Physical Rehabilitation for Veterinary Technicians and Nurses

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Introduction to Physical Rehabilitation for Veterinary Technicians/Nurses

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CHAPTER MENU

As veterinary technicians, we vow to further our knowledge and competence through a commitment to lifelong learning (NAVTA, 1987). Over the past decade, awareness of animal physical rehabilitation has increased, and rehabilitation has become a rapidly growing service within veterinary specialty hospitals, referral centers, and primary care practices. Every day, we hear about laser therapy and underwater treadmills, equipment that was not traditionally covered in the veterinary technician's college curriculum. Learning more about rehabilitation enables the veterinary technician to better assist the supervising veterinarian when physical rehabilitation therapies are recommended. This chapter aims to answer some questions about rehabilitation for veterinary technicians and nurses.

What is Rehabilitation?

Physical rehabilitation is the treatment of injury or illness to decrease pain and restore function (AARV, 2015). Rehabilitation is used

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to address acute injuries and chronic injuries or diseases that have been affecting a patient for a long time. Rest alone after injury usually does not relieve the problems caused by inflammation and spasm; for example, a muscle in spasm may not have adequate blood supply to heal. Protective mechanisms in place in the body following injury alter movement of the whole musculoskeletal system and increase strain on other areas. Physical rehabilitation should commence as soon as is possible for the patient and caregiver.

History of Human Physical Therapy

International History

Physicians such as Hippocrates and, later, Galenus are believed to have been the first practitioners of physical therapy, advocating massage, manual therapy techniques, and hydrotherapy (Physiosite, 2015). In Ancient Greece in around 460 BC, Hector practiced a technique called "hydrotherapy" (derived from the Greek words for water treatment). In 1894, physiotherapy was recognized in Great Britain as a specialized branch of nursing regulated by the Chartered Society of Physiotherapy. The first emergence of physiotherapy as a specialist discipline was in Sweden in 1913 when Per Henrik Ling founded the Royal Central Institute of Gymnastics (RCIG) for massage, manipulation, and exercise. In the following two decades, formal physiotherapy programs were established in other countries, led by the School of Physiotherapy at the University of Otago in New Zealand in 1913. From 1950, chiropractic manipulations were also introduced; this was initially most common in Great Britain. A subspecialty of orthopedics, within physiotherapy, also emerged at about the same time.

Developments in the United States

In the United States, physical therapists formed their first professional association, called the American Women's Physical Therapeutic Association, in 1921 (Moffat, 2003; APTA, 2015). In 1922, the association changed its name to the American Physiotherapy Association (APA) and in the 1930s, it introduced its first "Code of Ethics." At this time men were admitted and the membership grew to just under 1000. With the advent of World War II and a nationwide polio epidemic during the 1940s and 1950s, physical therapists were in great demand. The association's membership grew to 8000. By the late 1940s, the association had changed its name to the American Physical Therapy Association (APTA). The APTA represents more than 90 000 members throughout the United States. A national professional organization, APTA's goal is to foster advancements in physical therapy practice, research, and education. Currently 213 institutions offer physical therapy education programs and 309 institutions offer physical therapist assistant education programs in the United States.

History of Veterinary Physical Rehabilitation

Physical rehabilitation for animals has been practiced since the 1980s. In biomedical research, the use of animal models in treatment protocols is common, and this includes research in the field of physical rehabilitation. From the late 1980s and throughout the 1990s several groups helped to increase interest in canine and equine physical rehabilitation. These groups include the American Veterinary Medical Association (AVMA), the American College of Veterinary Surgeons (ACVS), and the formation of the Animal Physical Therapist Special Interest Group (APT-SIG) within the APTA. Success with human patients receiving postoperative physical therapy has galvanized the veterinary community into developing physical rehabilitation techniques that can be implemented for animal patients (McGonagle *et al.*, 2014). In June 1993, the APTA issued a position statement that "endorses the position that physical therapists may establish collaborative, collegial relationships with veterinarians for the purposes of providing physical therapy services or consultation" (APTA, 1993). In 1996, "Guidelines for Alternative and Complementary Veterinary Medicine" were adopted by the AVMA House of Delegates (AVMA, 2000) and new guidelines were adopted in 2001 (AVMA, 2001). Training in animal physical rehabilitation was establish by a group at the University of Tennessee (McGonagle *et al.*, 2014). This training and certification course was, and still is, provided for veterinarians, veterinary technicians, physical therapists, and physical therapy assistants.

The International Association of Veterinary Rehabilitation and Physical Therapy (www.iavrpt.org) became an official association in July 2008 and is a collaborative association of veterinarians, technicians, physical therapists, and other allied health professionals. Veterinarians interested in rehabilitation in the United States are encouraged to join the American Association of Rehabilitation Veterinarians (AARV), founded in 2007 (www.rehabvets.org). Veterinary technicians can become members of the AARV as associate members, as can other allied health professionals.

In 2010, the American College of Veterinary Sports Medicine and Rehabilitation was approved by the American Association of Specialty Veterinary Boards (AASVB), in order to establish and maintain credentialing and specialty status for veterinarians who excel in sports medicine and rehabilitation. A veterinarian can become board certified in either canine or equine specialties under this college (www.vsmr.org).

Veterinary technicians can take one of several certification courses in animal rehabilitation, as explained further in Chapter 2. For those technicians that are already certified in physical rehabilitation, a veterinary technician specialty group is under formation. This group is under the umbrella and direction of the National Association of Veterinary Technicians in America (NAVTA), and is called the Academy of Physical Rehabilitation Veterinary Technicians. This specialty certification will allow veterinary technicians and nurses to possess the credential VTS-physical rehabilitation. The mission statement of the academy is: "We are credentialed rehabilitation veterinary technicians providing assistance in physical rehabilitation, encouraging veterinary technicians to further education, while improving the quality of animals' lives."

Specifics About Veterinary Physical Rehabilitation

The AARV has produced a model set of guiding principles for the ideal practice of veterinary physical rehabilitative medicine (AARV, 2014) These model standards state:

- Patient care in the rehabilitation facility should be under the authority, supervision or approval of a licensed veterinarian certified in rehabilitation therapy.
- Initial examination and diagnosis should be determined by a licensed veterinarian with rehabilitation certification.
- The rehabilitation treatment plan should be formulated and the case managed by a licensed veterinarian with rehabilitation certification, or a combination of this veterinarian in consultation with an appropriately licensed physical therapist certified in animal rehabilitation.
- No technician/assistant (certified or otherwise) shall manage a rehabilitation patient.
- There shall be a formal policy in place to monitor and evaluate patient response to care.
- The practice shall use individualized rehabilitation and therapy plans including fitness plans.
- For patients with concurrent conditions: Clients shall be advised early in the course of care of the opportunity to request a second opinion or referral to a specialist for treatment of these conditions.

- The rehabilitation practice shall regularly update the patient's primary care veterinarian as well as any other veterinarian involved with the patient's current care.
- A summary of the initial rehabilitation evaluation findings should be sent to the referring veterinarian at the earliest opportunity, preferably within 24 hours of the evaluation.
- The patient shall be discharged back to the care of the primary veterinarian once therapy is complete.
- When referring a patient for additional workup, appropriate referral communication (such as letter, email, phone conversation) shall occur and should be properly documented in the patient's record.
- Evaluation for pain shall be part of every patient visit.
- Practice team members shall be trained to recognize pain and work in collaboration with the veterinarian to provide appropriate pain management including physical and pharmaceutical modalities.
- Since medical and emergent issues may arise during treatment, and pain management monitoring needs to be addressed by a veterinarian, having the rehabilitation veterinarian on site is ideal. A plan must be in place to address emergent care medical issues and pain management in the absence of direct (on site) veterinary supervision.
- Practice team members should be trained to identify causes of pain, levels of pain, medications and physical methods used to control pain.
- Pain scores should be documented in the medical record at each visit.
- Pain management techniques should be used when the presence of pain in a patient is uncertain.
- Clients should be adequately educated to recognize pain in their pet.
- Clients should be adequately educated about the possible effects of any dispensed analgesic, including adverse events.
- Tentative diagnoses and medical plans, or their subsequent revisions shall be communicated to clients at the earliest reasonable opportunity.
- A rehabilitation veterinarian should have current knowledge of veterinary approved diets, nutraceuticals and supplements as well as knowledge and skills in weight loss and weight-management programs.
- Nutritional assessment and counseling should be part of routine care.
- Recommended continuing education requirements:
  - Each veterinarian should have a minimum of 15 hours continuing education every 2 years specifically in veterinary rehabilitation topics.
  - Each veterinarian should have a minimum of 20 hours per year of documented continuing education in the field of veterinary medicine.
  - Each veterinary technician should have a minimum of 10 hours of documented continuing education in the field of veterinary rehabilitation every 2 years.
  - Each veterinary technician should have a minimum of 10 hours of documented continuing education in the field of veterinary technology every two years.
  - Each physical therapist should have a minimum of 15 hours of documented continuing education in the field of veterinary rehabilitation every 2 years.
  - Each physical therapist should complete continuing education in their own field as recommended by their governing state board.

How do Veterinary Technicians and Nurses fit in?

Veterinary technicians must complete either a 2-year (associate's degree) or a 4-year program (bachelor's degree) in the United States. Veterinary nurses are the primary para-veterinary workers in the United Kingdom and assist vets in their work, and have a scope of autonomous practice within which they can act for the animals they treat. This can include minor surgery. Registered veterinary nurses (RVNs) are bound by a code of professional conduct and are obliged to maintain their professional knowledge and skills through ongoing continuing professional development (RCVS, 2015). In the United States, in approximately 40 states, veterinary technicians are certified, registered, or licensed (Levine *et al*., 2014). Veterinary technician programs do not include extensive coursework in physical rehabilitation.

Most continuing education courses offered at international, national, and local meetings offer physical rehabilitation lectures and hands-on laboratories. The AARV provides a full day of lectures at the North American Veterinary Conference, the American College of Veterinary Sports Medicine and Rehabilitation (ACVSMR) offers lectures (canine and equine) at this conference and also a program in conjunction with the ACVS annual symposium.

Where Can I Become a Certified Rehabilitation Veterinary Technician?

The greatest asset for effective physical rehabilitation is an educated veterinary team (Sprague, 2013). A rehabilitation technician is a certified, licensed or registered veterinary technician who has completed a prescribed curriculum to receive the title of CCRA (Certified Canine Rehabilitation Assistant), CCRP (Certified Canine Rehabilitation Practitioner), or CVMRT (Certified Veterinary Massage and Rehabilitation Therapist). There are currently four certification programs in the United States that offer these titles.

Canine Rehabilitation Institute

The Canine Rehabilitation Institute (www.caninerehabinstitute.com) offers the CCRA program for veterinary technicians and the Certified Canine Rehabilitation Therapist (CCRT) program for veterinarians and physical therapists at training facilities in Florida and Colorado.

NorthEast Seminars

NorthEast Seminars (www.canineequinerehab.com) offers the CCRP or Certified Equine Rehabilitation Practitioner (CERP) for veterinarians, physical therapists, and veterinary technicians at the University of Tennessee.

Healing Oasis

Healing Oasis (www.healingoasis.edu) offers the CVMRT program for licensed veterinarians, licensed or certified veterinary technicians, licensed physical therapists, licensed nurses, and or licensed/certified massage therapists at their facility in Wisconsin.

Animal Rehabilitation Institute

The Animal Rehabilitation Institute offers the Certified Equine Rehabilitation Assistant (CERA) to veterinary technicians and physical therapist assistants. Veterinary continuing education units are currently being applied for through the AVMA (http://animalrehabinstitute.com/).

What is Involved in Becoming a CCRA, CCRP, CVMRT, CERA, or CERP?

Formal educational courses and wet labs are involved for all the certification courses. Each school has its own curriculum. The cost is relatively expensive for a veterinary technician, but this certification may allow the veterinary technician to command a higher salary. You must be a licensed veterinary technician (LVT), certified veterinary technician (CVT), or registered veterinary technician (RVT) in order to attend most of the courses. Veterinary assistants are not accepted in all but the Healing Oasis course. The best way to investigate the programs is to visit the Canine Rehabilitation Institute website (www.caninerehabinstitute.com) and look for Certified Canine Rehabilitation Assistant.

Practice Regulations for Veterinary Technicians

Candidates for certified or registered veterinary technician are tested for competency through an examination which may include oral, written, and practical portions. Every state is different and maintains its own regulations with respect to the practice of veterinary medicine. Practice acts, legislated by states and provinces, often define the responsibilities of the veterinary technician. These responsibilities and duties are dependent in part on the type of employment the individual chooses. Here are links to standards for practice acts provided by NAVTA and the American Association of Veterinary State Boards:

- http://www.navta.net/?page= state_resources1
- https://www.aavsb.org/PDF/Practice%20Act%20Model_FullDocument_9-6-10.pdf

Each person needs to investigate their own state practice act to see what encompasses practicing as a veterinary technician.

A rehabilitation veterinary technician should be working under the direct supervision of a credentialed rehabilitation veterinarian who directs therapy. The larger team may be made up of a credentialed physical therapist, the referring veterinarian, a veterinary specialist (surgeon, neurologist, etc.), a veterinary chiropractor, acupuncturist, hospital support staff, the owner, and other trained veterinary professionals.

Working in the Physical Rehabilitation Field

The duties of the rehabilitation veterinary technician include assisting their supervising veterinarian in evaluations and in performing therapies. Therapies that the technician can provide include application of prescribed physical modalities and therapeutic exercises. Part of patient care is ensuring patient records are up-to-date and accurate. Proper documentation of treatments should be completed each day. Any member of the rehabilitation team should be able to refer back to the record and understand the needs and past treatments of each patient. Clear client communication and education is also necessary. Chapter 2 Joining a Rehabilitation Team goes into detail about the role of each team member.

Pain plays a role in any patient's willingness and motivation. A patient's pain score should be assessed and documented in the medical record during each visit (AARV, 2014). A detailed history should indicate the degree of pain and the disability (Davies, 2014). How does the patient cope with the disability? If changes in a patient's pain level are noted, the supervising veterinarian should be notified. It is very important for the rehabilitation veterinary technician to remain in open communication with their supervisor about anything abnormal or any changes in progress.

Much of the certified veterinary rehabilitation technician's day is like that of any other LVT, RVT, or CVT. Animal patients are admitted, housed properly, and kept clean. Often during the day patients are taken outside so they can relieve themselves. Technicians may be required to pull records for the therapist (veterinarian or physical therapist) and to keep patient forms and records sent from the referring veterinarian in order and available. Equipment should be kept clean, orderly and ready for use. Assisting the therapist with their patients and listening to them is all part of the routine. At this point, any veterinary technician could fill this position. What sets the veterinary technician apart that is certified in rehabilitation?

Therapeutic Exercises

Therapeutic exercises are a daily part of the veterinary technician's routine. The owner/handler must be well educated on the exercise program, especially the home exercise program (HEP). The supervising veterinarian chooses the exercises and the technician carries them out. Exercises target proprioception and balance, specific muscle groups, overall pattern of gait, and overall strength and endurance. Therapeutic exercise equipment may include physioballs, cavaletti rails, balance blocks and discs, weights, tunnels, rocker boards, wobble boards, treadmills, air mattresses, or planks (Coates, 2013). Patient considerations such as motivation, footing, assistive devices, and leash/harness control must be assessed prior to beginning any exercise program, and the therapist/handler body mechanics must be monitored to prevent injury. Exercises are designed to address specific impairments and each is described with a goal, a technique, and a progression (McCauley and Van Dyke, 2013). In order to fully understand the therapies, certification at one of the rehabilitation schools is necessary.

Manual Techniques

Specialized manual techniques are used in evaluating and treating the patient. One of the techniques the technician is trained in is massage, as described by Coates (2013):

> Massage – Effleurage consists of long slow strokes, generally light to moderate pressure, usually parallel to the direction of the muscle fibers. Petrissage involves short, brisk strokes, moderate to deep pressure, parallel, perpendicular, or diagonally across the direction of the muscle fibers. It may include kneading, wringing, or skin rolling. Tapotement is rhythmic, brisk percussion often administered with the tips of the fingers, primarily used as a stimulating stroke to facilitate a weak muscle and cross-friction massage involves applying moderate pressure perpendicularly across the desired tissue. Pressure is maintained in such a way that the finger does not slide across the skin, but rather takes the skin with it.

Normal range of motion (ROM) is the full motion that a joint may be moved through. Passive range of motion (PROM) of a joint is performed without muscle contraction within the available ROM, using an external force to move the joint (Millis and Levine, 2014a).

Stretching techniques are often performed in conjunction with ROM exercises to improve flexibility of the joints and extensibility of peri-articular tissues, muscles, and tendons (Millis and Levine, 2014b).

Physical Modalities

Physical modalities are often used as part of the patient's treatment plan. They are used as tools to manage pain, weak muscles, inflexibility, limited joint ROM, and to aid in tissue healing (Niebaum, 2013). Physical modalities include the following:

- Superficial thermal agents – hot (thermotherapy) and cold (cryotherapy)
- Neuromuscular electrical stimulation (NMES) – usually used to address muscular weakness
- Transcutaneous electrical nerve stimulation (TENS) – used for pain relief
- Therapeutic ultrasound – a deep heating technique used for rehabilitating musculoskeletal conditions (Levine and Watson, 2014)
- Low-level laser therapy (LLLT) – using (not surgical) lasers to accelerate wound healing, promote muscle regeneration, treat acute and chronic pain, chronic and acute edema and neurologic conditions (Millis and Saunders, 2014)

- Extracorporeal shockwave therapy (ESWT) – to increase bone, tendon, and ligament healing, accelerate wound healing, and provide antibacterial properties and pain relief (Niebaum, 2013)
- Pulsed electromagnetic field therapy (PEMF) – to induce biological currents in the tissue. PEMF is approved by the US Food and Drug Administration (FDA) as safe and effective for the treatment of fractures and their sequelae (Rosso *et al.*, 2015). The main therapeutic purpose is for enhancement of bone or tissue healing and pain control (Millis and Levine, 2014a).

Additional areas of education include topics such as aquatic therapy, canine orthotics and prosthetics, rehabilitation of the orthopedic and neurologic patient, canine sports medicine, pain management, nutrition and geriatric patients.

Conditions that can Benefit from Physical Rehabilitation

A range of therapies are used to achieve one or more of the following functional goals:

- To speed recovery from injury or surgery
- To increase mobility and flexibility
- To mprove endurance and agility
- To decrease pain (Goldberg, 2016)
- To maintain function and prevent further problems
- To enhance quality of life.

Physical rehabilitation helps an individual that has had an illness or injury to achieve the highest level of function, independence, and quality of life as possible (Sharp, 2008). The success or otherwise of any surgery is as much down to the rehabilitation carried out as to the surgical technique performed. Some of the conditions that benefit from physical rehabilitation are listed in Box 1.1.

Rehabilitation offers numerous physiological benefits to patients, including:

- increased blood flow and lymphatic drainage to the injured area,
- reduction of pain, swelling, and complications,
- increased production of collagen,
- prevention of contractions and adhesions,
- promotion of normal joint biomechanics (Goldberg, 2016),
- prevention of other injuries,
- prevention of or reduction in muscle atrophy, and
- improved function and quality of movement.

Box 1.1 Sample conditions benefiting from physical rehabilitation

Orthopedic

- Postoperative rehabilitation (e.g., stifle or hip surgery, arthrodesis, amputation, ligament/tendon repair)
- Acute and chronic soft tissue injuries, involving muscle and fascia, tendon, joint capsule, or ligament (limbs or trunk)
- Arthritis (long-term management)
- Developmental orthopedic diseases (e.g., hip dysplasia, elbow dysplasia)
- Trauma and wound care

Neurological

- Postoperative rehabilitation (e.g., decompressive surgery, reconstructive surgery)
- Central or peripheral nerve injuries
- Fibrocartilaginous embolism, spinal shock
- Degenerative nerve disease (e.g., myelopathy, polyneuropathies)
- Balance/vestibular problems
- Nervous system trauma

General

- Pain management
- Athletic/working dogs (performance problems, improving strength and endurance)
- Obesity
- Depression
- Senior care

Source: Adapted from Sharp (2008).

Conclusion

A rehabilitation veterinary technician's job is complex and fulfilling. There are advancements in veterinary medicine daily, and animal physical rehabilitation is on the cutting edge. Specialized rehabilitation equipment is helpful, but a lot can be achieved without it. Physical rehabilitation is rewarding, even with minimal equipment; all you need is a rehabilitation team.

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Joining a Rehabilitation Team

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CHAPTER MENU

Introduction

People who Work in a Veterinary Rehabilitation Facility

A veterinary rehabilitation facility, like any veterinary clinic or hospital, relies on a team of people working together with a common goal. The common goal in a veterinary rehabilitation facility is to improve the quality of life of patients by improving the ability of the animal (and owner) to perform the activities of daily living necessary for the animal's life to be fulfilling. Activities of daily living are daily self-care activities in the patient's home.

A useful approach in explaining who works in a veterinary rehabilitation facility is to look at it from the point of view of the patient and caregiver (client) entering the facility for the first time.

The patient and caregiver will be greeted and welcomed by a receptionist, technician, or manager. The patient and caregiver will then either be directed to take a seat in the waiting room or be guided to an examination room where intake paperwork (and treats) will be handed out.

The receptionist's responsibilities are answering the phone, scheduling, admitting, and discharging patients and facilitating the flow of traffic in the building. They may also explain treatment plans and estimates. This person should have a good knowledge of the process of veterinary rehabilitation and the flow of the facility. In our clinic, Twin Cities Animal Rehabilitation and Sports Medicine (www.tcrehab.com), we do not have a conventional receptionist; instead our rehabilitation veterinary technicians and

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office manager (also a veterinary assistant) take turns acting as receptionist. This way, each time a current or potential client calls, they are able to speak to someone who is familiar with all aspects of the clinic and can schedule our complicated array of therapies with the appropriate person at the appropriate time.

For most patients, the rehabilitation technician will be the first to enter the examination room and will put the patient and client/caregiver at ease. History taking may be performed by the technician or the rehabilitation veterinarian. Once a complete and detailed history has been taken, the physical and observational examination begins.

The rehabilitation veterinarian (along with any other professionals) will make functional and physical diagnoses; using this information they will develop a treatment plan. This plan will include at-home and in-clinic therapy. The rehabilitation technician will take part in explaining the home and in-clinic therapy plan to the client/caregiver in an easy-to-understand way.

In-clinic therapies will be performed by a combination of the rehabilitation veterinarian, rehabilitation veterinary technician, physical therapist, and other professionals, such as a veterinary acupuncturist, animal chiropractor, or massage therapist. The person performing the therapy depends on the therapy recommended and on that person's skill set. Many rehabilitation veterinarians have additional training in manual therapies (including manipulations) and in acupuncture. Both physical therapists and chiropractors are trained manual therapists and in order to work in the veterinary world will need to have had additional training and certification in working with animal patients.

Team Members

The Rehabilitation Veterinarian

The rehabilitation-trained veterinarian will examine the patient and assess pain level, injured tissues, concurrent disease, and functional limitations. If further diagnostics are needed, they will be performed in order for an exact diagnosis to be made. The rehabilitation veterinarian will develop a treatment plan including at-home and in-clinic therapy, medications, and recommended nursing care. Other professionals, if present, will contribute to this plan. The rehabilitation veterinarian may be a Diplomate of the American College of Veterinary Sports Medicine and Rehabilitation or be certified in rehabilitation.

The Rehabilitation Veterinary Technician

The rehabilitation technician will assist with the examination. The technician will assist in handling the patient, and with taking and recording measurements and observations, such as vital signs and pain scoring. The rehabilitation technician will take part in educating the client and explaining the home care and in-clinic therapy plan. The rehabilitation technician will also take part in in-clinic therapies under the supervision of the rehabilitation veterinarian. The rehabilitation technician should have received specific training in veterinary rehabilitation.

The Physical Therapist

A physical therapist, trained in animal rehabilitation, can evaluate the animal patient with the rehabilitation veterinarian. A specific diagnosis needs to be made by a veterinarian. Together with the rehabilitation veterinarian, the physical therapist will develop and institute the treatment plan. Physical therapists who work in animal rehabilitation should be certified in veterinary rehabilitation.

The Physical Therapist Assistant

The physical therapist assistant works under the supervision and direction of the physical therapist and does not evaluate, but is able to perform many therapeutic treatments. Physical therapist assistants who work in animal rehabilitation should be trained and certified in animal rehabilitation.

Adjunct Team Members

Other team members can include veterinarians who are trained in acupuncture or spinal manipulative therapy (veterinary term for chiropractic) and other veterinarians including specialists (surgeon, oncologist, neurologist, primary care veterinarian and pain specialists). Chiropractors who have received additional training and certification in animal chiropractic along with massage therapists may be involved in care of the rehabilitation patient.

Becoming a Rehabilitation Technician (Nurse)

A rehabilitation veterinary technician or nurse is a skilled individual who has devoted time, study, and energy into training in the art and science of veterinary rehabilitation. A rehabilitation technician or nurse will be instrumental in the execution of the rehabilitation therapy plan and will often be the first line in noting a change in patient status and advocating for them. Before becoming a rehabilitation veterinary technician an individual will qualify as a veterinary technician or nurse.

According to the National Association of Veterinary Technicians in America (NAVTA):

> veterinary technicians and technologists are educated to be the veterinarian's nurse, laboratory technician, radiography technician, anesthetist, surgical nurse and client/caregiver educator. A veterinary technician is a graduate from a two-year, American Veterinary Medical Association (AVMA) accredited program from a community college, college or university. A veterinary technologist has graduated from an AVMA accredited bachelor degree program. Almost every state requires a veterinary technician/technologist to take and pass a credentialing exam.

More information is available on the website of the NAVTA (http://www.navta.net/default.asp?).

This training includes education in veterinary anatomy and physiology, pathology, pharmacology, and disease processes. All of this information is essential for someone working in the field of veterinary rehabilitation.

Becoming a veterinary nurse in the United Kingdom involves either taking vocational training or a degree course. More resources and information can be found on the website of the Royal College of Veterinary Surgeons (RCVS) at (www.rcvs.org.uk) and the website of the British Veterinary Nurses Association (www.bvna.org.uk).

Each country will have its own regulating body, and contacting the main veterinarian-regulating body of your country will be the best initial approach to finding out more.

Training in veterinary rehabilitation is available at several educational facilities in the United States (Northeast Seminars partnering with the University of Tennessee, Canine Rehabilitation Institute, Equine Rehabilitation Institute, Healing Oasis Education Center). For more information, see Chapter 1. Healing Oasis Education Center and Canine Rehabilitation Institute also run courses in other countries (e.g., Canada, Switzerland, UK, Australia, and Brazil). These courses average 121 hours of education in the format of didactic (lecture) teaching in person and online along with interactive, practical training. This training is followed by a certification examination. It is important to note that these certification courses are self-regulating and may differ in content. There is no overseeing body ensuring that information is correct and applicable. Some courses have sought approval from state educational boards (Healing Oasis, for example). After certification, the technician/nurse candidate gains a certificate in canine rehabilitation (CCRA (Certified Canine Rehabilitation Assistant), CCRP (Certified Canine Rehabilitation Practitioner), or CVMRT (Certified Veterinary Massage and Rehabilitation Therapist)). These courses are available to veterinarians, veterinary technicians, physical therapists, physical therapy assistants, and, in some cases, chiropractors, massage therapists, and veterinary assistants. The certification gained from these courses should always be interpreted in the light of the individual's other qualifications and degrees and does not provide a blanket qualification to practice rehabilitation medicine, or to make a diagnosis and to prescribe therapy.

Completion of the certification process and emerging as a certified rehabilitation technician is only the beginning of the journey into this rewarding and fulfilling field in veterinary medicine. The next steps are on-the-job training and continuing education, just as a veterinarian always continues their education and learning. Continuing education lectures, laboratories, and seminars in this subject are currently available at many major veterinary conferences. There are also stand-alone meetings entirely devoted to rehabilitation, such as the International Association of Veterinary Rehabilitation and Physical Therapy meeting (www.iavrpt.org) which occurs every 2 years and alternates between European and American locations, and the Symposium for Therapeutic Advances in Animal Rehabilitation (STAAR) (www.staarconference.com) in New Jersey annually.

The Rehabilitation Patient

Surgical Patients

Surgical patients often make up a large proportion of cases in an animal rehabilitation facility. Many rehabilitation facilities are housed in, or adjacent to veterinary surgical facilities. The surgical patient may be seen by the rehabilitation technician/nurse and the supervising rehabilitation veterinarian both before and after surgery. A patient may need to lose weight before undergoing anesthesia or the surgeon may have advised some pre-surgical strengthening. Most surgical patients that are referred for rehabilitation will have already had orthopedic surgery, or surgery aimed to improve neurologic dysfunction. The aim of rehabilitation therapy for these patients is to assist in recovery of strength and function; function includes flexibility and coordination. The specialist surgeon will give input to the rehabilitation practitioner about restrictions in activity relative to stability of the surgical repair/procedure. This input is from a unique perspective as only the surgeon has seen the full extent of tissue damage and the relative success (or struggle) in repairing and minimizing the effects of that damage. The surgeon will be principally concerned about healing of the surgical site and may want to be more conservative than the rehabilitation team. Understanding the surgeon's point of view and acting with collegiate respect is important, however the surgeon may need to be enlightened about the process of rehabilitation and the appropriate qualifications of the people he or she is working with pertinent to case management. Restricting activity and motion of the affected area unduly can transform the detrimental effects of immobilization from a temporary to a permanent one. In human medicine, mobilization of a patient after repair of a complex spinal fracture begins immediately post operatively (J Yeater, personal communication, 2015). A rehabilitation veterinarian should be the person to govern communications with the surgeon.

The Injured Non-surgical Patient

These are patients with a physical injury or disease affecting mobility and comfort for which surgery is not indicated, or in some cases not possible for reasons such as the risks of anesthesia. Many soft tissue injuries are treated this way. Having a specific diagnosis of tissue pathology as well as a diagnosis of functional limitations is of paramount importance. An exact diagnosis still needs to be reached in order to formulate an appropriate rehabilitation plan. Lame patients referred for "strengthening" should be carefully evaluated and diagnosed by the veterinarian before the onset of rehabilitation therapy; for example, exercising a patient with a severely damaged tendon can cause further pathology. The aim of rehabilitation therapy for the injured patient is to manage pain and restore maximal function.

Patients with Chronic Degenerative Disease

Chronic degenerative diseases (e.g., osteoarthritis, immune-mediated polyarthritis, degenerative myelopathy, spinal stenosis, obesity) all affect mobility and strength. The aim of rehabilitation therapy for these patients is to improve function in the light of their disability, to manage pain and to improve quality of life. Even an unstable neurologic patient with permanent nerve damage can improve gait with improved strength, because they can overcome the forces of motion while ataxic, and improve forward momentum and stabilization if their muscles are working well. Balance and proprioceptive exercises can result in a relative improvement in overall stability.

Geriatric Patients

As individuals age, they lose muscle (this muscle loss is termed sarcopenia) and fine motor control/balance along with strength. The relatively immobile patient is also prone to obesity. Aging is not a disease process, but the incidence of systemic disease does increase with age. The aim of rehabilitation therapy for these patients is to improve their quality of life through pain management, improvements in mobility, and regaining the ability to perform the activities of daily living – even if this requires the use of assistive devices (see Chapter 10). Concurrent morbidity (e.g., bladder infections from incomplete emptying in the weak patient) must be taken into account and, of all the rehabilitation patient populations, this aged one needs the most frequent veterinary intervention.

The Canine Athlete/Working Dog

Working with canine athletes is an extremely rewarding process. Trainers/caregivers are motivated and generally knowledgeable. These patients cannot self-advocate and yet they have the drive of a human professional athlete; injuries are common. The aim of rehabilitation therapy for these patients is return to sport or work. A survey of agility owners found the injury rate of agility dogs to be 32% at the time of survey (Cullen *et al.*, 2013). Injury rates in young human athletes vary from 12% to 28% depending on sport. This is of great concern to doctors because conditioned adult athletes have only a 2–3% injury rate (AOSSM, 2009; Ganse et al., 2014). Part of the problem for young human athletes is their open growth plates when training; part is thought to be due to inadequate conditioning and relative overload. Conditioning plans have the potential to reduce injury rates in sporting dogs along with maintenance therapies (usually manual therapies and acupuncture, possibly therapeutic modalities). The goal of conditioning is to optimize the performance of the athlete and minimize the risk of injury and illness. Training adaptations are specific to the nature of the exercise (e.g., muscle contraction type and mechanics) and so conditioning should be appropriate for the demands of the sport. For example, long periods of trotting or walking exercise are an inappropriate conditioning plan for a sprinting athlete.

Your Team Role as Rehabilitation Veterinary Technician

Being a Patient Advocate

As a rehabilitation veterinary technician/nurse, you will be one of the team members who interacts most with both patient and client/caregiver. As you provide veterinarian-prescribed therapies, the time that you spend with the patient and client/caregiver will give you a unique insight into the personalities of both, and this will help you to quickly recognize changes in patient status.

When you encounter a patient for the first time, there will need to be an immediate assessment of patient demeanor (all people experienced with working on animals tend to do this automatically) and an understanding of how this particular patient may respond to novel situations and touch. Clients may not be immediately forthcoming or even honest with themselves about how their loved one reacts to unfamiliar situations. Taking time to put the patient at ease, no matter how long that takes, is crucial to enable a full examination and functional assessment. The rehabilitation examination is extensive and relies on a lot of touch, including physically moving the patient around. If pain is an issue, the patient may react in an aggressive manner. It is therefore paramount that proper pain management be included in the final analysis. A relatively relaxed patient is easier to examine from the point of view of compliance but also from the point of view of identifying areas of discomfort. Understanding animal behaviors, including signs of stress and fear, and having fundamental training skills will go a long way towards enabling an easy examination and a low stress process. Animal behavior is a branch of veterinary medicine that extends into everything we do. If we can put our patients at ease, future therapy visits will go well.

History taking may be performed by the technician or the rehabilitation veterinarian. History taking is often a lengthy process and includes questioning the client about the exact home environment (e.g., flooring and stairs in the home, pain scoring using home behaviors, patient activity level, and number of walks each day), timeline of the problem, any current or previous treatments and medications, other concurrent disease and activity level before the issue (owner expectations of return to normalcy). The examination is a full physical and functional assessment. Once a complete and detailed history has been taken, the physical and observational examination begins. The rehabilitation examination looks for areas of dysfunction and pain. The examination includes subjective and objective observations, Examples of subjective observations include conformation and posture, stance and sit position, transitions between postures, ability to hold posture, and response to palpation (both static palpation and palpation during movement of a joint, stretch of a muscle. etc.). Objective observations are those that can be measured, for example measurement of thigh girth with a spring-weighted tape measure, using a stance analyzer to assess the weight put through each paw, and gait analysis. As rehabilitation technician, you will assist the rehabilitation veterinarian and any adjunct professionals with their examination. The rehabilitation technician assists in handling the patient, applying restraint, if needed, using a minimal restraint approach. The technician may also be responsible for taking and recording measurements and observations, pain scoring the patient, and charting. The rehabilitation examination takes longer than a routine clinical examination and keeping the patient and client relaxed and focused can be a challenge.

The rehabilitation veterinarian will make a physical diagnosis and a functional assessment. Using this information, they will develop a treatment plan. This plan will include at-home and in-clinic therapy. The rehabilitation technician will take part in explaining the home and in-clinic therapy plan to the client/caregiver in an easy-to-understand way. Communication skills and empathy are essential parts of being a rehabilitation veterinary technician, just as they are for a veterinary technician or nurse working in general practice. The technician is often the translator of words from medical terminology to accessible terms, and can repeat an explanation of the diagnosis in a different way. In many cases, the visit to the rehabilitation veterinarian is the last in a long list of visits to several veterinarians, and so clients may be frustrated with the long process and need time and a sympathetic ear to vent these frustrations. Part of the skill of communication is the ability to listen without interrupting and to help the client feel heard before moving on with a full explanation of the treatment plan which engages the client as part of the therapy team.

The rehabilitation technician will go over the recommended plan with the client/caregiver using a step-by-step approach. This will include a financial estimate for the in-clinic plan, explaining the in-clinic therapy plan along with prescribed medications and supplements, and then covering the home therapy plan. The client/caregiver should gain a thorough understanding of the initial plan, therapeutic goals, and the potential for changes in the plan. They should be educated about the time-consuming nature of therapy, along with having an understanding of reasonable benchmarks for improvement (expectations) and how long it can take for even small improvements to occur.

Any questions that arise from the client/caregiver can be addressed directly by you or conveyed to the rehabilitation veterinarian. Finally, mediating the checkout at reception by scheduling a set of therapy visits before the client leaves can help to improve compliance. As one of the main people communicating with the client, the rehabilitation technician should make sure that the client knows how to contact the clinic with any follow-up questions prior to next visit – the large amount of information generated from the first visit often takes time to digest and questions can come up later.

Talking casually with client/caregivers during therapy sessions and asking gentle questions about home progress can often reveal potential pitfalls in the home care plan and other red flags: "Fluffy doesn't chase squirrels in the back yard so I decided he needed some off leash time." You are also uniquely situated to address concerns and to notice early and subtle changes in patient status: "Sam is not getting any better, I am worried that therapy isn't working" and "We had a great Christmas thanks for asking, apart from Sam did get on the kitchen counter and stole a ham; he hasn't done that in years!" Information revealed during conversations can be used to gently counsel and guide the client/caregiver regarding small positive or negative changes. Any issues of potential concern can then be discussed with the client/caregiver and with your supervising veterinarian so that you can implement any change in therapy plan. Plan changes should then be explained to the client/caregiver.

The special relationship that develops during therapy between you and a client/caregiver means that you are uniquely situated as an ally and confidant, more so than the veterinarian or other professional. You may be the only person able to gently point out to a client/caregiver that they are being noncompliant, without seeming judgmental or negative. Sometimes the technicians that I work with will use an indirect approach and "tell the dog" that they cannot go off leash yet, and even though they feel better, it does not mean that they are fully healed. The rehabilitation veterinary technician also has the opportunity to gently remind the supervising veterinarian of issues. For example, the enthusiastic home plan with 15 separate exercises devised by the veterinarian may be overwhelming an otherwise compliant client/caregiver. Perhaps the client/caregiver has downplayed a physical issue that they themselves have, which restricts their ability to implement the home plan. It may be that the owner is at risk of getting bitten and did not want to admit that to the rehabilitation veterinarian.

Observing a patient for a relatively long period during therapeutic visits may also highlight an issue that was not noted during the initial examination. The rehabilitation technician can become a skilled observer of gait and function and use this information to alert the veterinarian of the need for reassessment.

Many patients in rehabilitation are at risk of, or are already suffering from concurrent disease, this can be as simple as a mild gastrointestinal upset, a medication reaction/interaction, or it may be a more complex systemic issue (diabetes, chronic kidney disease), or even an acute crisis such as a gastrointestinal bleed. As a veterinary technician, your skill set extends beyond rehabilitation, and using your other skills and knowledge of medicine will be needed daily. You will need to be able differentiate important issues, which require a halt in therapy and immediate veterinary attention, from mild issues that can be monitored.

Working with clients over the phone is another important part of the rehabilitation technician's job. Questions about therapy, the rehabilitation process and other medical questions can often be answered immediately, the rehabilitation veterinarian is involved only an as needed basis. This "gatekeeping and educating" job is very much a part of a rehabilitation technician's role and should not be undervalued.

