma, death, diabetes mellitus - Tx: ± Spontaneous recovery if protect from self trauma & give supportive care, Emesis, lavage, Niacinamide® (nicotinamide), supportive care			

Zinc phosphide JAVMA 205(3)p416, 1994; M8k 2147; E-hb 161, Cat 225; Tox 353; Tox-WW 282, 73t	• **Rodent control:** rats tend to die in open area - psychologically rewarding • Products: Gopha-rid, ZP, Zinc-Tox, Mr Rat Guard, Mouscon, Kilrat, Rumetan - Tends to cause emesis in non-rodent species • Phosphine (PH3) released in stomach - Mechanism of CNS effects unclear - ± Hepatic damage	• Rapid w/in 1/4-4 hours • Abdominal distention • Vomiting • Hypoglycemic shock • Death • Clonic spasm of head & neck • Anorexia & lethargy • Convulsions/paddling, generalized tremors, not hyperesthetic • Pulmonary edema	• Promptly frozen stomach content analysis • Phosphine or acetylene breath • Elevated zinc in blood, liver & stomach **DDx:** • Strychnine	• Evacuate & ↑ stomach pH - **Emetics** (Rompun/cat, apomorphine/dog) if hasn't already occurred - Activated charcoal - Gastric lavage w/ 5% sodium bicarbonate • Evacuate gas from stomach or • Reduce gastric acid production: cimetidine, ranitidine, omeprazole • Dextrose & intragastric bicarbonate Prognosis: Guarded
Bromethalin JAVMA 205(3)p416, 1994; M8k 2144; E-hb 161; H2B 1311; Cat 226; Tox-WW 286, 72t, 74t; NB 20.13	• **New rodenticide** bait for warfarin resistant rodents; Pathophysiology: **neurotoxin** - uncouples oxidative phosphorylation = hyperexcitability (like strychnine) & then depression; Products: Vengeance®, Assault®, Trounce® (green pellets). • CS: Rapid, dose dependent; - **Hyperexcitability, ataxia, weakness, gran mal seizures,** occasional paralysis, severe muscle tremors, running fits, hind limb hyperreflexia, anisocoria, CNS depression, death in 1-3 days: **ataxia** - ± Vomiting, Diarrhea, Coma up to 12 days • Dx: Hx (exposure), CS, No tests • DDx: **Rabies, Strychnine,** Organophosphates, DEET, Chlorinated hydrocarbons, Spinal chord injuries, Cerebral edema • Tx: **Remove** immediately: meal + **emesis; activated charcoal** + cathartic TID for 3 days; Minimize cerebral edema: mannitol (20%) IV, dexamethasone early; Seizures: diazepam, or phenobarbital; Support, supplemental feedings Prognosis: **Grave,** once clinical signs Tx ineffective			
Sodium fluoroacetate, Compound 1080, 1081 M8k 2146; Mk 50; E-hb 161; H2B 1306; E 465; Cat 224; NB 20.12; Tox-WW 289; Tox 340 *	• Available only to licensed **exterminators** - Mixed w/ black dye & added to bread, bran, carrots or cereal • Used for rodents & coyotes in W USA (controversial, because other animals susceptible - poisoning by eating poisoned rodents) • **Action: blocks cellular ATP** (blocks citric acid cycle/energy & cell respiration) - **Heart (arrhythmias) & CNS**	• **Rapid progression** (w/in 2 hrs of ingestion) • **Dogs:** - Apprehension, hyperirritability, **vomiting** - Repeated urination & defection, tenesmus - Dyspnea, frothing of mouth & nose - **Frenzied running & yelping fits** - Cyanosis - **Seizures** (tonic-clonic) w/ paddling - Collapse between running fits or seizure - Death in 2-12 hrs due to respiratory failure - Rapid rigor mortis - **rigid extension** - No heightened response to stimuli as in strychnine • Cats: - Similar signs to dog minus hyperactivity - Abnormal vocalization	• Hx (exposure, rodent) CS - Lack of hypersensitivity to stimuli • Hyperglycemia • Detection of 1080 in tissue difficult (baits, stomach contents, & kidney) • Postmortem: - **Flaccid heart** - Widespread cyanosis - Rapid rigor mortis: **extensor rigidity** **DDx:** • Strychnine (hypersensitivity to stimuli) • Chlorinated hydrocarbons • Organophosphates • Lead • Hypocalcemia • Garbage intoxication • Zinc phosphide	• Prevent absorption: - **Emesis &/or gastric lavage** (milk or lime water) - Activated charcoal if early • Block conversion of 1080 to toxic substance - **Monacetin®** (glycerol monoacetate) IM hourly or - 50% Ethanol PO & 5% acetic acid PO • Supportive care - Seizures - short acting barbiturates - O2 & artificial respiration for respiratory failure - Monitor arrhythmias (ECG) Prognosis: Guarded to grave, once CS Tx often ineffective

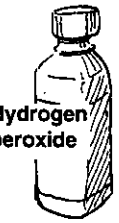
ATP block
CS: Frenzy, Yelping, Seizure, Death
Dx: Hx, not hypersensitive
Tx: Monacetin, Emesis, Support