Providing the Prescribed Therapies

Learning how to provide therapy takes time and teaching by an experienced rehabilitation team. Introduction to modalities and therapeutic exercises is provided at the rehabilitation courses. Most of your skill, however, will be gained on the job under supervision. Knowing when to apply therapy appropriate for the diagnosis is the job of the supervising rehabilitation veterinarian; a physical therapist trained in animal rehabilitation may also provide a therapy plan once a veterinary diagnosis has been made. Complex manual therapies are not provided by the veterinary technician and require additional training before they can be provided by a veterinarian. Physical therapists learn manual therapy techniques during their years in school, but still need additional training in specifics of animal anatomy and biomechanics before applying their skills (quadrupeds are very different to bipeds, horses are very different to dogs). Your supervisor will advise and teach you appropriate light manual therapies such as massage and stretches, you can also gain additional training such as massage. Your knowledge of veterinary anatomy and physiology will help you to understand and apply therapy to the appropriate site, for example knowing the specific origin and insertion of a muscle and the direction of the fibers can help you to apply therapeutic ultrasound and follow it with cross fiber massage. During therapy you will note any response from the patient. The subtlest signs of discomfort can be identified by a skilled veterinary technician/nurse. Signs of discomfort need to be differentiated from signs of general stress or restlessness. Halting the therapy for a moment and noting whether the patient then relaxes while still being restrained is a simple method of differentiating discomfort due to therapy from discomfort due to restraint so that you can alert your veterinarian when appropriate for a change in plan.

Bribery goes a long way during treatment sessions, high-value treats (and a variety of treats, from immediate reward to those needing some work to eat) help to ease patient tension and improve compliance. In our clinic (Twin Cities Animal Rehabilitation and Sports Medicine), we often ask that owners refrain from buying the same treats that we use in clinic. That way the patients happily visit for "special treat time." Most of our patients come into a therapy room and point their nose straight at the treat bucket.

Assessing pain level is a part of each therapy visit. Question the owners about home behaviors and note in-clinic behaviors and response to palpation. For example, when we provide laser therapy, we can palpate the treatment area before and after therapy and note whether we get some immediate pain relief.

Client/Caregiver Education

Education of the client extends from helping them to gain an understanding of the disease process or injury to helping them to be part of the rehabilitation team for their pet. The rehabilitation technician will need to teach the owner the therapeutic exercises that will be performed at home. Teaching is

Figure 2.1 Your team will have developed strategies for teaching, including handouts with pictures, posters, models, and step-by-step instructions. Explain and demonstrate the exercise, then it is time for the client to practice.

a skilled job, and your team will have developed strategies, including handouts with pictures, online video demonstrations, and step-by-step instructions to aid you (Figure 2.1). First demonstrating the exercise slowly to the owner, then watching them perform the exercise and giving gentle hints and tips is advised. Every person learns in a different way and so providing a demonstration, hands-on practice, and reminders to be used later is a good way of ensuring that everyone is on the same page. A review of home exercises should occur at regular intervals (for example weekly) during in-clinic therapy visits and, as the patient progresses, new exercises will need to be demonstrated. When teaching a home exercise, remember to take into account the fact that there may be multiple members of the household responsible for therapy and that not all clients will be skilled at teaching other household members. Clients also need to be taught to watch for postural decompensations and "cheating" during specific exercises.

Nursing Care

Part of nursing care is patient advocacy as described earlier in this chapter. Physically caring for a patient in clinic involves, for example, addressing discomfort, identifying areas at risk for pressure (bed) sores, and making sure elimination is occurring adequately at home and that the patient is clean. Having the necessary skills to express a bladder, pass a urinary catheter, and evacuate a rectum manually or via enema is part of a veterinary technician's training. Pain management involves the use of pharmaceuticals, manual therapies, and modalities and the protocol for each patient may need to be adjusted at each visit. Grooming to remove excess hair from paws to improve traction, nail trimming, and removing excess hair from the perineum is important for patients with disabilities. Counseling owners about the home environment, home modifications, assistive devices, and home nursing care is time consuming and adequate time needs to be devoted to this. For more on nursing the disabled patient, see Chapters 10–13.

Working Under Supervision

Working with a Diagnosis and Prescribed Therapies

A veterinary technician is legally obligated to work in veterinary medicine under the supervision of a veterinarian. The veterinarian is responsible for the diagnosis and for the therapeutic plan. Adjunct professionals may contribute to this plan; however, they are not suitable supervisors for veterinary technicians. Both the veterinarian and veterinary technician have skills that complement each other and so make up a team. It is sometimes the belief of general practitioners that veterinary rehabilitation is solely the practice of therapeutic exercise and that any person can quickly become skilled in veterinary rehabilitation ("there is not much to it"). This is very far from the truth. The rehabilitation examination should be one of the most extensive examinations that a veterinary patient undergoes. Patients arriving with an existing diagnosis are not an exception to this, just as a neurologic examination is different to an orthopedic examination despite some overlap, so a rehabilitation examination is very different. Patients undergo a thorough assessment of function, including pain level, muscle tone, strength, and mobility with objective measurements. The whole body is examined, not just the injured area. Compensatory issues are identified and a treatment plan covers all issues, including any systemic disease, endocrine issues, nutritional status, body condition, and body composition. Any rehabilitation patient who is not examined this way is done a disservice. Therapeutic approach changes frequently as patient status changes, if patient compliance is a challenge, or if inadequate progress is being made. The rehabilitation veterinarian and technician will be in constant communication. Daily medical rounds are recommended. Rehabilitation technicians will apply and assist with therapies and are therefore closely monitoring a patient just as a technician would monitor a hospitalized patient; parameters are set for when to change the plan and when it is necessary to consult your supervisor (Figure 2.2). The same protocol of communication with the veterinarian applies to all aspects of veterinary medicine.

Figure 2.2 Daily medical rounds are recommended. Parameters are set and recorded for the therapy, when to change the plan, and when it is necessary to consult your supervisor.

Box 2.1 Red flags – Alert the veterinarian of these changes

- Any worsening symptoms from previous sessions
- New lameness or gait changes
- Sudden muscle atrophy/weakness
- Postural changes – head tilt etc.
- Changes to balance/coordination
- Change in mentation
- Tremors, clonus, seizures
- Other neurologic changes – circling, falling, etc.
- Change in temperament
- Ocular changes
- Head shaking
- Broken nails, pad changes
- Swelling
- Pale mucous membranes
- Distended abdomen
- Increased respiratory effort
- Change in urine color or odor
- Changes in stool color or consistency
- Incontinence or change in frequency of elimination
- Gastrointestinal disturbance
- Change in skin/hair coat

Approaching a Change in Patient Status

A sudden decline in patient status is always a reason to alert the attending veterinarian. Subtle changes may take additional time to recognize. As rehabilitation veterinary technician/nurses, you will become very familiar with observing a patient's gait and behaviors. Patient status can decline due to pain, relative overload (exercise was increased too rapidly, patient jumped on and off the couch at home), infection (e.g., implant infection, urinary tract infection), systemic disease, and many other reasons. Unmasking of a previously unrecognized systemic disease can sometimes occur. For example, as we slowly increase demands on a patient's respiratory system, early laryngeal paresis may be identified by increased breath sounds and increased panting. The supervising veterinarian will then need to outline necessary precautions and change the therapeutic plan accordingly. In the case of laryngeal changes, the team will need to avoid thoracic compression during hydrotherapy and to provide frequent rest breaks while avoiding overheating.

It is important to remember and use every one of your skills, including general medicine. We use general medicine in our clinic every day, even though we are a stand-alone specialty rehabilitation clinic. Every clinic should have a list of red flags – signs that all therapists know are important indicators of a decline in patient status. Signs that indicate an emergency may not always be obvious to adjunct professionals (distended abdomen in an already obese patient, cardiovascular changes, hydration status, cool extremities) and a large rehabilitation team needs every individual to be on task in order to catch signs early (see Boxes 2.1–2.5).

Also, team members need to be aware of their own limitations in training, pay close attention to the patient throughout therapy (even during conversing with the owner), and understand that it is better to alert their supervisor than to overlook potential issues.

Box 2.2 Red flags for skin and coat

Skin

- Signs of pressure/friction
- Self-mutilation (e.g., lick granuloma)
- Wounds
- Urine scald
- Bruising
- Discharge

Coat

- Thinning/alopecia
- Thicker, coarse
- Dryness/flaking
- Pruritus

Box 2.3 Red flags to listen for

- Popping
- Clicking
- Scraping
- Vocalizing in pain
- Change in pitch of vocalization
- Breathing – stertor (heavy snoring or gasping)/stridor
- Cough
- Change in heart rate/rhythm

Box 2.4 Red flags to feel for

- Local temperature change
- Masses
- Enlarged lymph nodes
- Change in pulse
- Joint swelling (effusion)
- Edema
- Localized muscle atrophy
- Change in end feel on passive motioning
- Crepitus
- Flinch and aversion
- Bony and/or soft tissue asymmetry
- Joint displacement

Box 2.5 Red flag odors

- Ears
- Mouth
- Urine
- Wounds
- Skin/coat

Legal Issues

Working with a rehabilitation-trained veterinarian is necessary because only a veterinarian can legally make a diagnoses and prescribe treatment. A veterinary technician must work under veterinary supervision by law in the United States, so from a legal standpoint, a rehabilitation veterinary technician must have a supervising veterinarian. Working with a primary care veterinarian with no formal training in physical rehabilitation is not recommended, veterinary schools teach little to no physical rehabilitation at this time. Working for a surgeon managing postoperative rehabilitation cases without a rehabilitation veterinarian is also not ideal, as even specialty surgery training does not generally include training in rehabilitation therapy (or sports medicine). The challenge comes due to the relative scarcity of veterinarians trained in rehabilitation in the United States; however, as this branch of veterinary medicine grows, more facilities will house appropriately trained personnel. A rehabilitation veterinarian will often have other qualifications, for example manipulative therapies, myofascial dry needling, and acupuncture. Specialists in veterinary rehabilitation and sports medicine are veterinarians who have completed residency training in the subject, experienced a large clinical caseload and have published scientific research and passed a specialty examination; they are given the qualification Diplomate of the American College of Veterinary Sports Medicine and Rehabilitation (DACVSMR). The formulation of the therapy plan may involve consultation with veterinary specialists (e.g., neurologists, nutritionists, oncologists, surgeons, pain specialists), and with other professionals (e.g., animal chiropractors, physical therapists). The rehabilitation veterinary technician will be part of a small or large team whose direct supervisor is the veterinarian. Different states (and countries) will have different laws. Be aware of the law in your region and the specifics of required veterinary supervision for a technician or nurse.

Future Directions for the Rehabilitation Technician

Cutting Edge of Rehabilitation Medicine

Rehabilitation medicine continues to grow and expand in both availability and complexity. As part of the veterinary rehabilitation team, you will be at the forefront of an exciting and expanding branch of veterinary medicine. Joining a team of trained individuals will expand your knowledge base and experience. Setting up a rehabilitation department with no other qualified individuals in a regular veterinary practice is more of a challenge and less than ideal. Rehabilitation medicine should not be an adjunct to a regular veterinary practice, rather it is its own entity, with its own skill set, like surgery or oncology. We need to recognize the high level that rehabilitation practice can achieve and to avoid limiting ourselves to low-level therapeutic exercises and laser therapy. Focusing on best practices in veterinary rehabilitation will expand and further the field, allowing us to act in the patients' best interests and improve outcomes. Best practices are outlined in the American Association of Rehabilitation Veterinarians Ideal Standards listed in Chapter 1.

Regenerative Therapies

Regenerative medicine (stem cells and growth factors used to stimulate healing and grow new tissue) is still in its infancy. There is a large amount of ongoing research into the effects of regenerative techniques, and results are promising. As rehabilitation technician, you will need to be familiar with these procedures, from harvesting tissue and blood to extracting cells and then administering the therapy (usually by injection). You will assist with these procedures. Basic principles of collection and sterile technique are used, with the same techniques as for all sterile procedures. Stem cells and blood products are usually taken from the patient they are returned to, but research and early clinical trials are starting to use allogenic (same species, different individual) stem cells and there may eventually be "off the shelf" products available. (Parker and Katz, 2006; Black et al., 2007). Your supervising veterinarian will train you in sample handling, harvesting, and administration procedures. It is helpful to write protocols for your clinic so that all team members understand set-up and protocol. Companies such as Vet-Stem Biopharma (www.vet-stem.com) provide complete instructions for harvesting, processing and injection of the processed cells. Platelet-rich plasma (PRP) can be processed at an outside facility, or there are in-clinic systems available. It is imperative that the rehabilitation veterinarian is the one making any decisions about this therapy as different preparation methods yield very different products.

Orthotics and Prosthetics

In recent years, the field of veterinary orthotics and prosthetics has grown and continues to grow. It is no longer always routine to treat an amputee with the view that they will cope well throughout life; gait analysis studies actually show evidence to the contrary (Hogy et al., 2013; Jarvis et al., 2013). A patient with a missing limb also has minimal ability to compensate for an injury to the remaining limbs. When considering a prosthesis, the planning needs to be made preoperatively, prior to amputation. As patient advocate you will ensure that communications and planning between all veterinarians involved and with the owner go smoothly.

A patient with a limb deformity is no longer resigned to limited motion. Sophisticated devices allow for good movement at all gaits and speeds. Orthoses, braces, and prostheses are veterinary medical devices and need to be prescribed by a suitably trained veterinarian. These devices are complex and fit is custom. High-tech materials ensure close fit, minimal motion between device and limb, and low friction. This minimizes the risk of complications such as skin irritation. These devices can store the energy of motion to assist forward movement, just as the elastic tissues of the body do. Chapter 10 goes into detail about these devices.

Hospice

Hospice care is providing nursing care to a patient in the final stages of life or a disease process that will end in loss of life. Home hospice care is a relatively new field of veterinary medicine, there are mobile veterinarians that provide home-based care and many of these veterinarians have equipment for home-based hospice (e.g., intravenous fluids, injectable analgesics). The International Association of Animal and Hospice Care (www.iaahpc.org) is an excellent resource. As rehabilitation therapists, we work with a lot of aged patients and patients with high levels of morbidity, and so hospice care is relevant to the field. Providing caregivers access to home visits and understanding the limitations and patient needs in the home is part of the scope of all veterinary medicine.

Respite care (temporary hospitalization or boarding of a high-need patient) is provided in human medicine and involves temporary institutionalized care for disabled patients and a rest for their caregivers. A similar need is present but little provided for currently in veterinary medicine. Many rehabilitation clinics provide daycare or have facilities for hospitalization and extended rehabilitation stays.

Specific Organizations for Veterinarians and Veterinary Technicians

The proposed Academy of Physical Rehabilitation Veterinary Technicians is a forming organization that is under the NAVTA Committee on Veterinary Technician Specialties (CVTS). (www.aprvt.com). The Committee provides a standardized list of criteria and assistance for societies interested in attaining Academy status. The American Association of Rehabilitation Veterinarians (www.rehabvets.org) is an advocacy group that provides membership, continuing education, and other resources for veterinarians and technicians. The International Veterinary Academy of Pain Management is an organization of veterinarians and veterinary technicians/nurses that have a special interest in the study of analgesia and pain management. There is a certification offered to both the veterinarian and veterinary nurse. Certified Veterinary Pain Practitioner (CVPP) is a credential that requires continuing education credit hours, written case studies, and a qualifying examination (http://ivapm.org/for-professionals/certification/)

Conclusions

Being part of a rehabilitation team is a highly rewarding experience. Working as a rehabilitation technician expands your horizons and

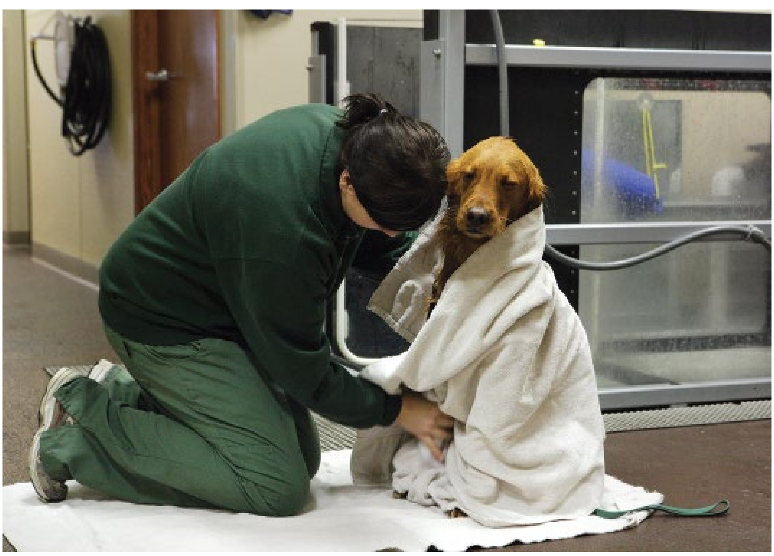

Figure 2.3 You will have the opportunity to work closely with patients on a relatively long-term basis. Rehabilitation is a rewarding career.

gives you an avenue to explore and gain skills beyond your veterinary technician certification or degree. Along with your new skills, you will use your veterinary technician training and practice conventional veterinary care every day, even in a practice that focuses only on physical rehabilitation. You will have the opportunity to work closely with patients on a relatively long term basis, often one on one, and with some autonomy. (Figure 2.3). You and your team will progress a case all the way to completion of care. Seeing your patient make a full recovery, or markedly improving their quality of life is immensely fulfilling. You end each work day knowing that you and your team are making a huge difference in your patients' quality of life and so making a difference to their whole family.

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3

The Veterinary Technician and Rehabilitation Pain Management

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CHAPTER MENU

Pain insists upon being attended to.
CS Lewis (1898–1963)

Introduction

Pain for the typical physical rehabilitation patient can occur during postoperative recovery, post injury, because of a disease state, or because of the aging process. It is beyond the scope of this chapter to provide in-depth information about the neurophysiology of pain, neuropharmacology, and most drug doses.

What are the Benefits of Physical Rehabilitation?

The benefits of physical rehabilitation are to:

- reduce pain (Sharp, 2008),
- increase and maintain muscle strength and flexibility,
- improve joint mobility,
- promote and restore normal movement patterns,
- increase cardiovascular fitness,
- combat acute and chronic inflammatory processes (Riviere, 2007),

Physical Rehabilitation for Veterinary Technicians and Nurses, First Edition.
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- improve blood perfusion and consequently tissue repair,
- prevent adhesions, fibrosis, and tissue retraction,
- stimulate the nervous system and prevent neurapraxia (temporary loss of motor and sensory function due to blockage of nerve conduction), and
- promote the healing process.

Top of the list of benefits of physical rehabilitation is "to reduce pain." Reviewing some of the human literature in evidence-based medicine for pain reduction and physical (rehabilitation) therapy, the following reports are found:

- "There is platinum level evidence that land-based therapeutic exercise has at least short term benefit in terms of reduced knee pain and improved physical function for people with knee Osteoarthritis" (Fransen and McConnell, 2008).
- "Extended exercises in water and swimming have been shown to reduce edema, inflammation, and peripheral neuropathic pain in a research model" (Akyuz and Kenis, 2014).
- "The most effective and strongly supported treatment modality for patients with PFPS (patellofemoral pain syndrome) is a combined physiotherapy program, including strength training of the quadriceps and hip abductors and stretching of the quadriceps muscle group" (Rixe *et al.*, 2013).

Research in veterinary medicine about the effects of physical rehabilitation on pain is less extensive. There have been several clinical studies, and a few notable ones are mentioned here. A study of 60 client-owned Labrador retrievers with hip dysplasia showed that exercise was associated with a decrease in the severity of lameness in dogs with hip dysplasia (Greene *et al.*, 2013). Seventy-five dogs with fibrocartilaginous embolism were examined through recovery, and it was found that hydrotherapy instituted immediately after diagnosis had a major positive influence on recovery (Gandini *et al.*, 2003). Therapeutic ultrasound used to treat two dogs with gastrocnemius muscle avulsions resolved lameness within one month as measured by forceplate (Mueller *et al.*, 2009). A survey-based retrospective study of dogs that underwent tibial plateau-leveling osteotomy for the management of cruciate disease found that dogs that had undergone rehabilitation therapy were 1.9 times more likely to reach full function at week 8; the group that underwent cage rest and leash walking was 2.9 times more likely to have unacceptable function at week 8 (Romano and Cook, 2015).

The World Health Organization's definitions for impairment and disability are pertinent to veterinary patients. Impairment is defined as "Any loss or abnormality of psychological, physiological, or anatomic structure or function." Disability is defined as "Any restriction (resulting from impairment) of ability to perform an activity in the manner or within the range considered normal for the species" (Davies, 2014a). If modified function was just a response to nociception (a painful, injurious stimulus), then analgesic medications would be enough; however, this is often not the case (Davies, 2014a). Musculoskeletal pain can be a part of any of the rehabilitation conditions listed above. The causes of musculoskeletal pain are not fully understood but likely involve inflammation, fibrosis, tissue degradation, and neurotransmitter and neurosensory disturbances, and may include central and peripheral hypersensitivity and impairment of descending inhibition of incoming nociceptive impulses (IASP, 2009).

It is important to remember that the credentialed physical rehabilitation veterinary technician is not to diagnose, prescribe, or perform procedures that are considered to be the practice of veterinary medicine, and must obey all individual state and regional laws and regulations pertaining to the field of veterinary physical rehabilitation (White, 2014). The credentialed physical rehabilitation veterinary technician will report to their supervising rehabilitation veterinarian on initial visit, during treatments and at all follow-up visits.

Veterinary physical rehabilitation is a discipline that encompasses the application of physical therapeutic and rehabilitation techniques (developed in humans and on lab animals) to animals whose comfort and function have been compromised in some way (Fox and Downing, 2014). In general, patients that present for rehabilitation therapy are reluctant to move. One of the major factors contributing to this reluctance is pain. “It is absolutely necessary that pain be controlled prior to initiation of physical rehabilitation” (R Downing, 2013, personal communication). The credentialed rehabilitation veterinarian (CCRT/CCRP/CVMRT) gathers information that will influence the treatment choices for individual patients. Patients experiencing acute pain following orthopedic surgery have different needs than the elderly dog experiencing the chronic maladaptive pain associated with long-standing osteoarthritis (Fox and Downing, 2014). Patients may present already being administered various pain medications that the rehabilitation veterinarian may consider changing. If it is at all possible the rehabilitation veterinarian should be in contact with the surgeon before a patient is referred for rehabilitation so that they are aware of the perioperative pain management plan. Excellent reviews of multimodal pharmaceutical management of pain can be found in *Pain Management for Veterinary Technicians and Nurses* (Albino, 2015) and *Canine Sports Medicine and Rehabilitation* (Epstein, 2013).

Although it is important for the credentialed rehabilitation veterinary technician/nurse to know and understand pain neurophysiology, neuropharmacology, and most drug doses, this is not the main job that they will have as far as pain management is concerned. As quoted from the *NAVTA Journal* article by White (2014):

> Pain plays a role in any patient’s willingness and motivation. A patient’s pain score should be assessed and documented in the medical record during each visit. (http://www.rehabvets.org/model_standards.lasso, 2013) A detailed history should indicate the degree of pain and the disability. How does the patient cope with the disability? If changes in a patient’s pain level are noted, the supervising veterinarian should be notified immediately. It is very important for the rehabilitation veterinary technician/nurse to remain in open communication with their supervisor about anything abnormal or any changes in progress.

Recognition and Assessment of Pain

Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage (Bonica, 1979; IASP, 2009). Pain motivates us to withdraw from potentially damaging situations, protect a damaged body part while it heals, and avoid those situations in the future (Lynn, 1984). It is initiated by stimulation of nociceptors in the peripheral nervous system, or by damage to or malfunction of the peripheral or central nervous systems (Woolf and Mannion, 1999). Most pain resolves promptly once the painful stimulus is removed and the body has healed, but sometimes pain persists despite removal of the stimulus and apparent healing of the body; and sometimes pain arises in the absence of any detectable stimulus, damage, or pathology (IASP, 2017).

Recognizing pain and assessing its intensity are both essential for its effective management. If pain is not recognized, then it is unlikely to be treated; failure to appreciate the intensity of pain will hamper the selection of an appropriately potent analgesic, raise doubts about the effectiveness of the administered dose, and result in less than optimal treatment (National Academy of Sciences, 2009). A reliable method of pain assessment allows an appropriate analgesic regimen to be used and effectively evaluated.

Assessment of Pain or Distress

Assessment of pain or distress may be based on many different criteria including (Goldberg, 2010):

- decreased activity,
- abnormal postures, hunched back, muscle flaccidity, or rigidity,
- poor grooming,
- decreased food or water consumption,
- decreased fecal or urine output,
- weight loss (generally 20–25% of baseline), failure to grow, or loss of body condition (cachexia),
- dehydration,
- decrease or increase in body temperature,
- decrease or increase in pulse or respiratory rate,
- physical response to touch (withdrawal, lameness, abnormal aggression, vocalizing, abdominal splinting, increase in pulse or respiration),
- teeth grinding (seen in rabbits and farm animals),
- self-aggression,
- inflammation,
- photophobia,
- vomiting or diarrhea, and
- objective criteria of organ failure demonstrated by hematological or blood chemistry values, imaging, biopsy, or gross dysfunction.

Some species-specific signs are listed in Table 3.1.

The most common approach to pain assessment is the use of charts and scales.

Are There Limitations to Pain Scales?

Pain scales should be used in conjunction with a thorough physical exam and history to assess every patient (Fox, 2014, pp. 27–45). The veterinary technician should recognize that all pain scales have limitations and that individual patient behavior may dictate prompt pain relief, regardless of the pain score. Caregivers should strive for low pain scores in a comfortable-appearing patient.

Pain scales can be subjective, such as visual analog scales (VAS), numerical rating scales (NRS), and simple descriptive scales (SDS) (Goldberg, 2010):

- VAS – uses a line with no markings. Numbers are at each end: 0 (no pain) and 100 (worst pain) (Figure 3.1).
- NRS – uses a number line with individual numerical markings (1–10) which are chosen as the score (Figure 3.2).
- SDS – numbers are assigned to descriptions that categorize different levels of pain intensity: 0 = no pain, 1 = mild pain, 2 = moderate pain, 3 = severe pain.

The Colorado State University Acute (Canine and Feline) are numeric and categoric, convenient pain scales that are easy to use in a clinical setting (Wiese, 2015). You can download these and an equine scale from http://csu-cvmbs.colostate.edu/Documents/anesthesia-pain-management-pain-score-equine.pdf.

Pain scales can be objective, such as the Glasgow Composite Pain Scale (Figure 3.3):

> A pain scale that takes into account the various dimensions of pain is thought to be more useful in indicating how much the pain "meant" to the animal, but VAS, NRS and SDS scales are unidimensional. A pain scale should ideally be multidimensional, in that several aspects of pain intensity & pain related disability are included and question especially the dynamic aspects. The Glasgow CPS is thought to be Multidimensional (Karas, 2011).

Several chronic pain scales have been developed for dogs, namely:

- Canine Brief Pain Inventory (CBPI) (Figure 3.4)
- Helsinki Chronic Pain Index (HCPI)
- Cincinnati Orthopedic Disability Index (CODI)
- Liverpool Osteoarthritis in Dogs (LOAD) Instrument and Questionnaire.

Table 3.1 Species-specific behavioral signs of pain.

Species	Vocalizing	Posture	Locomotion	Temperament
Dog	Whimpers, howls, growls	Cowers, Crouches; Recumbent	Reluctant to move; awkward, shuffles	Varies from chronic to acute; can be subdued or vicious; quiet or restless
Cat	Generally silent; may growl or hiss	Stiff, hunched in sternal recumbency; limbs tucked under body	Reluctant to move limb, carry limb	Reclusive
Primate	Screams, grunts, moans	Head forward, arms across body; huddled crouching	Favors area in pain	Docile to aggressive
Mice, rats, hamsters	Squeaks, squeals	Dormouse posture; rounded back; head tilted; back rigid	Ataxia; running in circles	Docile or aggressive depending on severity of pain, eats neonates
Rabbits	Piercing squeal on acute pain	Hunched; faces back of cage	Inactive; drags hind legs	Apprehensive, dull, sometimes aggressive depending on severity of pain; eats neonates
Guinea pig	Urgent repetitive squeals	Hunched	Drags hind legs	Docile, quiet, terrified, agitated
Horses	Grunting, nicker	Rigid; head lowered	Reluctant to move; walk in circles "up and down" movement	Restless, depressed
Chickens	Gasping	Stand on one foot, hunched huddled	None	Lethargic, allows handling
Cows, calves, goats	Grunting; grinding teeth	Rigid; head lowered; back humped	Limp; reluctant to move the painful area	Dull, depressed; act violent when handled

Sheep	Grunting; teeth grinding	Rigid; head down	Limp; reluctant to move the painful area	Disinterested in surroundings; dull, depressed
Pigs	From excessive squealing to no sound at all	All four feet close together under body	Unwilling to move; unable to stand	From passive to aggressive depending on severity of pain
Birds	Chirping	Huddled, hunched	From excessive movement to tonic immobility depending on severity of pain	Inactive; drooping, miserable appearance
Fish	None	Clamped fins; pale color; hiding; anorexia	None unless forced; if a schooling fish; will separate itself from others	First sign to occur is anorexia; lethargic; stressed easily
Amphibians	None	Closed eyes; color changes; rapid respirations	Immobility; lameness	Anorexia; aggressive;
Reptiles	Hiss; grunting	Hunched; hiding; color change	immobility unless forced	Anorexia; aggressive; lethargic; avoidance

This chart is meant to display some of the different signs species may exhibit if in pain. Individuals may not show any of these signs or they show signs not listed. This is meant as a general guide.
Source: Goldberg (2010).

0--100
No pain Worst pain

Figure 3.1 Visual analog scale (VAS) – pain scale.

Numerical rating pain scale

0--------1--------2-------3-------4-------5--------6---------7--------8--------9--------10
No pain Moderate pain Worst possible pain

Drawn by ME Goldberg

Figure 3.2 Numerical rating scale (NRS) – pain scale.

To date, the only multifactorial clinical measurement instrument for chronic pain in cats is the Feline Musculoskeletal Pain Index (FMPI) (Benito *et al.*, 2013). Otherwise there are no validated chronic pain scales for cats (Sekel, 2014). There is one paper (Lascelles *et al.*, 2007) that compared a client-specific outcome measure questionnaire with an activity monitor for ability to characterize impairment in 13 cats. Additional questionnaires and studies with cats have been completed (Bennett and Morton, 2009; Zamprogno *et al.*, 2010; Slingerland *et al.*, 2011; Vainionpaa *et al.*, 2012).

Suggestions for Effective Pain Scoring

- Have the same person evaluate the patient
- Place the VAS readings on the treatment/flow sheet as a chart
- Assess behavior
- Assess body posture, activity and position in cage
- Evaluate response to approach
- Interact with patient
- Palpation of surgical site
- Ask patient to ambulate, if appropriate
- Ask patient to eat, if appropriate.

In Summary

No single pain scoring system is right for all practices or facilities. In fact, it is less important which system you choose as it is to simply choose one system to be used by the entire team. Once a pain scoring system is chosen, apply it! At every single visit, assess the animal for pain and record the finding in the medical record. Each individual pain assessment is important; for a patient with chronic pain, trends are even more important because they tell us whether the patient's pain is improving or worsening. Similarly, surgical patients with acute pain need to be assessed at regular intervals (possibly every 2–4 hours immediately postoperatively) and thereafter twice daily with the results recorded in the medical record. Trends allow the team to understand the success of a perioperative pain management plan. Owners should be educated and taught how to pain score their pet. Encourage the owner to keep a chart of their pet's pain. A very basic chart for chronic pain can be extremely helpful (Box 3.1).

Pain Management Protocols and Education

The International Veterinary Academy of Pain Management (ivapm.org) offers an intensive program for veterinarians or licensed veterinary technicians/nurses to become a credentialed certified veterinary pain practitioner (CVPP). Having one or more CVPPs in the practice is beneficial for educating clients and team members and assuring clients that the practice is doing all it can to understand and manage pain in patients (Lee, 2014).

Dog's name ______________________________ **Date / / Time**

Hospital Number __________

Procedure or Condition ____

____

In the sections below please circle the appropriate score in each list and sum these to give the total score

A. Look at dog in Kennel

Is the dog

(i)		(ii)	
Quiet	0	Ignoring any wound or painful area	0
Crying or whimpering	1	Looking at wound or painful area	1
Groaning	2	Licking wound or painful area	2
Screaming	3	Rubbing wound or painful area	3
		Chewing wound or painful area.	4

In the case of spinal, pelvic or multiple limb fractures, or where assistance is required to aid locomotion do not carry out section **B** and proceed to **C**
Please tick if this is the case ☐ then proceed to C

B. Put lead on dog and lead out of the kennel

When the dog rises/walks is it?

(iii)	
Normal	0
Lame	1
Slow or reluctant	2
Stiff	3
It refuses to move	4

C. If it has a wound or painful area including abdomen, apply gentle pressure 2 inches round the site

Does it?

(iv)	
Do nothing	0
Look round	1
Flinch	2
Growl or guard area	3
Snap	4
Cry	5

D. Overall

Is the dog? *(v)*		*Is the dog?* *(vi)*	
Happy and content or happy and bouncy	0	Comfortable	0
Quiet	1	Unsettled	1
Indifferent or non-responsive to surroundings	2	Restless	2
Nervous or anxious or fearful	3	Hunched or tense	3
Depressed or non-responsive to stimulation	4	Rigid	4

Total Score (i+ii+iii+iv+v+vi) = ______

Figure 3.3 Short form of the Glasgow Composite Pain Scale. *Source:* Courtesy of Glasgow University, 2008. Reproduced with permission of New Metrica.

Today's Date: ☐☐ / ☐☐ / ☐☐
Month Day Year

Patient/Study ID# ____________________

Canine Brief Pain Inventory (CBPI)

Description of Pain:

Rate your dog's pain.

1. Fill in the oval next to the one number that best describes the pain at its **worst** in the last 7 days.
O 0 O 1 O 2 O 3 O 4 O 5 O 6 O 7 O 8 O 9 O 10
No Pain Extreme Pain

2. Fill in the oval next to the one number that best describes the pain at its **least** in the last 7 days.
O 0 O 1 O 2 O 3 O 4 O 5 O 6 O 7 O 8 O 9 O 10
No Pain Extreme Pain

3. Fill in the oval next to the one number that best describes the pain at its **average** in the last 7 days.
O 0 O 1 O 2 O 3 O 4 O 5 O 6 O 7 O 8 O 9 O 10
No Pain Extreme Pain

4. Fill in the oval next to the one number that best describes the pain as it is **right now**.
O 0 O 1 O 2 O 3 O 4 O 5 O 6 O 7 O 8 O 9 O 10
No Pain Extreme Pain

Description of Function:

Fill in the oval next to the **one number** that describes how during the past 7 days **pain has interfered** with your dog's:

5. General Activity
O 0 O 1 O 2 O 3 O 4 O 5 O 6 O 7 O 8 O 9 O 10
Does not Interfere Completely Interferes

6. Enjoyment of Life
O 0 O 1 O 2 O 3 O 4 O 5 O 6 O 7 O 8 O 9 O 10
Does not Interfere Completely Interferes

Figure 3.4 University of Pennsylvania Canine Brief Pain Inventory (CBPI). *Source:* Courtesy of University of Pennsylvania & Dr. Dorothy Cimino Brown.

Rehabilitation as a Treatment of Pain

The physical rehabilitation interventions aim to treat pain through techniques or modalities that:

- treat the cause of pain or
- mask, hide or modify the symptom of pain.

Treatment of the Cause of Pain

Chemical Pain

Inflammation as a Cause of Pain

- Aim: Promote resolution of inflammatory phase of healing (Veenman and Watson, 2008)
- Methods:

Today's Date: ☐☐ / ☐☐ / ☐☐
Month Day Year

Patient/Study ID# ______________________

Description of Function (continued):

Fill in the oval next to the one number that describes how during the past 7 days **pain has interfered** with your dog's:

7. Ability to Rise to Standing From Lying Down

O 0 O 1 O 2 O 3 O 4 O 5 O 6 O 7 O 8 O 9 O 10
Does not Interfere — Completely Interferes

8. Ability to Walk

O 0 O 1 O 2 O 3 O 4 O 5 O 6 O 7 O 8 O 9 O 10
Does not Interfere — Completely Interferes

9. Ability to Run

O 0 O 1 O 2 O 3 O 4 O 5 O 6 O 7 O 8 O 9 O 10
Does not Interfere — Completely Interferes

10. Ability to Climb Up (for example Stairs or Curbs)

O 0 O 1 O 2 O 3 O 4 O 5 O 6 O 7 O 8 O 9 O 10
Does not Interfere — Completely Interferes

Overall Impression:

11. Fill in the oval next to the one response best describes your dog's overall quality of life over **the last 7 days**?

O Poor O Fair O Good O Very Good O Excellent

Figure 3.4 (Cont'd)

- Ultrasound/laser/pulsed short wave diathermy (Braid-Lewis, 2002)
- Cold

Ischemia as a Cause of Pain

- Aim: Improve blood flow (Veenman and Watson, 2008)
- Methods:
  - Ultrasound/PSWD/heat
  - Active muscle contraction (manual techniques/muscle stimulation/exercise therapy)
  - Manual techniques (e.g., lymphatic drainage).

Mechanical Pain

- Aim: Alleviate abnormal force on normal tissue (Veenman and Watson, 2008)
- Methods:
  - Alleviate muscle spasm through medications or massage and acupressure
  - Alleviate postural faults/muscle imbalance/compensatory movement patterns through therapeutic exercises.
- Aim: Restore normal mechanical properties to damaged tissue (Veenman and Watson, 2008).
- Methods:

Box 3.1 Assessment for chronic pain in pets

1. Pain intensity

How bad was your pet's pain today?

- Severe – 1
- Moderate – 2
- Mild – 3
- None – 4

2. Pain relief

How much pain relief has the medication given your pet today?

- Complete – 1
- Good – 2
- Moderate – 3
- Slight – 4
- None – 4

3. Side-effects

Has the treatment upset your pet in any way today?

- Severe – 1
- Moderate – 2
- Mild – 3
- None – 4

4. How effective was the treatment this week? (Circle one choice)

Poor Fair Good Very good Excellent

For the chart below: Please match the corresponding question with the numbered questions above. Fill in an appropriate number for each day of the week indicating your pet's pain intensity, pain relief, and side-effects of medication. Please call your veterinarian or veterinary hospital if your pet is having pain that you feel is not being helped by dispensed medication.

Question	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Pain intensity							
Pain relief							
Side-effects							

  - Active and passive stretching
  - Joint mobilization
  - Rehabilitative exercise therapy.

Neurogenic Pain

- Aim: Alleviate adverse mechanical tension on nerves (Veenman and Watson, 2008).
- Methods:
  - Relieve muscle spasm through medications or massage and acupressure
  - Mobilize connective tissue component of neural tissue where restricted.

Treatment to Alter Pain Perception

Maximizing A-Beta Sensory Stimulation to Close the Pain Gate

This involves physiological manipulation of pathways involved in transmission and perception of painful sensations to mask, hide, or modify the perception of pain (Veenman and Watson, 2008). Commonly used rehabilitation techniques that aid with pain management are:

- use of analgesics to alter pain perception,
- transcutaneous electrical stimulation (TENS): A-beta fiber stimulation to close the pain gate,
- massage,
- joint mobilization,
- manipulation,
- heat, and
- cold.

Stimulating the Production of Endogenous Opioids

TENS and Endogenous Opioid Production Thirty minutes of low-frequency TENS (frequency 2–5 Hz, pulse width 200–250 microseconds) has been shown to raise opioid levels in spinal cord cerebrospinal fluid by 400% in humans. Levels can remain elevated for up to 6 hours. High-frequency TENS results in no significant change in opioid levels (Han *et al.*, 1991).

Electroacupuncture Electroacupuncture has been shown to increase beta-endorphin levels in dogs in dogs after ovariohysterectomy (Groppetti *et al.*, 2011) and to be equal to or better than phenylbutazone for treatment of chronic thoracolumbar pain in horses (Xie *et al.*, 2005).

Manual Techniques Manual techniques that may have a stimulatory effect on A-delta pathways leading to endogenous opiate release include:

- Acupressure – In a study on rats, acupressure raised the threshold to painful stimulus and this was reversed by naloxone, an opioid inhibitor, so implying the effect was through opioids (Trentini *et al.*, 2005).
- Trigger point release – Dry needling of trigger points in rabbits has been found to increase levels of endorphins (Hsieh *et al.*, 2012).
- Deep friction massage – In a small number of human volunteers, deep tissue massage was found to release endorphins (Kaada and Torsteinbø 1989).

Canine Rehabilitation

When Should your Patient be Assessed for Pain?

New patients should have a detailed history to correctly identify the animal's degree of pain and disability. Identifying how the patient copes with daily living activities creates a realistic picture of the patient's disability. Information regarding the following should be gathered (Davies, 2014a):

- Ability to ascend and descend stairs
- Ability to enter and exit vehicles
- Ability to cope with difficult surfaces such as wooden or tiled floors
- Ability to remain standing while eating
- Willingness to exercise and exercise tolerance
- Ability to remain squatting while defecating
- Ability to posture for urination
- Inappropriate elimination
- Willingness to play
- Change in demeanor
- Response to grooming
- Response or lack thereof to medication
- Effect of exercise on the lameness/pain
- Effect of rest on the lameness/pain
- Duration and intensity of the lameness/pain
- Changes in sleep patterns.

One of the first questions you should ask the client (whether new or long standing) is "Has your dog appeared painful?" If the dog is on pain medication, then you should ask what medications these are and the dosages. Each time the patient is seen the client should be asked about any changes to medications or stoppage of a specific type of medication. Good communication will improve outcome, and recent studies have shown that the relationship between the clinician and the patient and owner is of primary importance in successful management of chronic pain (Jamison, 2011; Davies, 2014a).

Clinical Evaluation

During the certified rehabilitation veterinarian's clinical evaluation, several items will be assessed:

- Posture – Assessment of posture during various positions (looking for kyphosis, lordosis, etc.), including transitions between those positions, for example sit to down to stand. Postural adaptations may be due to pain, stiffness, weakness, or a combination.
- Objective measurements – For example, goniometry to assess joint range of motion and compare for symmetry, muscle circumference measurements using

a spring-weighted (Gulick) tape measure, weight distribution using standing pressure platforms or scales.

- Response to palpation – This detects pain, muscle tone, resistance during passive motioning, and asymmetry (atrophy, swelling, fibrosis, etc.). Animals respond to a painful stimulus in a variety of ways, with a grimace or blink being a mild reaction, to flinch and aversion, to vocalization and aggression. This includes response during measurements taken. The diagnosing veterinarian begins with light digital pressure, sometimes using the hand to try to spread the load, progressing to palpating more deeply to feel texture of the tissue and identify focal painful spots (tender and trigger points). A skilled veterinarian understands animal behavior, and can recognize the difference between anxiety in response to touch and a pain response.
- Gait assessment – This portion of the assessment allows grading of the severity of the lameness, localization of the lameness, and description of the gait in terms of cranial and caudal phases, arc of flight, and linearity of the movement.
- Neurological examination – This should always be part of the assessment to help differentiate poor motion due to stiffness and pain, from ataxia due to neurologic disease. Although neurologic disease is often painful, each has different rehabilitation requirements and prognosis.

The credentialed rehabilitation veterinary technician/nurse will be assisting with various aspects of all of these assessments.

Rehabilitation Techniques

Commonly used rehabilitation techniques that aid with pain management in dogs are:

- cryotherapy,
- thermotherapy,
- therapeutic exercises,
- TENS or neuromuscular electrical stimulation (NMES),
- low-level laser therapy (LLLT),
- pulsed electromagnetic field therapy (PEMF),
- extracorporeal shockwave treatment (ESWT),
- acupuncture, and
- manual therapies, such as massage, mobilizations, manipulations.

All of these therapies are addressed in individual chapters of this textbook.

The Link Between Pain and Weakness

Weakness is defined as reduced strength in one or more muscles (MedlinePlus, 2014). It may be caused by diseases or conditions affecting many different body systems. It is generally accepted that muscle weakness in osteoarthritis is due to its atrophy, which is believed to be secondary to joint pain (arthrogenic muscle inhibition) (Valderrabano and Steiger, 2011). Persons with chronic hip joint pain have weakness in the hip rotator and hip abductor muscles (Harris-Hayes *et al*., 2014). It has been determined that both muscle and joint pain are associated with reductions in quality of life (Vasiliadis *et al*., 2002).

In cats with lumbosacral intervertebral disc disease, clinical signs include reluctance to jump, low tail carriage, elimination outside the litter box, reluctance to ambulate, pelvic limb paresis, urinary incontinence, and constipation (Harris and Dhupa, 2008). Canine and feline muscle contracture is reported to affect several different muscles. The clinical signs include: lameness, pain, weakness, decreased range of motion, a firmness noted throughout the entire muscle, and usually a characteristic gait. Predisposing factors for muscle contracture include: compartment syndrome, infection, trauma, repetitive strains, fractures, infectious diseases, immune-mediated diseases, neoplasia, and ischemia (Taylor and Tangner, 2007). From the studies in humans and animals it appears that muscle weakness can occur because of pain. Therefore, be sure to look at patients that have muscle atrophy. Bring this to the attention of the rehabilitation veterinarian and be sure to question the client about a decline in activity to determine how much pain is involved. A trial of pain medication can help to differentiate weakness due principally to pain from other causes.

Environmental Modifications

By having a conversation with the client, you can help to determine if some simple modifications to the home environment will aid mobility and reduce pain (Fox, 2014, pp. 243–244). Slippery floors are detrimental to the aging patient. Non-skid area rugs, flooring used in children's play areas, and rubber-backed mats are examples of how the owner can make the home more comfortable for a painful patient. Raising the water and food bowls off the floor and standing them on a non-skid surface makes mealtime more comfortable. Ramps can be used for getting into and out of vehicles. Child-restraint gates may be useful at the top and bottom of stairs. Memory foam or eggshell foam may help make sleeping more comfortable. Slings and assistive devices may be helpful.

Owners should be asked questions such as:

- Is the pet an indoor or outdoor pet?
- If the pet is indoors, does the home have steps that the pet must navigate?
- Does the pet sleep in the owner's bed?
- Does the pet travel in the car?
- What type of flooring is in the house, and what type of terrain is outside?

Questions regarding mobility and activities of daily living will help determine how much care the pet may need to maintain quality of life (Box 3.2) (Shearer, 2011). Facilitating a referral to a specialist in pet rehabilitation or pain management is highly recommended to ensure that the pet owner is aware of all aspects of care that may improve a pet's quality of life.

Many pets benefit from physical rehabilitation and pain management. A veterinarian should look for facilities that have certified rehabilitation veterinarians for advanced care for mobility-impaired pets. A referral to a veterinarian with special training in pain management (such as a CVPP) is also desirable (Shearer, 2011). Pain is often associated with mobility challenges and should be treated immediately, or anticipated and prevented. For a pet with hard-to-manage pain, referral to a CVPP may be critical. One remedy for caring for a pet that is experiencing pain is to give pain medications 1 or 2 hours before coming to the rehabilitation session (Millis *et al*., 2004). Signs of pain when performing everyday care or care at the rehabilitation session include biting, scratching, whimpering, crying out, moaning, wiggling, struggling, reluctance to move, and resisting the care (Shearer, 2011).

Painful Mobility Issues in Geriatrics

Dr. Julia E. Tomlinson DACVSMR states that in her practice she sees two types of geriatric pets with painful mobility issues: the aging, often overweight pet with little systemic disease and varying amounts of physical disability; and the extremely frail geriatric pet with reduced appetite, weight loss, concurrent diseases, and more extreme loss of strength and mobility (Tomlinson, 2012). Pain needs to be well controlled before strengthening begins so first she works on improving pain and flexibility. Very simple techniques such as range of motion (ROM) exercises and stretching can be taught to clients. Handouts with pictures are very helpful and can be referred back to when the therapist is not there to give advice. The exercises must be demonstrated for the client; then the client repeats the exercise back to the demonstrator to ensure it is being performed properly. "Pain during the motion must be avoided as much as possible and the fine art of adequate pressure, but not too much is a difficult one to teach." It is not until several weeks of this

Box 3.2 Mobility questionnaire – does your pet have signs of pain?

Pet's name____________________ Owner's name________________________

Breed____________________ Age________

In general, how do you rate your pet's health?

___Excellent ___Very Good ___Good ___Fair ___Poor

Has your pet ever seen a veterinarian because of joint pain, stiffness, or limping?

___Yes, Details____

___No

Living in pain can lead to changes in behavior. This can be hard to read in a pet. On average, would you say your pet is: (Choose one)

___Completely uninterested in their surroundings and sleeps all the time

___Will show interest, but no longer comes to greet you

___Mostly interested in life and food, but reluctant to play

___Plays only when encouraged and not for long

___Has had no change in personality

Has your pet's activity level changed?

___Seeks more affection than usual

___Reluctant to move

___Difficulty getting up from a laying position

___Repetitively gets up and lays down

___Trembling

___Circling

___ Lying very still

___Becomes restless

Has your pet's appetite/thirst changed?

___Yes ___No

Does your pet have trouble in areas he never used to need assistance?

___Stairs

- ___cannot manage any steps without assistance
- ___cannot manage a full flight of steps (only 2–4 steps alone)
- ___manages a full flight of steps, but has difficulty
- ___Can only go upstairs without assistance
- ___Can only go downstairs without assistance
- ___No problems on stairs

___Jumping

___Cannot jump onto the furniture without assistance

___Cannot get into your vehicle without assistance

___Has no problem jumping

Has your pet become protective of himself?

___Protects hurt body part ___Hides

___Doesn't put weight on a limb ___Limps

___Doesn't want to be held or picked up

Does your pet have pain, swelling, warmth, or stiffness in one or more legs?

___Yes, only one joint ___Very rarely

___Yes, in a few joints ___Never

___Yes, in many joints

How long can your pet walk without getting tired, limping or stopping?

___ Less than 5 minutes

___10 to 20 minutes

___more than 30 minutes/ my pet doesn't get tired or sore

___He does not show signs until after he is done walking and rests for a while (he will stiffen up)

Does your pet favor one side of his body more than the other?

___Yes, Describe____

___No

Did your pet's signs begin slowly or suddenly?

___Slowly, over the course of a few months

___Suddenly, within days or a few weeks

Has the joint pain suddenly gotten worse?

___Within the past few days

___Within the past few weeks

___No

In the morning, are the affected areas stiff for more than half an hour?

___Yes ___No ___There is no morning stiffness

Has your pet had a joint/bone injury or surgery?

___Yes, Details____

___No

___Unsure (Adopted)

Which of the following methods do you use to manage the pain, swelling, or stiffness? (Check all that apply.)

___Physical activity/exercise

___Nutritional supplements (fish oils, vitamins)

___Weight management

___Physical therapy/chiropractic/massage

___Cold or heat treatment

___medication

___Other____

___None of the above

Which medication and/or joint supplements do you currently use? (Check all that apply.)

___Prescription medication from veterinarian______________________________

___Over-the-counter medication____

___Aspirin

___Glucosamine human medication(brand)________________________________

___Veterinary joint supplement (brand) ___________________________________

___Herbal supplement (brand) ____

___Other____

___None of the above

Does your pet have any of the following conditions? (Check all that apply)

___Kidney disease ___Skin disease

___Liver disease ___Active infection

___Lung disease ___Bladder problems

___Cardiovascular disease ___Other

Is there anything else we should know about your pet? ___________________ _________________

____

____

____

Source: Courtesy of Dr. Julia E. Tomlinson.

therapy has been completed that Dr. Tomlinson will move on to strengthening and balance exercises.

Feline Physical Rehabilitation

Cats can benefit from appropriately planned rehabilitation techniques. Compliance with treatment is often less predictable than with dogs, and the success of therapy with cats demands a good understanding of feline behavior, coupled with excellent handling skills (Overall, 1997; Sharp, 2012a).

Points to Remember About Rehabilitation with Cats

Physiotherapy and rehabilitation with cats requires a calm, confident approach (Sharp, 2012b). Treatment time should be kept to a minimum to prevent boredom and minimize handling. Competent and confident manual skills are essential to ensure effective treatment. Use a hands-off approach whenever possible.

Treatment is best carried out in a quiet, calm environment with no distractions. Owner assistance can aid effectiveness of treatment and can ensure continuation of therapy between formal treatment sessions.

Cats are sometimes more cooperative with therapy than is often perceived. Do not disregard certain treatment modalities just because you think a cat would not accept the treatment – you may be surprised!

Ensure that pain is not a restriction to the performance of a treatment or exercise. Adequate pain relief is essential for effective therapy. Repetitive attempts to perform a treatment on a cat that is in pain are doomed to failure, and may create resistance to any further attempts at the same treatment.

Any physiotherapy and rehabilitation program should be tailored to the patient based on the individual cat's identified problems and needs.

Cats in Pain

Cats in pain may show the following tendencies (Robertson, 2008; Scherk, 2012):

- Decreased grooming
- Reluctant to jump
- An inability to jump as high as before
- Urinate or soil outside the litter box
- Increased or decreased sleep time
- Avoid human interaction
- Hide
- Dislike being stroked or brushed
- Inappropriate activity level
- Sit in the back of the kennel
- Altered mental attitude/demeanor (stupor or anxiety)
- Changes in attitude/personality
- Lack of comfort when palpated
- Facial expression
- Staring, fixed gaze
- Dilated pupils
- Lack of appetite and thirst
- Self-mutilation
- Vocalizations
- Posture
- Tachycardia
- Tachypnea.

Two excellent articles from the *Journal of Feline Medicine and Surgery* about feline rehabilitation can be found in the references by Sharp (2012a, 2012b). Figure 3.5 shows underwater treadmill therapy on a cat.

Equine Rehabilitation

Equitation involves close contact between horse and rider. Most presenting horses are athletes of some form, thus the rider expects a full return of function. Because of this, the Certified Equine Rehabilitation Practitioner (CERP) or Diplomate of the American

Figure 3.5 Jenn Panko RAHT, CCRP (COCM) performing underwater treadmill therapy on a cat.

College of Veterinary Sports Medicine and Rehabilitation must evaluate the horse, the farrier, the saddle fit, and the role of the rider in causing or magnifying the lameness (Davies, 2014b). The rider may need to undergo their own rehabilitation program if problems are caused by the rider's posture and balance, and collaboration with a physical therapist or chiropractor treating the rider is beneficial. An entire chapter is devoted to equine rehabilitation (see Chapter 22).

Pain Assessment for Horses

Behavioral changes associated with pain in the horse may include kicking or biting when the tender area is touched, generalized restlessness, sweating, frequent movement of the painful limb, or continuous shifting of weight from one limb to another (Davies, 2014b). Changes associated with back pain, such as poor performance, poor appetite, and slight changes in demeanor may be very subtle initially. These may progress to tail swishing or holding the tail to one side, bruxism, head shaking, resistance to saddling and grooming, loss of flexibility, stumbling, bucking, and rearing (Marks, 2000; Paulekas and Haussler, 2009). The horse may be withdrawn and the abdomen may have tight abdominal muscles or appear to be "tucked-up." The horse's breed and temperament must also be assessed.

Figure 3.6 Horse underwater treadmill at the University of Tennessee. *Source:* Courtesy of Dr. Steve Adair.

Objective measurements of pain in the horse that may be of assistance in diagnosing and treating pain include heart rate (not consistently increased in pain), respiratory rate, pressure algometry, thermography, kinematic gait analysis, and response to analgesia (e.g., nerve blocks). Many times the horse is placed on analgesics (usually non-steroidal anti-inflammatory drugs (NSAIDs)) as a trial to see if pain is present. If the problem does not improve with this single medication, then the horse is often incorrectly declared to not be in pain. This can lead to much more severe riding or controlling techniques (e.g., double twisted wire bit) being used on a horse in pain in order to "control" perceived bad behavior, when the problem is actually a normal response to pain.

The credentialed rehabilitation veterinary technician will be assisting the CERP veterinarian in carrying out the treatment plan for alleviation of this pain. Initially, the work is all on the ground to strengthen the abdominals and core musculature, followed by introduction of a rider (Davies, 2014b).

Ways to Treat Equine Pain

These include:

- analgesics,
- acupuncture,
- physical rehabilitation therapy (Figure 3.6),
- local heat,
- osteopathy,
- veterinary spinal manipulation or "veterinary chiropractic," and
- massage.

Conclusion

The certified rehabilitation veterinarian, certified rehabilitation veterinary technician, physical therapist, and owner must work as a team to have successful management of pain and restore the patient (no matter what species) to a functional life. Each animal should have its own tailored plan. Nothing should be "cook-book" in this process. The ultimate aim should be to restore the patient to an active and pain-free lifestyle, whether this is in the context of a slow leisurely walk or full athletic activity (Davies, 2014a).

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4

Communicating the Treatment Plan

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CHAPTER MENU

Introduction

Veterinary patients with conditions that necessitate physical rehabilitation programs are often prescribed prolonged therapy. Sessions may be required daily or several times per week and treatment often extends over many weeks or months. Whether the patient needs to be brought into the rehabilitation practice for therapy or is prescribed a home exercise program, it requires a serious commitment from the patient's owner/caregiver. Rehabilitation does not guarantee a complete return to function, and setbacks and/or failures are not uncommon. Thorough owner/caregiver communication regarding the treatment plan, benchmarks of progress, and expected results is essential in order to achieve a satisfactory outcome. The client/caregiver will almost always be asked to actively participate in some portion of the rehabilitation program. It is essential that the owner/caregiver has a good understanding of the basic theoretical, technical, and behavioral components of the exercises/techniques in order to safely, properly, and effectively assist with the rehabilitation plan. By understanding the basic rationale for the components of the plan, the client will have a greater investment and motivation to adhere to the prescribed plan. Incomplete or inaccurate understanding of techniques can lead to injury or failure to achieve a maximal recovery. Some owner/caregivers do not fully understand animal behavior and may misinterpret signs of stress in their pet. For the

Physical Rehabilitation for Veterinary Technicians and Nurses, First Edition.
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plan to be effective and fun for both the owner/caregiver and the pet, minimizing behavioral stress is critical. It is often the veterinary technician's role to provide this important client education.

Diagnosis and Progress Assessments

Although clients do not always need or want a thorough understanding of the pathophysiology of the patient's disorder, at least a basic understanding of the diagnosis and dysfunction is important in order for the caregiver to be an active participant in the rehabilitation program. The veterinary technician should have a good understanding of the patient's diagnosis and the expected progression of healing (from specific tissue pathology to whole body function) in order to answer questions that arise during rehabilitation visits.

Progress assessment markers (Box 4.1), such as goniometry, pain scoring systems, muscle girth measurements, functional scores, and activities of daily living (ADL), are often used to document a patient's response to therapy. These assessments are an excellent way to document and demonstrate progress, especially when patient improvement may be slow or subtle. Video recording the patient initially and periodically throughout the rehabilitation process can also aid understanding of improvements. Client input is often necessary when acquiring some of the subjective assessments, such as with a pain scoring system, ADL, and quality of life evaluation. The client should be included in the assessment and reassessment process, keeping them updated on how their pet is responding through these markers. This helps to keep the client engaged in the pet's therapy program.

Box 4.1 Progress assessments

Subjective

- Observations: such as sit symmetry
- Pain assessment score
- Lameness scores
- Gait patterns
- Quality of life
- Activities of daily living (ADL)
- Body condition score
- Ease of position transitions (sit-to-stand)

Objective

- Girthometry
- Goniometry
- Force plate analysis
- Functional scales, such as Texas Spinal Cord Injury Scale or Proposed Stifle Function Scale
- Time/distance to fatigue
- Presence of tibial thrust/cranial drawer
- Presence of conscious proprioception

Goals

Every rehabilitation program should establish a set of goals for the patient. These goals, set by the rehabilitation veterinarian, are developed in conjunction with the client's expectations for the patient's return to some level of function. These goals are customized for each patient, and in our experience are based upon a current understanding of the pathophysiology of the patient's disorder, estimated tissue healing abilities, patient's ADL, and the owner/caregiver's expectations. The goals should be communicated clearly to the owner/caregiver to ensure owner/caregiver perception of program success. If the client and therapist have different goals in mind, they may not be satisfied with the outcome.

Goals must be reasonable and attainable. Unrealistic goals can cause clients to become discouraged and lead to abandonment of the rehabilitation effort. Setting several small goals over short periods of time, with reassessments to confirm goals met, along with praise for reaching these small goals, can serve to keep clients motivated to continue the rehabilitation effort.

The Therapy Prescription

The discussion of the rehabilitation plan should be included in all phases of veterinary treatment planning, regardless of whether the patient has a scheduled intervention, such as surgery, or is suffering from acute trauma or injury. The earlier the client is exposed to the idea and impact of rehabilitation, the more likely they are to become invested in the plan. Rehabilitation plans can vary in time intensity from one session per week to several sessions per day. In many cases, the plan requires a large time commitment from the individual performing the therapies. Although elaborate, time-intensive therapy plans can speed recovery for the patient, it is essential to take into consideration the client's time availability and lifestyle as well as the financial commitment when developing the plan. In one study of human physical therapy patients, one of the strongest factors of non-compliance was perceived barriers by the patient (Sluijs *et al.*, 1993). These perceived barriers were often related to the time involved in completing the exercises. Clients are often busy with work, family, and other activities. If clients are asked to commit more time than they have available, there is a risk that the client will either not perform all of the therapies, or become discouraged and abandon the rehabilitation effort entirely. If the client only performs a portion of the plan and neglects other segments, the program may become unbalanced, which may risk injury or failure to achieve a maximal recovery.

Many veterinary physical rehabilitation programs employ a combination of several different therapies, exercises, and modalities. Each one of these therapies offers the patient benefits, often in different ways. The veterinary technician should be well versed in the benefits and risks, if any, of each therapy so that this information can be fully communicated with the client. Clients often have questions about different modalities, especially when they may increase the cost or result in any temporary discomfort to the patient. Clients who do not understand the benefit of a particular modality are more likely to exclude or decline these treatments even if their pet may have benefited

Activity Restrictions

In rehabilitation practice, we often spend a large portion of time informing clients of the importance of exercise in their pet's therapy. For example, we may stress the importance of strengthening core musculature to support orthopedic incompetency, and that regular exercise is important in promoting joint health in arthritic patients. Although we need to communicate the importance of exercise, we cannot overlook the critical importance of activity restriction. In most cases, restriction does not mean a complete lack of activity, it means a focus on a narrow range of acceptable activities. In fact, in most situations a balance of both exercise and activity restrictions are required for a successful outcome. It can be challenging to communicate this need for balance with clients; there may be a feeling of depriving their pet of enjoyment if freedoms are limited. If the importance of therapeutic exercise is overemphasized, the client may push the patient too hard, resulting in injury. If activity restrictions are overemphasized, clients can become fearful of doing too much, and the pet may not improve at an acceptable rate. The trained veterinary technician can play a valuable role in educating the client on the benefits and risks of both exercise and activity restriction.

Assistive Devices

As technology and interest in animal rehabilitation increases, so does the availability of assistive devices for animals such as orthotics, prosthetics, carts, and other mobility devices. Although the specific use and function of these devices is beyond the scope of this chapter and is covered elsewhere (see Chapter 10), it is important for the veterinary technician to be educated on their proper use and potential adverse effects. The veterinary rehabilitation technician will often be asked to demonstrate how to properly apply and use the devices, educate the pet owner on the appropriate duration of wear of the device, and to inform the client on how to monitor for discomfort and contact sores from these devices. Pictures and videos can help to communicate how to use and to jog the memory later.

Figure 4.1 Photo of a patient showing signs of stress during a therapy session (moving away from the therapist, while ignoring a food reward). The therapist is utilizing calming body language of sitting to the side, averting the gaze, and maintaining gentle contact with the patient. *Source:* Photo by Tracy Darling.

Keeping it Positive

Physical rehabilitation plans often entail exercises or procedures that are performed repeatedly, or as a series of repetitions over several sessions. In addition, many of the movements or positions that we ask of our patients are not natural, and may even be uncomfortable for the animal patient. Improper or uneducated application of these techniques or failure to recognize the subtle body language associated with increasing stress (Figure 4.1) can easily result in the patient developing an aversion to therapy.

This aversion can often be avoided by being alert to signs of stress and using reward-based training and low stress handling techniques (see Chapter 9) to keep patients encouraged and engaged in therapy. Animals can often be trained to willingly perform exercises with very little assistance. When pets stay engaged and perform tasks willingly, it becomes a much more pleasant experience for the client, patient, and rehabilitation professional. When demonstrating rehabilitation techniques with the client, the veterinary technician can show the client how to use rewards (e.g., food, toy, or praise) to motivate the patient (Figure 4.2). Another advantage of using training techniques to accomplish the techniques is that it provides mental exercise, which can be an effective means of releasing energy in a patient that has activity restriction. Clients should also be educated about the early signs of fatigue or aversion to therapy so sessions can be abbreviated if needed. When used successfully, most patients will show up for therapy very excited to begin each session. This engagement of the patient in turn motivates the client, and therapy is more likely to continue and be successful.

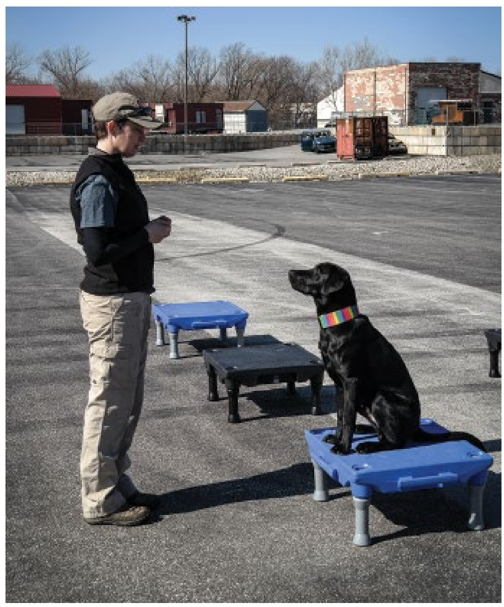

Figure 4.2 Reward-based training as part of a fitness and conditioning program.

Prescriptions and Supplements

Medications and supplements are often prescribed for veterinary physical rehabilitation patients to treat infections, reduce pain and inflammation, promote joint health, and reduce anxiety, as well as many other indications. The veterinary technician is an integral part of communicating the administration and proper usage of these important pharmaceuticals. Clients often have questions or concerns about why certain drugs or supplements are prescribed, how they will help their pet, whether there are drug interactions, what side-effects to look for, and how to administer medications. The veterinary technician can help increase compliance and treatment success when they have a thorough understanding of the commonly utilized medications and supplements. Sometimes medications are prescribed to be given "as needed." Clients often need specific criteria to indicate to them when these medications should be administered. For example, a dog that is being treated with a non-steroidal anti-inflammatory drug (NSAID) to be given as needed, may become reluctant to rise or be slower climbing stairs after a therapeutic exercise session and then would benefit from receiving a dose of the NSAID. Discussions about the clinical signs of conditions such as discomfort or nausea can help to reassure clients that they have the knowledge to properly use these medications. Reinforcing these discussions by providing written instructions and/or handouts can ensure that medications are administered properly.

Adverse Events and Setbacks

When communicating with clients about physical rehabilitation treatment plans, a discussion about the possibility of setbacks or adverse events should always be included. Although our goals are always to improve a patient's condition, there may be times during therapy where clinical signs worsen, or a new injury occurs. Besides being detrimental for the patient, these incidents can be devastating to clients and can strain the relationship between the client and the rehabilitation team. For these reasons, clients should always be educated about the potential for setbacks during therapy, what steps should be taken to mitigate them, how to identify signs of injury early, and how these setbacks will be addressed by the rehabilitation team. This information may be especially important when clients have elected physical rehabilitation in lieu of surgical options. Clients should be advised to discontinue activities at home and contact the therapist immediately upon the suspicion of an injury or adverse event with their pet.

Compliance

The nature of the condition may impact owner commitment and compliance. Any treatment including rehabilitation may be considered to be an optional extra ("icing on the cake"), or even an extreme measure because of the option of euthanasia in veterinary medicine. The presence of sudden disease versus gradual decline, the age of the pet, the general health of the pet, the relationship with the owner as well as the outlook for return of function may influence the initial commitment to rehabilitation of a pet. Once a client commits to a course of physical rehabilitation, the next challenge is to ensure compliance with the recommended plan.

In one study of human physical therapy patients, only 35% of adult patients fully complied with their prescribed regimen (Sluijs *et al.*, 1993). Compliance becomes even more complicated when the client providing the rehabilitation is not the patient, but rather the caretaker. This model of care is most similar to parents undertaking rehabilitation therapy for their children. Adherence to a recommended treatment plan has been associated with parental expectations and belief in the impact of the program. These factors are strongly influenced by the professionalism of, communication by, and trust in the health care professional (Dimatteo, 2004; Rabino *et al.*, 2013). It has also been proposed that parents are most likely to adhere to their child's recommended physiotherapy if they perceive a severe disease threat (Rabino *et al.*, 2013); although not documented, in veterinary medicine, adherence may be impacted by the potential for return to acceptable function and quality of life. Based on human data, compliance is also influenced by how the therapist fulfills the individual's preference for an active versus passive role in health care of their dependent. A report published by the American Animal Hospital Association stated "using multiple approaches to client education and communication increases compliance" (Albers and Hardesty, 2009a, p. 16).

In both adults and children with chronic conditions, treatment adherence is less than 50% (Simons *et al.*, 2010). In older adults, the most common barriers to treatment adherence are time, transportation, perception of treatment efficacy, and fear of pain or injury (Austrian *et al.*, 2005). With children and adolescents suffering from chronic pain, the most common barrier was a negative attitude about the treatment recommendation; however early success with exercise increased the future compliance for physical therapy (Simons *et al.*, 2010). These finding emphasize both communication and design of a plan that can be implemented early and have measurable success. Based on the adage that "past behavior is the best predictor of future behavior," clients who have participated in fitness and conditioning programs with their dogs prior to an injury or illness are more likely to adhere to therapist recommendations.

Communication

There are several aspects of the rehabilitation program that are essential to communicate in order to maximize patient success. Shortcomings in any of these areas may compromise patient recovery. Setbacks during a therapy program are not uncommon, and often clients require frequent coaching and encouragement to keep them motivated. The veterinary technician works very closely with the client and patient throughout the rehabilitation process, and is therefore a vital part of the communication effort.

Communication skills are at the heart of the effective home rehabilitation plan. All communication should be based on recognition of the value of the client, attention to the client's needs and concerns, acknowledgement of the client's message, empathy with the client, and a goal of providing the best care for both the client and the pet (Dreeben, 2011) (see also Chapter 7).

The communication style of the veterinary technician needs to be adjusted to each client. Clients will respond differently to verbal and non-verbal communication. Clients will be particularly attuned to the non-verbal communication between the technician and the pet, paying attention to the veterinary technician's level of comfort, empathy, and compassion. Any discrepancy between verbal expression of empathy and non-verbal cues will undermine the trust of the client and their confidence in the treatment plan. Although authentic expression of empathy (being able to understand and share the feelings held by the client) is one of the most powerful components of effective communication, the skilled veterinary technician also needs to be sensitive to cultural diversity and beliefs of the client. Verbal communication will be the foundation of sharing information and teaching the client. Effective verbal communication includes written and oral communication. The learning style and emotional state of the client will help determine how the client will most effectively receive information.

There are several recognized learning styles (Box 4.2). For people who learn by the hearing (aural) the therapist will need to articulate in words the full therapy plan, whereas verbal learners or patients under emotional duress may benefit from a combination of verbal and written communication and may be more likely to return with the need to "talk through the plan." Providing a conduit for additional follow-up communication

Box 4.2 Standard learning styles

Descriptions of learning modalities

- Visual: Learn by seeing shapes, pictures, three-dimensional objects
- Tactile (kinesthetic): Learn by touch, manipulating objects or the body, gestures
- Auditory: Learn by hearing words, sounds, tones, rhythms
- Verbal: Learn by articulating, reading or writing words
- Logic: Learn by deriving information from reasoning

Learning styles

- Accommodator = Concrete experience + active experiment: strong in "hands-on" practical doing (e.g., physical therapists)
- Converger = Abstract conceptualization + active experiment: strong in practical "hands-on" application of theories (e.g., engineers)
- Diverger = Concrete experience + reflective observation: strong in imaginative ability and discussion (e.g., social workers)
- Assimilator = Abstract conceptualization + reflective observation: strong in inductive reasoning and creation of theories (e.g., philosophers)

For further information see Barbe *et al.* (1979), Leite *et al.* (2010), and Kolb (2015).

Source: Adapted from https://en.wikipedia.org/wiki/Learning_styles and www.learning-styles-online.com.

such as an email address is extremely beneficial. When explaining and demonstrating therapeutic exercises, some clients may be able to learn from watching the therapist perform the exercise, whereas others need to have the hands-on experience. Demonstration can be effective, especially if the therapist describes each action and demonstrates common errors to avoid. Many individuals, however, will require the kinesthetic experience of having their hands/body move in the proper motion. This can be augmented by the therapist guiding the movements, or by feedback for the caretaker of watching themselves in a mirror or on video. The visual reminders of videos, photos, or drawings are particularly important to visual learners and provide a guide to remind all clients of the proper technique that they have learned. Some clients will learn best by understanding the theory behind the actions; for example, if it is explained how exercises that encourage eccentric muscle contraction, such as crouching through a tunnel, are used to strengthen muscles of the limbs and core (Figure 4.3).

In a study of children with cystic fibrosis, parents found written and video instructions were a valuable adjunct to verbal and practical training; however, the documents must be professional, current, and credible (Tipping *et al.*, 2010). Information overload is a risk, especially for a client who is dealing with a sudden and unexpected event. Repetition and patience will be critical in the communication process.

Note: it is important to emphasize the privacy of clinic-provided videos; they should not be shared online or used for therapy on other animals.

Continued advances in technology give us the ability to communicate with clients in a variety of ways. Utilizing multiple communication modalities can help enhance client understanding and retention of what can sometimes be an overwhelming amount of information. There is so much information about clinical findings, diagnosis, treatment options, side-effects, and many other aspects of a patient's condition that cannot always be communicated effectively using one form of communication alone. One of the most common ways we communicate with clients is verbally, either over the telephone, or in person during an appointment session.

Figure 4.3 A patient performing a crawl exercise for a treat reward. *Source:* Photo by Tracy Darling.

The use of verbal communication is an effective way to relay information, and it is also a means to build relationships with clients. Pairing verbal communication with something visual, such as anatomical models or pictures, can help clients' understanding of disorders and disease processes. When communicating a treatment plan with a client, hands-on instruction in how to properly perform exercises and other therapies are essential in developing client confidence in carrying out such treatments at home (Figure 4.4).

Online videos demonstrating commonly used techniques are a great way to reinforce hands-on instruction, as they can be accessed on-demand by the client after they leave the clinic. Videos can be customized by the rehabilitation clinic, or there are many great online resources of topics related to physical rehabilitation that can be shared with clients.

Figure 4.4 Veterinary technician providing hands-on instruction in the execution of assisted exercise.

Treatment schedules can often be quite elaborate. It is helpful to provide a treatment schedule in written format. Home exercise plans can be printed and handed to the client or sent via email after each visit.

The nature of the condition and expectation for the necessary duration of home rehabilitation is variable. Lessons from parents of children with cystic fibrosis provide some insights into approaches to client education with severely affected patients or those with chronic disease (Tipping *et al.*, 2010). In a qualitative study evaluating factors that impair delivery and retention of physiotherapy education of parents and impact effective home physiotherapy treatment, three major themes were identified: (i) transition from one life or disease stage or even location to another, (ii) psychological distress often associated with the learning process and the underlying condition, and (iii) social connectedness with the health professional and social networks. In the case of pets, no doubt the connectedness with the pet is also a major factor.

Discussing Finances

When discussing treatment plans with clients, it is often necessary for the veterinary technician to discuss the estimated cost of services. Finances can be a stressful topic for some clients. In our experience, there are some ways to approach the topic without added difficulty. Focusing on the needs of the patient and explaining how the services will benefit the patient is an excellent way to increase client acceptance (Albers and Hardesty, 2009b, p. 19). Clients may be more willing to accept the cost associated with a treatment when they can appreciate the value of the service. For example, a therapy visit of US$150 might sound expensive to an client, especially when told that their pet will need weekly visits for 12 weeks. On the other hand, if they first learn that each 1-hour therapy visit will include massage therapy, therapeutic laser, an underwater treadmill session, and assisted exercise, they may be surprised to hear that each visit will only cost US$150. Disclosing all costs and obtaining written consent before providing services are good ways to avoid financial conflict after therapy sessions are completed.

Follow-Up

In a study of rehabilitation compliance in human athletes, patients with emotional support were more likely to adhere to their rehabilitation regimen (Byerly *et al.*, 1994). This is likely to be also the case with caregivers of veterinary patients undergoing rehabilitation. Client communication should not end when the client leaves the clinic. The veterinary technician can be utilized to maintain an open line of communication with clients in between rehabilitation visits. Clients often leave an appointment excited to start rehabilitating their pet, but may be overwhelmed or nervous about carrying out treatments properly. Clients also may have questions after they leave, but might not be inclined to reach out until their next visit. A follow-up phone call or email the day after an initial visit to check-in will not only help answer client questions, but will keep the line of communication open and reassure the client that you are behind them 100%. This support should continue throughout the treatment program. The veterinary technician can provide valuable support during follow-up therapy visits. Technicians often perform many of the functional assessments and can discuss these results with the client, providing praise for improvements and being prepared to discuss the potential causes for lack of improvements.

Conclusion

The way in which a treatment plan is presented and communicated with clients will have a powerful effect on patient outcome and should not be overlooked. There are many ways that the rehabilitation team can use effective communication to maximize success in the veterinary rehabilitation patient. This aspect of rehabilitation practice is often tasked to the veterinary technician. The unique knowledge and perspective of the trained veterinary technician makes them well suited for this important responsibility.

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5

Manual Therapy Treatment

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CHAPTER MENU

Introduction

Canine rehabilitation treatment can be categorized into three groups: therapeutic exercise, modalities, and manual therapy. This purpose of this chapter is to discuss manual techniques commonly used in rehabilitation. As a treatment, manual therapy utilizes skilled hands-on techniques. Safe and effective use of these techniques requires specific training and an understanding of indications, contraindications, expected results, and red flags.

What is Manual Therapy?

Manual therapy is used to address musculoskeletal pain and disability. Treatments include a variety of techniques involving a combination of pressure, force, and movement applied to soft tissues and joints. These techniques include soft tissue mobilization (STM), passive range of motion (PROM), muscle stretching, and joint mobilization/manipulation. Joint mobilization and joint manipulation will be covered briefly in this text as they can be performed only by an appropriately trained veterinarian (trained in rehabilitation or manipulative therapies), a physical therapist with training in animal rehabilitation, or a chiropractor trained in animal chiropractic.

Goals of Manual Therapy

Before initiating any treatment, the therapist must specify the goal of the treatment. The specific goals of each technique will be

Physical Rehabilitation for Veterinary Technicians and Nurses, First Edition.
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discussed later in this chapter. Typically, one or more of the following goals are expected with manual therapy:

- Increased circulation
- Decreased pain
- Decreased swelling
- Increased range of motion (ROM)
- Increased flexibility
- Improved proprioception
- Relaxation and decreased anxiety.