Insecticides — TOXICOLOGY

Condition	Facts & Cause	Presentation/CS	Diagnosis	Treatment
Organophosphates, (OPs) & Carbamate, Anticholinesterase **	**See NS pg 576: Common poisoning** - insecticides, pesticides & anthelmintics **Alike - carbamate: reversible OPs: irreversible** CS: **Slobbering, Dyspnea, Vomiting, Muscle tremors & twitching, CNS CS rare, Death** Dx: Hx, **Response to atropine** Tx: **Emergency - stop absorption, Atropine, 2 PAM** Px:: **OP's: guarded; Carbamate: good**			2 Pam
Chlorinated hydrocarbons, CHC, Organochlorine insecticides **	**See NS pg 578: Persists in environment**; Insecticides: **DDT banned,** only **lindane** & methoxychlor now; **Cats** especially susceptible; lipid-soluble CS: **Vomiting, hypersalivation, Twitching & tremors, Convulsive seizures, Death** **Dx: Hx, Convulsive seizures & twitching, Levels** Tx: Symptomatic, Detoxify (wash or charcoal), **Valium** Px:: **Guarded to good** w/ early diagnosis & Tx - weeks to recover			
Amitraz, Acaricides JAVMA 205(3)p415, 1994; H3B 1259; Cat 221; Tox-WW 245	• **New formamidine insecticide** • Amitraz in tick collars & ectoparasite swine products • Exposure: eating flea collar • Alpha adrenergic agonist: cardiovascular collapse & respiratory depression	• Ataxia, disorientation • Depression • Hypotension • PU (polyuria) • Vomiting, anorexia • Diarrhea • Vocalization • Seizures	• HX, CS • Lab: hyperglycemia supports Dx • Bradycardia **DDx:** • Cholinesterase inhibitors • Pyrethrins	• Detoxification - Ingestion: emetics, activated charcoal, cathartic - Dermal: wash soap & water • Supportive: diazepam (Valium®) for seizures, ± dextrose IV • Yohimbine IV: antidote, safer than atropine (hypotension)
Rotenone H3B 1260; H2B 1317; Cat 220; Tox-WW 241	• Extract of Derris & Lonchocarpus plants • Flea control & premise insecticides, topical, Sebumsol • Excessive topical powders or dips, cats most commonly • Toxicity enhanced if combined with pyrethrins	• Vomiting & diarrhea • Tremors, hyperexcitability • Lethargy & stupor • Dyspnea & respiratory depression • ± Tremors • ± Seizure	• Hx (exposure), CS • ± Hypoglycemia Public health: Home & garden sprays	• **Detoxify** - Dermal: wash in soap & water - Ingestion: emetics or gastric lavage if < 4 hrs & no seizures, Activated charcoal + saline cathartic • **Supportive**: Diazepam (Valium®) or barbiturates (not phenothiazine tranquilizers) repeated as needed for seizures - ± Dextrose IV if hypoglycemia Prognosis: Excellent in most cases
Pyrethrins, Pyrethroids JAVMA 205(3)p415, 1994; M8k 2065; E-hb 160; H3B 1259; H2B 1316; 5min 1004; Cat 220; Tox-WW 241, NB 20.8 **	• **Pyrethrins**, natural product from pyrethrum flower (Chrysanthemum - low levels), pyrethroids: synthetic type 1 & 2, relatively safe • Piperonyl butoxide: cytochrome P-450 inhibitor insecticide • **Insecticides/flea** control (aerosol, sprays, dusts, dips, shampoos) house & garden & agriculture products • Repetitive nerve discharge (reversible prolong sodium conductance in nerves) • Cats more susceptible than dogs Public health: not totally "safe"	• **Asymptomatic** unless high doses • Hypersalivation • Vomiting & diarrhea • Paw flicking, Ear twitching • Tremors, hyperexcitability • Depression • Dyspnea • Seizure - hyperthermia • Weakness, prostration • Death or recovery in 24-72 hours • Contact dermatitis	• Hx (exposure), CS • No diagnostic test **DDx:** • Rabies • Chlorinated hydrocarbon • Organophosphate toxicosis • Metaldehyde poisoning • Strychnine • Nicotine • Aminopyridine poisoning • Pseudorabies • Meningitis • Lead poisoning	• Usually mild & self limiting • Detoxify - Dermal: wash in soap & water - Ingestion: emetics or gastric lavage if < 4 hrs & no seizures - A. charcoal + saline cathartic • NO atropine • Supportive: - Methocarbamol (Robaxin®) IV muscle relaxant (not phenothiazine tranquilizers) - Vit E ointment for dermatitis Prognosis: **Excellent** unless overwhelming exposure
Other Insecticides M8k 2061; H3B 1260, 1281; H2B 1316, 1317, 1318, 1337; Cat 220; Tox-WW 246, 247	• **Citrus oil extracts** (control of lice, ticks & fleas - limonene, linalool), poisoning rare, cat treated at dog dose - CS: Ataxia, weakness, paralysis, depression, hypothermia - Tx: Supportive: bath in warm soapy water & keep warm & well ventilated, Px: excellent • **Boric acid**: ant & roach baits, cleaning compounds - CS: Vomiting, diarrhea, weakness, ataxia, seizures, tremors, oliguria, anuria, depression - Dx: Hx (exposure), CS, UA, boric acid in urine - Tx: Emesis, activated charcoal, fluids, Tx renal failure, peritoneal dialysis • **DEET**: N, N-diethyltoluamide, insect repellent, flea control, neurotoxicity, hypotension - CS: Rapid: Vomiting, anorexia, tremors, seizures, hypersalivation - Dx: Hx (exposure), CS, 20 ppm in serum diagnostic - Tx: Detoxify: dermal: wash in soap & water, Ingestion: emetics or gastric lavage, activated charcoal + saline cathartic; Supportive: diazepam or barbiturates, atropine sparingly for hypersalivation & GI hypermotility • **Naphthalene**: coal tar of petroleum hydrocarbon, **mothproofing** products - CS: Vomiting, bad breath (mothballs), cataracts in neonates - Dx: Hx, CS, Methemoglobinemia, Heinz body anemia, hemolysis, hemoglobinuria, hepatic damage & nephrosis - Tx: Emesis, activated charcoal + saline cathartic, ascorbic acid, fluids, bicarbonate, blood transfusions • **Nicotine**: alkaloid from tobacco plant (*Nicotiana tabacum*); tobacco leaves or insecticide (Black Leaf 40), darts for dogcatchers; stimulates sympathetic & parasympathetic systems - CS: Rapid: hyperactivity, vomiting, salivation, tremors, dyspnea, tachycardia, weakness, paralysis & death - Dx: Hx (exposure), CS, nicotine in stomach skin or urine - DDx: Strychnine, xanthines, organophosphates, carbamates - Tx: Emesis, gastric lavage (potassium permanganate), activated charcoal, soapy & water , ± atropine, O2, Valium® m ± Stimulants (phenylephrine, amphetamine sulfate) • **Arsenic**: see page 773			

Herbicides

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Herbicides M8k 2042; H3B 1263; H2B 1321; E-hb 164; E 320; Cat 229; Tox-WW 257; Tox 261	• **Routinely sprayed on pastures** grazed by animals • If used properly **few toxic problems** - Toxicities usually due to accidents • Organic synthetic herbicides more commonly used than inorganic • No evidence of public health risks	• Nonspecific signs, similar to all herbicides	• History (exposure), • CS are nonspecific & Dx is difficult • Rule out DDx before diagnosing herbicides • Chemical analysis may help but may not confirm	• Detoxify: - Wash for dermal exposure - Ingestion: Emesis, activated charcoal + cathartic . ± Ion trapping • Supportive: fluids, diuresis • Protect people Px: Good



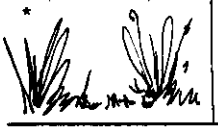
Hydrogen peroxide

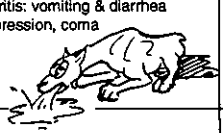
Routine pasture sprays, toxic accidents
CS: Nonspecific to all
Dx: Hx, Rule out DDx
Tx: Detoxify, Supportive: fluids, diuresis
Px: Good

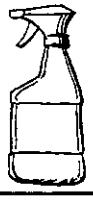
Herbicides in dogs
- Dipyridyl compounds
  - Paraquat
  - Diquat
- Phenoxy herbicides
  - 2,4-D
  - MCP
  - Silvex
- Thiazines
- Glyphosate
  - Roundup
  - Kleenup
- Algacide
  - Monuron (Telvar®)
  - Dicholone (Phygon®)

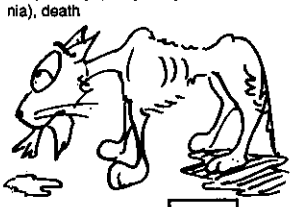
Herbicides with no or only mild toxic effects reported in dogs
- Alachlor
- Bendiocarb
  - Ficam
  - Turcam
- Benifin (Balan)
- Bensulide (Betasan)
- Chloroflurenol
- Dacthal
- Dicamba
- Dinitro compounds
- Na Chlorate
  - Atrazine
  - Prometone