Expected Results

Once a treatment is completed, the therapist must determine if the desired effects were achieved. Unlike other types of treatment (e.g., therapeutic exercise with a goal of strengthening), change is expected to occur relatively quickly, within one to two manual therapy sessions. Using the "test–re-test" model of data collection will help to determine the effect of the treatment (Hendrickson *et al.*, 1993). This technique is applied by performing an objective measurement prior to the treatment (pre-test) and again after the treatment (re-test). In so doing, one can objectively determine if the treatment goals were accomplished.

For example, if the treatment goal is to increase shoulder extension PROM, PROM is measured with a goniometer prior to the treatment and again afterwards. Improved ROM should be noted.

If improvement is not noted, the treatment and re-test measurement should be repeated. If there is still no improvement, your supervising therapist should be notified, as the joint may need further evaluation to properly identify the limiting structure and institute a change in the treatment plan.

Preparing the Patient for Manual Therapy

Building trust with the patient is critical to a successful treatment. Manual work requires that the patient be willing to be touched. Some patients are uncertain or anxious in a new environment. As veterinary technicians and nurses, you are acutely aware that animals cannot have the treatment explained to them and need other forms of reassurance. Anxiety may be magnified when someone other than their owner attempts to handle them. Thus, the following suggestions are recommended for creating a non-threatening environment for the patient:

- Allow the patient to explore their surroundings before being handled.
- Allow the patient to get used to your voice and presence before touching them.
- Use a quiet treatment space and speak in a soft, reassuring voice.
- Encourage the patient to settle in the treatment area using owner, treat, and toy motivation; do not use force (Yin, 2009).
- Allow the patient to move a little; apply minimal restraint.
- Start with soft, quiet hands; move your body and hands slowly.
- Work on non-painful areas first.

See Chapter 9 for more information.

Manual Techniques

Soft Tissue Mobilization

STM is a therapeutic technique in which superficial and deep layers of soft tissues are manually manipulated. The goal of treatment is to normalize tissue function. The tissues addressed include muscle, tendon, ligament, and fascia. STM is often grouped under the umbrella term "massage;" however, massage is the general concept, whereas STM is the specific how and what. It is used within a total systematic therapeutic approach, designed to achieve functional goals. These techniques are used in conjunction with additional therapeutic techniques as part of a complete treatment plan (Hesbach, 2014).

Effects of Soft Tissue Mobilization

STM is purported to affect several of the body's systems and have a range of mechanical, physiological, and psychological benefits. Authors describe effects on the muscular, nervous, lymphatic, circulatory, and endocrine systems (Fritz and Grosenbach, 2009; Salvo, 2012). By affecting these systems, mechanical, physiological, and psychological results are noted. Much of the information regarding STM is based on hypothesis and anecdotal experience. Underlying tissue changes have not been well researched to date. Short-term effects are demonstrated subjectively in human medicine; however, there are no studies to support the efficacy of long-term effects. There is a tremendous need for further research in STM.

The proposed physiologic effects of STM can be categorized into three groups: reflexive (indirect), mechanical (direct), or both (Fritz, 2004). Reflexive responses occur as a result of stimulating the nervous or endocrine systems. Mechanical effects are produced in response to direct force to the body. The various types of mechanical forces are discussed below. Mechanical effects can be measured objectively (Fritz, 2004).

Authors refer to a variety of responses, including (DeLisa *et al.*, 2005):

- vascular changes,
- decreased edema,
- breakdown and prevention of adhesions,
- decreased pain, due to the release of endorphins,
- stimulation of cutaneous mechanoreceptors and muscle spindle receptors in superficial skeletal muscle,
- reflexive vasodilation, and
- patient relaxation.

Current research suggests that the effects of STM include decreased motor unit activity of the muscle, increased tissue extensibility, and increased ROM (Sefton *et al.*, 2011).

Studies have demonstrated a reduction of pain by increasing T lymphocyte proliferation, both in diseased and in healthy patients (Austin *et al.*, 2012). It is speculated that this effect in massage is related to stress reduction or lymphatic activation, but the underlying mechanisms have yet to be verified (Billhult *et al.*, 2009; Wang *et al.*, 2014).

Compressive STM techniques have been shown to increase immunomodulatory effects on rat skeletal muscle, offering an alternative to anti-inflammatory medication (Waters-Banker *et al.*, 2014).

Types of Forces

STM techniques are designed to deliver one or more kinds of force with the intent of creating specific physiological effects (Fritz and Grosenbach, 2009; Simancek, 2013). There are myriad STM techniques, each designed with a specific purpose in mind. They are differentiated by the type of force being applied, these forces consisting of compression, tensile, torsion, shear, and bend.

- *Compression* is a force that compresses soft tissues together, referred to as tissue approximation. Tissue approximation is used to support circulation, stimulate nerve function, and restore connective tissue mobility (Fritz and Grosenbach, 2009). Compression is used in several techniques, such as effleurage, pettrissage, and ischemic compression (Simancek, 2013).
- *Tensile* is a force that occurs when two ends of a structure are pulled in opposite directions. It is a lengthening force. Therapeutically, this force is used to promote fiber realignment and extensibility (Simancek, 2013).
- *Torsion* is a force that involves twisting or turning of soft tissues. This force is used in kneading techniques (Simancek, 2013).
- *Shear* is a sliding force in which two structures slide across each other, creating friction. This force is used in friction massage (Simancek, 2013).
- *Bending* is a force that combines compression and tension such that a compressive force is applied to one side of the structure while a tensile force is applied to the opposing side. These forces are applied perpendicularly across the tissue (Simancek, 2013).

Contraindications

If the appropriate amount of pressure is applied during STM, there are very few contraindications (Furlan *et al.*, 2002). A few that should be considered include:

- acute inflammation,
- skin or deeper tissue infections,
- burns, and
- deep vein thromboembolic disease.

Techniques

Passive Touch Passive touch allows the person performing massage and the patient to make an initial connection. The patient is allowed to settle, become accustomed to the therapist's hands and respond to the calm, quiet environment. The therapist relaxes and hopefully this is communicated to the patient. Allow both hands to rest on the patient. If the patient becomes anxious, spend a few minutes gently stroking the patient to allow them to calm down (Robinson and Sheets, 2015).

Effleurage Effleurage is a French word meaning "to skim" or "to touch lightly on." It is a gliding stroke characterized by rhythmic, long, broad, continuous strokes of light to moderate pressure. Effleurage is often performed parallel to the fibers of the muscle and on larger muscles groups or throughout an entire limb. The therapist's hands are open and relaxed, working in a hand-over-hand pattern (Salvo, 2007; Fritz and Grosenbach, 2008) (Figure 5.1).

Pressure and direction can be varied, making this technique quite versatile (Fritz, 2004). A more superficial effleurage stroke is presumed to stimulate cutaneous mechanoreceptor firing. Increased mechanoreceptor nerve firing into the spinal cord may reduce central nervous system input of smaller diameter, slower signaling pain fibers, thus reducing the perception of pain (Gay *et al.*, 2015). Because a deeper stroke can mobilize and aid resorption of extracellular fluids, deep stroking is recommended only in the direction of venous or lymphatic flow, whereas superficial strokes can be in any direction (DeLisa *et al.*, 2005). Effleurage can be used as an introductory technique when initiating a treatment, as a method of directing fluids toward the heart or lymph system, or as a means of promoting relaxation. It allows the therapist's hands to palpate the body and to explore underlying tissues.

The postulated effects of effleurage (Fehrs, 2010a) are that it:

- moves blood and lymph toward a desired area and removes metabolites;
- reduces pain by decreasing edema and therefore nociceptor firing and releases endorphins;
- promotes relaxation via the reflex effects that occur with stimulation of nerve endings, including the release of neurotransmitters and local hormones (e.g., vasopressin and oxytocin); and
- inhibits muscle spasm via prolonged pressure of the Golgi tendon organ and muscle spindles (Chaitow, 2010).

Petrissage Petrissage is a French word meaning "to knead." It represents a classification of strokes that include a variety of movements

Figure 5.1 Effleurage.

Figure 5.2 Petrissage.

such as lifting, kneading, compressing, wringing, and rolling of soft tissues. Unlike effleurage, petrissage is a compressive, stimulating stroke.

Petrissage techniques such as lifting, kneading and skin rolling are performed by "picking up" the soft tissues between the thumb and the flat side of the index finger(s) or between the two hands of the therapist (DeLisa *et al.*, 2005) (Figure 5.2).

The postulated mechanical effects of petrissage include:

- increased tissue extensibility,
- increased circulation,
- muscle relaxation,
- decreased pain, and
- improved cellular nutrition (Salvo, 2007).

Tapotement Tapotement is based on the French word "Tapoter," meaning to tap or pat. This technique involves rapid, repetitive striking of the tissues and is used as a stimulating technique. There are several variations of this technique used in human medicine, such as tapping, hacking, slapping, cupping, pinching, or plucking. Tapping is the gentlest technique and is used commonly in canine rehabilitation to stimulate a muscle in orthopedic or neurologic cases.

In this technique, the tips of fingers are used to tap the muscle at a brisk rate (Fritz, 2004).

The postulated mechanical effects of tapotement (Fehrs, 2010b; Salvo, 2007) are that it:

- increases circulation,
- warms and softens underlying tissue,
- stimulates nerve endings, and
- produces tiny muscular contractions that result in increased muscle tone. This is thought to happen via stimulation of mechanoreceptors in the fascia and Golgi tendon organs.

Friction Massage Friction massage was first described by Hippocrates, but was popularized by Dr. James Cyriax, a British orthopedic physician who worked with physical therapists to develop a number of orthopedic evaluation and treatment techniques including friction massage. This technique is commonly used to maintain/improve mobility within ligaments, tendons, and muscles and to prevent adherent scars from forming (Chamberlin, 1982; Robinson and Sheets, 2015). Instrument-assisted cross friction massage has been shown to increase tissue perfusion in collateral ligaments of the rat knee (Loghmani and Warden, 2013). In addition, friction massage aims to realign fibers caused by micro tearing of injured tissues. Friction massage is usually performed as a deep technique affecting multiple layers of tissue. The primary effect is the application of shear stress to underlying tissue, particularly at the interface between two types of tissue (DeLisa *et al.*, 2005).

The tip or "ball" of the finger or thumb is used in this technique. Enough pressure is applied to the specific tissue such that the shear force is directed to deeper, rather than superficial, layers of the tissue. The finger does not glide across the tissue but rather creates shear force transmitted to a deeper interface. The therapist's fingers and the patient's skin move as one (Chamberlin, 1982). The direction of force can be parallel to, perpendicular to, or diagonally across the fibers. If the treatment goal is to realign fibers (tendons, ligaments, or muscles), cross friction massage is specifically performed perpendicular to the tissue fibers. In human medicine friction massage lasts approximately 5–15 minutes (Goats, 1994). This may not be realistic for animal patients.

The postulated mechanical effects (Salvo, 2007; Chamberlin, 1982) of deep massage include:

- fiber realignment,
- maintenance or increase in mobility,
- break down of scar tissue, and
- hyperemia.

Ischemic Compression Ischemia is a restriction of blood supply to the tissue. Ischemic compression is performed on a tender point or trigger point. This technique intentionally blocks the blood supply to the painful nodule such that upon release there is a resurgence of blood (Travell and Simons, 1983).

The pad of the thumb or finger is used to apply direct, static, moderate-to-heavy pressure over the tender point or trigger point. Pressure is gradually increased according to patient tolerance and continued for up to 1 minute. Following the treatment, the muscle should be gently stretched so the muscle can "remember" its new length (Travell and Simons, 1983).

The postulated mechanical effects of ischemic compression are that it:

- increases local circulation,
- removes waste products,
- increases oxygen, and
- promotes healing (Travell and Simons, 1983).

Myofascial Trigger Points

Trigger point release (TPR) techniques were popularized by the physician Janet Travell as early as 1942 because of her work on myofascial pain. She defines a trigger point as a hyperirritable point within a taut band of a muscle (Travell and Simons, 1983). Trigger points are classified as "active" or "latent." An active trigger point is painful and has a predictable pattern of referred pain, which "frequently occurs within the same dermatome, myotome or sclerotome as that of the [trigger point] but does not include the entire segment" (Travell and Simons, 1983). An active trigger point causes a clinical pain complaint. It prevents full lengthening of the muscle, weakens the muscle, and mediates a local twitch response of muscle fibers when adequately stimulated (Bron and Dommerholt, 2012). When compressed within the patient's pain tolerance, it produces referred motor and often autonomic phenomena, generally in its pain reference zone. A latent trigger point is clinically quiescent with respect to spontaneous pain; it is painful only when palpated (Bron and Dommerholt, 2012). A latent trigger point may have all the other clinical characteristics of an active trigger point and always has a taut band that increases muscle tension and restricts range of motion. For further information see Chapter 25.

Joint Range of Motion

Joint ROM refers to the movement that occurs at a joint (flexion, extension, abduction, adduction, internal rotation, external rotation) (Norkin and Levangie, 1992).

Joint motion can be passive or active. Passive ROM (PROM) requires a second party (the assistant) to move the joint through the desired ROM *without* participation of the patient. No muscle contraction occurs with PROM. If the patient assists or resists the motion, it is no longer "passive." Active ROM (AROM), on the other hand, requires the patient to contract muscles to move the joint through its available range.

Joint ROM consists of both osteokinematic and arthrokinematic motion. Osteokinematic motion occurs when boney segments move about a joint axis. Arthrokinematic motion is the movement that occurs between opposing joint surfaces *within* the joint. Arthrokinematic motion is passive and cannot be visualized (see section on Joint Mobilization).

Importance of Range of Motion

Normal joint ROM is essential for normal osteokinematic movement. Normal joint motion is also necessary for proper function of associated tissues (muscle/tendon, ligament, disc, meniscus, cartilage, etc.). If joint ROM is limited, abnormal stress can occur at the joint and/or related soft tissues. The patient likely attempts to make up for lost motion by increasing movement within the joint or at an adjacent joint. This is referred to as compensation. Compensation can result in secondary joint hypermobility, joint irritability, abnormal use or stretch of related muscles, and pain (Weiner, 2001; DiBerardino *et al*., 2012; Wise, 2015). Early attention to limited ROM is important to avoid the secondary effects.

What can Limit Joint Range of Motion?

ROM can be restricted by several structures and conditions. These include swelling, muscle/tendon, ligament, capsular tightness, pain, meniscus, and a joint mouse. It is important to identify the restricting structure so that treatment can be guided accordingly. The source of limitation will be determined by assessing end-feel at the end range of osteokinematic motion (Sprague, 2013). Overpressure is applied into the restricted range and the sensation or "feel" of the restriction in the therapist's hands is noted. The therapist identifies the limiting structure by "feel." End feels are categorized as muscle/tendon, soft tissue approximation, capsular, muscle spasm, boggy, bony, springy, or empty (O'Sullivan and Schmitz, 1994). End feels transmit specific sensations to the therapist's hands depending on the source of a joint's stiffness at the end ROM (Sprague, 2013).

Passive Range of Motion

Maintaining or improving joint ROM is important in preventing the negative effects of immobilization. PROM is used as a manual treatment technique with the aim of maintaining or regaining joint ROM. Because this technique is directed at the joint, the joint must be positioned such that active muscular restriction is minimized. For example, when treating a restriction into elbow extension, the shoulder must be placed in a neutral position. If the shoulder is placed in a flexed position, elbow extension will be limited by muscle tightness of the biceps. PROM is performed within the patient's comfort level so that muscle splinting (a protective response involving active muscle tightening) does not occur (Figure 5.3).

Treatment Technique The technique used when performing PROM entails:

- stabilizing the proximal bony segment;
- moving the distal bony segment to its end range;
- maintaining the proper plane of motion (not allowing abduction/adduction or rotation); and
- working within a pain-free range of motion (to avoid muscle splinting) (Reese and Brady 2010).

Manual contact or hand placement is critical when performing PROM. Keep in mind that the distal bone is moved on a stabilized proximal bone. Therefore, one hand will stabilize the proximal bony segment and the other hand will support the limb while moving the distal bony segment. Support of the limb usually occurs at the joint just distal to the one being treated. For example, in the case of shoulder extension, one hand will stabilize the scapula (acromion) while the other hand supports the limb at the elbow and moves the humerus into extension. If the scapula is not stabilized, motion will occur at both the scapulothoracic joint and the glenohumeral joint. When performing PROM, the therapist must be mindful of moving the limb in the proper plane of motion. In the example of shoulder extension

Figure 5.3 Passive range of motion.

Figure 5.4 Glenohumeral extension.

PROM, the humerus should remain in the sagittal plane, not allowing shoulder adduction, abduction, or rotation (Figure 5.4).

It is important to watch for any cues of patient discomfort. These may be as subtle and a change in respiratory rate or licking of the lips or as blatant as muscle splinting or vocalization. If the patient splints (actively contracts muscles), the movement is no longer passive.

Determining the Effectiveness of Treatment

The test and re-test concept (as explained in the section on Soft Tissue Mobilization) is used to determine the success of a treatment with PROM. Objective changes in ROM are measured with a goniometer and documented in degrees. Goniometric measurements can be taken before and after treatment to determine the effectiveness of the treatment (Figure 5.5).

The term goniometry is derived from two Greek words: *gonia*, meaning angle and *metron*, meaning measure. A goniometer is an instrument used to measure angles. Within the field of human physical therapy, goniometry is used to measure the total amount of available motion at a specific joint (Dutton, 2015). Goniometers come in a variety of

Figure 5.5 Goniometer.

Figure 5.6 Stifle flexion measurement.

sizes and shapes and are usually constructed of either plastic or metal.

Measurement of PROM requires proper placement of the goniometer at the joint being measured. A goniometer has two arms that move around a fulcrum. A list of the bony landmarks is used to align the goniometer with a proximal bony landmark, the joint axis and a distal bony landmark. The proximal arm or "stable arm" is lined up with the proximal stabilized bony segment and does not move during measurement. The distal arm or "moving arm" is lined up with a distal bony segment and will move as the joint is taken through ROM. The axis or fulcrum is lined up with the approximate joint axis. The therapist must maintain the proper PROM manual contacts discussed earlier as well as stabilize the goniometer on the limb (Figure 5.6).

ROM Standards

In human medicine, normal joint ROM has been well documented and specific values are available (Norkin and White, 2009). Normal joint ROM of the canine patient is not well established due to conformation variability by breed (Thomas *et al.*, 2006) (Table 5.1). Two canine studies have looked at the reliability of goniometry and have documented ROMs by joint for a particular breed in dogs without lameness or radiographic

Table 5.1 Commonly used goniometric bony landmarks.

Joint	Proximal arm	Axis	Distal arm
Shoulder	Spine of scapula	Acromion	Lateral epicondyle
Elbow	Greater tubercle	Lateral epicondyle	Lateral styloid
Carpus	Head of radius	Lateral styloid	5th metacarpal
Hip	Midline of ilium	Greater trochanter	Lateral epicondyle
Stifle	Greater trochanter	Lateral epicondyle	Lateral malleolus
Tarsus	Head of fibula	Lateral malleolus	5th metatarsal

Table 5.2 End-feel guidelines.

Joint	Motion	NL End-feel
Shoulder	Flexion	Soft tissue
Shoulder	Extension	Capsular
Elbow	Flexion	Soft tissue
Elbow	Extension	Boney
Carpus	Flexion	Capsular
Carpus	Hyperextension	Capsular
Hip	Flexion	Soft tissue
Hip	Extension	Capsular
Stifle	Flexion	Soft tissue
Stifle	Extension	Hard capsular
Tarsus	Flexion	Muscle–tendon
Tarsus	Extension	Capsular

abnormalities. These measurements were correlated with radiographic measurements (Jaeger *et al.*, 2002; Thomas *et al.*, 2006) (Tables 5.2 and 5.3). Due to conformational variability, between breeds we must rely on comparison to the contralateral side if that side is considered normal. Normal would be considered the absence of an injury or condition that might affect ROM. Goniometry has also been researched in cats and osteoarthritis correlates with reduced ROM (Jaeger *et al.*, 2007; Lascelles *et al.*, 2012).

Frequency, Intensity, and Duration of ROM

Treatment prescriptions must include specific parameters of frequency, intensity, and duration (APTA, 2014). Frequency refers to how often ROM will be performed (i.e., daily, three times/day, every other day etc.). Intensity refers to the number of repetitions that will be performed. Duration refers to the number of sets of the prescribed repetitions.

For example, for shoulder extension PROM, 10 reps × 1 set, 3×/day:

- Frequency 3×/day
- Intensity 10 repetitions
- Duration 1 set (of 10 repetitions).

Precautions/Contraindications of PROM PROM is a relatively safe technique with few precautions or contraindications. Caution should be used in the case of acute tears, fractures, and surgery. In human medicine,

Table 5.3 Range of motion (degrees) of various appendicular joints measured by goniometry in 16 healthy Labrador Retrievers.

Joint	Position	Mean	95% Confidence interval of the mean	Median
Carpus	Flexion	32	31–34	32
	Extension	196	194–197	196
	Valgus	12	11–13	12
	Varus	7	6–8	7
Elbow	Flexion	36	34–38	36
	Extension	165	164–167	166
Shoulder	Flexion	57	54–59	57
	Extension	165	164–167	165
Tarsus	Flexion	39	37–40	38
	Extension	164	162–166	165
Stifle	Flexion	42	40–43	41
	Extension	162	160–164	162
Hip	Flexion	50	48–52	50
	Extension	162	160–164	162

Source: Adapted from Jaeger *et al.* (2002).

gentle, pain-free PROM is used in each of these instances to stave off adhesion, contracture formation, and sluggish circulation leading to a prolonged recovery time (Kisner and Colby, 2012).

Stretching

Stretching is a manual technique used to increase the extensibility of muscle fibers (Page, 2012). Whereas PROM affects the joint and its associated soft tissues (joint capsule and ligament), stretching primarily affects muscle and associated tendons. Decreased flexibility or muscle tightness can occur passively or actively. Passive tightness may be the result of postural adaptation or scarring and active tightness may result from overuse, injury, or spasm (Page, 2012). As a treatment, the goal of stretching is to increase the flexibility of the tight muscle.

Importance of Flexibility

As discussed in the previous section, ROM can be limited by several structures, one of which is muscle. If muscle tightness restricts ROM, compensation may occur, resulting in abnormal stress to the joint and/or related tissues (Weiner, 2001; Jarvis *et al.*, 2013; Wise, 2015). Therefore, it is important to address issues of decreased flexibility early in the rehabilitation process.

Treatment Techniques

There are several techniques used to increase muscle flexibility, such as static stretching, modified stretching, and active stretching.

Static Stretching A static stretch involves holding a muscle in a stretched position for a prolonged period. Static stretching has been found to be effective in increasing muscle flexibility (Page, 2012). A word of caution has been offered regarding this type of stretching. Research has demonstrated that a static stretch can result in “stretch-induced strength loss” (McHugh and Cosgrave, 2012). This suggests that static stretching would be ill-advised prior to an athletic event. A dynamic stretch is recommended in this case.

A static stretch is performed by positioning the muscle in the stretched position and maintaining the position for a prolonged

Table 5.4 Thoracic limb muscle stretches.

Muscle group	Movement
Brachiocephalicus	Extend the head and neck, pull front leg forward
Rhomboids	Glide scapula ventrally
Biceps	Flex shoulder, extend elbow
Supraspinatus	Flex shoulder with slight internal rotation at humerus
Infraspinatus/teres minor	Extend shoulder, adduct limb
Deltoid (spinal head)	Extend shoulder, adduct limb
Triceps (long head)	Flex elbow then flex shoulder joint
Latissimus dorsi/teres major	Extend shoulder, slight external rotation and abduction at humerus
Subscapularis	Flex shoulder, externally rotate/slightly abduct humerus
Superficial pectoral	Adduct the forelimb, assist in protraction and retraction
Deep pectoral	Extend shoulder, abduct limb at humerus
Carpal flexors	Flex elbow, extend carpus
Carpal extensors	Extend elbow, flex carpus
Digital flexors	Flex elbow, extend carpus and digits
Digital extensors	Extend the digits

period. Research suggests that the effects of a 30-second sustained stretch are maintained significantly longer than those of a 15-second stretch. Stretching for longer than 30 seconds does not have increased benefit for human muscles (Bandy and Irion, 1994; Page, 2012). Canine muscles have different fiber type composition to humans and so may respond differently to stretch, but because current evidence is lacking we extrapolate information from another species. As therapists, we should use our palpation skills to assess the effects of stretching.

The position of stretch is determined by reversing the action(s) of the muscle (Tables 5.4 and 5.5). For example, the biceps brachii muscle has two proximal head attachments and extends from the distal end of the scapula to the proximal end of the radius. When it contracts, it flexes the elbow joint (Coville, 2016). This treatment technique must be comfortable for the patient so that splinting (contracting the stretched muscle) does not occur as this would negate the intent of the treatment (Figure 5.7).

Modified Stretching It is important to note that the safest and most effective stretch targets the belly of the muscle, rather than the tendon. Excessive loading of a tendon can result in irritation of the tendon (Sharma and Maffulli, 2005). The modified stretch assures that the stretch occurs in the belly of the muscle.

This technique is a two-step process. First, the muscle is placed in the stretch position until it is taut (not tight). In the case of a two-joint muscle, the proximal joint is positioned first, followed by the positioning of the distal joint (Figure 5.8). For example, the hamstring muscle group is stretched by first flexing the hip. Then the stifle is extended until the muscle feels taut. Once this position is achieved, the second step is to perform STM at the belly of the muscle with the intent of manually "bending" or stretching the muscle belly.

Active Stretching For the dog, cat (or horse) that would "rather do it themselves" a dynamic or active stretch can be taught. This

Table 5.5 Pelvic limb muscle stretches.

Muscle group	Movement
Iliopsoas	Extend hip, internally rotate femur
Semimembranosis	Flex hip, extend stifle. Slight abduction at femur
Semitendinosis	Flex hip, extend stifle. Slight external rotation at femur
Biceps femoris	Flex hip, extend stifle. Slight adduction and internal rotation at femur
Gracilis	Flex hip, extend stifle, abduct limb at femur
Sartorius (cranial band)	Flex stifle, extend hip
Pectineus/adductors	Abduct limb at femur
Gastrocnemius complex	Extend stifle, flex tarsus
Superficial digital flexor	Extend stifle, flex tarsus, extend digits
Tibialis anterior	Extend tarsus
Digital flexors	Flex the digits
Digital extensors	Extend the digits

Figure 5.7 Biceps stretch.

Figure 5.8 Hamstrings stretch.

type of stretching is recommended prior to an athletic event.

The targeted muscle is stretched by luring the patient into a position of stretch. For example, the hip flexor muscle group can be stretched by encouraging the dog to put his front legs up on a chair, bringing the hips into an extended position. Another example is a stretch of the triceps and latissimus dorsi muscles by luring the dog into a play bow position. The disadvantage of active stretching is that the origin of the muscle is not stabilized, making the stretch less specific to one muscle (Figures 5.9 and 5.10).

Frequency, Intensity, and Duration

There are varying opinions regarding frequency and duration of stretching for optimal results in gaining and maintaining flexibility. With regard to frequency, human research demonstrates that stretching more than once each day does not have significant benefits. In addition, stretching four times a week was shown to improve flexibility 82% greater than stretching only twice a week (Brady, 2013). An earlier study demonstrated that there was no increase in muscle length after 2–4 repetitions (Taylor *et al.*, 1990).

Figure 5.9 Psoas stretch.

Figure 5.10 Play bow.

Applying these findings to the canine patient, the recommended stretching prescription is:

- Frequency 4 times/week
- Intensity per patient comfort (to avoid splinting)
- Duration 30-second stretch.

Precautions/Contraindications

Like PROM, stretching is generally a safe treatment technique if performed within the patient's comfort level. The following precautions and contraindications should be considered.

Precautions

- Joint hypermobility
- Newly healed fractures
- Postoperative tendon repair
- Vigorous stretch post immobilization.

Contraindications

- Bony block
- Recent fracture
- Acute pain with movement
- Acute inflammation or infection
- Hematoma.

Joint Compression

Joint compression is a mobilization technique in which opposing surfaces of a joint are manually approximated (Kaltenborn, 1989). The goal of the treatment is to decrease pain, decrease swelling, improve proprioception, and simulate weight bearing.

This technique is performed by stabilizing one joint surface and mobilizing the opposing surface such that the joint is compressed. No joint motion occurs. Joint compressions consist of quick oscillations or pulses and can be performed in non-weight-bearing (NWB) or weight-bearing (WB) positions. In the NWB position, the proximal bone is stabilized and the distal bone is mobilized through a long lever arm. Conversely, in the WB position the distal bone is stabilized (on the ground) and the proximal bone is mobilized. For example:

- Stifle joint compression in NWB position: The proximal hand stabilizes just above the stifle and the distal hand uses the calcaneus/tarsus as a hand-hold to perform the approximating oscillations.
- Stifle joint compressions in WB position: The distal hand stabilizes the paw on the ground with a hand-hold on the calcaneus/tarsus and the proximal hand performs the oscillations from just above the stifle toward the ground.

Frequency, Intensity, and Duration

Joint compression can be performed frequently throughout the day. Intensity is determined by the goal of the treatment. Duration is 1–2 minutes (Table 5.6).

Other Techniques

It is important to understand that there are numerous manual techniques used to address soft tissue and joint dysfunction. Each technique requires advanced study and training in order to be performed properly and safely. The following are a few such techniques.

Table 5.6 Depending on the goal of the treatment, the amount of force applied and the speed of the oscillations are varied.

Goal	Force of compression	Speed of oscillation
Pain	Light	Moderate to fast
Swelling	Moderate	Moderate
Proprioception	Light to moderate	Moderate to fast
Weight bearing	Moderate	Moderate

Joint Mobilization

As mentioned earlier, joint ROM consists of both osteokinematic and arthrokinematic motion. Joint mobilization is a technique used to treat arthrokinematic restrictions (Kaltenborn, 1989). Veterinary technicians and nurses are not trained in or approved to perform these techniques.

Arthrokinematic motion is passive, involuntary motion that occurs between two joint surfaces during osteokinematic motion. Arthokinematic motion is assessed with a joint play assessment glide.

Arthrokinematic dysfunction is addressed with joint mobilization by gliding one joint surface on an opposing stabilized joint surface. Treatment parameters include: (i) type of mobilization (glide or traction), (ii) grade of mobilization (I, II, III, or IV), and (iii) direction of mobilization (cranial, caudal, dorsal, ventral, medial, lateral, etc.). The convex/concave rule is used to determine the proper direction of the treatment glide. This rule is based on the mechanics of a concave surface moving on a convex surface and vice versa.

Myofascial Release

Fascia is a three-dimensional web-like matrix of thin, tough connective tissue. It surrounds muscles, organs, bones arteries, veins, and skin throughout the entire body (Salvo, 2012). The tissue is richly innervated with mechanoreceptors and these nerves can become sensitized and recruited as nociceptors (signaling pain).

Myofascial restrictions are caused by inflammatory responses, trauma, or surgical procedures. Fascia is a supporting structure that also aids in function. Myofascial release (MFR) is a soft tissue technique that specifically addresses fascial restrictions. Fascial restrictions are treated using either direct or indirect MFR techniques. The direct technique is a more aggressive technique. It involves placing all three planes of fascia into a stretched position ("restrictive barrier") until the sensation of a release is experienced in the therapist's hands. The goal is to create changes in the fascia by stretching the fascia and mobilizing adhesive tissues. The indirect technique, on the other hand, is a gentler approach and more appropriate for the canine patient. In this case, all three planes of fascia are places on slack (away from the barrier), allowing the fascia to "unwind."

Strain–Counterstrain

Based on the work of osteopathic physician Lawrence Jones, strain–counterstrain is a technique designed to reduce abnormal neuromuscular reflex within a tissue. His technique addresses areas of inappropriate proprioceptor activity that results in somatic dysfunction. On palpation, these areas are tense and tender and are referred to as "tender points." The technique is performed by passively placing the involved muscle or segment in a maximally shortened position. The position is held for 90 seconds. The goal of the technique is to reduce neuromuscular firing and to "reset" muscle tension. Expected results are a resolution of tension (muscle activity) and at least a two thirds reduction in pain on palpation within a treatment session. Strain–counterstrain is considered an indirect technique because its action is away from the restricted barrier (Basmajian and Nyberg, 1992).

Lymphatic Drainage

Lymphedema is a condition caused by damage to the lymph transport system (lymph nodes or lymph vessels). It is characterized by swelling of the limbs. Primary lymphedema is thought to be an inherited condition in humans and has been reported in a case study of two whippet siblings (Schuller *et al.*, 2011) and in draft horses (Affolter, 2013), whereas secondary lymphedema is usually the result of damage to the lymph system due to trauma, surgery, removal of nodes, or irradiation (Lee *et al.*, 2011).

The principles of manual lymphatic drainage (MLD) were considered as early as the 1800s by the founder of osteopathy, Andrew Still. His appreciation of the complexity of the lymphatic system stimulated a flux of further investigative work. MLD requires an extensive understanding of the anatomy and mechanics of the lymph system. The theoretical basis of MLD is that it: (i) stimulates the lymphatic system via an increase in lymph circulation, (ii) expedits the removal of biochemical wastes from body tissues, (iii) enhances body fluid dynamics, thereby facilitating edema reduction, and (iv) decreases sympathetic nervous system responses while increasing parasympathetic nervous tone, yielding a non-stressed body-framework state (Vairo *et al.*, 2009). Treatment is often followed by the application of compression bandages (DeLisa *et al.*, 2005).

As a manual technique, MLD is a gentle technique in which rhythmic, repetitive, precise hand movements are used to affect the direction and speed of lymphatic flow (Willis, 2004). This technique is performed with light pressure (approximately 1–4 ounces (28–113 g)) in order to avoid collapse of the lymphatics. Treatment is initiated by “opening” the proximal node (that fluid is being drained toward) followed by more distal work, directing the fluid back toward the proximal node. This creates a path for the lymph as well as a suctioning effect to help draw the lymph toward the proximal node.

Manual Techniques as Home Exercise Program

One of the most important elements of a successful rehabilitation program is the home exercise program (HEP). To maintain and/or progress gains made in the clinic, the owner must be compliant with a home program. Thorough owner education is the key to compliance. See more about the home exercise plan in Chapter 6.

Owner education should include:

- an explanation of the injury or condition in layman’s terms,
- an explanation of the purpose of each technique/exercise as it relates to resolution of the condition and improved function for the patient, and
- an explanation of how to identify a red flag or a negative response to the treatment.

Once the owner understands the relevance of the HEP, instruction in performing the program can take place. There are three components to instructing an owner in a HEP.

- *Demonstration*: A visual and verbal demonstration should be performed. This includes a verbal explanation of handling skills, hand placements, and specific nuances.
- *Practice*: The owner should practice all techniques/exercises while in the clinic until performed safely and effectively.
- *Take-home instruction*: Owners should be provided with written instructions and pictures of each exercise or technique, including frequency, intensity, and duration of each element. Additionally, video recordings done by the owner on phone or video camera can be extremely helpful.

Conclusion

The goal of veterinary physical rehabilitation is to restore maximal function. In this chapter, we discussed one element of a rehabilitation program – manual techniques (AARV, 2016). These techniques promote tissue health and mobility, laying the groundwork for normal function. With the appropriate use of manual techniques in combination with an individually designed therapeutic exercise prescription, effectiveness and efficiency in the rehabilitation process can be achieved.

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6

Home Exercises

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CHAPTER MENU

Introduction

Client involvement in a rehabilitation program may be minimal, or the therapy may be performed entirely by the client in the home environment. To design the ideal program, both the client and the patient must first be assessed. The client must be committed to the plan, and have the mental, emotional, and physical capability to work with the patient. The rehabilitation team must work with the client to create a program that is effective and fits with the client's capabilities and resources. The therapist must ensure that the client can correctly perform the therapies, and the patient should be assessed regularly until the therapeutic goals are reached.

Assessing the Client

Level of Commitment

Several factors can affect a client's level of commitment to a rehabilitation program. It is important to understand some of that factors that may impede the client from participating in the therapy. Once the rehabilitation team is aware of potential factors that may reduce client compliance, they may be able to adjust the program to improve the client's ability to commit.

Probably the most important factor for client compliance is whether they value rehabilitation as a treatment. The client's previous personal experience with exercise or with physical therapy can have a positive

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or negative effect on their attitude toward rehabilitation for the patient. The client's cultural background may also affect their beliefs in the value of therapy. A basic understanding of the patient's health condition and how rehabilitation can help is also important. Client education by the rehabilitation team can make a significant difference in the client's understanding of the value of rehabilitation, which may help motivate them to follow a program.

Financial considerations can also affect client compliance because clients must be willing and able to pay for a rehabilitation program. Sometimes financial considerations will affect the type of program the patient is entered. If clients have minimal financial constraints, they may be able to take advantage of extensive in-house therapy. For many patients and clients, it is appropriate to consider some in-house therapy along with home exercises. However, if funds are limited, the client may request a program that is strictly carried out at home with minimal intervention on the part of the rehabilitation team. A frank discussion of the cost of rehabilitation enables the rehabilitation team to develop a program that is affordable for the client to carry out. In some cases, the less expensive option may be less ideal for the patient. However, this may be preferable to the client electing to pursue no therapy because it is unaffordable.

Time constraints may also affect the degree to which the client adheres to a program. If the rehabilitation program recommended is too time intensive, the client may become overwhelmed and entirely abandon it in frustration. It is important to have a non-judgmental discussion to establish how much time the client can realistically commit to the program each day. Once this has been established, a program can be designed to maximize the available time.

The client's understanding of the value of rehabilitation, along with any financial or time constraints should all be discussed prior to creating the rehabilitation program. Any factors that may be barriers to commitment must be considered when designing the program, because the "ideal" program will not be effective if the client is unable to remain committed to it.

Physical Abilities

Rehabilitation can be very physically and mentally demanding for the client or the animal handler. The client's general physical abilities should be assessed during the initial discussion about the rehabilitation program. If the client volunteers information about personal medical conditions or physical limitations, discuss how the program may be designed to adapt to these conditions. If the client does not volunteer any information, the therapist must decide whether it is appropriate to initiate a conversation pertaining to the client's physical capabilities.

The therapist should carefully observe the client during any training sessions where the client is demonstrating proficiency in handling the patient. The client may be required to get down on the ground with the patient for some exercises and may need to transition from a squatting to a standing position frequently. In some cases, the client may need to lift and support the patient. In addition, some exercises may require a certain level of agility or speed on the part of the client, if the patient is to perform correctly. Exercises that are complex or require precise timing may be too difficult for some clients to understand and perform well. If the therapist suspects that the client may have physical or mental difficulty with certain exercises, they may need to be modified or dropped from the home program.

There are situations where multiple handlers are required to have the patient perform the treatments correctly. This most commonly occurs in large dogs that are non-ambulatory or have severe physical impairments. In these situations, the client must be able to identify other individuals in the home environment who will be able to participate in the patient's care.

It is very important for the client to be physically fit for them to perform rehabilitation on their pet. Many home exercise programs include a lot of walking or stair climbing. If clients have been sedentary or have any potential risk associated with an increase in activity, it should be recommended that they consult their physician before beginning the rehabilitation program for their pet. The goal is to improve the patient's physical ability, not decrease the client's! However, sometimes the patient's need for exercise is helpful motivation for the clients to improve their own physical fitness.

Animal Handling Skills

The animal handling skills of the client can affect the design of the rehabilitation home program. Knowledge of basic obedience commands is nice but not necessary. However, the client must be able to control or redirect the patient's behavior. If the client is unable to control the patient's movements they may be performed ineffectively, or even worse, could result in further injury to the patient.

As clients understand more about animal training, they are better able to motivate or alter patient behaviors. Although this is not essential for passive types of therapy, it becomes more important for active exercises, particularly if the movements become more complex. For example, controlled leash walking can be performed with minimal handling skills (although this can vary with the patient's personality and level of training). However, having a patient perform sit-to-stand exercises requires a higher level of control that can be made easier if the client can shape the patient's behavior.