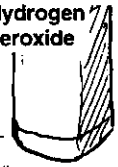
Phenoxy herbicides, 2,4-D, Chlorinated phenoxy derivatives, M8k 2059; H3B 1268; Tox-WW 261, 259t	• **Phenoxys, Synthetic** herbicides; e.g., 2,4-D, MCP, Silvex® • Reported but not verified in dogs on freshly sprayed lawns • Relatively nontoxic	• Vomiting & diarrhea, bloody feces • Myotonia • Ataxia, posterior weakness • Periodic clonic spasms	• Hx (exposure) • Lab: ↑ AP, LDH, creatine for liver, kidney & muscle damage	• Detoxify: - Wash for dermal exposure - Ingestion: activated charcoal, Ion trapping w/ Na bicarbonate; • Supportive: fluids, diuresis • Protect people Prognosis: Good w/ prompt Tx
Triazines M8k2061; H2B 1321; Tox-WW 259t	• Synthetic herbicides for crops (corn) • Atrazine®, Simazine®, Prometone® • Relatively toxic to ruminants	• Anorexia • Depression, weakness • Salivation • Dyspnea • Muscular spasms • Ataxia • Recumbency, death	• Exposure • Nonspecific CS so Dx difficult • Necropsy: enlarged, friable liver; pulmonary edema & hydrothorax	• ↓ Exposure & absorption (emesis, activated charcoal, cathartic) • Supportive • Diuresis
Glyphosate, Roundup M8k 2060; H3B 1265; H2B 1322; Tox-WW 260t; Cat 228	• Roundup®: herbicide for agriculture • Kleenup®: home spray • Toxicity: irritant, wide margin of safety, low toxicity if applied properly • Not reported in dogs	• Skin irritation • Gastroenteritis: vomiting & diarrhea • ± CNS: depression, coma	• Hx (known exposure) • CS are not characteristic	• Detoxify: emesis, activated charcoal, sodium sulfate cathartic • Supportive & symptomatic
Algacide H3B 1265; H2B 1323; Cat 228	• Home aquarium products for algae, may contain triazines or diquat • Monuron (Telvar®), Dicholone (Phygon®)	• Dermatitis • Depression, lethargy • Gastroenteritis (vomiting & diarrhea) • Ataxia, hyperreflexia • Large doses: cardiac or respiratory arrest; liver & kidney damage	• Hx (known exposure), CS	• Emesis/gastric lavage • Activated charcoal + cathartics
Dipyridyl compounds, Paraquat, Diquat M8k 2043; Mk 1656; E-hb 164; E 320; H3B 1264; H2B 1322; Cat 228; Tox 260, 262; Tox-WW 263, 258t	• **Rare** • Desiccant herbicide • Toxic effect - free radical damage to tissues, mainly in dogs & cattle • Spot sprays for weeds • Used as a **malicious poisoning against dogs**	• **Tissue irritation** (mouth lesions, skin & cornea) • **Gastroenteritis** (vomiting, diarrhea) • **Respiratory** (delayed dyspnea, pneumonia), death	• Hx (known exposure), CS **DDx:** • Organophosphates • Carbamates • Chlorinated hydrocarbons • ANTU • Allergic reactions • Ethylene glycol • Garbage toxicosis • Viral gastroenteritis	• Tx: w/in 24 hours: Oral absorbent (Bentonite® &/or Fuller's earth® [activated clays] better than activated charcoal + cathartic (Ground clay-based kitty liter in emergency - efficacy? • Fluids, Diuresis (mannitol or Lasix®) • Biochemical antagonist recommended (orgotein a superoxide dismutase [Palosein®], acetylcysteine [Mucomyst®], niacin, riboflavin, ascorbic acid [Vitamin C]) • O2 contraindicated **Px: Grave in clinically affected dogs**









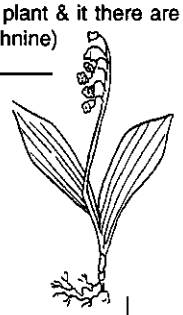


Poisonous Plants

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Poisonous plants JAVMA 205(4)p558, 1994; M8k 2099; H3B 1284; H2B 1333; C12T 217; Cat 229; Tox-WW 143, 10 *	• **Lethal plant poisonings rare** • Many ornamental plants are poisonous • Pets chew on greenery but prefer grass to poisonous plants - Predisposing factors to eating plants, boredom, young age, winter • May develops a taste for one - so discourage or remove plant	• Varies with plant eaten • **Vomiting & diarrhea common** • **Fatalities - rare** • ± Abdominal pain • ± Nausea • ± Salivation • ± Diarrhea • ± Cardiovascular collapse	• **Diagnosis difficult unless witness ingestion or see in vomitus** • Hx (exposure), CS • Plant material in vomitus or stomach contents	• **Remove GI contents** - Induce vomiting in a conscious pet (apomorphine (dog), xylazine (cat), syrup of ipecac or hydrogen peroxide) - Gastric lavage - Activated charcoal: followed in 30 minutes with: - Cathartic (sodium sulfate or 70% sorbitol) to hasten removal of toxicant-charcoal complex • Supportive & symptomatic care • Other Tx depending on plant & it there are antidotes (cyanide, strychnine)

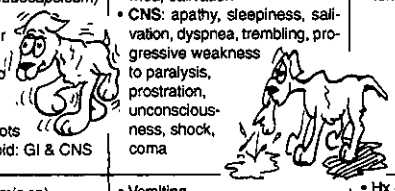
Poisonous plants

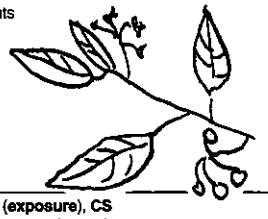
- Araceae family
  - Dumbcane (Dieffenbachia sp)
  - Split-leaf philodendron (Monstera sp)
  - Dashine (Colcasia sp)
  - Elephant ear (Alocacia sp)
  - Jack-in-the-pulpit (Arisaema sp)
- Nightshades (Solanum sp)
  - Nightshades (Solanum nigrum)
  - Jerusalem cherry (Solanum pseudocapsicum)
  - European bittersweet (*Solanum dulcamara*)
- Glycoside containing plants
  - Milkweeds (Asclepias sp)
  - Lily-of-the valley bush (*Convallaria majalis*)
  - Oleander (*Nerium oleander*)
  - Laurel or azalea (*Rhododendron* sp)
  - Foxglove (Digitalis sp)
- Taxine alkaloids
  - Japanese yew (*Taxus cuspidata*)
  - European yew (Taxus)
- Walnut (*Juglans nigrum*)
- Onions or garlic (*Allium* sp)
- Sago palms (Cycads or Macrozamia sp)
- Bleeding heart (*Dicentra spectabilis*)
- Marijuana
- Easter lilies (*Lilium longiflorum*)
- Blue green algae
- Caladium (*Caladium* spp)
- Gastrointestinal irritants
  - Poinsettia (*Euphorbia*) (also cardiovascular)
  - Aloa vera
  - Crown of thorns (*Euphorbia*)
  - Snow-on-the-mountain (*Euphorbia*)
  - Azalea (*Rhododendron*)
  - Bulbs of tulips, daffodil, iris, amaryllis
  - Castor bean (*Ricinus communis*)
  - Rosary pea (*Abrus precatorius*)
  - English ivy (*Hedera helix*)
- Mistletoe (*Phorandendron*)
- Soluble oxalates
  - Rhubarb (Rheum)
  - Beet tops (*Beta vulgaris*)
  - Devil's ivy
  - Sorrel (*Oxalis*)
  - Dock (*Rumex*)
- Contact irritants
  - Nettles: spurge, stinging, wood (*Urtica*)
  - Poison ivy, oak & sumac (*Toxicodendron*)
  - Asparagus fern (*Asparagus*)
  - Trumpet creeper/cow itch (*Campsis*)
  - Giant hogweed (*Heracleuum*)