The client should also have a basic understanding of animal behavior. Some clients may need guidance to understand body language. This is particularly important if the patient may be inclined to bite or scratch, so the client can avoid becoming injured during a therapy session. The client should also be instructed to interpret signs that the patient may be painful. This is helpful because additional therapies may be indicated if the patient is painful. In addition, clients are fearful of creating pain and become reluctant to perform the therapy. If they can more accurately assess the patient's pain, they are more likely to perform appropriate therapy.

Clients may benefit from some instruction to improve their animal handling skills. It is important not only to explain handling skills to the client but also to show them physically, and then have them demonstrate proficiency. In this way, the therapist can identify potential problems in the animal handling techniques.

Client–Patient Bond

The relationship between the client and the patient plays a big role in successful rehabilitation. The client's emotional bond often provides significant motivation for the client to persist in helping with the recovery process. In addition, the shared bond can often enable the client in motivating the patient to perform desired activities. Clients may understand what toys or treats best motivate their pets, as well as which activities they particularly enjoy. A more intimate knowledge of the patient's personality may give clients an advantage, because they may be able to "think outside the box" to motivate the patient to perform an exercise or movement.

In some cases, the client relationship may hinder the rehabilitation program. Some clients may be reluctant to push the patient to do any activity when they encounter resistance. In addition, some clients may be concerned that they are going to create pain or further injury. These clients must be educated so they understand what needs to be done, and gain confidence that their efforts are necessary and beneficial.

Clients need to be able to notice any subtle changes in the patient. They need to be instructed to take note of any physical changes that are either seen or felt by physical palpation and take note of any behavior change that arises during their in-home treatments. And as previously mentioned, the clients must also be able to watch for signs of pain, and distinguish it from fatigue or stress. Some clients are very skilled at understanding their pet's personality and behaviors, while others may need some guidance and education related to typical animal behaviors.

Rehabilitation Goals

Rehabilitation goals should be discussed early in the assessment process. The rehabilitation team can help establish realistic end goals, based on their knowledge of the condition and prognosis. The team can also suggest whether the goals are likely to be achievable with the patient receiving home care only. In many cases, a combination of in-house therapy and home care, or extensive in-house therapy may be more appropriate.

Client expectations should also be explored during this discussion. It is important for the therapy team to know what the client anticipates and desires as the outcome. Do they want their pet to return to full working duty or do they just want it to be able to climb up on the couch again? If there is a disparity between what the client expects and the probable outcome, this should be recognized before beginning the therapy program. Although it is beneficial to be optimistic, a realistic outcome needs to be discussed.

Assessing the Patient

Motivation

Motivating patients to work can be one of the most difficult aspects of rehabilitation. There are several factors that can affect individual motivation. Patients that are painful, fatigued, or stressed may be distracted or reluctant to be active. Very young patients may have a brief attention span, while geriatric patients may have cognitive impairments that reduce their ability to follow directions (Salvin *et al.*, 2010). Patients that have already undergone some type of training may be better able to understand what the handler or client is trying to get them to do. In addition, some patients are more adept at learning what behavior is expected of them. Although popular opinion may be that certain breeds are easier to work with than others, every individual is different.

Using food or treats as motivation is one of the easier and more popular ways of getting the desired behavior. However, not every patient is food-motivated. When treats are not effective, various toys may be tried. In some cases, many different types of toys must be tried until one is identified that is particularly motivating to the individual. Some patients respond best to positive verbal feedback from their owners. Teaching an owner the appropriate time and type of praise during exercise is important to ensure the patient understands the desired behavior. Often it is necessary to be innovative and to try different techniques before discovering what works best for the patient. Regardless of what typically works best for the therapist, always remember that it will not work for every patient.

Training

It is important to consider the patient's level of training. If patients do not already know basic obedience commands such as "sit," then it may be more difficult to have them perform sit-to-stands. The therapist may be able to train basic skills as the therapy progresses. However, if the client is performing home therapy, they may be unwilling or unable to train the patient. The complexity of the exercises must be chosen with the patient's level of training in mind. If the patient is not trained to do a certain command, it is still possible to lead them through the movement or shape the behavior, with the right type of motivation. Bear in mind that the client must possess or learn training skills if the therapy program is being done at home.

Some patients already have a high level of training. This can make it easier to design a varied therapy program. However, this type of patient may lose focus if the therapeutic activities are very simplistic and repetitive. For this type of patient, it may be necessary to challenge them not only physically but mentally as well.

Goal of Exercise Program

The goal is to return the patient to the highest level of function as is possible. To do this, the therapist must understand which exercises are beneficial and which are contraindicated. To meet the goal it is sometimes best to focus on accomplishing short-term goals or individual exercises. It is important to remember that the patient must be evaluated at regular intervals throughout the rehabilitation program. It may be necessary to adjust goals or the expected time the goals are reached as the patient progresses through the program.

Assessing the Resources

Environment

Factors in the home environment will influence the development of the therapeutic exercise program. As the activity level is increased, walking up stairs or hills may be recommended, if available. A pond, lake, hot tub, or swimming pool may be recommended for water therapies such as walking in water or swimming. However, these may not be appropriate to include in the therapeutic plan if the client has limited access to these resources or is unable to use them safely.

The patient's environment may also need to be controlled to prevent further injury. Most patients need to be housed indoors, and often need to be confined to a relatively small area when they are unsupervised. This is typically best accomplished by use of a kennel or a small room. Early in the rehabilitation program it may be undesirable for patients to be traversing flights of stairs, and this can present a challenge if they are in the habit of sleeping in an upstairs bedroom. In addition, patients who are recumbent need a padded area to rest. If the home has hardwood or tile floors, weak patients may need non-skid boots or assistance to prevent slipping. The dog door may also need to be temporarily inactivated to limit unsupervised access to the yard. Appropriate activity levels should be discussed to ensure the patient is prohibited from doing too much too soon.

Equipment

Knowledge of the client's available equipment is just as important as understanding the home environment. The equipment that the client has or that they can make will heavily impact the structure of the home exercise program. Most therapeutic exercise equipment can be purchased inexpensively at a local department store, but clients who are crafty and willing can make some of the equipment. Another option may be for the rehabilitation business to loan, rent, or sell equipment to clients.

A basic rehabilitation home program can often be created with minimal to no equipment. If the patient needs to reach a high level of function, particularly if they need to return to sports-specific or work-specific activity, some specific exercise equipment may be needed. However, for this type of patient, clients usually have access to necessary training equipment.

Training the Client

Initial Instruction of Exercises

The initial instruction with the client must be very detailed. This begins with a handout that explains the home program. A home exercise program should not just list the exercises but also give detailed descriptions and photos of the exercises and explain how to perform them. The client is given so much information during the discharge that it is easy for them to forget what was said or lose a piece of paper. Providing a video of the exercises is also very helpful. The correct form can more easily be conveyed by video as compared to written instructions. Clients may be overwhelmed by all the instructions, so it is helpful for them to have information that they can to refer to once they get home.

Providing verbal and written instructions is essential, but these alone are not sufficient. The therapist should demonstrate the correct techniques with the patient. The client should then practice the techniques with the therapist's guidance. This allows the therapist to ensure that the client understands the exercises and can perform them correctly with the patient. This session also gives the client opportunity to ask questions, and the practice activities improve their self-confidence. A client who has demonstrated appropriate technique, and who is confident that they can perform the therapy, is more likely to adhere to the program.

Finally, if any assistive devices are sent home, the therapist should ensure that the client is completely comfortable with how they work and how to apply them. Slings, carts, and braces should be evaluated by the therapist or veterinary team to ensure they fit the patient properly. It is best to have the client practice applying and removing the device several times, until the client and therapist are confident that the client can use it correctly. The client must also be advised to watch for complications. Specific regions of the body where an apparatus may pinch or rub should be pointed out, and specifics of when to act should be given when "any issue more than hair loss needs to be addressed." In general, the client should be instructed to call immediately if they notice any potential problems and to avoid the use of the device if possible until examination can be performed.

Education Regarding the Patient's Condition

It is very important for the client to be aware of the patient's condition. Client education on pain assessment is key in ensuring that the patient's comfort level is adequately addressed. In educating clients about pain, they must be told the signs to watch for during exercises that may indicate a problem. Signs of pain can include vocalizing, excessive panting, dilated pupils, limping, restlessness, and change in behavior or personality (Gaynor and Muir, 2015).

Clients also need to know what complications may occur from any of the recommended treatments, physical or pharmaceutical. The potential complications will vary depending on the initial problem and the patient's condition, and must be identified by the rehabilitation team. The potential complications should be explained to the clients, and they should also be given a written description of potential signs. Clients should also be given guidelines that outline when an exercise should be stopped and when to seek additional help. In addition, the clients should be given an idea of the rate of progress to expect as they progress through the program.

Follow-Up

The follow-up evaluations are just as important as the initial exam. These evaluations are used to determine whether the patient is improving as expected or new problems are noted. If the patient is not improving as expected, the reason for this must be evaluated. It is possible that the initial goals were overly optimistic. It is also possible that the client is having difficulty following the rehabilitation program, or the patient may be experiencing complications. Regardless, the rehabilitation program may need to be modified to address any problems.

A phone call is one way to see how the client is coping with the exercises at home. Weekly phone calls allow the therapist to assess whether the client is comfortable with the prescribed exercises and to obtain an update on the patient's progress. Bear in mind that the client's self-report of patient progress may be inaccurate. In addition, a client may be unaware that they are performing therapy incorrectly. Therefore, it is important to have the client repeat the exercises after they are shown how to perform them during the initial assessment. The therapist may also help motivate the client by phone if they are having difficulty performing the exercises or becoming frustrated with lack of progress.

Ideally, the patient should be re-evaluated roughly every 4 weeks depending on the problem. Some will need to be seen sooner and some later. If the patient is also receiving in-house therapy, a re-evaluation can be scheduled during one of these visits. The patient should not be released to full activity until a final evaluation is performed.

Home Exercises

Thermotherapy

Application of cold packs is beneficial after any surgery because it helps reduce inflammation and aids in pain control (Cameron, 2003). Cold packs may also be applied after exercise to reduce inflammation. This may be especially beneficial for patients with arthritis, because the cold can reduce the pain and inflammation of arthritic joints. A cold pack can also be applied to an area that has been traumatized, to reduce hemorrhage and inflammation (Cameron, 2003).

Several different forms of cold packs are available for use. Commercially available gel packs are nice because they remain pliable even when frozen, can be easily disinfected, and usually can double as a hot pack (Figure 6.1). Crushed ice can be placed in a sealable plastic bag to create an ice pack. A small amount of water may be added to help eliminate the dead space. Ice can be placed in a pillowcase or moist towel, although this can be messy. Using a bag of frozen vegetables has been recommend for emergency situations. This is a less effective method because of the dead space between the vegetables, so is not recommended for use during therapy sessions. An ice slush can be made by mixing four parts water to one part rubbing alcohol in a sealed bag and placing in a freezer. Note that this alcohol–water mixture performs at a lower temperature than crushed ice. Therefore, this type of cold pack should never be applied directly to the skin because it carries an increased potential for causing cold-induced injuries (Cameron, 2003).

Figure 6.1 Commercial gel packs are relatively inexpensive. The rehabilitation facility may sell them to the client, or they can be purchased at a local drug store.

Before applying a cold pack it can be wrapped in a cloth or thin towel to protect the skin and keep the cold pack clean. For maximal cooling effect, the towel can be moistened. However, when using a true ice pack or alcohol slush pack, the cooling is more intense, so the towel should be dry. The cold pack should be held firmly in place or secured with an elastic bandage to ensure good skin contact. The application time should be at least 10 minutes to effectively reduce pain and swelling, and may be repeated every 1–2 hours (Cameron, 2003). It may not be necessary to treat that often, and may be impractical for the clients. A typical recommendation is to apply the cold pack for 10–20 minutes (Dragone *et al.*, 2014), 2–4 times daily, or after each therapy session.

Heat therapy can also be used in a home program. Some of the effects of heat are peripheral vasodilation, increase in metabolic rate, relaxation of muscle spasms, improvement of soft tissue elasticity, and reduction in pain. Indications to use heat would be to help reduce pain and muscles spasms, to enhance stretching, or to warm the tissues before activity. Use of local heat therapy is contraindicated in the presence of active bleeding, acute inflammation or infection, swelling or edema, neoplasia, or impaired sensation to the area (Cameron, 2003). This means that heat should not be applied near a surgical incision during the first few postoperative days when there is inflammation associated with the surgical procedure! A hot pack encourages dilation of blood vessels, resulting in increased blood flow and metabolic activity to the area (Cameron, 2003); this would be undesirable if there is postoperative inflammation.

The most commonly used hot packs are sacks or bags filled with beans, rice, cracked corn, bentonite (a hydrophilic silicate gel), or other inert materials. As mentioned above, the same gel packs can be used as either cold packs or hot packs. A hot pack can also be created by heating a damp towel or bag of water in the microwave; however, these methods may result in less effective heating. Although hot packs can be beneficial, bear in mind that heat from a hot pack only penetrates a few centimeters beneath the tissue surface.

The hot pack should be checked against a person's skin to ensure that it does not feel too warm for the patient. A towel or cloth may be placed between the hot pack and skin if there are any concerns about overheating the skin. In addition, the skin should be observed intermittently for signs of excessive redness. In addition, animals with normal sensation should be monitored for evidence of discomfort. Hot packs are generally applied to an area for 15–30 minutes. This may be done 2 or 3 times daily, and may be done as a warm-up prior to exercise or stretching.

Passive Range of Motion

Passive range of motion (PROM) is performed by moving a joint within its available range of motion, using an external force. The benefits of PROM are that it maintains range of motion, helps prevent joint contracture, reduces pain, and improves synovial fluid production and diffusion (Millis and Levine, 2014). It is important to remember that PROM does not prevent muscle atrophy, nor does it improve strength or endurance. PROM can enhance blood and lymphatic flow, but not as effectively as active range of motion does (Kisner and Colby, 2007). Range of motion exercises are contraindicated if the movement could cause further injury or instability. For example, a tenuous fracture repair could be compromised by excessive movement, so it is very important to discuss the therapeutic plan with the surgeon before beginning therapy. In most cases, PROM is beneficial if performed at a slow, controlled speed and within a comfortable range of motion for the patient.

It is best to perform PROM in a quiet room with as few distractions as possible so the patient can relax. The patient should be in lateral recumbency with the affected leg up.

If the patient is aggressive, it may need to be muzzled. If the patient seems to be painful, the pain management protocol may need to be modified prior to performing PROM. In some cases, two people are needed to perform PROM – one to restrain or calm the patient and one to do the exercises.

When performing PROM on a postoperative orthopedic patient, it may be most efficient to focus on the affected joint; however, it is important to maintain normal range of motion in all joints. When performing PROM on a neurologic patient with a spinal cord injury, PROM should be performed on all major joints. For example, if the patient is paraplegic, PROM should be performed on the joints of both hind limbs, and if the patient is tetraparetic PROM should be performed on the joints of all four limbs.

It may be necessary to spend a few minutes gently massaging the affected limb to promote further relaxation, and gradually move toward the affected joint. Some patients do not like their feet being touched so it may be better to start proximally and move slowly, rather than grabbing hold of the patient's foot. Motions should be slow and controlled. This is not a race! One hand should be positioned to support the limb proximal to the joint, while the other hand supports the limb distal to the joint. The entire limb should be supported with the joints in neutral positions to prevent any excessive joint stresses. The two hands are slowly moved to gently flex the affected joint, while the other joints are allowed to maintain neutral positions. The joint is flexed as completely as possible until some resistance is met or until the patient displays signs of discomfort. Discomfort may be displayed by muscle tension, pulling the limb away or turning the head toward the affected area. With hands in the same supportive positions, the joint is extended fully, stopping before the patient displays signs of discomfort. An alternative method is to support the entire limb and flex and extend all the joints by moving the limb in a way that mimics an exaggerated walking step, or "bicycling," movement. This method of PROM is more appropriate when the patient is nearly using the leg actively. Remember that the stifle and hock positions are related, so maximum flexion of one of these joints requires simultaneous flexion of the other. When done correctly, PROM should not be a painful experience nor should it cause any signs to worsen.

The most appropriate treatment prescription will vary with the condition. However, for most postoperative conditions, 15–20 repetitions (for each joint), 2–4 times daily is adequate (Millis and Levine, 2014). PROM is typically discontinued when the patient can use the leg, and flex and extend the affected joint voluntarily. Although the patient may not be completely normal at this point, the focus of therapy changes to promote active range of motion exercises.

It is important to show the clients how to correctly perform PROM so that it can be done correctly and safely at home (Figures 6.2 and 6.3). If the client struggles to master the technique or the patient is uncooperative, the therapy team must decide whether the client should persist in attempting to do the PROM. It is possible that the potential risk of injury (to the patient or the client) outweighs the anticipated benefit of PROM. However, most clients can learn how to perform effective PROM. In these cases, it is still recommended that they demonstrate their technique during patient re-evaluations because they may not realize when their technique is suboptimal. Most clients enjoy learning this skill and it can be empowering for them to feel they are contributing to the successful recovery of their pet.

Stretching

Various stretching techniques may be used to improve joint range of motion and extensibility of periarticular tissues, muscles and tendons. Passive stretching is not the same as PROM. PROM activities occur within the unrestricted range of motion of the joint, while stretching moves a restricted joint beyond the available range of motion to

Figure 6.2 Every home therapy should be demonstrated to the client with their pet.

Figure 6.3 After receiving instructions, the client practices the home exercise with feedback from the rehabilitation staff.

elongate the soft tissues (Kisner and Colby, 2007). Static stretching is similar to PROM from the standpoint that the patient is not actively involved in the movement.

A static stretch is performed using a similar technique as for PROM. The patient should be as relaxed as possible, and the limb is held and supported on either side of the affected joint. The joint is then moved to the end of its available range. This may be flexion or extension, depending on where the joint restriction is located. There is limited evidence from which to determine the most effective stretching protocol. In healthy adults, stretching for 30 or 60 seconds was more effective than 15 seconds or less (Bandy *et al.*, 1997). There is reportedly no increase in muscle elongation beyond 2–4 repetitions of static stretching (Page, 2012). The optimal frequency and duration for static stretches is still being researched. Static stretching is typically a little uncomfortable for the patient, and can be more challenging to perform than PROM. In addition, there is a higher risk of causing injury to the patient. For these reasons, static stretching may not be the best choice for a home program.

Active stretches can be performed by coaxing or luring the patient to move into positions that accentuate joint flexion or extension, which stretches the associated soft tissues (Figures 6.4). Since the patient is controlling the motion, the risk of overstretching is

(a)

(b)

Figure 6.4 The patient can be encouraged to stand in a position that results in active stretching of specific joints. (a) Active stretch on a disc – little dog. (b) Active stretch on a bosu – bigger dog.

(a) (b)

Figure 6.5 Exercises can be prescribed based on what equipment the client has available. Clients can be instructed how to perform active stretching with no equipment. However, it is important to avoid training the pet to perform any behaviors that may be undesirable. (a) Active stretch on a person – little dog. (b) Active stretch on a person – bigger dog.

relatively low. These stretches are often performed by use of a toy or treat to lure the patient into various positions, hence they may be termed "cookie stretches." One example of an active stretch is to coax a dog to stand with its hind legs on the floor and its front legs on a stair step (which step depends on the size of the patient and degree of stretch desired). This could be used to encourage hind limb extension, promoting stretch of the hip and stifle flexors (Figure 6.5).

The classic "cookie stretch" can be used to promote stretching of the cervical and thoracic spine. It is also a type of weight-shifting exercise that can simultaneously help improve balance, and limb and back strength. This is performed by having the patient stand on a surface with good traction. The cookie is used to lure the patient's head to one side, and then the other. Luring the patient's nose to the shoulder will focus on stretching of the neck, while luring to the hip or hock will focus stretching of the trunk. The nose may also be lured up and down to stretch the ventral and dorsal aspects of the neck. The patient can be enticed to hold the stretch by delaying delivery of the treat while the patient is maintaining the end range position. Although this is a straightforward exercise, it can be challenging for some clients to master the luring techniques so the patient remains in a standing position without moving the feet. The therapist must decide on an individual basis whether this type of stretch is indicated, and if so, whether the client will be able to perform it correctly.

Massage

Massage is the manipulation of soft tissues, and several different styles have been developed. The basic concept is to apply pressure and friction to the patient's skin. Massage can improve lymphatic flow, and one of the indications is to reduce limb edema. Massage helps reduce anxiety and pain, but there is limited scientific evidence to support other potential benefits (Sutton and Whitlock, 2014).

Clients often enjoy giving massages to their pet. The pet may become more relaxed as a direct result of the massage, and it often appears to improve the bond between the client and patient. Massage may be performed prior to a therapy session to calm the patient. Massage may also be performed following exercise, particularly to reduce muscle spasms and pain.

The type and extent of massage may depend partly on the client's level of comfort and skill. The first step in performing a massage is to have the patient lie in lateral recumbency in a quiet room. The client may be instructed in basic stroking, effleurage, and petrissage techniques (see Chapter 5). The massage may be general (for general relaxation and pain reduction), or focused on tissues of the affected area. The initial massage may be supervised by the therapist to ensure that the client is using appropriate techniques. The massage should not cause pain or discomfort.

Weight Shifting

Weight shifting exercises are relatively simple activities that most clients can easily learn to perform. This type of activity can be done for patients who can stand, but who need to work on improving balance and fine motor control. Shifting of the body increases mechanoreceptor firing in the joints and soft tissues, which increases feedback to the central nervous system regarding body position. This feedback results in increased muscle recruitment to stabilize the body (Deliagina *et al.*, 2014). Weight shifting may also be performed to encourage weight bearing on a limb. The simplest type of weight shifting is done with the patient standing (with assistance if needed), while someone gently pushes the patient from side to side or front to back in a rhythmic fashion.

For example, the client may place one hand on each shoulder or hip and gently sway the patient from side to side. Making the movements larger or more rapid will increase the difficulty of the exercise. Another method of weight shifting is to use the "cookie stretches" as previously described. Weight shifting activities can be made even more challenging by having the patient perform them while standing on an air mattress or couch cushion. There are many other types of weight shifting exercises, but they require equipment that most clients do not have at home. In addition, these are more complex and require more skill to do correctly, so may not be appropriate for many clients.

For more details about weight shifting, see Chapter 19.

Assisted Walking

Patients that are weak or non-ambulatory may need assistance to stand and to walk. The patient should be fitted with the most appropriate sling to be used by the client at home. It is important to instruct the clients on proper techniques for lifting and assisting patients, to preserve client health. In some cases, the patient may be fitted for a cart, particularly if the dysfunction is anticipated to be prolonged or permanent.

Clients with patients that spend most their time recumbent must be instructed on basic nursing care to prevent urine scald and decubital ulcers (see Chapter 11). The clients must also be alerted to watch for foot abrasions in patients that have neurologic deficits or abnormal postures. They should seek veterinary care as soon as they notice any reddened skin beginning to develop. Foot abrasions can often be prevented by boots.

Controlled Leash Walking

Slow leash walks are typically a key component to most rehabilitation programs, particularly early in the rehabilitation process. Slow leash walking is indicated for patients who have lameness, weakness, or proprioceptive deficits. The authors have observed that the patient is more likely to use each leg in the proper gait sequence and more likely to bear weight on a lame leg when encouraged to walk slowly. It may help to praise lame patients whenever they touch the affected foot to the ground.

Instructions for the clients must be very clear and detailed. For maximum control, the leash must be a short lead (1–2 meters long), and not a retractable leash. Ideally, the patient should be walked in a normal "heel" position. If the client–patient team lacks obedience training, the patient may walk a few steps ahead or to the side of the client, but it must be as controlled as possible. Retractable leashes are strongly discouraged because the tendency is for the client to relinquish control of the patient, allowing activity that is inappropriate or too vigorous.

The appropriate duration and frequency of the walks varies with the patient's condition. A typical postoperative program might start with 5-minute walks, 2–4 times daily. Over time the duration of the walks may be gradually increased. In general, the duration or frequency of the walking sessions should only be increased after the client instructed to do so by the rehabilitation team. A guideline that can be used to increase cardiorespiratory conditioning is to increase the duration of the walks by 10–15% each week (Millis *et al.*, 2014a). However, this guideline may not be appropriate for patients recovering from orthopedic or neurologic injuries or surgeries.

Balance, strength, and active range of motion exercises may be incorporated into the patient's walking program. During each walking session, the patient may spend a portion of the time walking on uneven or unstable surfaces, such as grass, sand, or snow, if available. Walking over different terrain may challenge the patient's balance, and it can also encourage flexion of the limb joints. Joint flexion may also be enhanced by exercises in which the patient steps over objects, such as a garden hose, broomstick, PVC pipe, or rungs of a ladder placed on the ground (Figure 6.6). Clients who have working or sporting dogs may have agility equipment, such as cavaletti rails that they can use. Inclines, declines, or stairs may also be integrated into the walking program, depending on what is accessible to the client. Walking down stairs is particularly beneficial for increasing range of motion of the stifles and hocks (Millard *et al.*, 2010), while walking up ramps promotes range of motion of the forelimb joints (Carr *et al.*, 2013).

Figure 6.6 Step-over exercises can be prescribed using materials that can be obtained cheaply and easily by the client.

Strength Exercises

A walking program will improve strength of the limbs. Walking up hills or stairs may be used to focus on strengthening of the hind limbs. The client must understand the importance of moving slowly to discourage the patient from hopping or skipping up the steps. The client must also be able to recognize signs of fatigue, and avoid pushing the patient too quickly. Hills or stairs can be challenging for the cardiorespiratory endurance and muscular strength, so these exercises should be gradually introduced into the program, particularly if the patient is deconditioned.

Sit-to-stand exercises can also be incorporated into a home program to improve strength and range of motion of hind limbs (Millis *et al.*, 2014a). It is best to have the client include some sit-to-stand exercises after 5 minutes of walking to warm up the muscles. Although sit-to-stand exercises look simple, they can be difficult to perform correctly. The patient must sit and stand symmetrically, without leaning to one side or favoring one leg. In the authors' experience, patients often tend to abduct the affected limb to avoid fully flexing it during the sit or fully bearing weight during the transitions. The client must be instructed to watch for this method of "cheating." It may be prevented by positioning the patient with the affected leg next to a wall or other object that prevents lateral movement of the leg during the exercise. It may be most efficient to start by including 5–10 sit-to-stand exercises once or twice daily, during the walking sessions (Millis *et al.*, 2014b). The number of daily sessions and repetitions can be increased over time as the patient's strength improves.

Crouched walking is another relatively simple exercise to improve limb strength and range of motion. One technique is to have the patient walk through a child's play tunnel or dog agility tunnel. However, the tunnel must be small enough that the patient cannot stand up inside it. This type of equipment may not be available to the client; however, other objects may have the same effect. For example, the client may have a chair or table that the patient could walk under. Another convenient and inexpensive option is a telescoping shower rod. It can be placed in a doorway or hallway at an appropriate height to force the patient to flex the limbs to walk under it.

Sport-Specific Exercises

The end goal of the rehabilitation program is that the patient returns to full function. In many cases, this does not involve a high degree of athleticism. However, the goal for some patients is to return to a competitive sporting activity or to return to strenuous work. For these patients, the clients typically have a good understanding of the type of strength, endurance, and agility that is required. These clients also tend to have more experience with animal training and access to specific training equipment.

The final portion of the rehabilitation program for these patients should focus on building the specific skills and endurance needed for that individual. The rehabilitation team can work with the client to design a program that is gradual, yet progressively improves patient function. Although this type of client tends to be very observant, it is still important to reassess the patient at regular intervals to ensure they are meeting retraining goals and not sustaining any injuries or setbacks.

Conclusion

The therapist must assess both the client and the patient carefully before creating a home exercise program. The therapist and the client must establish realistic outcome goals. Clients must be committed to the therapeutic plan. The therapist must determine which therapies are realistic for the clients to perform at home, considering their available resources and their animal handling skills.

Under the therapist's guidance, most clients can learn basic skills to provide effective therapy for their pet. Clients with working dogs or high-level athletes may carry out more complex home exercises to refine specific skills. Recheck evaluations are needed to ensure that the client is performing the therapies correctly and the patient is progressing toward the therapeutic goals.

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7

Supporting the Client and Patient

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CHAPTER MENU

> *Medicine should be practiced as a form of friendship.*
>
> Leon Bernard, French physician (early 1900s)

> *We are the first generation to allow pets to sleep in our beds.*
>
> Marty Becker, DVM, 2010 (personal conversation)

Introduction

In recent decades, pets have made a migration of biblical proportion from the back yard to the bedroom and from the kennel to the couch. Studies consistently reveal that 80–85% of pet owners consider their pets to be members of the family. Companion animal ownership is associated with a range of physical, psychological, and social health advantages (Smith, 2012). Pet health is important to the human family. The human–animal bond refers to the attachment between a human and their pet. Attachment refers to a particular type of long-lasting affectional bond that develops between two individuals (Bowlby, 1969; Bretherton, 1992). It provides a sense of security and reduces feelings of stress and anxiety (Carter, 1998). The relationship between dog and owner/caregiver has been proposed to resemble the child–parent bond (Kubinyi *et al.*, 2003; Serpell, 2003; Fallani *et al.*,2006). Overall, studies show that pet dogs react in a similar way to infants when participating with their owners in a strange

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situation challenge (Topál *et al.*,1998; Rehn *et al.*, 2013). The relationship between cat and caregiver has some similarities, despite cat affection being difficult to prove (Vitale Shreve and Udell, 2015). The caregiver of a cat certainly has the same strong feelings that a dog owner does. Advances in veterinary medicine provide the opportunity for pets to live longer and better than ever. Physical rehabilitation has facilitated mobility and therefore healthier lives for many animals. The veterinary technician or nurse fulfills the role as advocate on behalf of beings who cannot advocate for themselves.

In order to fulfill this advocacy role, it is critical for veterinary technicians involved with providing physical rehabilitation to understand the importance of actively engaging both the client and the pet in the planned care, as well as how to accomplish that goal. Compliance is the key.

The Effect of Pain and Morbidity

How Pain and Dysfunction Undermine the Human–Animal Bond

Palliative care in the health care arena means to treat the symptoms of a disease without the intention of curing it. Because pain is a major factor in diminished quality of life, pain management plays a critical role in applying palliative care and hospice principles to pets (Downing, 2011a) as well as a critical role in improving function for any rehabilitation patient.

Understanding pain physiology is critical to treating painful conditions, whether end-of-life or ongoing, because it allows a layering of various chemicals and modalities to best address the needs of the individual patient. Likewise, a specific understanding of how pain is expressed, both within a species but also how it can vary between individuals, allows more direct targeting of analgesic therapy. These can all be reviewed in Chapter 3. Teaching the client/caregivers to recognize symptoms of pain in their pet allows the client to take an active role in helping their pet cope with the stranglehold unrelieved pain can cause. Understanding the nuances of diagnosing and treating pain is even more critical in long-term and end-of-life care, because often these treatments will be fairly prolonged, and so the side-effects of each treatment may have time to become fully expressed. A host of treatments for pain are increasingly available in veterinary medicine. These include drugs, acupuncture, physical modalities, and interventional medicine.

Pain medicine, like palliative medicine, is highly tied into the social and psychological health of humans and companion animals (Wright, 2013). This complex interplay between medicine, ethics, and compassion is a daily conversation in which all three components drive decision-making, including but not limited to the application of evidence-based theory and practice. In long-term care, both acute and pathologic pain may be present, but nearly always there will be chronic pathologic pain components. It is highly recommended that a composite, behavioral type of pain scale is utilized in this setting. Visceral and deep sources of pain will often reflect onto muscles and fascia that share the neurological framework. The body can serve as a roadmap to the sources of pain and discomfort that the patient is experiencing (Wright, 2013).

There are certain aspects of pathologic pain that may be measured in animals. Depression can lead to morbidity. One of the core symptoms of depression is anhedonia, the decrease and loss of interest in pleasurable activities. For pets, we measure interest in food or motivation for play. We also measure how they are interacting socially with other animals in the group, and changes in sleep patterns and daytime activity level. Another behavior that has been used frequently to measure animal depression is whether they readily give up when exposed to a stressful situation. Clients need to be educated to watch for these behaviors in their pets during the rehabilitation process.

Aims of Physical Rehabilitation

The Role of Physical Rehabilitation in Managing Pain and Restoring Function

The aims and benefits of physical rehabilitation are many, including reduction of pain; promotion of the healing process; muscle strengthening, improving joint flexibility; promoting/restoring normal movement patterns; cardiovascular fitness; engaging mentally and enhancing the patient's sense of well-being (Sharp, 2008; Downing, 2011b). Rehabilitation helps an individual that has had an illness or injury to achieve the highest level of function, independence, and quality of life possible. The success of any surgery is as much down to the rehabilitation carried out as to the surgical technique performed (Sharp, 2008).

Pets tend to lose muscle and balance with age (Bellows *et al.*, 2015). This age-related muscle and proprioceptive loss can lead to inactivity and weight gain, increased stress on joints from diminished stability of surrounding musculature, and injuries from tripping and falling (Jurek and McCauley, 2011). Chronically ill patients, particularly patients experiencing chronic, pathologic (maladaptive pain), are generally less active than their non-painful counterparts. Prolonged inactivity leads to a state of deconditioning in which muscle strength is lost and endurance declines. Muscles may contract, leading to decreased range of motion (ROM), and bones may become osteopenic (Downing, 2011b). Rehabilitation supports the client and patient in the home environment because it improves the ability of the pet to perform the activities of daily living (sometimes with the help of the client) (Figure 7.1). Improving home activity and ease of motion is one of the main aims of physical rehabilitation.

Client Engagement and Compliance

Compliance for the veterinary health care team means that pets, including those pets who can benefit from physical rehabilitation, receive the care that the veterinarian knows they need and deserve. In the past,

Figure 7.1 Improving home activity by practicing the stairs in clinic.

compliance meant asking, “Did the client do as he or she was instructed?” Because of this approach, veterinarians have consistently overestimated client compliance with medical recommendations.

The 2003 American Animal Hospital Association compliance study (AAHA, 2003) showed that the biggest single failing in achieving good compliance for pet health care was the lack of an effective recommendation. The data further identified that clients *want* what is best for their pets, and that they *would* comply with veterinary recommendations if the practice and veterinary health care team tried to assist them.

Some of the obstacles to effective recommendations include:

- inadequate communication with clients;
- inadequate education of clients about why certain treatments are necessary;
- information overload for the client;
- overestimation of the client’s willingness or ability to be involved in and to pay for the pet’s care.

Improving compliance consists of three important factors working together:

$$\text{Compliance} = \text{Recommendation} + \text{Acceptance} + \text{Follow-Through}$$
$$(\text{C} = \text{R} + \text{A} + \text{FT})$$

The word “CRAFT” is an easy way to remember how to better engage the client in the pet’s physical rehabilitation.

Each rehabilitation patient needs an effective recommendation from the veterinarian made with conviction, and with the specific needs of the pet at its core. The veterinary technician will play a critical role both in communicating the details of the veterinarian’s recommendation as well as clarifying the client’s understanding of the recommendation (Figure 7.2). The client must next accept the specific rehabilitation recommendation made on behalf of the pet. This acceptance will hinge both on the client’s understanding of what will be required of them and on the logistics surrounding the rehabilitation plan itself.

Figure 7.2 Client engagement means deep conversations.

Finally, the veterinary technician plays a critical role in the necessary follow-through.

Goals include:

- ensuring that the rehabilitation patient receives the prescribed therapy by providing reminder calls, emails, or text messages, depending upon the client's preference;
- supporting the client as needed with appropriate updates about the pet's progress;
- fine-tuning the client's at home participation in rehabilitation;
- serving to reinforce the details of the veterinarian's messaging to the client about the pet's ongoing rehabilitation needs.

What Are the Steps to Improving Compliance for Physical Rehabilitation Patients?

Step One

The veterinary team must speak with one voice. The veterinary technician must understand the rehabilitation treatment plan and be able to discuss the goals and details of treatment with the client. Educating the client about the rehabilitation plan, encouraging ongoing participation of the client in that plan, and reassuring the client when needed are all important roles the veterinary technician can fill. As an extension of the veterinarian, the veterinary technician facilitates continuity of care as rehabilitation progresses and once the pet "graduates" from the rehabilitation program.

Step Two

Answer two important questions: "How do we provide pet rehabilitation here?" and "How do we speak to clients about how we provide pet rehabilitation here?" Veterinary technicians have an opportunity and an obligation to be able to answer these two questions. By knowing the details of the treatment plan, the veterinary technician will participate in delivery of rehabilitation and also provide strong, detailed communication with the client to coordinate what happens in the facility with the rehabilitation care that occurs at home.

Step Three

Provide consistency and follow-through to facilitate successful rehabilitation for each patient. This means coordinating the "3 R's" of rehabilitation:

- rechecking the patient alongside the veterinarian
- reassessing the patient in dialog with the client
- revising the treatment plan and assisting with execution.

The veterinary technician should understand the arc of care and outcome expectations for each rehabilitation patient. Schedule the next reassessment and/or rehabilitation appointment before the client leaves following the current session. The veterinary technician truly serves as a facilitator of care for the rehabilitation patient, working with all three parties – the patient, the veterinarian, and the pet owner.

Success for the veterinary technician working with rehabilitation patients means leaving the client not with unanswered questions, but instead with unquestioned answers. The veterinary technician's activities during physical rehabilitation serve to enhance, lengthen, and strengthen the precious human–animal bond. There is no greater contribution for a veterinary technician to make as he or she advocates on behalf of a being who cannot advocate for itself!

Helping the Client to Make a Decision

Many of the practices and techniques that are considered to be physical rehabilitation can be taught to the client so that they may be performed each day. Specific activities, procedures, and techniques may be performed as tolerated to avoid compromising pain management or overly fatiguing the patient. Physical medicine and rehabilitation provide non-pharmacologic interventions and tools used to enhance care of the patient in palliative and hospice care (Downing, 2011b).

The skilled technician is a source of vital information required to administer appropriate therapies that the rehabilitation veterinarian has chosen. He or she is a trusted caretaker for both hospitalized and outpatients. The success of this relationship is terribly important for all patients and applies to elective, routine, and extraordinary cases.

Client education begins at the initial visit. Providing verbal, written, and hands-on instruction is imperative for client understanding. Clients need to be taught that physical rehabilitation can extend quality of life for their pet. Owners of pets with life-limiting conditions may feel confused and helpless; increasing their involvement in the decision-making and care of their pet can provide them with a feeling of empowerment. High-quality nursing care must be provided for patients when there is no longer an expectation of achieving a cure (Kerrigan, 2013). The major goals of such care include maintaining physical comfort, including assistance with the animal's bodily functions and activities of daily living, minimizing any complications and side-effects of the disease or medication, and prevention or relief of pain and other physical discomforts including nausea, anorexia, and diarrhea. Time spent with an owner taking a "daily activity" history is beneficial for the comfort of both the patient and the owner. Providing pleasures such as companionship and social interaction, along with mental stimulation and play (permitted by the animal's physical condition) (Figure 7.3) can help greatly offset the unpleasant physical feelings associated with the disease and relative confinement (Kerrigan, 2013). In general, the animal's attitude, responsiveness, and enthusiasm for interactions with the family members must be assessed regularly. If the animal's psychosocial condition declines, it is imperative to reassess the nursing interventions, methods of analgesia, and owner activities to make any necessary adjustments that may restore quality of life. Psychosocial care also includes assistance for family members in dealing with the distress and burden of caring for their sick pet, along with other difficulties such as financial concerns or the acknowledgement of anticipatory grief (Balducci, 2007).

Figure 7.3 Providing mental stimulation and play as permitted by the animal's physical condition.