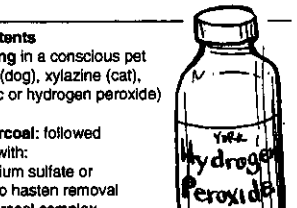


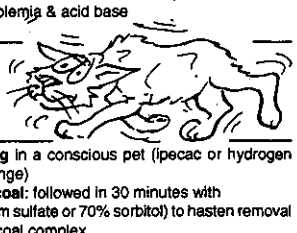
Poison control center
ph # (900) 680-0000

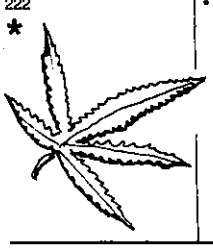
Nightshade, Solanum poisoning, Solanaceous alkaloids JAVMA 205(3)417,'94; M8k 2120t; H3B 1286; H2B 1343; Tox-WW 370 *	• Solanacea (nightshade) family - Nightshades (*Solanum nigrum*) - Jerusalem cherry (*Solanum pseudocapsicum*) - European bittersweet (*Solanum dulcamara*) - Christmas cherry (*Solanum pseudocapsicum*) • Plant poisonings rare • Pets chew on greenery but prefer grass to poisonous plants • May develops a taste for one - so discourage or remove plant • Green fruit most toxic, then, red or black fruit, leaves, stems & roots • Pathophysiology: steroidal alkaloid: GI & CNS	• Rapid course: succumb or recover in 24-36 hours • **GI**: anorexia, nausea, colic, vomiting, constipation, diarrhea, salivation • **CNS**: apathy, sleepiness, salivation, dyspnea, trembling, progressive weakness to paralysis, prostration, unconsciousness, shock, coma	• **Diagnosis difficult unless witness ingestion or see in vomitus** • Hx (exposure), CS • Plant material in vomitus or stomach contents	• **Remove GI contents** - **Induce vomiting** in a conscious pet (apomorphine (dog), xylazine (cat), syrup of ipecac or hydrogen peroxide) - Gastric lavage - **Activated charcoal**: followed in 30 minutes with: - **Cathartic** (sodium sulfate or 70% sorbitol) to hasten removal of toxicant-charcoal complex • Supportive & symptomatic care • Milk for GI signs
Sago palms toxicosis * JAVMA 205(3)p417, 1994; Tox-WW 384; PP/USA/C 123	• Sago palms (*Cycads* or *Macrozamia* sp) • Florida & Texas • Plant poisonings rare • Pathophysiology: steroidal alkaloid - glycosides **hepatotoxic & neurotoxic**	• Vomiting • Diarrhea, salivation • Icterus, coagulopathy • Coma, death w/in hours to days • ± Hind limb paresis & paralysis	• Hx (**exposure**), **CS** • Plant parts in vomitus • Plant in stomach contents • ↑ Alanine transaminase (due to hepatotoxicosis) • Postmortem: centrilobular necrosis, bile retention, icterus, ecchymotic hemorrhages	• **Induce vomiting** in a conscious pet - Induce vomiting in a conscious pet (apomorphine (dog), xylazine (cat), syrup of ipecac or hydrogen peroxide) • Gastric lavage • **Activated charcoal**: followed in 30 minutes with • **Cathartic** (sodium sulfate or 70% sorbitol) • Fluids for hypovolemia & acid base • Kaolin/pectin
Bleeding * heart JAVMA 205(3)417, '94	• Bleeding heart (*Dicentra spectabilis*) • CS: CNS: Trembling, salivation, hyperexcitability, vomiting, recumbency, opisthotonus & convulsions w/in 10 minutes of ingestion; but **rarely fatal** • Dx: Exposure), CS, plant parts in vomitus & stomach contents • Tx: Time: commonly recover w/o treatment			
Marijuana. Hemp plant JAVMA 205(3)417,'94; M8k 2100t; H3B 1282; H2B 1338; Cat 236; Tox-WW 310, 368; PP/USA/C 222 *	• Marijuana: dried leaves of hemp plant (*Cannabis sativa*) • Hashish: resin extracted from hemp plant • Active ingredient: tetrahydrocannabinol (THC) • Dog > cat • Eat cigarette (roach, joint, etc.) or a whole lid, or laced brownies • Mechanism: not clear, change in levels of biogenic amines in CNS	• **CNS**: ataxia, incoordination, depression, excitement, hallucination (barking & agitation) • **GI**: vomiting & dry mucous membranes • ± Hyperthermia & tachypnea	• Hx (**exposure**), CS • **Plant parts in vomitus** • Plant in stomach contents • ± THC in urine • Bradycardia	• **Induce vomiting** in a conscious pet (ipecac or hydrogen peroxide by syringe) • **Activated charcoal**: followed in 30 minutes with • **Cathartic** (sodium sulfate or 70% sorbitol) to hasten removal of toxicant-charcoal complex • ± Assist ventilation • Keep warm & secure • ± Diazepam (Valium) if excessive excitement of aggression • ± Atropine for bradycardia Prognosis: **Good**

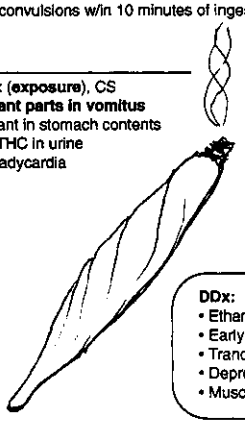












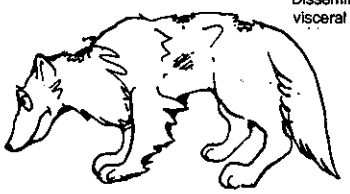
DDx:
- Ethanol
- Early ethylene glycol
- Tranquilizers
- Depressants
- Muscle relaxants

Poisonous Plants

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Onions or Garlic JAVMA 205(3)p417, 1994; M8k 2122t; Tox-WW 397; NB 20.5 *	• **Onions or garlic** (Allium sp) • Plant poisonings **rare** • Eating large number of onions at one time may result in toxicity, but unlikely • Pathophysiology: intravascular hemolysis	• **Hemolysis** - **Icterus** - **Anemia**	• Hx (exposure), CS • Plant parts in vomitus • Plant in stomach contents • Lab: anemia, hemoglobinuria, icterus, Heinz bodies, hemoglobinemia, anisocytosis, poikilocytosis, reticulocytosis	• **Blood transfusions & fluids**
GI irritants, Gastrointestinal irritants JAVMA 205(3)417,'94; H3B 1284; H2B 1341; C12T 218; Tox-WW 379, 32 **	• **Nontoxic but irritating to GI** • Gastrointestinal irritants - Poinsettia (*Euphorbia*) - Aloa vera - Crown of thorns (*Euphorbia*) - Snow-on-the-mountain (*Euphorbia*) - Azalea (*Rhododendron*) - Bulbs of tulips, daffodil, iris, amaryllis - Castor bean (*Ricinus communis*) - Rosary pea (*Abrus precatorius*) - English ivy (*Hedera helix*)	• Irritation, vesicles or mucous membranes • Gastroenteritis, abdominal pain - Diarrhea - Vomiting	• Hx (**exposure**), CS • Plant parts in vomitus • Plant in stomach contents	• **Remove GI contents** - Induce vomiting in a conscious pet (apomorphine (dog), xylazine (cat), syrup of ipecac or hydrogen peroxide - Gastric lavage - Activated charcoal, followed in 30 minutes with: - Cathartic (sodium sulfate or 70% sorbitol) to hasten removal of toxicant-charcoal complex • Supportive & symptomatic care • Kaopectate (kaolin + pectin) or Pepto Bismol Prognosis: **Good** **Rompun** **Apomorphine**
Mistletoe H2B 1341; Tox-WW 381; PP/USA/C 383 *	• Mistletoe (*Phorandendron*) • GI irritant & • Cardiovascular effects: due to amines phenylethylamine & tyramine	• Irritation, vesicles or mucous membranes • Gastroenteritis, abdominal pain	• Hx (exposure), CS • Plant parts in vomitus • Plant in stomach contents • Slowed pulse • ECG: cardiac arrhythmias • Serum potassium: hypo- or hyperkalemia	• **Remove GI contents** - Induce vomiting in a conscious pet: apomorphine (dog), xylazine (cat), syrup of ipecac or hydrogen peroxide) - Gastric lavage - Activated charcoal: followed in 30 minutes with: - Cathartic (sodium sulfate or 70% sorbitol) to hasten removal of toxicant-charcoal complex • Supportive & symptomatic care • Kaopectate (kaolin + pectin) or Pepto Bismol • Ventricular arrhythmias: Antiarrhythmics: phenytoin, propranolol or lidocaine
Cardiac glycosides *	**See Cardio pg 245:** Digitalis-like toxicity; Oleander, Foxglove; **unpalatable** CS: **Found dead**, Mydriasis; GI (**vomiting, diarrhea, salivation**); Dyspnea; Coma Dx: Hx, CS, ECG Tx: **Rarely possible - too fast** Prognosis: **Poor**			

Nephrotoxic plants, Soluble oxalates, Rhubarb poisoning M8k 2077; H3B 1269; H2B 1342; 5min 336; Cat 229; Tox-WW 387; PP/USA/C 230, 33 *	• **Soluble oxalates** - Rhubarb (Rheum) - Beet tops (Beta vulgaris) - Devil's Ivy - Sorrel (Oxalis) - Dock (Rumex) • Mechanism: absorbed into blood & **chelates> calcium** - May precipitate in renal tubules = blockage & necrosis	• **Vomiting & diarrhea** • **Hypocalcemia tetany** • **Acute renal failure** - Polyuria • Cardiac failure	• Hx (exposure), CS • Plant parts in vomitus • Plant in stomach contents • Calcium oxalate crystalluria • Hyposthenuria	• **Remove GI contents** - Induce vomiting: apomorphine (dog), xylazine (cat), syrup of ipecac or hydrogen peroxide - Gastric lavage w/ activated charcoal or - Calcium hydroxide (limewater) or calcium gluconate solution PO to precipitate oxalate as calcium salts - Cathartic (sodium sulfate) to hasten removal of toxicant-charcoal complex • **Demulcents:** Kaopectate (kaolin + pectin) or Pepto Bismol to protect GI • **Supportive & symptomatic** care: - Fluids (renal failure) - Diuresis - Calcium solution IV for hypocalcemia Prognosis: Poor if advanced clinical signs **Hydrogen peroxide**
Contact irritants, Nettles ** H3B 1287; H2B 1344; Cat 229; Tox-WW 376 PP/USA/C 57, 209, 449	• **Contact irritants** - Nettles: spurge nettles, stinging nettles, wood nettles (*Urtica*) - Poison ivy, oak & sumac (*Toxicodendron*) - Asparagus fern (*Asparagus*) - Trumpet creeper/cow itch (*Campsis*) - Giant hogweed (*Heracleuum*)	• Dermatitis • Glossitis, stomatitis • Vomiting	• Hx (exposure), CS	• Wash skin: copious warm, soapy water, wear gloves • **Remove GI contents:** induce vomiting, gastric lavage, activated charcoal, cathartic • Topical Tx for blisters or ulcerations Prognosis: **Good**
Mushrooms 5min 834; H3B 1287; H2B 1344; E-hb 165; Cat 229; PP/USA/C 71, 88 *	• **Mushrooms:** - *Amanita phalloides*: cholinergic: GI, CNS - *Gyromitra* spp.: hemolysis: liver, kidney, CNS - *Coprinus atramentarius*: arrhythmias & hypotension - Inocybe & Clitocybe spp: cholinergic effects	• Muscarinic CS - Hypersalivation - Vomiting & diarrhea • Ataxia, paralysis, coma • Liver & kidney damage - Icterus, azotemia • Psychotic: euphoria, hallucinations, in people	• Hx (exposure), CS • Mushroom in stomach	• **Remove GI contents:** induce vomiting, gastric lavage: potassium permanganate, activated charcoal followed in 30 minutes with a cathartic (sodium sulfate) • Physostigmine IM • Propranolol for cardiac arrhythmias • Penicillin may reduce uptake by liver • Supportive & symptomatic care • Monitor liver function Prognosis: ? **Hydrogen peroxide**
Aflatoxins M8k 2077; H3B 1269; H2B 1345; 5min 336; E-hb 167; Tox 416; Tox-WW 416 *	• *Aspergillus flavis* & *Penicillium* spp on feeds (corn, cottonseed, peanut, millo) • Produce toxins, most common in **poultry, swine & cattle** • Aflatoxins B1 particularly toxic to dogs; usually repeated exposure in feed	• Anorexia • Depression • Weakness • PU/PD (polyuria/polydipsias) • Diarrhea, (bloody) • Icterus • Prostration & death w/in 7-10 days	• History (exposure), CS (clinical signs) • ↑ Clotting, ↓ fibrinogen & platelets	• Detoxify: emesis or lavage, activated charcoal & cathartics • Hydrated sodium calcium aluminosilicate (HSCAS): absorbs aflatoxins in GI • Supportive & symptomatic Tx **Hydrogen peroxide**

Poisonous Plants

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Toxic blue-green algae, Algae poisoning, Algal poisoning JAVMA 205(3)p417, 1994; Mk 1638; H3B 1288; H2B 1345; Tox 451; Tox-WW 384, 79t; PP/USA/C 60 	• *Microcystis aeruginosa, Anabaena flosaquae, Aphanizomenon flos-aquae* • Hot, dry summer bloom (green scum) on lakes & ponds • Mid-W USA & Canada • Algae dies, toxin in water - foul fish smell, wind blows to shore, animals drink water - dies • **Ruminants more sensitive than monogastrics** **Bloom on water** **CS: CNS, GI, Death** **Dx: Difficult** **Tx: Emesis & support**	• **Death** w/in minutes to hours ("fast death factor" [cyclic polypeptide] • **Vomiting** • **Abdominal pain** • **Diarrhea** • Prostration • Rigidity • Muscle tremors • **Dyspnea** • ± Convulsions • Incoordination & death • Survivors: icterus, enteritis, nephritis, hepatitis	• **Diagnosis: very difficult - history** • Exposure • Algae identified in water or stomach contents supportive 	• No specific antidote, often animal dead or dying before Tx • **Emesis or lavage then activated charcoal & cathartic** • **Supportive care** **Hydrogen peroxide** **Prognosis:** Poor, die in 24 hrs; survivors may have liver damage
Prototheca, **Green algae,** Protothecosis, Opportunistic algae E-hb 498; SAP 703, 690t; H2B 1239; 426; IM 341; C12T 326, 329; C11T 1067, 1250 ★  	• **See Systemic Diseases** • **Green algae:** unicellular, colorless, w/ saprophytic, fungus-like mode of nutrition - *Ptototheca zopfii, P. wicerhamii* - Ubiquitous: found in sewage & animal wastes - Ingestion, wound contamination - Immunosuppression potentiates • **Disseminate diz in dogs** (Collies) • **Cutaneous in cat** • Rarely colonize GI: - Severe necrotizing or ulcerative enterocolitis Disseminates widely to other visceral organs, eyes, CNS **Dog: Disseminated: Large bowel, CNS, Ocular, Skin** **Cat: skin**	• **Dog: Disseminated** - **Chronic large bowel diarrhea** - **Weight loss** - **CNS:** depression, ataxia, paresis, vestibular, seizures, deafness - **Ocular:** blindness, intraocular inflammation, chorioretinitis, exudative retinitis w/ retinal detachment, anterior uveitis, anterior uveitis, panophthalmitis - **Skin:** crusty exudates of trunk, limbs & mucous membranes, draining ulcers - Kidney: renal insufficiency • **Cats: skin** - firm nodules on extremities, feet & head 	• **Hx, CS, PE** • **Lab: nonspecific** • **Colonoscopy** (thickened, corrugated mucosal folds m/b friable or ulcerative) • ID organism: CSF, rectal scrapings, rectal biopsies - Round, unicellular organism, 5-15µm, refractile capsule (blood agar, Sabouraud's dextrose media) Giemsa, GMS, PAS • Definitive: IFA testing at centers for Diz Control • CSF: pleocytosis (lymphocytes or granulocytes), ↑ protein **DDx:** • Eye & CNS: - Distemper - Systemic mycoses - Granulomatous meningoencephalitis • Large bowel diarrhea: - Histoplasmosis - Trichuriasis - Inflammatory bowel diz - Neoplasia	• Excision of skin lesions • Drugs tried for dogs: amphotericin B IV, ketoconazole PO, gentamicin sulfate, polymyxin B, nystatin, itraconazole • Successful Tx not reported **None reported** Prognosis: • **Disseminated: grave** no reported successful Tx • Ocular: resistant to Tx • Skin: guarded may respond to months of ketoconazole