Financial Decisions

In the veterinary world we come across many different scenarios when it comes to clients making financial decisions for their pets so it would be a mistake to generalize; however, some examples of client type are used here to illustrate barriers to compliance:

- *The price shopper* – This client values veterinary care but shows great loyalty to practitioners who demonstrate that they keep costs down. This client questions any optional treatment program, whether pain or physical rehabilitation, and asks about the need for any items that you itemize in a treatment plan. One way to talk to these clients is to break down the cost of treatment on a day-to-day basis, thereby showing that pain control and physical rehabilitation is really a very inexpensive part of the process of caring for the animal.

  – *TIP*: Take the time to answer questions about the importance of pain control and physical rehabilitation.

- *The procrastinator* – This client values veterinary care and likes your clinic, but finds visits stressful and so is less likely to visit regularly. Regular clinic visits are a vital component of a comprehensive rehabilitation plan; a patient will take longer to benefit and will get less benefit from a protracted, infrequent therapy plan. Explain the risks of waiting to treat the issue and the effect of infrequent visits. Attempt to remove barriers to needed visits (pet taxi, time of day, wait time), procedures or medications with as much convenience and connection as you can muster.
  – *TIP*: Listen to the client's needs and interests. Take time to form the long-term rapport you need to bond with the client and their pet.
- *The avoider* – This client is sometimes distrustful and likely has a do-it-yourself mentality. In these cases, emphasize the urgency of performing any procedure and of providing pain control. When it comes to procedures, emphasize the long-term effects of client decisions made in the moment. A client needs to know that bad management of acute pain, including not moving forward with physical rehabilitation, can set up patients for chronic, long-term pain.
  – *TIP:* Smart practitioners can disagree about whether the highest standard is an "always" standard when well-meaning people lack funds or you cannot provide the highest care for less every time. Explore your own practice philosophy.
- *The neglector* – This client is the most passive type of pet owner, who strongly resists investment in even minimum care. But sometimes neglectors just do not know what the pet needs. Their attitude can change with the right education; we know they care about their pet.
  – *TIP*: Stop using words like "ought to" and "should" and start using words like "need" and "deserve."

When clients have financial difficulty, the rehabilitation veterinarian and technician/nurse need to discuss privately whether pursuing advanced diagnostics will change the course of treatment. Does the client have the resources to pursue corrective surgery? What about an orthosis or prosthesis? The client should never be shamed into feeling that they are inadequately caring for their pet. The technician/nurse can be an advocate for the client when they are too embarrassed to speak up about costlier treatments. If the client cannot afford a full rehabilitation plan, then an alternative plan can be put into place where the client can be taught some rehabilitation techniques to be performed at home with an agreement for in clinic recheck examinations as often as possible. When talking to owners about exercise, comprehensive instructions need to be given about limitations, frequency of walks and therapeutic exercise, and consistency. Dissuade owners from overexercising their dogs at weekends. Types of exercises are all explained in detail in Chapter 6.

Supporting the Patient

The quality of pain management in practices seems to be directly related to veterinary technicians and nurses. This includes the physical rehabilitation veterinary technician/nurse. The role of advocate for a non-verbal patient can be daunting. Veterinary technicians and nurses are in the unique position of being responsible for most of the patient care and and its quality without the freedom to prescribe or initiate therapy (Shaffran, 2008). Knowledge of the appropriate techniques, modalities, therapies, and equipment prescribed by the rehabilitation veterinarian is essential for good communication between veterinarians and veterinary technicians/nurses. The skilled technician is a source of vital information for the rehabilitation veterinarian every day in practice. Technicians use critical thinking, observation, and interpretive skills to make important recommendations. Discussion of each case directly with the veterinarian might include the technician's particular concerns about a patient. Based on his or her interaction with patients, the technician may offer suggestions for adjustments, changes, or additions to the program. Giving technicians a voice in the rehabilitation process creates a truly positive team environment in which their thoughts and skills are valued. Daily medical rounds are important to the rehabilitation team, allowing communication encompassing patient advocacy. Patients ultimately receive better care when a technician can advocate, and technicians are satisfied knowing that they are doing everything they can to ensure the well-being of patients in their charge.

Improving Quality of Life

Quality of life (QoL) is best approached by first deciding what is important for the animal, and second by working out what can be assessed for use in decision-making. This requires a combination of assessing those qualities of life from the animal's point of view and the assessment from the observer's point of view. Animal QoL includes the feelings of the animal, which can be broadly classified as pleasant or unpleasant (Kerrigan, 2014a). Using the analogy of balance scales, QoL can be improved by increasing the pleasant feelings and decreasing the unpleasant ones. The veterinary team and client should partner to consider the current QoL of the pet and identify ways in which this can be maintained as the pet progresses through their senior years.

Appropriate analgesics should be used for conditions that can affect QoL. An example is for the most common musculoskeletal condition affecting dogs and cats, osteoarthritis. Osteoarthritis may affect up to 20% of dogs over 1 year of age, and nearly 50% of musculoskeletal disorders identified in a 10-year span in 16 veterinary hospitals resulted from joint disease (Canapp, 2013). In 2002, Hardie *et al.* examined skeletal radiographs of 100 cats over 12 years of age and found that over 90% of cats had radiographic evidence of degenerative joint disease. In addition to the use of analgesics and supplements (Cotman *et al.*, 2002; Fritsch *et al.*, 2010), environmental management and modification can provide some easy ways for clients to enhance the QoL of the arthritic pet's everyday world. Modifications of sleeping surface, eating bowls, and home flooring can help pets with compromised mobility (see Chapters 10 and 12). There are many anxiety and depression treatments that can help a pet to be more calm (allowing the client to be less worried). These treatments range from pheromone collars to supplements, such as milk proteins, through to medications (Roush *et al.*, 2010).

Nutritional counseling should be available to the client. Veterinary technician/nurses often play a role in the nutritional evaluation process and it is essential to standardize the procedure. A good starting point to ensure consistency among team members and to focus on evidence-based research is the global nutrition guidelines of the World Small Animal Veterinary Association (WSAVA, 2011) or the nutritional assessment guidelines of the American Animal Hospital Association (AAHA, 2010).

It is important to advise clients to create frequent moments of enjoyment for their mobility-challenged companion through environmental enrichment. An aging pet, for example, may be less mentally alert and responsive, which can be mistaken by owners as "old age" stubbornness or a lack of interest in playtime activities (Kerrigan, 2014a). Environmental enrichment should focus on positive interactions such as petting or massage, as well as new and varied opportunities for exploration, including different walks/surroundings, find-and-seek games and other stimulating ways to obtain food and treats. Food toys which require pushing, lifting, pawing, or rolling to release food can help aging pets to remain active and alert (Landsberg *et al.*, 2012).

Mobility

As mentioned above, home modifications can be made to support the physically challenged patient and to enable an improvement in mobility. Mobility issues will always affect QoL to some extent, but with the right aids a pet can have a good life. The needs of both the human and the pet need to be balanced. For details about mobility issues and aids, see Chapter 10 on assistive devices. Mobility changes in late life may include frailty syndrome. This is a term from human medicine (Cesari *et al.*, 2016; Ekdahl *et al.*, 2016), which describes a decline in the body's functional reserve, lower energy metabolism, smaller muscle cells, and altered hormonal and inflammatory functions. Some of these signs have been identified in dogs (DeLorey *et al.*, 2012; Wallis *et al.*, 2016) (Figure 7.4) and the authors have seen them in cats. Frailty leads to increased susceptibility to disease and functional dependency which can be a huge strain on both human and pet (see Chapter 12).

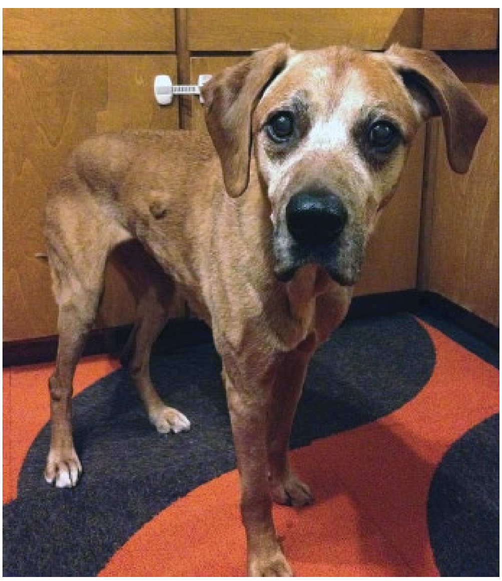

Figure 7.4 Elderly dog with frailty syndrome. Muscle loss is seen by evident bony prominences.

Behavioral Changes

Behavioral changes can affect and even sever the human–animal bond. These changes can occur at any stage of life. An example of a disease causing behavioral changes is cognitive dysfunction (Rème *et al.*, 2008). Clinically, cognitive dysfunction may result in various behavioral signs, including disorientation; forgetting of previously learned behaviors, such as house training; alterations in the manner in which the pet interacts with people or other pets; onset of new fears and anxiety; decreased recognition of people, places, or pets; and other signs of deteriorating memory and learning ability (Landsberg and Araujo, 2005; Araujo *et al.*, 2008). Behavioral signs related to anxiety, vocalization, night waking, soiling in cats, and aggression in dogs are more often spontaneously reported to veterinarians, which is likely related to the impact of these behaviors on the owner (Landsberg *et al.*, 2012). Companion animal relinquishment has been defined as when an owner voluntarily gives up ownership or possession of their pet. This includes surrender, euthanasia, and abandonment (Coe *et al.*, 2014). According to the National Council on Pet Population Study and Policy, shelters in the United States euthanize 72% of relinquished cats, many because of house-soiling behavior (Carney *et al.*, 2014). Changes in behavior can occur with additions to household, loss of a special human, moving home location, and other stressors. One such stressor may be the home exercise plan prescribed. When teaching home exercises, using positive reinforcement and food motivation is the best way to prevent or reduce stress between human and pet (see Chapter 9). Be sure to check in with the client about home exercises, having the client demonstrate again at the clinic and assessing the pet's behavior when doing the home exercises in clinic. The rehabilitation team needs to rule out pain as a cause of poor compliance and to revise the plan as needed. For a patient coming to the end of life, any small change in QoL can make a huge difference. Consult a veterinary behavior specialist if needed. Remember that behavior changes may be part of more global nervous system signs in the cause of cerebral disease or neoplasia.

Veterinary Home Hospice Care

The American Veterinary Medical Association (2014) stated that hospice care offered within the context of veterinary practice or the home environment, and consistent with veterinary practice legislation, gives clients time to make decisions regarding a companion animal with a terminal illness or condition and to prepare for the impending death of that animal (Kerrigan, 2014b). If home care is going to be utilized, then consent must be gained from the client. Many mobile veterinarians will visit the client and patient in the home to assess the current situation. The client's record should be updated to state that the patient is terminal and/or incapacitated and is being cared for at home with appropriate analgesia and limited supportive care at the bequest of the family for hospice care and euthanasia once QoL becomes inappropriate (Villalobos, 2009).

For both humans and animals, the most common condition necessitating hospice care is cancer. One key difference between humans and animals with regard to hospice care options is the availability of euthanasia for animals. A pet owner's goals and priorities may vary and transform as morbidity progresses, therefore, they should be made aware that if they commit to a home-care hospice program, the situation will be closely monitored and if at any point management becomes difficult the situation will be reviewed. A supportive, coaching approach from the veterinary team is essential to help clients address the needs of their pet at home. The veterinarian will provide the treatment care plan and the veterinary technician/nurse can be supportive, providing educational materials and demonstrations. The level of care needed for the pet should be thoroughly discussed so that it may be ascertained how much the pet owner can contribute to the level of care required (Hancock *et al.*, 2004). This will dictate how much external care is required and if, in fact, a home-care program is a viable option for this pet and owner (Kerrigan, 2014b).

Incontinence is an issue that should be discussed with the family members as many end-of-life patients will develop urinary and/or fecal incontinence. Owners must be educated regarding the prevention of urine and fecal scald along with the basics of good hygiene practices. The veterinary nurse can offer advice regarding the wearing of personal protective equipment and appropriate disposal of soiled materials along with safe disposal of any sharps used. These are important considerations about which pet owners must be thoroughly informed prior to committing to a home-care hospice program. More about continence issues and home care can be found in Chapter 11. Ideally, a social location within the home should be selected as the pet's designated area. This will enable the pet to be part of the normal family activities, especially if this is what they had been used to doing. All areas in which the pet will reside must have access to drinking water in order that the animal does not have to physically move to another location to get a drink; such a strategy will help to minimize the risk of dehydration (Kerrigan, 2014b).

Palliative Care – Fluids at Home, Injectable Medications as well as Oral

Provision of home hospice care will require the owner, and possibly other family members, to provide medication and care techniques detailed in the care plan. The veterinary technician or nurse could demonstrate how to administer a subcutaneous injection; the pet owner would then demonstrate the technique back to the veterinary nurse in order that their level of competency may be assessed. Written instructions should also be provided to the client for clarification and review. By educating clients to provide certain types of care in their home, it helps them to gain confidence and feel they have a sense of control. This improves coping strategies in stressful circumstances. Some specific veterinary practices allow the veterinary technician/nurse to visit the client's home, under the veterinarian's direction, to assess QoL, perform appropriate nursing interventions, and provide encouragement and support during this difficult period.

A practice vehicle will be required to make home visits. In addition to the initial financial outlay of this, running costs, fuel, and insurance will all need to be factored into the overall cost of the program (Kerrigan, 2014b).

At some point, it may become necessary for temporary hospitalization of the patient. Hospice pets often require special boarding care or daycare with their veterinary team for supervision, wound care, hygiene, hand feeding, and even placement of esophagostomy tube to help the patient get over a period of not eating (Villalobos, 2004). This care can and should be willingly provided at the primary care veterinary hospital. This service may be the key to sustaining a hospice pet for working owners (respite care). Be sure to arrange convenient drop-off and pickup times that fit the client's working and travel schedule.

Other Medication Considerations

For pets that are difficult to medicate, oral medications may be compounded into a more palatable medication or administered subcutaneously if owners are comfortable and competent with the procedure. It may also be possible to reconstitute medication to a transdermal or transmucosal formulation (McVety, 2012). Not all transdermal medications are absorbed systemically to therapeutic levels. Your veterinarian will be aware of those that are scientifically verified. What must be of paramount concern here is that the patient's level of analgesia is not severely compromised because it is being cared for in the home environment. A pain scale should be taught to the owners so that daily pain score can be recorded and assessed. It is necessary to have a pain scale that can encompass both aspects of acute and chronic pain. This ensures that the client working with veterinary personnel can help the pet owner to anticipate, prevent, locate, and relieve pain in the in-home hospice patient. A review of pain management can be found in Chapter 3.

When It Is Time to Say Goodbye

Veterinarians are the individuals trained to recognize when QoL has declined and suffering has become unacceptable. When discussing end of life, the team has to assess two things – the patient's QoL and the client's feelings. As part of a patient's therapy team the technician/nurse has an important role.

There is a QoL scale developed by Dr. Alice Villalobos called the HHHHHMM scale. Each of the categories is rated on a 1–10 scale (10 is best):

- Hurt
- Hunger
- Hydration
- Hygiene
- Happiness
- Mobility
- More good days than bad.

A score of 35 or more out of 70 reflects an acceptable QoL. This scale can help a client to understand their pet's needs but other factors may play a part in the client's decision for their pet. Regarding pain level, you and your veterinarian need to educate the client. Home behaviors will be different to those in clinic and need to be recorded and taken into account. This scale can be found at Dr. Villalobos's webpage (http://pawspice.com/).

How you navigate the discussion with the owner is not difficult but the topic needs to be approached with caution. Questions such as “How have things changed for your pet?”

and "Is he still excited to see you when you get home?" can open up conversation. Let them talk to you – they may tell you a lot more than they tell the veterinarian. Alert your veterinarian in your regular communications at patient rounds. Recommend to the client that they make an appointment to "check in" with the veterinarian. Take time, even if you are running late.

Find a Way to End on a Good Note

Work to understand the client's decision. Even if you are not ready to say goodbye, you too have a strong bond with the pet. Remember the load on a primary caregiver can be huge and home behaviors and factors may be worse than described. Use words carefully: "I am sorry you and Spot are going through this." Beware of the question "What would you do?" Answer taking into account information you have so far and using your knowledge of this client's personality. Be sure to stress that the decision is a very individual one.

After Loss

Send a card to express your sentiments but do not imply your grief is greater! Remember that client beliefs may differ from yours. Grief counseling is available; it is a difficult thing to suggest.

Keep a list of bereaved clients and contact them when you see a rescue dog or cat. Even if they are not ready, they will be glad that you thought of them.

Conclusion

Communication is the key to supporting both client and patient through the rehabilitation process, whether it is a relatively short-term process, with a return to good function for the patient or a long-term period of care that is ongoing until end of life. The veterinary technician/nurse plays a huge role in communicating the client's needs and wishes to the rehabilitation veterinarian. You will help to educate the clients in order to provide the best care that they can give to their beloved pet. Rehabilitation is a large commitment for a client and pet as well as for the rehabilitation team. Regular communication, counseling about expected setbacks, and providing short- and long-term goals can help to keep everyone in the clinic on message and the client aware of a cohesive, committed approach to care.

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8

Nutritional Counseling

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CHAPTER MENU

Introduction

Nutrition plays a vital role in the prevention and management of many conditions seen by veterinary health care team members. This can especially be seen in the rehabilitation of certain disease conditions and should be considered an integral component of the physical rehabilitation protocol. This chapter will look at how nutrition supports the goals of veterinary rehabilitation as well as the technician's role in counseling clients on the importance of nutrition.

Nutritional Assessment

Proper nutrition is a critical component for maintaining the health of pets. Every patient, healthy or ill, that enters the veterinary hospital should have an evaluation of their nutritional status and health care team members should make a nutritional recommendation based on this evaluation. The goal of patient assessment is to establish the key nutritional factors and their target levels in light of the patient's physiologic or disease condition. This assessment is vital and is, in fact, the fifth vital assessment to be performed by the health care team.

The nutritional assessment considers several factors, including the animal, the diet, feeding management, and environmental factors. The nutritional assessment is an iterative process in which each factor affecting the animal's nutritional status is assessed and reassessed as often as required (Thatcher *et al*., 2010).

Although the impact of nutrition on health is a complicated area of study, the American

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Animal Hospital Association (AAHA) and the World Small Animal Veterinary Association (WSAVA) nutritional guidelines can be abridged into three steps:

1) Incorporate a nutritional assessment and specific dietary recommendation in the physical exam for every pet, every visit.
2) Perform a screening evaluation (nutritional history/ activity level, body weight and body/muscle condition score) – every pet, every visit.
3) Perform an extended evaluation for a patient with abnormal physical exam findings or nutritional risk factors such as lifestage considerations, abnormal body condition score or muscle condition score, poor skin or hair coat, systemic or dental disease, diet history of snacks or table food that is greater than 10% of total calories, unconventional diet, gastrointestinal upset, or inadequate or inappropriate housing.

Obesity

Pet obesity has reached epidemic proportions in the United States and other industrialized countries. It is estimated that 35% of adult pets and 50% of pets over age 7 are overweight or obese (German *et al.*, 2006). Obesity can be defined as an increase in fat tissue mass sufficient to contribute to disease. Dogs and cats weighing 10–19% more than the optimal weight for their breed are considered overweight; those weighing 20% or more above the optimum weight are considered obese. Obesity has been associated with a number of diseases as well as with a reduced lifespan. A combination of excessive caloric intake, decreased physical activity, and genetic susceptibility are associated with most cases of obesity and the primary treatment for obesity is reduced caloric intake and increased physical activity. Obesity is one of the leading preventable causes of illness/death and with the dramatic rise in pet obesity over the past several decades, weight management and obesity prevention should be among the top health issues health care team members discuss with every client.

Causes of Obesity

Obesity is an imbalance of energy intake and energy expenditure. It is a simple equation – too much in, too little out! There are a number of risk factors that affect energy balance. Indoor pets in North America are typically neutered. There are many positive health benefits associated with neutering, however it is important that metabolic impacts of neutering are addressed as well. Studies have demonstrated that neutering may result in decreased metabolic rate and increased food intake, and if energy intake is not adjusted, body weight, body condition score (BCS), and amount of body fat will increase resulting in an overweight or obese pet. Other recognized risk factors for obesity include breed, age, decreased physical activity, and type of food and feeding method (Burkholder and Toll, 2000; Rosenthal, 2007).

Health Risks Associated with Obesity

There are many health conditions associated with obesity in pets, including arthritis, diabetes mellitus, cancer, skin diseases, lower urinary tract problems, hepatic lipidosis, and heart disease. Obese pets are also more difficult to manage in terms of sample collection (blood, urine) and catheter placement and may be more prone to treatment complications, including difficulty intubating, respiratory distress, and slower recovery time and delayed wound healing. It is widely believed that obesity affects quality of life and leads to reduced life expectancy. The dramatic impact of excess body weight in dogs and cats has been demonstrated. In cats, it is estimated that 31% of diabetes mellitus and 34% of lameness cases could be eliminated if cats were at optimum body weight. In dogs, lifespan was increased by nearly 2 years in dogs that were maintained at an optimal body condition (Burkholder and Toll, 2000). It is important to recognize and to communicate to our clients that fat tissue is not inert – obesity is not an aesthetic condition that only affects our pet's ability to interact with us on a physical activity level. Fat tissue is metabolically active and, in fact, is the largest endocrine organ in the body and has an unlimited growth potential. Fat tissue is an active producer of hormones and inflammatory cytokines and the chronic low-grade inflammation secondary to obesity contributes to obesity-related diseases (Burkholder and Toll, 2000; Laflamme, 2006).

Evaluating Weight and Nutrition

Most pet owners do not recognize or admit that their pet is overweight. The entire health care team needs to commit to understanding and communicating the role of weight management in pet health and disease prevention. In particular, the veterinary technician is the primary source for client education – the interface between the client, the doctor and the rest of the hospital team – and is the key advocate for the patient.

Again, every patient needs an assessment to establish nutritional needs and feeding goals. These goals will vary depending on the pet's physiology, obesity risk factors, and current health status. Designing and implementing a weight management protocol supports the team, the client and, most importantly, the patient (Rosenthal, 2007).

A comprehensive history including a detailed nutritional profile and a thorough physical examination, including a complete blood count, serum chemistry, and urinalysis, are the first steps in patient evaluation. Signalment data should include species, breed, age, gender, neuter status, weight, activity level, and environment. The nutritional history should determine the type of food (all food) fed, the feeding method (how much, how often), who is responsible for feeding the pet, and any other sources of energy intake (no matter how small or seemingly insignificant) (Box 8.1).

Obtaining a complete nutritional history supports consistency and accuracy of patient information, helps to pinpoint potential barriers to client compliance, guides client discussion, and supports the optimal weight management program for the pet.

Be sure to weigh the pet and obtain a BCS at every visit and record the information in the patient's medical record. It is helpful to use the same scale and chart the findings for the client. BCS is important to assess a patient's fat stores and muscle mass. A healthy and successful weight management program results in loss of fat tissue while maintaining lean body mass and consistent and accurate assessment of weight and BCS is an important tool to track

Box 8.1 Questions for nutritional assessment

The following questions should be part of every nutritional assessment:

- What brand of food do you feed your pet? (try to get specific name)
- Tell me what your pet eats in a day
- Do you feed moist or dry or both?
- How do you feed your pet – feeding method (how much, how often)?
- Does your pet receive any snacks or treats of any kind? If so, what and how often?
- Do you give your pet any supplements?
- Is your pet on any medications, including chewable medications? If so, obtain name and dosage
- What type of chew toys does your pet play with?
- Do you feed your pet any foods or treats not specifically designated for pets (such as human foods)? If so, what and how often?
- Does your pet have ANY access to other sources of food (neighbor, trash, family member, etc.)?

progress. The use of body condition charts and breed charts are helpful tools in discussing the importance of weight management with clients and will help them visualize what an optimal weight would look like on their pet.

Although subjective, BCS is a tool to evaluate body fat. The goal for most patients is a body condition of 2.5–3.0 out of 5 or 4–5 out of 9, which is considered to be ideal (Figures 8.1 and 8.2).

An ideal BCS is believed to help decrease health problems, including musculoskeletal conditions. The evaluation of muscle mass independent from body fat content assessed by BCS, is known as muscle condition scoring. Muscle condition scoring includes visual examination and palpation over temporal bones, scapulae, lumbar vertebrae, and pelvic bones. The loss of muscle unfavorably affects the strength, immune function, and wound healing of pets. After all information is collected and analyzed in the assessment phase a treatment plan is implemented. This is followed by repeated assessment and adjustment of the plan (Figures 8.3 and 8.4).

A newer tool in obtaining an accurate fat percentage on the pet's body is Body Fat Indexing (BFI) – especially for overweight and obese pets (Ahima, 2006; Wortinger and Burns, 2015a). This method of obtaining a more accurate body fat percentage has been utilized and confirmed by veterinary nutritionists and provides a better method for pinpointing the amount of fat on a specific pet, thus aiding in accurately calculating an amount to feed for an overweight pet, better identifying the pets' ideal body weight, insuring proper and safe weight loss, and increasing the overall success in the weight management program.

Weight Management Program

As with many aspects of health care, designing a successful weight management program is not a "one program fits all" for our patients. The components of a successful weight management program include consistent and accurate weight measurement/patient monitoring, effective client communication, identification of compliance gaps and utilization of tools to reinforce compliance, client and patient support, and program restructure as needed.

Setting a goal for weight loss and calculating the appropriate energy intake starts with determination of the pet's ideal body weight. Ideal body weight is a starting goal that is adjusted for appropriate body condition as the pet loses weight. It is important to determine the number of daily calories that will result in weight loss while providing adequate protein, vitamins, and minerals to meet the pet's daily energy requirement (DER). The DER reflects the pet's activity level and is a calculation based on the pet's resting energy requirement (RER).

There are a couple of basic formulas that all technicians should memorize or have on laminated note cards in every exam room (along with a calculator)! The most accurate formula to determine the RER for a cat or a dog is:

$$\text{RER kcal/day} = 70(\text{ideal body weight in kg})^{0.75}$$

RER is determined initially, followed by the DER. DER may be calculated by multiplying RER by "standard" factors related to energy needs. The calculations used to determine energy needs for obese prone pets or for pets needing to lose weight are (Rosenthal, 2007; Wortinger and Burns, 2015a):

- Obese prone dogs DER = 1.4 × RER
- Weight loss/dogs DER = 1.0 × RER
- Obese prone cats DER = 1.0 × RER
- Weight loss/cats DER = 0.8 × RER

Gathering the above information is crucial and takes only a few minutes. This information provides the foundation for developing a weight loss program that includes:

1) Target weight or weight loss goal
2) Maximum daily caloric intake
3) Specific food, amount of food and method of feeding.

Figure 8.1 WSAVA body condition score for cats. *Source:* http://www.wsava.org/sites/default/files/Body Condition Scoring for Cats.pdf

Figure 8.2 WSAVA body condition score for dogs. *Source:* http://www.wsava.org/sites/default/files/Body%20condition%20score%20chart%20dogs.pdf

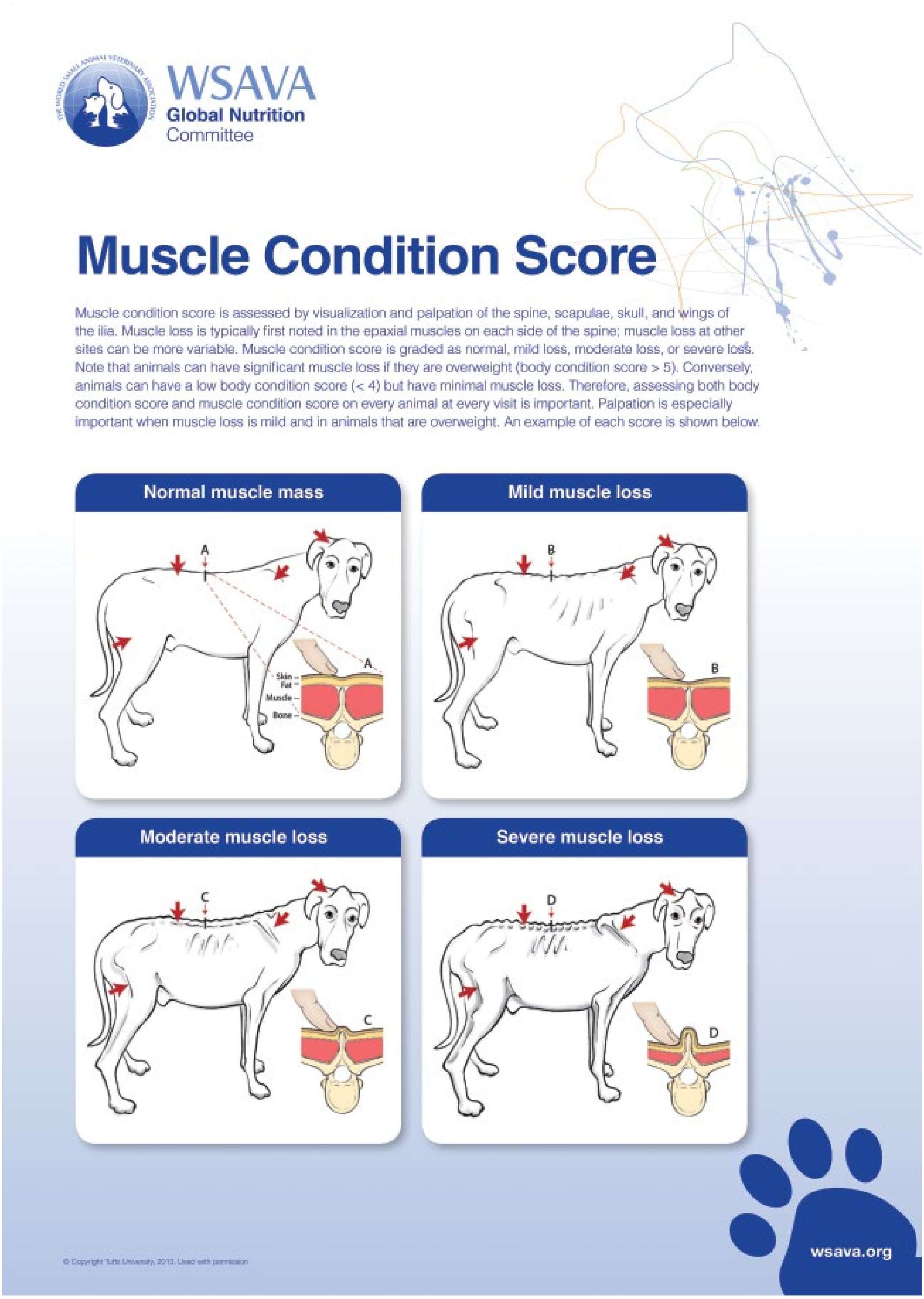

Figure 8.3 WSAVA muscle condition score for dogs. *Source:* http://www.wsava.org/sites/default/files/Muscle%20condition%20score%20chart%202013.pdf

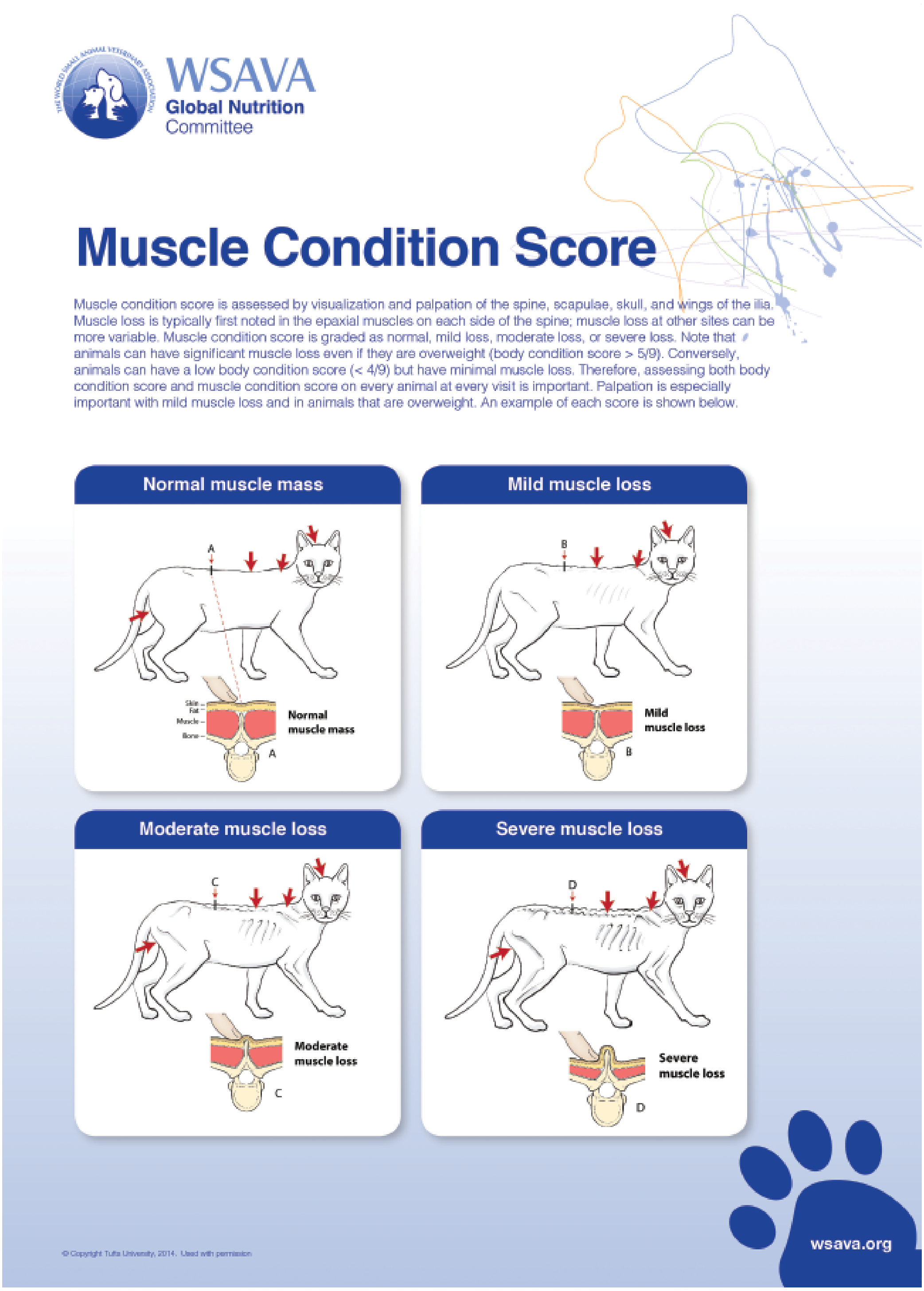

Figure 8.4 WSAVA muscle condition score for cats. *Source:* http://www.wsava.org/sites/default/files/Muscle%20condition%20score%20chart-Cats.pdf

Box 8.2 Specific recommendations that support a successful weight loss program

- Feeding consistency (same time, same amount, same place, same dish, etc.) including feeding the pet-designated dish only
- Ensure the use of an 8 ounce (240 mL) measuring cup
- Recommend the appropriate weight loss food and calculate the initial amount to feed
- Discuss the importance of total energy intake (do not feed anything other than the recommended food at the designated amount)
- Make appropriate recommendations for treats and adjust the caloric intake of the base food accordingly
- Encourage client's to feed their pet's separately if possible
- Recommend appropriate exercise for the pet
- Offer suggestions on ways other than food to reward or bond with their pet
- Evaluate, adjust, communicate, and encourage on a consistent basis

The program should also include specific protocols for monitoring the pet's weight (schedule these before the client leaves and send reminder cards/e-mails/texts). Also prior to leaving, the health care team should adjust the pet's energy intake and exercise guidelines/suggestions accordingly (Box 8.2).

Successful weight management begins with recognition of the importance of weight control in our pets. It is essential that the health care team, specifically the veterinary technician, communicate the serious effects that even a few excess pounds can have on the health and longevity of their pet's lives. Weight management should be a cornerstone wellness program in every clinic and the veterinary technician the champion of the program and advocate for the patient.

Osteoarthritis

As in humans, osteoarthritis is the most common form of arthritis recognized in all veterinary species. A slowly progressive condition, osteoarthritis is characterized by two main pathologic processes: (i) degeneration of articular cartilage with a loss of both proteoglycan and collagen and (ii) proliferation of new bone. Furthermore, there is a variable, low-grade inflammatory response within the synovial membrane (Anandacoomarasamy *et al.*, 2008). Current estimates of the prevalence of arthritis in senior and geriatric dogs range from 20% to 25%. The prevalence of osteoarthritis in adult cats is 33%, with the prevalence in senior cats rising to 90% (Lascelles and Robertson, 2010). The objectives of treatment for osteoarthritis are multifaceted: reduce pain and discomfort, decrease clinical signs, slow the progression of the disease, promote the repair of damaged tissue, and improve the quality of life. A multimodal approach to osteoarthritis provides the best results for dogs with chronic pain due to osteoarthritis and include a combination of anti-inflammatory and analgesic medications, disease-modifying osteoarthritis agents (DMOAs), nutraceuticals, weight reduction, exercise programs, physical therapy, and therapeutic foods. Applying an individualized combination of these management options to each patient will enhance quality of life, which is the ultimate goal of therapy.

Weight Reduction

We have discussed the fact that obesity is epidemic in companion animals. Numerous studies indicate that 25–40% of adult dogs are overweight or obese. Similar to the Centers for Disease Control (CDC) estimate that approximately 33% of all human adults suffer from arthritis, an estimated 20% of the adult canine population suffers from osteoarthritis. One long-term study has documented that the prevalence of osteoarthritis is greater in overweight/obese dogs than in ideal weight dogs (83% vs. 50%) (Kealy *et al.*, 2000; Burns, 2011). Consequently, it is reasonable to assume a significant portion of arthritic dogs will be overweight/obese and vice versa. Managing these concurrent conditions presents many challenges.

Before a disease can be treated it must first be diagnosed. As disease entities, osteoarthritis and overweight/obesity present diagnostic challenges for very different reasons. Clinical signs of osteoarthritis are often not obvious on examination, particularly early in the disease process. Signs of overweight/obesity may be readily apparent, but often they are overlooked or dismissed as inconsequential. Diagnosis of osteoarthritis requires a combination of history, physical examination findings, and radiographic evidence of degenerative joint disease. Although this may seem straight forward, historical clues crucial to diagnosis may not be readily apparent on routine veterinary examination. Owners often believe many signs of osteoarthritis are a part of "normal" aging and consequently fail to report them unless prompted by the health care team.

Clinical signs of advanced arthritis include difficulty rising from rest, stiffness, or lameness. A thorough, disease-specific history should be taken and may reveal evidence of subtle changes early in the course of osteoarthritis, such as reluctance to walk, run, climb stairs, jump, or play. Signs may be as discreet as lagging behind on walks. Owners are often unaware of the correlation between behavior changes and arthritis. Yelping or whimpering and even personality changes (i.e., withdrawal, aggressive behavior) may be indicative of the chronic pain of osteoarthritis. It is recommended to use an owner questionnaire with every potential osteoarthritis patient to assist with early detection of osteoarthritis.

Recognizing signs of osteoarthritis in cats is much more difficult. Cats often suffer in silence and the veterinary health care team must rely upon the owner's evaluation and a thorough history to discover potential signs and symptoms of osteoarthritis in cats. The changes often noted by owners can be categorized into four groups: mobility, activity level, grooming, and temperament. Mobility changes include reluctance to jump; not jumping as high; and changes in toileting behavior due to inability to climb into the litter box. Activity level changes manifest in decreased playing and hunting and a change in sleep patterns. Grooming changes may be noticed when the cat becomes more matted or unable to groom certain areas, and the claws may be overgrown because they cannot stretch out to "scratch/sharpen" claws. Changes in temperament are demonstrated by the cat hiding from owners or other pets in the house and seeming "grumpy" (Paster *et al.*, 2005; Bennett and Morton, 2009). Many of these signs are again attributed to "old age" in the cat by the owner. Thus it is important for the technician to take a thorough history and ask open-ended questions that may help uncover otherwise overlooked signs of osteoarthritis in cats.