2 PAM®: pralidoxime 576
4-MP®: 4-methylpyrazole 352
5-Fluorouracil®: fluorouracil

AAAAA

Accutane®: isotretinoin
Achromycin®: tetracycline
Acta-Char®: activated charcoal
Acthar®: ACTH (corticotropin gel) 656
Actigall®: ursodiol
Adalat®: nifedipine
Adequan®: polysulfated glycosaminoglycans, GAGS 598
Adrenalin®: epinephrine
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BBBB

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Banamine®: flunixin meglumine 114
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Brevibloc®: esmolol
Brevital®: methohexital sodium
Bricanyl®: terbutaline 114
Buprenex®: buprenorphine HCl
Buspar®: buspirone
Butazolidin®: phenylbutazone 731
Bute®: phenylbutazone 731

CCCC

Calan®: verapamil
Calciferol®: ergocalciferol (Vit D2)
Calciparine®: heparin calcium
Camalox®: calcium carbonate 346, 421
Canestran®: clotrimazole 703
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Carrisyn®: acemannan
Cefadyl®: cephapirin sodium
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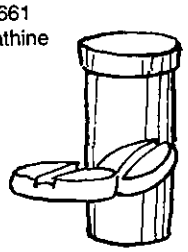
Duraquin®: quinidine gluconate
Dynapen®: dicloxacillin
Dyrenium®: triamterene



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EFA-Z-Plus®: essential fatty acids
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Fulvicin®: griseofulvin 727
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GGGG
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Hiprex®: methenamine hippurate
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Mesantoin®: mephenytoin
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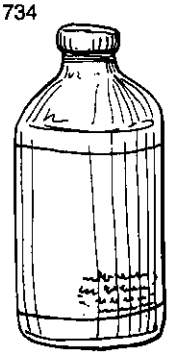

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spironolactone: Aldactone®
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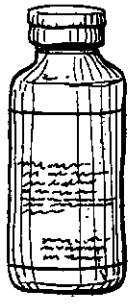

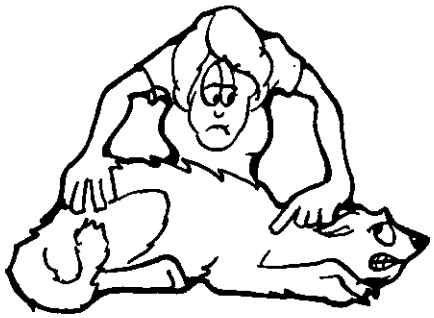

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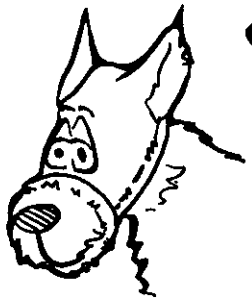


Measurements - Equivalents

M8k 2196; Mk 972; C12T 1417; H2B 1386

Fluids

1 L (liter)	= 1000 ml (10^3 ml)	≈ 1 qt (1.0567 L)
1 dl (deciliter)	= 100 ml (10^2 ml)	
1 ml (milliliter)	= 0.001 L (10^{-3} L)	= 15 minims (16.23)
	= 1 cc (cubic centimeter)	
1 µL (microliter)	= 0.000001 L (10^{-6})	
1 fl oz (fluid oz)	≈ 30 ml (29.57)	
1 pt (pint)	≈ 500 ml (473.2)	= 16 fl oz
	≈ 1/2 L (473.2 ml)	= 2 cups
1 qt (quart)	≈ 1 L (946.4 ml)	= 1.136 imperial L
1 gal (gallon)	≈ 4000 ml (3785.6)	≈ 4 L
	= 4 quarts	= 4.55 imperial L
	= 0.833 imperial gal	
1 cup	≈ 250 ml	= 8 fl oz
1 drop	= 1/20 ml	
1 tsp (teaspoon)	= 5 ml	
1 tbsp (tablespoon)	= 15 ml	
1 minim	≈ 0.06 ml (0.062)	

Length

1 yd (yard)	= 91.44 cm	≈ 1 m
1' (ft/foot)	≈ 30 cm (30.48)	
1" (in/inch)	= 2.54 cm	
1 m (meter)	≈ 40 " (39.37)	≈ 1 yd
	= 100 cm	
1 cm (centimeter)	≈ 0.4" (0.39)	= 10 mm
1 mm (millimeter)	≈ 0.04" (0.039)	

Weights

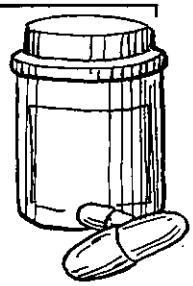
1 kg (kilogram)	≈ 2.2 lb (2.205)	= 1000 g
1 mg (milligram)	= 0.1 g (10^{-3} kg)	= 1/65 (0.015) gr
1 g (gram)	≈ 15 grains (15.43)	= 10 mg
	= 0.035 oz	
1 µg (microgram)	= 0.000001 g (10^{-6})	
1 ng (nanogram)	= (10^{-9})	
1 pg (picogram)	= (10^{-12})	
1 gr (grain)	≈ 65 mg (64.8)	≈ 0.065 g
1 oz (ounce)	≈ 30 g (28.35)	
1 lb (pound)	≈ 1/2 kg (0.454)	= 16 oz
1 µg/gm	= 1 part per million	= 1 mg/kg
1 ton	= 2,000 lb	
1 metric ton	= 1,000 kg	= 2,205 lb

Abbreviations

a, aa	artery (ies)	esp	especially	m/	may	R/O	Rule out
abd	abdomen	ext	external	m/b	maybe	RR	respiratory rate
abnorm	abnormal	FB	foreign bodies	med	medial	rt	right
ABs	antibiotics	Feds	Federal agents	membr	membrane	Rx	drug(s)
bact	bacterial, bacteria	fx, fxs	fracture(s)	metab	metabolic	SID	once a day
BID	twice/day	gen	general	min	minute	sm	small
bilat	bilateral	hi	high	MLV	modified live virus	spec	spectrum
C&S	Culture & Sensitivity	hr(s)	hour(s)	mo (s)	month, months	SQ	subcutaneous
caud	caudal	HR	heart rate	n, nn	nerve(s)	supf	superficial
CrN	cranial nerve	hs	at night	neg	negative	Sx	surgery
conc	concentrate	Hx	history	norm	normal	thru	through
cran	cranial	IM	intramuscular	PCV	packed cell volume	TID	three times/day
CS	clinical signs	IN	intranasal	perf	perforating	TP	total protein
d(s)	day, days	incr	increase	PM	postmortem	Tx	treatment
decr	decrease	infec	infection	PMNs	neutrophils	UMNs	upper motor neurons
DDx	differential Dx	inflam	inflammation	PO	per os/orally	usu	usually
defc	deficiency	int	internal	pos	positive	unilat	unilateral
degen	degenerative	IP	intraperitoneal	ppt	precipitate	vac	vaccination
dist	distal	IV	intravascular	PRN	as needed	ventr	ventral
diz	disease	jt	joint	preg	pregnancy	v, vv	vein(s)
DJD	degenerative joint diz	lat	lateral	prblm	problem	w/	with
		lb	pound	prox	proximal	w/i	within
DOC	Drug of Choice	lg	large	Px	prognosis	w/o	without
dors	dorsal	lig (ligg)	ligament(s)	q	every (as in q12 hrs)	wk(s)	week, weeks
Dx	diagnosis	LMNs	lower motor neurons	QID	four times/day	wt	weight
elev	elevated	ln, lnn	lymph node (s)	repro	reproduction	yr(s)	year, years
envir	environment	lt	left	resp	respiratory	#	number or pound

VetBooks.ir

Drug abbreviations

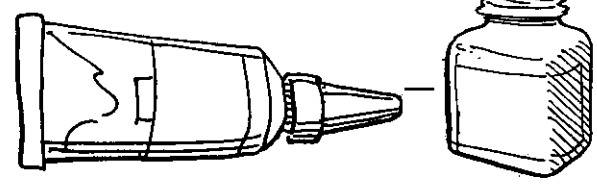


Routes of administration

PO	per os, by mouth or orally
SQ	subcutaneous injection
IM	intramuscular injection
IV	intravenous injection
IP	intraperitoneal (into peritoneal cavity)
IN	intranasal
IC	intracardiac
IT	intrathecal (into subarachnoid space)

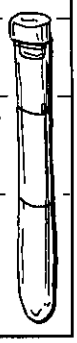
Dosage Schedules/Timing

q	every (e.g.; q4h = every 4 hours)
SID	every day, q day or every 24 hours
BID	twice a day, q 12 hours
TID	three times a day or q 8 hours
QID	four times a day or q 6 hours
QOD	once every other day, q 48 hours
PRN	as needed, as in "1 tablet PRN for pain
hs	at night



Blood Tube "Run Down"

Color (ingredients)	**Uses**	**Comments** [Resulting testing solution]
Red (nothing)	Common chemistries Serology Occult heartworm	[Serum]
Red & black (None, separator)	Common chemistries Serology Occult heartworm	[Serum]
Green (lithium heparin)	"Stat" chemistries Hormone tests Ammonia	"Stat" = Don't have to wait for clotting [Heparin plasma]
Black (Batroxobin enzyme + soybean trypsin inhibitor)	Fibrin degradation products (FDP)	Used for DIC dogs [serum]
Gray (NaFl)	Glucose	[Plasma]
Gray (Diatomaceous earth)	Activated clotting time	[Whole blood clot]
Gray w/ bright yellow label (nutrients)	Urine culture	[Urine]
Blue (Na Citrate)	PT & PTT Von Willebrand's diz (hereditary coagulopathy, Dobies)	Must fill tube completely
Purple (EDTA)	CBC Fibrinogen Microfilariae heartworm Hormone tests Serology	[EDTA plasma]



Clinical chemistry: normal range

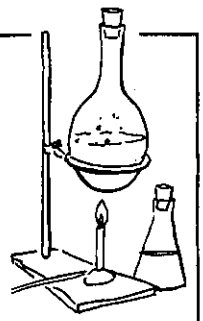
M8k 2192; Mk 969; H2B 1380; C12T 1395

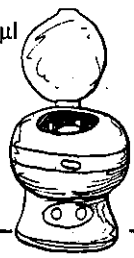
	Dog	Cat
BUN (Urea nitrogen) mg/dl	10-25	16-30
Creatinine mg/dl	0.5-2.0	0.5-2.0
Total bilirubin mg/dl	< 1.0	< 0.6
Cholesterol mg/dl	100-300	100-200
Glucose mg/dl	60-110	70-120
Total Protein g/dl	5.0-7.0	5.0-8.0
Albumin g/dl	2.3-4.0	2.7-4.0
A/G ratio	0.8-2.0	0.8-1.5
Fibrinogen mg/dl	150-200	150-200
Electrolyte:		
Na (sodium) mEq/L	140-155	145-160
K (potassium) mEq/L	3.5-6.0	3.5-5.0
Cl (chloride) mEq/L	100-125	110-125
Ca (calcium) mg/dl	9.0-12.0	8.0-12.0
P (phosphorus) mg/dl	2.5-6.0	3.0-8.0
Mg (magnesium) mg/dl	1.5-3.0	2.0-3.0
Acid-base		
pH	7.30-7 .40	7.25-7.40
CO_2 mEq/L	20-30	20-25
$pHCO_3$ (Bicarbonate) mEq/L	20-25	16-22

Enzymes:	Dog	Cat
SAP (Alk phos) IU/L	20-150	10-100
ALT/SGPT (SALT/serum alanine aminotransferase/ serum glutamic pyruvic transaminase) (IU/L)	10-115	15-50
AST, SGOT (AST/aspartate aminotransferase) IU/L	10-50	10-40
CPK (CK, creatine phosphokinase) U/L	20-120	20-200
GGT (gamma-glutamyl transferase) U/L	1-10	2-20
LDH (lactate dehydrogenase) IU/L	10-90	10-100
SDH (sorbitol dehydrogenase) U/L	3-10	2-6
Amylase U/L	< 1,000	1,2000
Lipase STU/dl	< 1	< 1

Normal - RBCs & WBCs

	Dogs		Cat	
PCV (hematocrit) %	40-55		30-45	
RBCs (erythrocytes) $10^6/\mu l$	5-9		5-10	
Hgb (hemoglobin) g/dl	12-18		10-15	
MCV (mean corpuscular volume) fL	60-75		40-55	
MCH (mean corpuscular Hgb) pg	19-25		13-17	
MCHC (mean corpuscular Hgb conc.) g/dl	30-36		30-36	
Reticulocytes (%)	0-1.5		0-1	
RBC life span (days)	120		70	
Thrombocytes µl	200-500,000		100-300,000	
WBC (leukocytes) $10^3/\mu l$	5,000-17,000		5,000-20,000	
PMNs (Neutrophils)	3,000-12,000	(60-70%)	3,000-12,000	(35-75%)
Bands $10^3/\mu l$	< 300	(0-3%)	< 300	(0-3%)
Lymphocytes 103/µl	1,000-5,000	(12-30%)	1,500-7,000	(20-55%)
Monocytes $10^3/\mu l$	150-1,300	(3-10%)	0-850	(1-4%)
Eosinophils $10^3/\mu l$	100-1,000	(2-10%)	100-1,000	(2-10%)
Basophils $10^3/\mu l$	Rare		Rare	