Diagnosing overweight/obesity is of the utmost importance and leads to diagnostic, curative, and preventive strategies that may be lost in the absence of a diagnosis. The first step to diagnosing overweight/obesity is consistent recording of both a body weight and BCS.

Prevention

In dogs, risk factors for developing osteoarthritis include age, large or giant breeds, genetics, developmental orthopedic disease, trauma, and obesity. Risk factors for overweight/obesity in dogs include age, certain breeds, being neutered, consuming a semi-moist, homemade, or canned food as their major diet source and consumption of "other" foods (meat or other food products, commercial treats, or table scraps). The radiographic prevalence of canine hip dysplasia, a leading cause of osteoarthritis in dogs, has been reported to be as high as 70% in golden retrievers and Rottweilers (Eby and Colditz, 2008). Golden Retrievers, Rottweilers, and Labrador Retrievers are overrepresented in the population of overweight/obese dogs.

Dogs found to be overweight at 9–12 months of age were 1.5 times more likely to become overweight adults (Kienzle *et al.*, 1998; Christensen *et al.*, 2007; Eby and Colditz, 2008; Anandacoomarasamy *et al.*, 2009). Owners of dogs at risk for obesity and osteoarthritis must be educated on the importance of lifelong weight management. The incidence and severity of osteoarthritis secondary to canine hip dysplasia can be significantly influenced by environmental factors such as nutrition and lifestyle (Impellizeri *et al.*, 2000; Kealy *et al.*, 2000; Burns, 2011). A long-term study has acknowledged that the prevalence and severity of osteoarthritis is greater in dogs with BCS above normal compared to dogs maintained at an ideal body condition throughout life. Over the lifespan of these same dogs, the mean age at which 50% of the dogs required treatment for pain attributable to osteoarthritis was significantly earlier (10.3 years, $P < 0.01$) in the overweight dogs as compared to the dogs with normal BCS (13.3 years).

Obesity is also a risk factor for the most common traumatic cause of osteoarthritis in dogs – ruptured cruciate ligaments. Overweight/obese dogs have a 2–3 times greater prevalence of ruptured cruciate ligaments compared to normal weight dogs. Understanding the correlation between maintaining their dog at a healthy weight and decreasing the risk of disease may be a powerful motivator for many owners.

In humans, the epidemic of obesity is largely attributed to changes in the availability, quantity, and composition of food and the decrease in the amount of physical activity needed for daily living. Physical activity levels of dogs often mirror their human companions. Owners should be encouraged to respond with play activities or praise rather than food rewards.

Nutritional Management

Historically, the stress of excess weight on the skeletal system has been thought to be the primary offender in the pathophysiology and progression of osteoarthritis. Yet, adipose tissue is no longer considered simply a storage site for energy; rather it is now recognized as a multifunctional organ. Adipose tissue plays an active role in a variety of homeostatic and pathologic processes. Recent studies have documented that adipocytes secrete several hormones, including leptin and adiponectin, and produce a diverse range of proteins termed adipokines. Among the currently recognized adipokines is a growing list of mediators of inflammation: tumor necrosis factor α, interleukin-6, interleukin-8, and interleukin-10 (Towell and Burns, 2011). These adipokines are found in human and canine adipocytes. Production of these proteins is increased in obesity, suggesting that obesity is a state of chronic low-grade inflammation. Low-grade inflammation may add to the pathophysiology of a number of diseases commonly associated with obesity, including osteoarthritis. This also explains why somewhat small reductions in body weight can result in significant improvement in clinical signs.

Nutrigenomics and Osteoarthritis

Nutritional supplementation of omega-3 fatty acids is a relatively new concept in the management of dogs with osteoarthritis. Recent studies provide high-quality data that show a diet with high levels of total omega-3 fatty acids and eicosapentaenoic acid (EPA) can improve the clinical signs of canine osteoarthritis. The use of a therapeutic canine food with higher levels of omega-3 fatty acids (specifically EPA) for the management of osteoarthritis has been supported by four randomized, double-blinded, controlled clinical trials using client-owned dogs (Fritsch *et al.*, 2010a, 2010b; Roush *et al.*, 2010a, 2010b). One 6-month study and two 3-month studies were conducted in US veterinary hospitals. In addition, a 3-month prospective study was carried out in two veterinary teaching hospitals. Overall, 500+ dogs with osteoarthritis were studied. Participating dogs were diagnosed with osteoarthritis based on history, clinical signs, and radiographic evidence. Dogs were fed either a typical commercial dog food or a test mobility food, which has higher concentrations of total omega-3 fatty acids and EPA and lower omega-6:omega-3 fatty acid ratios. At baseline and throughout the studies, subjective and objective veterinary evaluations were executed. Owners were also asked to subjectively evaluate their dogs throughout the studies.

These studies provide high-quality evidence that illustrate the benefits of incorporating a food with high levels of omega-3 fatty acids into the management of the pain of osteoarthritis in dogs. In normal canine cartilage there is a balance between synthesis and degradation of cartilage matrix. In arthritic joints damage to chondrocytes incites a vicious circle which culminates in the destruction of cartilage, inflammation, and pain. The mechanisms responsible for the demonstrated clinical benefits of omega-3 fatty acids include controlling inflammation and reducing the expression and activity of cartilage-degrading enzymes.

Cartilage degradation begins with loss of cartilage aggrecan and is followed by loss of cartilage collagens. This results in the loss of ability to resist compressive forces during movement of the joint. EPA is the only omega-3 fatty acid able to considerably decrease the loss of aggrecan in canine cartilage. It inhibits the upregulation of aggrecanases by blocking the signal at the level of messenger RNA (Caterson *et al.*, 2000; Caterson, 2004).

Inflammation is not only a vital reaction but it also plays an essential role in the pathophysiology of osteoarthritis. The polyunsaturated fatty acids (PUFAs) are critical components in the initiation and mediation of inflammation. Arachidonic acid (AA, 20:4*n*-6) and EPA (20:5*n*-3) act as precursors for the synthesis of eicosanoids, a significant group of immunoregulatory molecules that function as local hormones and mediators of inflammation. The amounts and types of eicosanoids synthesized are determined by the availability of the fatty acid precursor and by the activities of the enzyme systems that synthesize them. In most conditions, the principal precursor for these compounds is AA, although EPA competes with AA for the same enzyme systems. The eicosanoids produced from AA are pro-inflammatory and when produced in excess amounts may result in pathologic conditions. In contrast, eicosanoids derived from EPA promote minimal to no inflammatory activity (Wander *et al.*, 1997).

Eating foods which contain omega-3 fatty acids results in a decrease in membrane AA levels as omega-3 fatty acids replace AA in the substrate pool. This yields an accompanying decrease in the capacity to synthesize eicosanoids from AA. Studies have documented that inflammatory eicosanoids produced from AA are depressed when dogs consume foods with high levels of omega-3 fatty acids. In addition to their role in modulating the production of inflammatory eicosanoids, omega-3 fatty acids have a direct role in the resolution of inflammation. Resolution of inflammation is a progressive, active process involving a switch in the production of lipid-derived mediators over time. Pro-inflammatory products of omega-6 fatty acids metabolism (prostaglandin E2, prostaglandin E12, and leukotriene B4) are thought to initiate this sequence. AA-derived mediators foster the extravasation of inflammatory cells. With time and in the presence of sufficient levels of omega-3 fatty acids, a class shift occurs towards production of two families of pro-resolving omega-3-derived mediators – resolvins and protectins. These mediators serve as endogenous stop signals by preventing inflammatory cell recruitment, stopping “cell entry” and promoting resolution by removing inflammatory cells from the site. The identification of these two new families of omega-3-derived chemical mediators may clarify the mechanisms that underlie the many reported benefits of dietary omega-3 PUFAs. Absence of sufficient dietary levels of omega-3 fatty acids may contribute to “resolution failure” and perpetuation of chronic inflammation.

In cats with osteoarthritis two therapeutic foods are available for management of osteoarthritis in the United States. Hill's Prescription Diet® Feline j/d™ is available in the United States as well as Europe. The active ingredients include high levels of *n*-3 PUFAs (DHA), natural sources of glucosamine and chondroitin, methionine, and manganese. Just as in dogs, high levels of *n*-3 PUFAs control inflammation in cats. However, in cats DHA rather than EPA inhibits the aggrecanase enzymes responsible for cartilage degradation (Innes *et al.*, 2008; Burns, 2011). Natural sources of glucosamine and chondroitin increase proteoglycan production by chondrocytes and inhibit inflammatory mediators. Methionine and manganese enhance chondrocyte viability, provide building blocks, and act as a sulfur donor for the production of proteoglycans. Royal Canin Veterinary Diet® Mobility Support JS® Feline is available in the United States and Canada. The chief ingredient is green-lipped mussel, which contains anti-inflammatory constituents aimed at improving joint health. Other active ingredients are DHA, EPA, glycosaminoglycans, such as chondroitin sulfate, which are components of cartilage; an amino acid (glutamine), which is a precursor of glycosaminoglycans; and minerals important to maintaining healthy cartilage (i.e., zinc, copper, and manganese). The efficacy of therapeutic nutrition utilizing omega-3 fatty acids is supported by three studies (Frantz *et al.*, 2010; Fritsch *et al.*, 2010c; Sparkes *et al.*, 2010; Burns, 2011). The efficacy of therapeutic nutrition utilizing green-lipped mussel is supported by one published study (Lascelles *et al.*, 2010).

Research suggest therapeutic nutrition provides an effective and safe way to manage both dogs and cats with osteoarthritis. Foods with high levels of *n*-3 fatty acids have the dual value of controlling inflammation and pain while slowing progression of the disease by reducing cartilage degradation. Efficacy of therapeutic nutrition for osteoarthritis is supported by multiple clinical trials in arthritic pets.

Developmental Orthopedic Disease

The goal of a feeding plan for pediatric pets is simple – to create a healthy adult. The specific objectives of a good feeding plan are to achieve healthy growth, optimize trainability and immune function, and minimize obesity and developmental orthopedic disease. Growth is a complex process involving interactions between genetics, nutrition, and other environmental influences. Nutrition plays a role in the health and development of growing pets and directly affects the immune system body composition, growth rate, and skeletal development.

Developmental orthopedic diseases (DODs) are a diverse group of musculoskeletal disorders that occur in growing puppies and may be related to nutrition. Canine hip dysplasia (CHD) and osteochondrosis are the most common musculoskeletal problems with a nutrition-related etiology. Specific nutritional factors that are thought to increase the risk of DOD in young dogs include:

- free choice feeding (excess energy consumption),
- feeding high energy foods (rapid growth), and
- excessive intake of calcium from food, treats and/or supplements (dietary imbalance) (Richardson *et al.*, 2010; Burns, 2014; Wortinger and Burns, 2015b).

Osteoarthritis secondary to DOD can be minimized by educating owners of young dogs to offer appropriate nutrition during the critical growth phase. All puppies whose adult weight is estimated to be ≥50 lb (23 kg) should be fed a growth food specifically formulated for large-breed dogs. As discussed earlier, maintaining an ideal BCS throughout life will decrease trauma to joints and the development of osteoarthritis.

Patient Assessment

Pediatric pets should be assessed for risk factors before weaning to allow implementation of recommendations for appropriate nutrition.

A thorough history and physical evaluation are necessary. Special attention should be paid to large- and giant-breed puppies, breeds, and gender (including intact and neutered) at risk for obesity. Furthermore, growth rates and BCS provide valuable information about nutritional risks. Growth rates of young dogs are affected by the nutrient density of the food and the amount of food fed. It is important that puppies be fed to grow at an optimal rate for bone development and body condition rather than at a maximal rate. Growing animals reach a similar adult weight and size whether growth rate is rapid or slow. Feeding for maximum growth puts puppies at increased risk for skeletal deformities and has been found to decrease longevity in some species (Burns, 2014). In Labrador Retrievers, even moderate overfeeding resulted in overweight adults and decreased longevity.

The most practical indicator of whether or not a puppy's or kitten's growth rate is healthy is its BCS. Health care team members should be comfortable assessing BCS all patients; and with growing patients should reassess at least every 2 weeks to allow for adjustments in amounts fed and, thus, growth rates. Owners can and should be taught to assess body condition and are likely to become more aware of the appearance of a healthy growing puppy and kitten. Regularly assessing body condition provides immediate feedback about optimal nutrition.

Key Nutritional Factors

The requirements for all nutrients are increased during growth compared with requirements for adult dogs. Most nutrients supplied in excess of that needed for growth cause little to no harm. However, excess energy and calcium are of special concern; these concerns include energy for puppies of small and medium breeds (for obesity prevention) and energy and calcium for puppies of large and giant breeds (for skeletal health). In addition, essential fatty acids can affect neural development and trainability of puppies.

Energy

Energy requirements for growing puppies consist of energy needed for maintenance and growth. During the first weeks after weaning body weight is relatively small and the growth rate is high. Puppies use about 50% of their total energy intake for maintenance and 50% for growth. Gradually, the growth curves reach a plateau, as puppies become young adults. The proportion of energy needed for maintenance increases progressively, whereas the part for growth decreases. Energy needed for growth decreases to about 8–10% of the total energy requirement when puppies reach 80% or more of adult body weight. A puppy's DER should be about 3 times its RER until it reaches about 50% of its adult body weight (Wander *et al.*, 1997). Thereafter, energy intake should be about 2.5 times RER and can be reduced progressively to 2 times RER. When approximately 80% of adult size is reached, 1.8–2 times RER is usually sufficient.

These factors are general recommendations or starting points to estimate energy needs. Body condition scoring should be used to adjust these energy estimates to individual puppies.

Prevention of obesity is essential and should start at weaning. After puppies and kittens become overweight, it is challenging to return to, and maintain, normal weight. Too much food intake during growth may contribute to skeletal disorders in large- and giant-breed puppies. If the pet is overweight and/or obese and this is carried into adulthood, the risk for several important diseases is increased. These include hypertension, heart disease, diabetes mellitus, dyslipidemias, osteoarthritis, heat and exercise intolerance, and decreased immune function. Studies show that moderate energy and food restriction during the postweaning growth period reduces the prevalence of hip dysplasia in large-breed (Labrador Retriever) puppies and increases longevity in rats without hindering adult size (Richardson *et al.*, 2010; Burns, 2014; Wortinger and Burns, 2015b). Nonetheless, the pet may not receive enough energy and nutrients to support optimal growth if fed a food with a very low energy density and low digestibility. This may result in consumption of large quantities of the food, which can overload the gastrointestinal tract, resulting in vomiting and diarrhea. Health care team members should initiate monitoring of energy and food intake and body condition at an early age to help keep the pet at a healthy weight throughout life.

Protein

Protein requirements of growing dogs differ from the requirements of adult dogs. During puppyhood, protein requirements are highest at weaning and decrease progressively until adulthood. Puppies 14 weeks and older, should receive at least the minimum recommended allowance for crude protein, which is 17.5% dry matter (DM). The recommended protein range in foods intended for growth in all puppies (small, medium, and large breed) is 22–32% DM. Most dry commercial foods marketed for puppy growth provide protein levels within this range (Burns, 2014; Wortinger and Burns, 2015c).

Protein levels above the upper end of this range have not been shown to be detrimental but are well above the level in bitch's milk. Protein requirements of growing dogs differ from those of adults. An important difference is that arginine is an essential amino acid for puppies, whereas it is only conditionally essential for adult dogs. Foods formulated for adult dogs should not be fed to puppies (Burns, 2014). Although protein levels may be adequate, energy levels and other nutrients may not be balanced for growth.

Fat

Growing dogs have an estimated daily requirement for essential fatty acids (linoleic acid) of about 250 mg/kg body weight, which can be provided by a food containing between 5% and 10% DM fat. Research has shown that docosahexaenoic acid (DHA) is essential for normal neural, retinal, and auditory development in puppies. Inclusion of fish oil as a source of DHA in puppy foods improves trainability and should be considered essential for growth. The minimum recommended allowance for DHA plus EPA is 0.05% DM; EPA should not exceed 60% of the total. Thus, DHA needs to be at least 40% of the total DHA plus EPA, or 0.02% DM (Richardson *et al.*, 2010).

When feeding young pets, we must remember that fat contributes greatly to the energy density of a food and excessive energy intake can cause overweight/obesity and DOD. The minimum recommended allowance of dietary fat for growth (8.5% DM) is much less than that needed for nursing, but more than is needed for adult maintenance (5.5% DM). In order to deliver a DM energy density between 3.5 and 4.5 kcal/g, 10–25% DM fat is necessary. This range of dietary fat is recommended from postweaning to adulthood (Richardson *et al.*, 2010).

The principal functions of dietary fat are to act as:

- a source of essential fatty acids,
- a carrier for fat-soluble vitamins, and
- a concentrated source of energy.

Calcium and Phosphorus

Although growing dogs need more calcium and phosphorus than adult dogs, the health care team must remember to educate owners that the minimum requirements are relatively low. Puppies have been successfully raised when fed foods containing 0.37–0.6% DM calcium and 0.33% DM phosphorus (Richardson *et al.*, 2010).

Large- and giant-breed puppy foods should contain 0.7–1.2% DM calcium and 0.6–1.1% phosphorus. Foods with a calcium content of 1.1% DM provide more calcium to puppies just after weaning than if bitch's milk is fed exclusively. Small- to medium-sized breeds are less sensitive to slightly overfeeding or underfeeding calcium; thus the level of calcium in foods for these puppies can range from 0.7 to 1.7% DM, (0.6–1.3% phosphorus) without risk. The phosphorus intake is less critical than the calcium intake, provided the minimum requirements of 0.35% DM are met and the calcium:phosphorus ratio is between 1:1 and 1.8:1. For large- and giant-breed dogs, the calcium:phosphorus ratio should be between 1:1 and 1.5:1 (Richardson *et al.*, 2010).

Digestibility

Puppies that are fed foods with decreased energy density and decreased digestibility will need to eat larger amounts of food to achieve growth. Consequently, this increases the risk of flatulence, vomiting, diarrhea, and the potential development of a "pot-bellied" appearance. As a result, foods recommended for puppies should be more digestible than typical adult foods. An indirect indicator of digestibility is energy density. Foods with a higher energy density are likely to be more digestible (Richardson *et al.*, 2010; Burns, 2014).

Carbohydrates

Although no specific level of digestible (soluble) carbohydrates exists for growing puppies, it is recommended that the level of digestible (soluble) carbohydrates around 20% DM may optimize health.

Conclusion

Successful treatment and prevention of musculoskeletal disease conditions require a comprehensive approach which includes preventive measures and a multimodal management program. Clinical signs of musculoskeletal diseases are often not obvious on examination, especially early in the disease process. Although signs of overweight/obesity are readily apparent they are often overlooked or dismissed as inconsequential. Documenting a diagnosis of overweight/obesity is critical to the management of these disease conditions. Diagnosing overweight/obesity requires consistent recording of both a body weight and BCS. Early diagnosis of osteoarthritis and DOD enables early intervention, which in turn often improves the long-term outcome for the patient. Consistent use of a thorough, disease-specific history may raise awareness of subtle changes early in the course of osteoarthritis and DOD. Successful management of osteoarthritis/DOD and obesity requires nutritional intervention.

Rehabilitation programs are designed to be part of a multimodal approach. One important part of the rehabilitation of veterinary patients is nutrition. Health care teams should have knowledge of nutrition and specific nutrients which play a role in certain disease conditions. Rehabilitation incorporates a number of treatment modalities. A nutritional plan should be part of each patient's rehabilitation therapy and should continue following successful completion of the rehabilitation program. Reassessment is required until nutritional and rehabilitative goals are met.

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9

Motivating Your Patient

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CHAPTER MENU

Introduction: Why we Need to Motivate the Rehabilitation Patient

Patients that need rehabilitation are often painful. It is also likely that the patient has undergone multiple previous examinations for the issue that the patient is presenting for, before the rehabilitation examination and treatment even occurs. This means that the painful area has been palpated repeatedly. The natural guarding of an injured body part, which is part of protecting an injury while it heals, can be compounded and amplified by the repeated experiences of physical examination. We expect a lot of our patients, often without giving them coping mechanisms. Most veterinary patients have not been fully desensitized to a routine, brief veterinary physical examination, even after multiple visits to the primary care veterinarian. The rehabilitation examination is a much more extensive than a routine examination and hence is a prolonged process with a great deal of patient handling.

A relaxed patient is more compliant and easier to examine and diagnose; muscle tension is reduced and pain signs are easier to discern

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when the overall stress level of a patient is low. It is mutually beneficial for the patient and for the veterinary team to have the examination and subsequent therapies in a low-stress, high-reward environment for the patient.

After examination and diagnosis, a rehabilitation prescription is made. This prescription can involve both in-clinic therapies and daily in-home therapies. A relaxed environment for the initial evaluation process, and, consequently, a relatively calm patient, also helps the client to fully participate in learning about the pet's condition and the at-home and in-clinic therapy plan without distractions of stress and concern for the pet. Both active and passive exercises may be prescribed for the patient. A motivated patient will comply with the plan, whereas forcing an exercise by using restraint without motivation often leads to increasing reluctance from the patient. Reluctance reduces both patient and client compliance. The rehabilitation team should aim for as much happy patient engagement as possible to achieve the best results. Building and maintaining a good relationship with each patient is important for the rehabilitation team in clinic, but vital for success with at-home exercises.

Understanding Animal Psychology

It is important to appreciate that reinforcement and punishment are defined by their effect, not by the intent of anyone who may be delivering them. When discussing positive and negative aspects of a handling or motivation technique, it should only be about how that approach is received by the patient. It is common to assume that since no harm is meant, the procedures are not perpetuating fear in the patient. Teaching this approach to the client starts with understanding and explaining the situation from the animal's point of view. There are many resources that make understanding canine body language easier. For example, in Doggie Drawings (www.doggiedrawings.net), drawings starring a Boston Terrier named Boogie illustrate important information such as "How Not to Greet a Dog" and "Doggie Language" in an informal and entertaining way. The American Association of Feline Practitioners has created an online resource for cat behavior that covers many topics (www.catvets.com). "Pleasant veterinary visits for cats" points out that "clients are more willing to obtain regular veterinary care, including more extensive preventive and therapeutic care, if the visits are pleasant. Calm, relaxed cats enable us to perform more thorough physical examinations and enable clients to better focus on our recommendations" (American Association of Feline Practitioners, 2004).

Helping clients to understand how to better read their pet's body language leads to being able to apply that knowledge, and then change their approach to their pet during an exercise as needed in order to improve comfort and compliance. This will foster a successful relationship long term. It is important for us, as professionals, to use correct terminology when discussing and teaching behavior modification and training. For a glossary of terms, see Box 9.2.

Classical Conditioning Versus Operant Conditioning

Reinforcing Behaviors

The most well-known example of classical conditioning is Ivan Pavlov's experiments with salivating dogs (Pavlov, 1928). Present food, and the dog salivates. Ring a bell, and the dog does not salivate. Ring a bell then present food, and the dog salivates. Ring the bell, and the dog now salivates. Pavlov effectively used classical conditioning to associate a ringing bell with food (Overall, 2013). We often use this to our advantage when working with our patients in the clinic. Many of the patients that we treat are fearful of new surroundings, strangers, and new activities. When we pair a primary reinforcer – something innately reinforcing to the dog (typically food) – with a neutral (uninteresting)

Figure 9.1 Frozen treats take time to consume, allowing the animal to work at the reward.

or stressful experience, we can create a positive association and change how the dog perceives the situation for the present, and how he or she will perceive the same situation in the future. It is important to note that we should make every effort to create positive experiences, not just neutral experiences. At our clinic, Twin Cities Animal Rehabilitation and Sports Medicine, a few treats utilized are freeze-dried meat (which is also popular with our feline patients), peanut butter, and frozen peanut butter yogurt cups (Figure 9.1). For the increasing number of dogs with food intolerances, hydrolyzed (hypoallergenic) treats are available as well.

Real Life Example

A client was unwilling to use food rewards in clinic.

Client: "Sparky doesn't need treats to behave."

Technician: "We want to build the best association with us, the building, and the equipment we can. Using food helps us to reinforce calm, cooperative behavior."

Client: "He needs to listen because I said so."

Technician: "We use food to see how willing Sparky is to do exercises for us. If we know Sparky likes food, and knows how to earn food but will not sit, I will ask for other behaviors (down, stand) first. Then ask for sit. If he will make the other movements, but still shows hesitation to sit, this can help us to identify pain and understand where it hurts so that we can help Sparky to recover."

Emotional Response – Creating Associations with the Environment

Where Pavlov is known for his work with the bell, B.F. Skinner is known for the four quadrants of operant conditioning (Skinner, 1938). Skinner's principles were that desired behaviors should be reinforced; behaviors can be built in incremental steps; and that immediate reinforcement generally provides a better learning experience than delayed reinforcement. These principles have been used extensively in training. Operant conditioning breaks learning down into four areas or subsets. In each area we evaluate our training/motivating based on whether we have successfully increased or decreased the frequency of a behavior (Martin and Martin, 2009) (Box 9.1).

Positive reinforcement is often used, and usually without thinking too much about it.

Box 9.1 Reinforcements

	Positive (add)	Negative (remove)
Reinforcement (desirable)	Add something desirable to increase the frequency of a behavior	Remove something aversive to increase the frequency of a behavior
Punishment (undesirable)	Add something undesirable to decrease the frequency of a behavior	Remove something desirable to decrease the frequency of a behavior

Source: Adapted from Martin and Martin (2009).

Successful influence on behavior using this technique generally occurs, but we can always try to do a better job of communicating with our patient more clearly. A key piece, often missing when motivating a patient, is looking closely at what exact behavior or action is being reinforced. This requires precise attention to detail. Dogs are uniquely attuned to small motions; for example, the handler may be rewarding a "behavior chain" of brief contact of one foot on a balance disc with a step back off again, when the goal is to reinforce standing still with both front feet on a balance disc.

Improving the timing of rewards, typically by adding in a "secondary reinforcer," will shorten the amount of training time. The most common secondary reinforcer is a "marker" (a unique way to mark a behavior), such as a clicker, verbal tongue clicks, verbal yes, or other less commonly heard word (avoid "okay"). The purpose of the secondary reinforcer is to give the handler more time between desired behavior and getting around to giving the primary reinforcer (reward). A secondary reinforcer helps to give the animal clarity about the exact behavior (e.g., limb placement) that is desired and so being reinforced. The animal knows that a reward will follow the secondary reinforcer. The patients typically learn about a secondary reinforcer without too much dedicated training if there is consistency with the type of marker used. Mark the behavior, then deliver the reward. Practice mark, followed by reward, for multiple new behaviors to build value for the marker. Since both hands are usually needed for restraint and carrying out exercises, using a secondary reinforcer that is a verbal marker will help an animal to identify the behavior being rewarded, and this will give the handler time to access, then deliver, the treat reward.

In cases where a verbal marker is utilized, remember that inflection (the tone and pitch of your voice as it says the word) can impact the effect. For this reason, a tongue click may be preferred over a verbal "yes." One of the rules of good training is to always pair the secondary reinforcer with food or it will quickly lose value. Using these techniques while the client is in clinic with the patient allows time for observation and learning techniques to apply at home, and time for answering questions if needed (Box 9.2).

Box 9.2 Key terms used for reinforcement

- *Reinforcer* – Any consequence that causes the preceding behavior to increase (e.g., treats)
- *Behavior chain* – Specific sequence of discrete responses, each associated with a stimulus
- *Primary reinforcer* – Primary reinforcers are biological (e.g., food, pleasure from a toy)
- *Secondary reinforcer* – A conditioned reinforcer; the dog knows something good is coming
- *Marker* – A unique way to mark behavior (e.g., "yes!")
- *Luring* – Using a reward to increase attention and interest (e.g., to initiate motion)
- *Conditioning* – Associations between stimuli and response

Working to make positive or neutral associations with the environment in the clinic can include more than just the use of reinforcers. Maintaining a quiet environment is extremely important for some patients. Patients who are reactive to noise can react to something as small as a beep from an ultrasound machine. It is possible to get the sounds turned off on some ultrasound and e-stim machines. Shockwave units can make a lot of sound. The use of ear mufflers can help in patients that are not sedated for therapy, and can also help lightly sedated patients (Figure 9.2). Sometimes a white noise machine can help reduce sounds outside the treatment room. The white noise of some underwater treadmill units can dull general clinic noise in some cases. All staff members should be cognizant of raising their voices, even in laughter. Calming music can help some patients to relax, and there are specific tempos of music made to calm dogs (e.g., Through A Dog's Ear™) available in CD

Figure 9.2 Patient undergoing shockwave therapy. He is wearing ear muffs and licking a frozen treat.

Figure 9.3 A low matted table for examination and therapy, the table is 40 cm high.

or MP3 format. It is recommended to have individual stereos/speakers in each room to allow for volume control rather than having music playing at the same level throughout the clinic. The importance of comfortable, traction flooring should not be underestimated; a patient will feel more relaxed if they are better able to grip the floor. Examination tables, if used, should have traction; low matted tables are recommended (Figure 9.3).

Understanding Body Language

Evaluating stress while in the clinic can be challenging. A stress level scale developed by Dr. Karen Overall is a helpful tool to accurately assess the current stress level for a dog while in clinic (Overall, 2013). Knowing how to properly evaluate the behavior of a patient is going to help to foster the best relationship, so that we can meet our goals. We can also provide some assignments for the client to work on these handling situations in a positive way at home.

The most basic signs of stress are yawning, lip licking, or blinking. The most severe is biting for carnivores (biting and kicking for equids and ungulates). Most patients fall somewhere in the middle of this spectrum; they are not completely comfortable with what is going to happen, but are not predisposed to bite. Dr. Overall suggests taking note of body posture, tail posture, ear posture, gaze, pupils, respirations, lips, activity, and vocalization. If we take the time to learn about what the patient behaviors mean, we can make decisions about how thorough and lengthy the hands-on portion of each visit is (Figures 9.4 and 9.5). We can quickly discern when a patient needs a break so that stress (cortisol) levels can drop back to a more neutral state. In cases of rising stress with danger signs, we can evaluate whether we need to postpone the examination, or restrain the patient for safety of personnel; the best option for all concerned being to postpone the examination/therapy when patient stress is reaching concerning levels.

Building Motivation and Value Through Food Rewards

As discussed previously, food is a powerful primary reinforcer for our patients. Utilizing this effectively includes gathering information about diet and feeding rituals in the home. Two of the most common reasons for lack of food motivation are free feeding at home and weight control issues. Free feeding is when food is left out always for the pet. This can be a measured amount or filled at will. The measured amount still often means

Figure 9.4 Poster showing dog behavioral postures. *Source:* Courtesy of Dr. Sophia Yin.

no portion control. Free feeding makes our primary reinforcer (food) far less rewarding for the dog, as it is always available; there is no drive to eat from a human hand. Many free-fed dogs are also overweight, so by addressing one problem, we address both. Food is such a powerfully useful tool and it is often overlooked. Help the client to set up a feeding schedule that works for everyone. For dogs with a necessity for low caloric

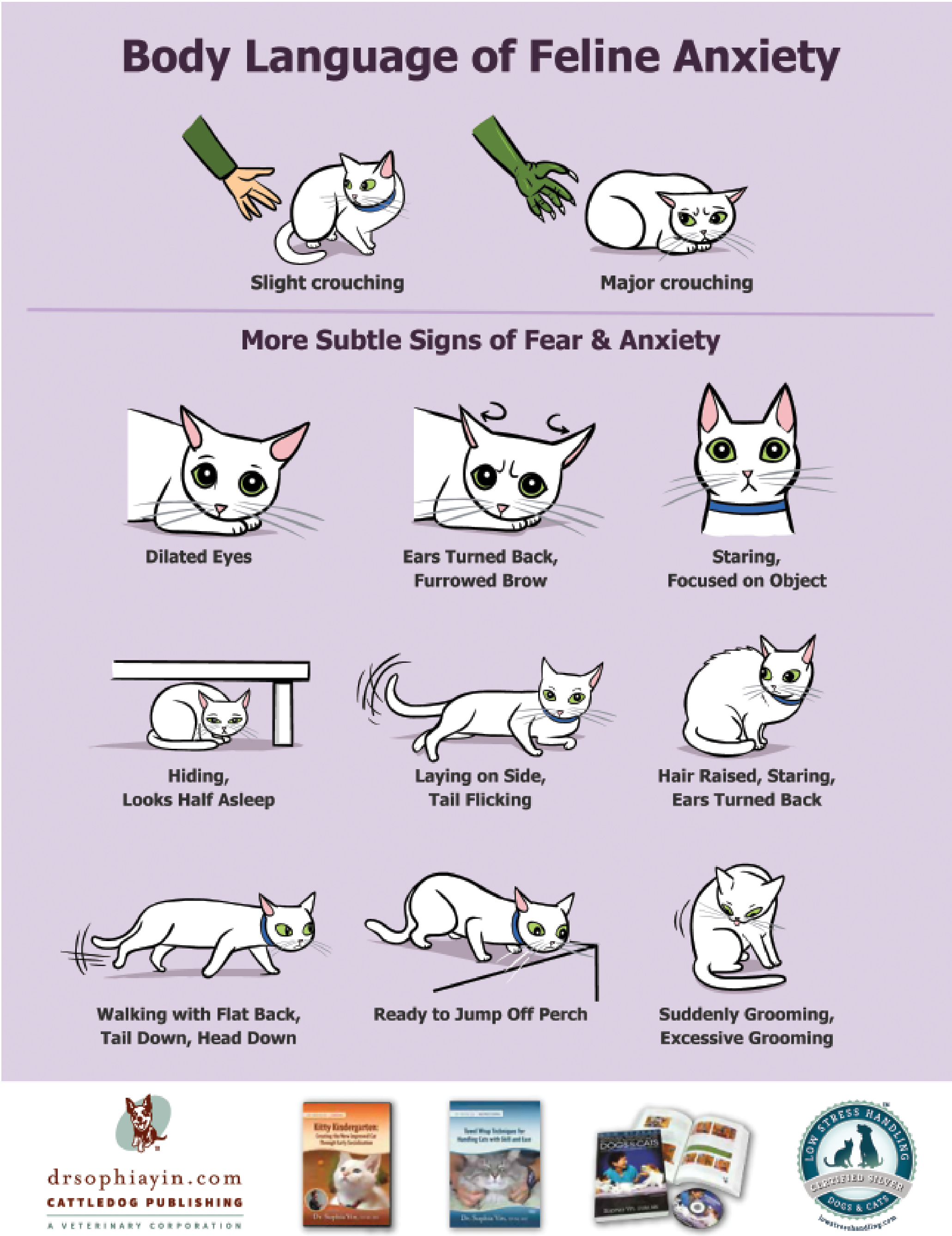

Figure 9.5 Poster showing cat fear and anxiety postures. *Source:* Courtesy of Dr. Sophia Yin.

intake, a common recommendation is to use meals as treats. By teaching the dog to work for meals, a lot is accomplished; when appetite is high, so is drive and attention to the reward. Using the normal diet as reinforcement while in familiar environments allows for a wider variety of high-value reinforcement in more stimulating (usually also more stressful) environments. Reserving a variety of treats specifically for therapy appointments can help the whole process to proceed more smoothly. For cats, very high-value foods with strong odors (freeze-dried meat, baby food) can help to stimulate a cat to eat; for example, move to eat while stretching front legs up onto a raised surface, so elongating the spine and extending the hips (Figure 9.6). Many horse clients and trainers use treats. For both cats and horses, it is even more important than it is for dogs to have a treat that takes multiple bites or licks to consume as these patients tend to gain less reinforcement from interaction with people.

A positive relationship is fostered if the goal of motivation and training is cooperation. Prescribed rehabilitation exercises provide an opportunity for training, thereby providing the patient with mental stimulation and the client with strengthening of the human–animal bond. Patients who are undergoing rehabilitation are usually exercise restricted. This can lead to unwanted behaviors due to boredom and excess energy. Training requires concentration from the animal (as well as the handler), this mental activity and stimulation causes some fatigue, and so decreases boredom.

Figure 9.6 A feline patient being lured into stretch using freeze-dried meat. Note his left rear extends less. The patient has had a femoral head excision.

Replacing the normal food bowl with a work-to-eat toy (also known as a food toy) is another great way to encourage mental stimulation and avoid boredom. For horses, work-to-eat toys such as the Amazing Graze™ treat toy (www.HorsemensPride.com) can help to alleviate the boredom of stall confinement. The rehabilitation team needs to be cognizant of the type of toy and the effort and motions required to release food from the toy. Choosing an appropriate work-to-eat toy needs to be taken into consideration. A toy that requires a lot of movement with the patient concentrating on rolling the toy, instead of on their gait compensations, may result in relative overload of an injury. The disabilities of the patient need to be considered, and the team should be sure to counsel the client about providing the work-to-eat toy in a confined area.

Luring, Shaping, and Marking Behaviors

Luring is the motivating technique that is used most often, as most patients can be motivated by food. Having an assortment of high-value reinforcers (treats and fun toys), as well as instructing clients to bring known favorite treats from home can help. Even the most outgoing and typically social dogs can be unsettled by new experiences. The rehabilitation team should be creative with the treats, but as mentioned previously, reserve the exciting stuff for situations where it will be harder to motivate due to distraction and stress (for example a treatment such as dry needling of myofascial trigger points, which causes some discomfort). A helpful recommendation is to make up a bag of goodies to be kept in the refrigerator or freezer that combines a few really tasty snacks and some regular food. An example snack "grab bag" ready to go with everything cut up into small pieces would contain: cubes of cheese, strips of boiled chicken, regular dry food, and a commercially available soft treat.

Although it may seem to be a skill that most dogs are born with, teaching an animal to "lure" is invaluable. Luring is when the animal follows the treat (Martin, 2009b) to perform a desired behavior. Most clients are familiar with luring without realizing, but may not be maximally successful. It is important to feed often during the luring process, to keep the patient focused more on the food than on the goal behavior (a desired motion, or simply remaining still during a therapy). For this reason, treats that can be nibbled on or something that can be licked at, providing a slow, continuous reward, are great options. When teaching a dog to lure, start with small steps, do not have the complete behavior as the goal; instead, reward small behaviors. Many dogs tend to sink down to the ground instead of standing still when manipulated. When we need a dog to stand for examination, luring into that position would be a multistep process. First let the dog nibble from their current, undesired, position. Next bring the treat up and forward just a little so the dog continues to be engaged. Finally reward the full stand with a rapid succession of treats in a short "burst" (Figure 9.7). The posture is maintained by continued intermittent rewards.

Teaching a horse or a cat to lure is a very similar process, but motivation may differ between individuals.

Luring requires focus on the part of the animal. Overly exuberant dogs are approached in a similar manner to shy dogs so that stress/unfocused energy does not distract from the food-luring process. Present the food to the patient without eye contact, and with your body turned to the side, if the dog acknowledges you but does not take from your hand, then gently toss a treat across the floor. Aim to toss the treat behind the dog, not in their face. Once the patient recognizes you as the source of the treat, they are more likely to accept a treat given from your hand. These non-assertive behaviors by rehabilitation team members will keep the dog focused on the treats and avoid stressors, overexcitement, and other distractions.

Figure 9.7 Luring a patient from a sit into a standing position for examination

Simple Games: Set Up for Success

As mentioned previously, a patient that can be lured into different positions is much easier to work with. Starting with behaviors that are easily lured helps keep patient and owner motivated with success. Having the patient follow a food luring head up, head down, body in a circle, into a sit, or into a stand are some basic behaviors that most dogs do on a regular basis. Cats will stretch and move their body in response to luring too. Breaking the final behavior down into smaller, incremental steps helps to set up both client and patient for success. If the end goal is to have the patient lie in lateral or in sternal recumbency, it is necessary to think of the behaviors that build up to that. Clients who get involved in the whole process of making the prescribed rehabilitation therapies into a game tend to be more successful in maintaining, or in many cases, strengthening their human–animal bond and in completing the rehabilitation goals.