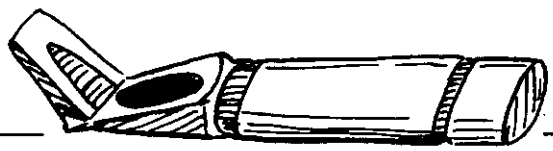
Patient monitoring - normals

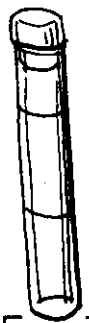
M8k 2188; Mk 966; H2B 1383

	Dogs	Cats
Rectal temperature	102°F (38.9°C) 101-102°F	101.5°F (38.6°C) 101.5-102.5°F
Heart rate (beats/min)	70-150	150-200 (120-210)
Respiratory rate (breaths/min)	20 (16-20)	25 (20-24)
Capillary refill time (CRT) (sec)	< 2	< 2

All Labs vary widely!!!

These are only general guidelines for interpreting laboratory data





Cerebrospinal fluid analysis

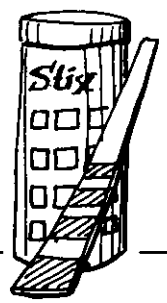
H2B 1383

	Dog	Cat
Color	Clear, colorless	
Pressure (mm H2O)	< 170	< 100
Cell count/µl		
WBCs (mononuclear)	< 8	< 8
RBCs	None	None
Protein (mg/dl)	< 25	< 20

Urinalysis

H2B 1381; C12T 1412; M8k 2189

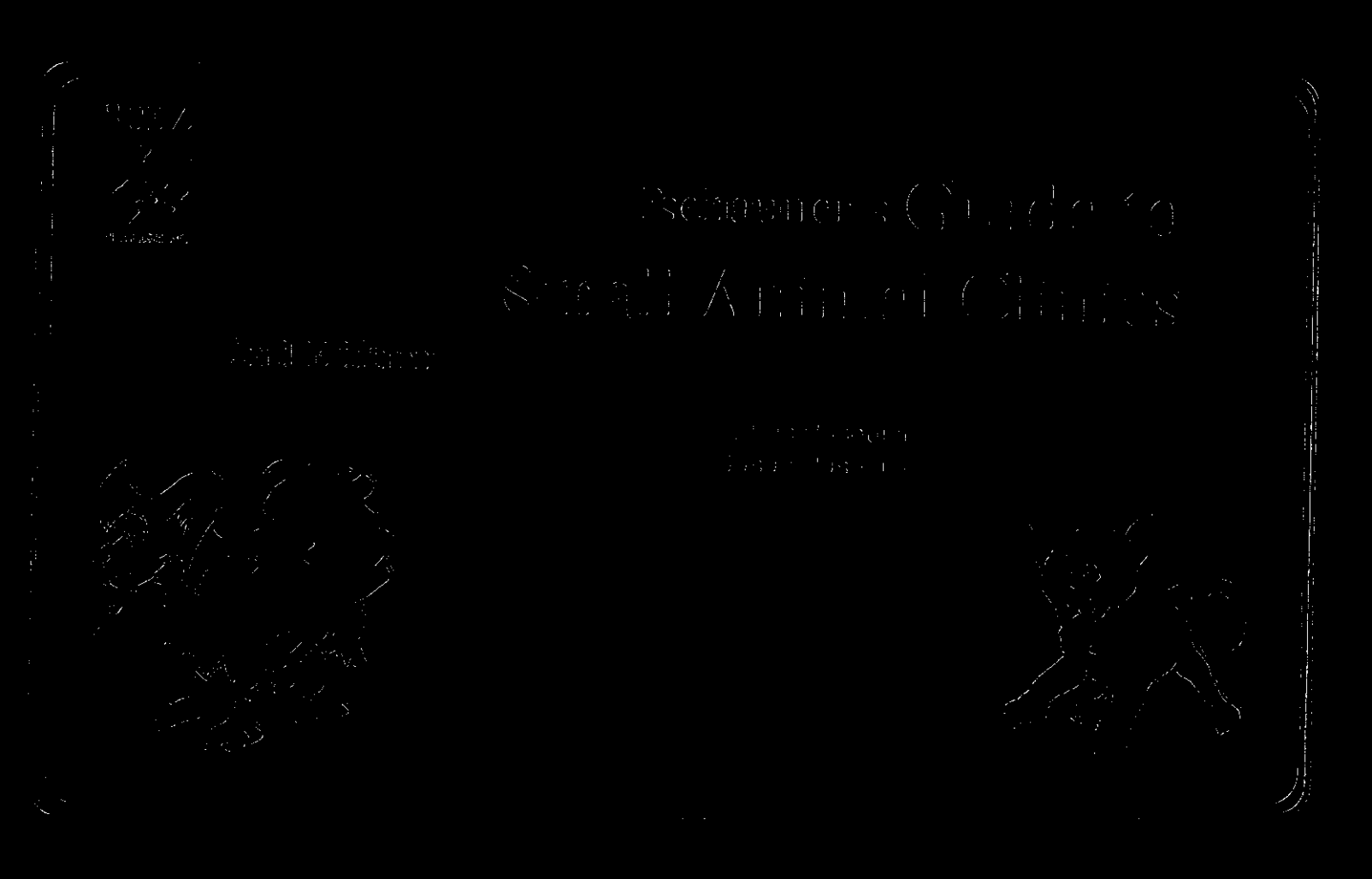
	Dog	Cat
Color	Light yellow	Yellow
Turbidity	Clear	
Specific gravity	1.015-1.045	1.015-1.060
Urine volume (ml/kg/day)	25-40	20-30
Semiquantitative tests/dipstick		
Protein	Negative when SG < 1.035 Trace when SG > 1.035	
Blood	Negative	
Glucose	Negative	
Ketones	Negative	
Bilirubin	Trace when SpG > 1.035	Negative
pH	5.0-7.0	



Manual clinical chemistry procedures

C12T 1401

	Dog	Cat
Bile acids (µmol/L)		
Fasting	0-9	≤ 2.2
2 hr postprandial	0-30	≤ 12.6
Sulfobromophthalein retention (% at 30 min)	≤ 5%	≤ 3%
Anion gap (µmol/L)	15-25	15-25



Saunders Guide to Small Animal Clinics is a quick reference guide to conditions found in dogs and cats. It is constructed in easy to read charts dealing with facts, causes, clinical signs, diagnosis and treatment of the most common conditions. It provides an easy to use differential diagnosis list for most conditions, with one chapter totally dedicated to hypertrophy. Its many levels allow different approaches to assimilating the information, either by skimming to get a handle on each condition, or delving deeper. Keyed to other veterinary texts for easy reference, it is an excellent starting point for studying for the national board exam.

Chris Pasquini's other books include *The Atlas of Equine Anatomy*, *The Atlas of Bovine Anatomy*, *Anatomy of Domestic Animals*, *Guide to Bovine Clinics*. Two books he worked on received the "Award of Excellence" by the Association of American Medical Illustrators including *The Anatomy of Domestic Animals*. They are all teaching texts clarifying the complex. *Saunders Guide to Small Animal Clinics* continues the tradition of making veterinary information more accessible to the veterinary student.

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