Having Intent and Understanding Trust

Leading by example is a powerful way to teach clients about building and maintaining trust with their animal, and their animal's trust of the rehabilitation team. During an initial consultation, while the veterinarian is learning about the patient's history, the technician can be building a relationship with the patient. The luring process can initially be time consuming (e.g., tossing treats to a shy or fearful patient and slowly building trust), so beginning the process during the time taken to record patient history and during the time taken to make initial observations about the patient before handling (postures, gait, and transitions, etc.) is efficient. This approach means that by the time the patient needs to be handled, they have had some exposure to the luring/reward process.

Home Exercises – Knowing When to Stop

Many clients who bring a pet in for rehabilitation are unaware of subtle signs of pain. Vocalizing is typically the only sign recognized by clients, so education about pain-related behaviors and understanding pain level at home is an important part of the initial evaluation process. Every exercise prescribed by the veterinarian must be performed with comfort in mind. Improper application of technique, changes in patient status/function, or fatigue can be the difference between an exercise going smoothly without pain and one being met with resistance due to pain and stress. Pain and fatigue levels can vary day to day depending on other activity level and additional compounding factors. Counseling clients in typical pain and stress-related body language will help to set the stage for knowing when to stop (Figure 9.8). A patient who is averting eyes, shifting away, lip licking, or pulling ears back is showing signs of pain and discomfort; these signs occur at relatively mild levels of discomfort, and long before vocalizing will happen. Proceeding with more caution and modifying the exercise to decrease physical pressure (e.g., limiting end-range joint motions) will not only keep the patient more comfortable physically, but it will help to preserve the relationship between patient and client. If in doubt, the client should stop the exercise and it should be re-evaluated with the client in the rehabilitation clinic. Video footage of the exercise and associated behaviors at home may also be helpful. Hesitation is often the first sign of fatigue, but can also be the first sign of discomfort. Be sure to counsel about rest and about not pushing through an exercise if the patient's willingness decreases.

Rehabilitation therapy can cause mild transient discomfort but should not be an uncomfortable process beyond this. In the veterinary world, we rely on patient compliance and a breakdown of this compliance can mean an

Figure 9.8 International Veterinary Academy of Pain Management (IVAPM) pet pain awareness poster for client education, 2016. *Source:* Courtesy of IVAPM.

end to therapy; we cannot force our way through a patient's pain by reasoning with the patient about long-term gains being worth the discomfort. We aim to avoid philosophies espoused in human therapy and sports training such as "no pain, no gain." Instead we focus on teaching cooperation and compliance to develop a willing partnership between patient, client, and the rehabilitation team.

Problem Solving and Dealing with Challenging Patients

Case Examples

Case No. 1: Human Reactive and Handler Aggressive

A 7-year-old German Shepherd presented for work-up of a forelimb lameness. She had been rescued from a reportedly abusive home and exhibited fear-based anxiety that led to aggression if not kept under threshold. She was not acclimated to a muzzle and had low level of treat motivation. For her initial evaluation, she had received anti-anxiety medications, essential oils, and herbal calming supplements prior to arriving at the rehabilitation clinic. The client was initially insistent on handling the dog. The patient would take treats when tossed near to her and progressed to taking treats out of the technician's and veterinarian's hands; however, when attempts were made to handle her forelimbs she became very anxious, demonstrated by vocalizing and showing her teeth.

A soft cone was placed around her head by the client, followed by feeding treats rapidly. She was then restrained as lightly as possible while the client fed her, but she would not always eat. Forelimb examination was as brief as possible. It was determined that diagnostic ultrasound was needed to obtain a full picture of the cause of the identified shoulder pain. A low-stress plan was made for the next visit. It was determined that removing the client from the room decreased the stress of the dog. In addition to the medications, oils, and supplements she received prior to her first visit, we played calming music (Through A Dog's Ear™) and worked as efficiently as possible.

It was noted that she settled better with a hands-off approach and would take tossed food, but she was unfortunately not trustworthy being unrestrained. Throughout the diagnosis and treatment of her front limb injury, we discovered that she was much more predictable and easier to handle with consistency. The client had established a chain of events that we followed for each treatment regarding handing the dog off. The owner entered an already prepared room with the patient, then waited for a couple of minutes. The restraining technician entered the room first, to be handed the leash. The patient was asked to get up on the table and lie down sternal on the right side of the restraining technician. The treatment technician sat to the right of the patient. The patient was treated in a specific room, held with minimal restraint necessary for safety (right arm around neck, left hand holding the leash), and her vocalizations were ignored in favor of the technicians carrying on a normal conversation. Success was very dependent on the frame of mind the patient arrived in. All treatments were completed with only one therapy appointment involving increased vocalizing coupled with struggling against restraint consistently. All other appointments had infrequent and inconsistent vocalizing.

Case No. 2: Fearful Patient

A 5-year-old medium-sized mixed breed dog presented for back pain. The dog was not very treat motivated at home, and even less so when stressed. The client brought multiple types of treats to the consultation and used massage techniques to aid compliance. Chewy strips of sweet potato and peanut butter in a very thin consistency were readily consumed. He received laser treatments for 3 weeks, where he learned to relax.

When hydrotherapy was initiated, the patient had higher stress levels than he had demonstrated before, even at his consult. He would not take food. The underwater treadmill was a change in environment and expectation, and changes were stressful for him. He also had the added stressor of movement (whereas for laser therapy he had been relatively still, in a quiet room) along with being in a higher traffic, open-plan area. For three appointments, the technician and the client tried the same approach as was used in the consultation. The same treats, essential oils, and predictable massage were used while the patient walked in the underwater treadmill. Despite this, the patient demonstrated higher levels of stress than at the initial consult. Social pressure, in the form of paying direct attention, added stress for the patient; the owner repeatedly offered peanut butter for the patient to lick without expecting him to do so. The client and technicians continued to try offering a variety of treats, but stopped interacting with the patient purposefully while in the water. When the owner and technician had a conversation without paying attention to the patient, he was calmer. This was repeatable with future appointments. By the fourth underwater therapy appointment, the patient could walk calmly and take treats.

Case No. 3: Food Allergy and Anxiety

A 10-year-old Australian Shepherd with food allergies presented with biceps muscle pain and elbow osteoarthritis. The patient was already taking the medication fluoxetine for anxiety at initial presentation. During visits, she would shake and retreat into the corners of the room. Even light handling would result in a struggle to escape touch. Attempts were made to allow acclimatization, she visited just briefly for treats and then left. During these acclimatization visits, she was very nervous but when she took food, she relaxed. Treats used were dry kibble from home, supplemented with hypoallergenic treats in the clinic. After several desensitization visits, examinations were possible using this approach but treatment procedures (even the low stimulus of a modality) resulted in an escalation of her stress response. After several therapy sessions, she began to reach her threshold more quickly with each follow-up visit. Premedication was elected, using trazodone at home 2 hours before the car ride, but unfortunately had minimal effect. After communication with her primary care veterinarian, alprazolam was prescribed for situational use. This raised her threshold for stressors and enabled the team to complete rehabilitation.

The patient has some long-term issues, therefore her visits for follow-up at the clinic are very ordered with the aim of minimizing stress. She enters the room at least 10 minutes before the appointment time and listens to her favorite music from home (country and western from her owner's phone). With each visit, time is consciously allocated to talk about her progress at the start of the visit with no hands on for at least 5 minutes. The hypoallergenic treats given in clinic are not the same as her everyday home treats, therefore they provide higher motivation for luring and reward. Therapy decisions always take into consideration the stress of each plan and modality, and handling needed (e.g., contact needed along with beeping sounds of the laser versus soundless, no-contact pulsed electromagnetic field therapy).

Case No. 4: Obese Patient with Orthopedic Disease

A 35-pound (16 kg), 9-year-old Shetland Sheepdog (body condition score 8/9) presented for slow recovery from bilateral medial patellar luxation surgery. She was estimated to be 15 pounds (7 kg) overweight, due in part to two luxating patellas that did not allow her to fix her knees in extension and minimal activity for the past 6 months, but also due to being overfed for reduced activity. The rehabilitation veterinarian prescribed in-clinic therapy including hydrotherapy in the underwater treadmill. Initially the dog was not motivated to walk in the treadmill so the client used large pieces of freeze-dried liver to motivate and reward her (approximately 10 calories per average-sized treat). The dog would consume about half of her daily calories at each therapy session, while still being fed her usual meals.

The technician addressed the overfeeding by giving multiple options: use lower calorie treats, bring meals from home to use, or break the current choice into very small pieces. The client elected to use smaller pieces. An additional positive of using smaller "tastes" of treats is that the patient walked more consistently, with larger pieces she would stop walking to chew. The client was hesitant at first and it took a couple sessions to get the treats consistently small enough that the dog was only consuming about 20 calories per session. Motivation was maintained, while still being careful of total caloric intake.

Case No. 5: Home Environment Issues

A 6-year-old straight-line racing Whippet presented with a deltoid muscle strain. It was an acute injury that had occurred at an event. His owner had mobility problems and usually exercised her dogs to maintain fitness by letting them run in her large yard every day, chasing a Frisbee™. Practice on a lure line was once weekly but only in racing season. Visits for in-clinic therapy were not a problem, however the patient had to be exercise restricted at home, in a multi-dog household. A dog walker was utilized. In the clinic, appropriate modalities and manual therapies were used. Daily stretching was prescribed for home with consideration for the owner's disabilities. The patient was not making adequate progress in the rehabilitation plan, shoulder extension continued to be restricted, and some intermittent lameness was seen at a trot. After some discussion, it was determined that the owner had not been utilizing the dog walker daily and was tired of restricting her dog so had allowed some yard time for a mental break. The owner reported that the dog was much more relaxed, having been able to freely run, and was holding his front leg up only a little, a lot less than he had initially. She suggested she allow more activity and use an anti-inflammatory to help the pain. The pros and cons of this approach were discussed at great length and a compromise achieved. The patient could have off-leash yard time alone, not with the other dogs and no Frisbee.

The client agreed to make the long drive to the clinic twice weekly for exercise therapy for another month to bridge the gap between limited home exercise and full home exercise. The situation was not ideal, but the yard time alone progressed to Frisbee retrieves as the patient progressed, and then on to yard time with other dogs. An issue of lack of conditioning remains and straight-line racing fitness has not been achieved.

Case No. 6: Too Much Fun/Equipment Cues

A 7-year-old Rottweiler presented for strengthening and gait retraining. Previously he had been exercised on a land treadmill at home but it was overstimulating for him so had to be managed carefully. At his first underwater therapy session, he was put in a non-restrictive harness then led into the empty underwater treadmill. Since he seemed to be comfortable, although very excited, the treadmill started to fill with water. The patient began to thrash happily in the water. Attempting to hold him back with the harness only escalated his behavior more. His handler then remembered that a harness has only been used previously when doing bite sport work (a high-adrenaline and very reinforcing activity). He bit at, splashed, and tried to spin in circles in the water. He had never been exposed to water outside of a kiddy pool in the yard, to which his response had been similar. At this appointment, he was barely responsive to cues from his handler. He would not take food, and he could not be distracted by toys.

We developed a training plan to desensitize him to water. He had to perform obedience to earn access to the water. The sound of water splashing made it very difficult for him to perform the behaviors he was asked for. He had to demonstrate calmness to be able to stay in the water. We used a martingale lead to be able to prevent him from biting at the water if he was unresponsive to cues, and a calming cap (http://www.thundershirt.com/thundercap.html) to help him tune out external stimuli. His handler worked on his responses to his obedience position cues (sit, down, stand, walk forward specifically). Initially, he vocalized when not allowed to be in the water. After only two sessions in clinic, he could walk into and out of the underwater treadmill without trying to dig at or bite the low-level water sitting in there. He was responsive to cues from his handler. Homework included walking in and out of the edge of the water at a boat-loading dock. By the fourth session, the patient could walk in the moving treadmill in the water, although continued use of a calming cap was needed.

Case No. 7: Motivating the Excitable Dog with No Focus

A 1-year-old Greater Swiss Mountain dog underwent rehabilitation therapy post surgery for a shoulder osteochondrosis. It soon became apparent that he lacked self-control. He was often overstimulated and could not focus when there was food present. It was nearly impossible to get thoughtful work with luring, as he was too focused on getting the food. He frequently stayed for the day so one technician was responsible for his therapy without help from the client. Teaching him how to earn food was the priority. He needed something to work on while walking in the underwater treadmill for strengthening, so he was taught a specific focal target in the treadmill. This was made easier because he would eat treats dropped in the water, so the technician could reward from any position by tossing the treat at the front of the underwater treadmill tank. The pieces of this final behavior that was shaped included walking in the water, head carried in a neutral position, eyes faced forward. It started with verbally marking, then rewarding a neutral head position with the technician standing in front. As this behavior became fluent, the technician began moving side to side in front, only marking and rewarding when the criteria were met. By the end of his treatment, he could walk for 20 minutes with reinforcement delivered on a variable schedule.

Case No. 8: Motivating the Obese Feline Patient

RockinRhonda was a 13-year-old, calico, spayed, female, domestic shorthair cat that was painful, morbidly obese, and diagnosed with osteoarthritis. Her left stifle was worse than her right (both showed severe degenerative joint disease), and she had suspected previous bilateral cruciate ligament tears, plantigrade stance bilaterally in hindlimbs, and marked weight shift to front limbs (J Panko and J Bowra, personal communication, 2016, www.thespaw.com/).

The immediate rehabilitative goals were as follows:

- Stage 1: Assessment, pain management plan, activities of daily living
- Stage 2: Physical rehabilitation plan
- Stage 3: Lifestyle, fitness, core strength, mobility, and pain management lifelong care.

The equipment/modalities/therapies used included:

- Pain management
- Nutrition plan
- Joint health management
- Hydrotherapy
- Therapeutic laser
- Therapeutic exercise.

This morbidly obese kitty (22 lb (10 kg)) at initiation of rehabilitation is undergoing a plan that includes the following:

Pain Management and Joint Health

- Onsior® (robenacoxib 6 mg orally once daily), evaluating efficacy daily and reducing dose in correlation with weight loss.
- Therapeutic laser (see Stage 2: Physical rehabilitation plan).
- Glycoflex Chews™ (loading does of 3 chews per day for 6 weeks) then 2 chews daily, reducing dose in correlation with weight loss.
- Cartrophen® injections (0.33 mL subcutaneously every 7 days for 4 doses, then one dose every 30 days, reducing dose volume per weight loss).

Nutrition Plan

- Assess body fat index and create a safe weight loss and management plan using the Hill's Healthy Weight Protocol™.
- Monthly weigh-ins. Recalculate nutrition plan monthly.
- Measured and controlled Hill's Metabolic® Wet and Dry + Glycoflex® chews.

Physical Rehabilitation Plan

- Low-impact exercise sessions (underwater treadmill) 2–3 times daily for up to 5 minutes, increasing length of sessions and reducing buoyancy as tolerated.
- Swimming in pool to improve cardiovascular fitness and assist with weight loss.
- Once she can tolerate it, progressively add in cavaletti poles flat on the ground, progressing to 5 cm then 8 cm off the ground to promote front and hind limb weight shifting, flexion, and extension, weight shifting with front limbs on balance pad, progressing to front limbs on balance disc, progressing to having front limbs on yoga block while eating to increase challenge of hind end weight shift.
- Environmental modifications: Provide low litter box with 3 cm step in, padded bedding, and medium-sized dog kennel. As hind end strength improves, raise feed bowls to promote weight shifting to hind end and engagement of core muscles while eating and return to normal litter box use to promote flexion of stifles and hips.
- K-Laser™ stifles, elbows, and shoulders, 3 watts, 1 cycle each joint, twice weekly for 3 weeks, then re-evaluate. Move to weekly laser sessions when mobility improves.
- As pain and weight diminish, incorporate therapeutic exercise program to increase core strength, build hind limb muscle mass, improve hind limb strength and plantigrade stance, overall mobility, and ability to complete activities of daily living.
- Monthly re-evaluations with Dr. Jeff Bowra, DVM, CCRP or, as concerns arise, progress stops, or plan needs modification.

Long-Term Lifestyle and Mobility Plan

- Ongoing pain management, weight management, joint health management and physical rehabilitation with Jenn Panko, RVT/CCRP, OCMC, CAPMC, under the supervision and direction of Dr. Jeff Bowra, DVM, CCRP.

At the current time (August 25, 2016) RockinRhonda is 11 lb (5 kg) and is continuing with her prescribed physical rehabilitation plan.

Motivating the Client

Motivating the patient is always the most necessary step for in-clinic rehabilitation. For home rehabilitation, we have two factors – we must motivate the client to motivate the patient. Daily home exercises (often several times a day) can become difficult to fit into a busy schedule, and therefore knowing the importance of the prescribed exercises along with the reasoning for each exercise can help to motivate the client (and every person involved in home care of the patient). Some clients want to know exactly why the prescribed exercises will help, others just want to know that the exercise will help. Explaining the exercise verbally when first introducing it, and explaining in written handouts and videos helps to aid motivation. Demonstrating the exercise with the patient shows the client that the patient is willing to perform the exercise. The next hurdle is to use the client to motivate the patient. This can be a significant challenge. It helps to meet all members of the family as there may be one member who is particularly adept at motivating and working with the pet. This may not be the primary caregiver. Sometimes the client's compassion for the patient may present a roadblock in that the caregiver does not want to hurt their pet. Explaining how the exercise should feel and the relative "cost" (slight initial discomfort during a stretch for example) versus benefit can help to motivate the client to perform the exercise. As stated earlier, no exercise should be truly painful; in the veterinary world we rely on patient compliance and a breakdown of this compliance can mean an end to therapy. Motivating your patient and client in a low-stress way can achieve great goals.

Conclusions

A behavior-centered rehabilitation clinic will be a successful clinic. Motivating a patient with positive (usually food) rewards in a calm environment aids in a low-stress visit for examination, and subsequently for therapy. As the number of visits increases, the stress level of the patient should ideally decrease, or at least not escalate. Minimizing handling and other stressors is vital where possible. A compliant, relaxed patient will benefit greatly from rehabilitation therapy. Home compliance for exercises is an important part of therapy, and motivating both the patient and the client leads to a successful outcome and a rewarding experience with rehabilitation. The trust gained from a low-stress therapeutic course for a patient and client will stand the practice in good stead for reaching therapeutic goals, and for future referrals.

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Resources

Through A Dog's Ear. www.throughadogsear.com

Understanding canine body language. http://www.doggiedrawings.net

Interactive feeding toys for dogs

Busy Buddy Toys. http://www.petsafe.net/busybuddy

Green slow feeder. http://northmate.com/category/products/green/

Kong. www.kongcompany.com

Orka. http://www.petstages.com/our-products/

Interactive feeding toys for cats

Slimcat.http://store.petsafe.net/slimcat-interactive-feeder

Trixie Fantasy Board. https://www.trixie.de/heimtierbedarf/en/shop/Cat/

Interactive feeding toys for horses

Amazing Graze. www.horsemenspride.com/products/#tour-5

Posters

Dr. Sophia Yin Dog Postures. http://info.drsophiayin.com/free-poster-on-body-language-in-dogs?portalId=13722&hsFormKey=4ca331cd8d62797c35e7d9e59e39d27f&submissionGuid=72ec5c14-c618–4b00-af88-a60f298c8a42#widget_388815

Dr. Sophia Yin Cat Postures. https://drsophiayin.com/blog/entry/new-poster-the-body-language-of-feline-anxiety/

10

The Disabled Patient Part 1: Assistive Devices and Technology

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CHAPTER MENU

Introduction

Assistive technology is an umbrella term that includes assistive, adaptive, and rehabilitative devices for individuals with disabilities and also includes the process used in selecting, locating, and using them. Assistive technology (for this chapter called devices) can be defined as "any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities" (Nicolson *et al.*, 2012). The implications for veterinary rehabilitation are as follows:

- Assistive devices can decrease effort and energy expenditure for family caregivers of animals with disabilities.
- Assistive devices can increase animal independence, and therefore decrease family caregiver burden.
- Rehabilitation veterinarians and their technicians/nurses need to educate and guide family caregivers on the use of assistive devices for their pet in order to improve the chances of correct use along with patient acceptance.

In the past 20 years we have had a surge of understanding and innovation for veterinary pain management and rehabilitation. This

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chapter will endeavor to highlight some of the useful devices, including orthoses and prostheses.

History

Canine "wheelchairs" have been on the US market for around 55 years. Dr. Lincoln Parkes designed carts in 1961 for his surgical patients, usually small-breed dogs but some German Shepherds. By the late 1970s, he had formed a company – K9 Carts (Glenn Parkes, personal communication). Carts are usually custom-made using the specific measurements of the canine, feline (or other) patient. In 2008, a mass market dog wheelchair was produced (Walkin' Wheels, http://walkinwheels.com/). This device fit a range of dog shapes and sizes and made dog wheelchairs easier for veterinarians to stock ready for future use (Bluebird Care, 2015).

The profession of bracing predates surgery. Bone setters and appliance makers were skilled artisans (Mich, 2014). Orthopedic surgery development caused bracing to become secondary to surgery. The correct term for braces is orthoses. Orthoses are defined as any medical device attached to the body to support, align, position, prevent, or correct deformity, to assist weak muscles, or to improve function (Mich, 2014).

Originally, blacksmiths (farriers) and armor makers were prosthetists. As the US Civil War dragged on, the number of amputations rose astronomically, forcing Americans to enter the field of prosthetics. James Hanger, one of the first amputees of the Civil War, developed what he later patented as the "Hanger Limb" from whittled barrel staves (Norton, 2007). The American Orthotic and Prosthetic Association was founded following World War I. Today's devices are much lighter, made of plastic, aluminum, and composite materials to provide amputees with the most functional devices.

When we optimize movement and mobility for our patients, we can significantly affect their physical and mental health. Organizations such as the American Association of Rehabilitation Veterinarians, the American College of Veterinary Sports Medicine and Rehabilitation, and the recently formed Academy of Physical Rehabilitation Veterinary Technicians are educating veterinarians on the use of assistive devices, orthoses, and prostheses to improve the mobility and functionality of the veterinary patient.

Which Patients Need Assistive Devices?

Patients that have a physical injury, who are postoperative, are orthopedic or neurological, or who have other physical rehabilitation needs due to chronic conditions may be in need of an assistive device. It is necessary to assist postoperative patients in getting into and out of cages, and to help them up from a recumbent position, as well as assisting while ambulating to prevent slips, excess weight bearing on a new repair, or further pain and injury. The patient must be allowed to become accustomed to any assistive device and the procedures involved in placement and assisting ambulation (Drum *et al.*, 2014).

Patients with spinal cord injuries may have reduced body sensation and awareness (proprioception) but be ambulatory, or may be non-ambulatory paretic or fully paralyzed. It is important for the therapist to recognize the need for assisted standing even in a paralyzed patient. The cardiovascular system and the respiratory system benefit from being upright, in addition to the beneficial effects on muscle circulation (Olby, 2010). In patients who have some motor function, assisting motion is necessary in order to prevent falls as well as to provide the benefits of gait repatterning and strengthening (McDonald and Sadowsky, 2002).

Figure 10.1 Sling for geriatric dog.

Types of Assistive Devices

Devices Used for Assisted Standing

Standing exercises focus on strengthening shoulder, elbow, hip, and stifle extensors and re-educating muscles needed for balance and proprioception. They can also aid lung and cardiovascular function. Several approaches can be used to facilitate standing. Particularly when a patient is large, assistive devices such as slings, physio rolls, mobility carts, wheelchairs, or lifts may be used to maintain a patient in a standing position (Drum *et al.*, 2014). Smaller patients can be supported manually to maintain a standing position (Drum, 2010).

Devices that can be used include:

- Slings (Figure 10.1)
- Therapy balls (Figure 10.2)
- Hoyer lift (Figure 10.3).

Figure 10.2 Therapy ball assisting standing.

Devices Used for Assisted Ambulation

Devices for assisted ambulation can be used to help weak or paretic patients. The devices used to assist companion animals may support or protect weak, unstable joints or feet (orthoses, boots); replace a missing portion of a limb (prostheses); or facilitate locomotion (slings, carts, ramps, steps) (Marcellin-Little and Levine, 2014). Assistive devices may also decrease the complications present in recumbent patients, including decubitus ulcers (Adamson *et al.*, 2005).

Figure 10.3 Dr. Tomlinson with a patient in a Hoyer lift.

Pets wearing assistive devices should not be left unsupervised. Several sessions may be needed to establish acclimation. Low-stress handling techniques and positive reinforcement should be observed (see Chapter 9). In general, hair removal should be avoided as hair provides skin protection, but some devices may require that hair be clipped. Devices should be inspected for wear and damage and cleaned daily. The skin should be inspected twice daily. Cleaning is especially important if there are any incisions, wounds, or open sores in contact with the assistive device.

Boots

Boots can be used to protect paws from environmental hazards, for example to protect working animals from ice and snow, rocky terrain, or hot surfaces. Patients with proprioceptive deficits may wear boots to provide more traction, protect skin, or to stop them wearing their nails down to the quick (Prydie and Hewitt, 2015). Wearing boots at home can provide traction on slippery floors and breathable boots can be left on during the day. Boots act as sock-like coverings and are securely fastened by Velcro straps at the top. Most have a rubber sole to prevent slipping and are machine washable. The boots should be removed several times daily to assess the skin condition, especially in neurologically impaired patients, and, if possible, when performing therapeutic exercise to increase weight bearing and proprioception through the bottom of the pads (Adamson *et al.*, 2005). A proper fit is essential, and appropriate education instructions for skin care and rehabilitative exercises must be communicated to the owner.

Customized grip socks are also available. These have rubber tread under the paw surface or over the whole foot, including dorsally. Old socks may also be used to help provide padding; however, if the top is secured with tape care should be taken to avoid cutting off circulation (Marcellin-Little and Levine, 2014).

One study that evaluated a custom orthotic boot found that the boot was effective at immobilizing the distal extremity and reducing contact between a wound and the boot, which allowed for complete healing by contraction and epithelialization (Hardie and Lewallen, 2013).

Where Do I Get Boots?

- *Pawz*™ (http://pawzdogboots.com/boots/) are a thin rubber boot without padding so the dog is able to feel the ground. Tip: The animal's feet can get hot so use foot powder to prevent moisture build-up or put a few small holes in the boot with a pin to create airflow around the foot (Prydie and Hewitt, 2015). The author recommends to not leave the boot on for more than 3 hours at a time.
- *Cushy-Paw Slippers*™ (www.therapaw.com/) are padded, grippy slippers for indoor comfort and protection.
- *Ruffwear boots – Grip trex*™ (http://www.ruffwear.com/Barkn-Boots-Grip-Trex_3) are all-terrain boots and are a little thicker soled with canvas upper. They can be adapted for sore feet by lining with foam and can be used for multiple applications of indoor and outdoor foot protection.

- *Lewis Brand Vented Rubber Dog Boots*™ (http://www.gundogsupply.com/-950-.html) protect the dog's feet from sand burrs, rocks, and brush, and can also protect an injured foot or sore pad. Because they are molded to foot shape they can help to keep the toes in proper extension for gait in animals that have mild proprioceptive issues. The boots are made of tire tread rubber with a tread on the sole to increase the life of the boot and for non-slip traction.
- *Foufoudog*™ (www.foufoubrands.com) are rubber-dipped socks with an anti-slip silicone sole that claim to keep paws dry, clean, and warm! The stretchy sock design makes it easy to put on, and the hook and loop allows you to wrap the sock securely so they do not fall off. The strap can be detached for quick walks or use around the house. The innovative rubber dip protects paws from outdoor elements such as water, snow, dirt, salt, and hot pavement.
- *Dr. Buzby's ToeGrips*™ (www.toegrips.com/) provide traction on slippery floors. These are rubber rings that fit around the dog's nail to provide grip through friction just below the nail tip. Care must be taken to pull the grips down from the cuticle as the nail grows. Dogs tolerate these well but note that some breeds, such as Dobermans, who do not have nail contact with the ground, and some individuals who do not engage the toenails when slipping, will not benefit from toe grips (Prydie and Hewitt, 2015).
- The purpose of the *Medipaw® X* boot (various suppliers) is to protect various appliances, such as leg bandages, splints, and casts. It can be used over incisions and is good for patients trying to bite or disturb a wound as in lick granulomas. The boots or suits are available for dogs and cats.

Slings and Harnesses

Slings may be strapped around the belly or fitted for the forelimbs, hindlimbs, or both. They should have long, hand-held straps attached to allow proper body mechanics to avoid personal injury to the handler when supporting the pet. Slings aid in transitioning a recumbent animal, especially larger dogs, to a standing position (Adamson *et al.*, 2005). They can also assist with ambulation and prevent falls on slippery floors, especially after surgery, to avoid further injury to the animal. Support slings are available for forelimb assistance and patients with amputations. Patients who cross their pelvic limbs may benefit from the placement of a rolled cotton towel within a pelvic limb sling (Marcellin-Little and Levine, 2014). Slings used for the forelimbs should not obstruct respiration, and urine flow should not be compromised with hindlimb slings in male dogs. Slings should have a soft lining against the animal's skin to avoid irritation and sores, and they should be washable. Slings may be used for supported standing for therapeutic exercises such as repeated sit to stands. When documenting patient progress, the amount of assistance given through sling support can be rated as minimum, moderate, or maximal.

Harnesses are a more useful aid to mobility. They can be worn for several hours a day and provide easy access to a "handle" to lift the dog up (Prydie and Hewitt, 2015). This is particularly important if it is a larger dog to help the owners avoid injuring themselves. Animals with cervical injuries, especially following neurosurgery, will require chest harnesses to support their mobility without interfering with the injury site. There are also harnesses available with extra-long straps. These are useful for small dogs where the owners are likely to damage their back by reaching down to hold the harness.

Where do I get Slings and Harnesses?

- *GingerLead Sling*™ (www.gingerlead.com/) is a sling with handles and an extension leash to the collar for control of patient speed and motion. It allows the patient to feel supported while providing controlled mobility.
- *FourFlags Quick Lift*™ (http://www.fourflags.com/s.nl/sc.11/category.6990/.f) is a sling made of nylon pack cloth, available with or without fleece lining.
- *Komfy Fleece Dog Mobility Sling*™ (http://www.seniordoggy.com/komfy-fleece-mobility-sling/) is a fleece-lined sling.

- *Hartmans Hip Helper™* (www.hartmanharness.com/) is a harness which is designed to be worn for hours at a time. It provides a handle over the rump for easy lifting assistance.
- *Help 'Em Up Dog Harness™* (http://helpemup.com) is a padded harness designed for daily wear. Handles sit over the whithers and over the rump. Front harness and rear harness can work together or separately. This is M.E. Goldberg's favorite harness because it offers the most control.

Ramps and Stairs

Ramps for dogs are useful for getting in and out of a vehicle, getting into the owner's bed, or going up and down steps. They are especially useful in geriatric patients. Ramps offer a solution that helps to protect the dog's joints when jumping and the owner's back when lifting the dog in and out of a vehicle. It is also advisable to have a ramp for getting out of a vehicle if the dog has had front-leg surgery, is prone to carpal hyperextension injuries, or has a tendency to hyperextend its carpus, as jumping out of a car will aggravate this (Prydie and Hewitt, 2015). Telescoping ramps are available. Measure the height of the bed or vehicle to calculate how steep a ramp will be, based on its length.

Stairs are helpful for pets wanting to get to a higher elevation such as owner's beds, sofas, or window access. Cats particularly like using carpeted stairs. Be sure to use stairs that are strong enough for the weight of the pet and to look at pitch and overall width of the unit.

Where do I get Ramps and Stairs?

- *Discount Ramps™* (www.discountramps.com) have a wide variety of ramps.
- *Pet Classics Indoor Pet Ramps™* and *Pet Classics Outdoor Pet Ramps™* (www.petclassics.com/) are wooden ramps made for cats and dogs and covered with carpet.
- *Wayfair™* (http://www.wayfair.com/Dog-Ramps-and-Stairs-C1804268.html) offer a variety of pet ramps and stairs for both indoor and outdoor use.
- *Doctors Foster and Smith™* (http://www.drsfostersmith.com/cat-supplies/furniture/ramps-and-stairs/ps/c/3261/10345/11278#) have a range of cat ramps and stairs.
- *SolVit™* (http://www.solvitproducts.com/ramps) supply ramps and ramp accessories to help the pet get in a vehicle.

Carts and Wheelchairs

Carts can allow functional independence for impaired animals. They aid in ambulation and can be used to provide therapeutic exercise. They are normally suggested for paretic or paralyzed patients, patients with severe osteoarthritis, and obese patients, and may be used with other devices such as boots (Borghese *et al*., 2013). Carts have also been used for patients with long-term balance (vestibular and cerebellar) issues (Pazzaglia and Molinari, 2016).

When determining the most appropriate cart, consider the size and weight of the dog or cat, the amount of support needed, the patient's residual strength and mobility, and the caretaker's physical abilities. Getting a patient into and out of a cart can be very difficult and may require a lot of lifting.

Fitting Cart fitting can be challenging, and rehabilitation veterinarians and their technicians or nurses should plan on spending at least 45 minutes making adjustments aimed at getting the best ground clearance, allowing motion of ambulatory limbs with minimal restrictions and balancing the weight of the cart (Pancotto, 2015). Clients should practice getting the pet into and out of the cart during the fitting. Most cart manufacturers will assist with adjustments if sent a picture of the patient in the cart. Important positional factors include a straight topline (not bowed or curved), the patient should have good ground contact in the normal ambulatory limbs and toe-touch in weak or paretic limbs, and the strap should clip just behind the scapula. Overweight dogs may need added belly bands.

Where Do I Get Carts?

- *Dewey's Wheelchairs for Dogs™* (https://www.wheelchairsfordogs.com/home.html) are custom-made to a pet's measurements.
- *Doggon' Wheels USA™* (www.doggon.com/) are custom-made to the pet's measurements, weight, and activity level. Dog and cat carts are available. The patient can be backed into the cart and the rear limb sling then snaps into straps on the cart.
- *Eddie's Wheels for Pets™* (http://eddieswheels.com/) are custom-built for dogs and cats. The welded padded saddle gives solid support but the pet does have to be lifted into the cart. For cat patients, they send out a cat harness for the cat to get used to wearing while the wheelchair is built. The cat harness should be put on the cat to wear at all times, so that he or she gets used to wearing something and once the cart arrives, a piece of double-sided Velcro is used to attach the cat harness to yoke of the cart.
- *K9 Carts™* (www.k9carts.com/) are adjustable and available for dogs and cats.
- *Walkin' Wheels* (www.handicappedpets.com) come in standard sizes that are adjustable. Different-sized wheels and bar lengths make a kit so that the cart can be modified for a patient. For larger dogs, steel reinforcement bars are added. These carts are better for rear limb issues only; a belly band can help patients with abdominal weakness.

Beds and Bedding

Orthopedic dog beds provide the necessary and supportive firmness a geriatric pet needs to sleep comfortably. These beds give a pet the support and comfort of orthopedic foam, making them the best pet beds for older, ailing, and postoperative dogs, or those with arthritis. A pet bed provides a sense of security. Advise the client to locate a comfortable place in their home for the pet bed, and keep the bed in the same location so the pet learns that he or she has a special resting spot. Pet beds are comfy and most pets would prefer to sleep somewhere soft that provides cushioning and insulation instead of on the cold, hard floor.

Important Factors to Consider Before Choosing a Pet Bed

- *Sleeping style.* Some pets like to sleep curled up in a cozy ball, but others like to sprawl out. Have the owner observe the pet's sleeping style to help determine the right bed for him or her. Does the pet like the security of leaning against something? Or does the pet like to have enough room to stretch? These are important questions to consider before choosing.
- *Pet type, size, and activity level.* Is this for a dog or cat? Big dogs will need a larger, sturdier bed with a thick, more durable cover than a smaller dog would need. Cats prefer window perches to satisfy their curiosity. Older pets would benefit from heated pads or orthopedic beds for relief from arthritis.
- *Style and budget.* Nowadays, pet beds come in a wide range of styles, colors, materials, and prices, so there is something for every taste and budget.

Popular Types of Pet Beds

- *Orthopedic pet beds* provide extra cushioning for bones, helping to soothe painful pressure points. The large size of an orthopedic pet bed is great for pets that like to sprawl out while sleeping. The mattress type of pet bed is recommended for large dogs, while orthopedic window perches are recommended for cats. Some of the smaller orthopedic pet beds may be used for either dogs or cats.
- *Donut (bolster) beds.* If the pet likes to curl up or sleep with his or her head resting on a pillow, a donut or bolster bed is good choice. This style of pet bed usually has a cushioned bottom and a raised side. It is cozy for smaller pets since the round shape of the pet bed helps retain body heat.
- *Pillow or cushion beds.* This pet bed is basically a large pillow or cushion. It comes in many different sizes, and is a great choice for pets that like to stretch out while sleeping.

- *Heated pet beds* are recommended for older pets that may have joint pain or stiffness. The gentle heat soothes and reduces stiffness, keeping the pet warm and cozy while sleeping. Even smaller pets, such as cats, can benefit from a heated pet bed since they lose body heat easily. Consider a using a heated pet bed if the client lives in a colder climate.
- *A pet cot* should be considered if the dog or cat likes to rest outdoors. Pet cots protect the pet from the rough ground, especially asphalt that may get too hot in the summer or too cold in the fall or winter. Many pet cots are made of a waterproof fabric which helps make cleaning easier. The sturdy frame makes it ideal for larger dogs.

Where Do I Get Pet Beds?

- *Kuddle Kots*™ (http://kuddlekots.com/) are made as ortho or chiropractic beds. They were originally designed for Dachshunds. It is best to speak to the manufacturer.
- *The PetCot™ Company* (www.petcot.com/) makes beds for home, boarding kennels, and veterinarians. They can be vinyl, making them easy to clean, or have a fleece cover. Cage inserts are available for the veterinarian's hospital and a raised pet bed for dogs with incontinence. Replacement parts, fleece covers, and orthopedic inserts are available as well.
- *The SleePee Time Bed*® (http://www.handicappedpets.com/sleepee-time-bed-for-incontinent-pets) is a new product specifically designed to help dog incontinence and older dogs get a good night's sleep. It can also be used simply as a cool, comfortable sleeping surface for any pet.
- *Care-A-Lot Pet Supply* (http://www.carealotpets.com/departments/cat-supplies/cat-beds-and-cuddlers.aspx) offer cat beds and cuddlers, including heated beds, plush beds, round beds, and one hanging cat condo.
- *Wayfair*® *Dog Beds* (http://www.wayfair.com/Dog-Beds-C409475.html) offer orthopedic beds, bolster beds, fleece beds, pet cots, and pet sofas.

Hydraulic Patient Lifts

Hydraulic lifts are either manual or electric. They can be found at medical supply stores and purchased new, used, or rented. A few are being made specifically for dogs. It is important to purchase a sling attachment used specifically for dogs even if you buy a human version lift. A lift can be used to manage a large tetraparetic or tetraplegic cervical patients. A patient lift (patient hoist, jack hoist, hydraulic lift) (Figure 10.4) is usually a sling lift, allowing the patient to assume a stand position. The patient may need to be supported by therapy balls.

- The *Equa-Lift Hoist*™ (http://eddieswheels.com/p/19/Hospital-Equipment) is used in conjunction with a Hoyer™ lift or overhead track system and a Help 'em Up Harness ™. The hoist provides a safe, balanced way to move disabled animals in and out of the therapy stand, clinic quad cart, or hydrotherapy unit.

Premade Orthoses

Splints and Braces

A splint is a device applied to any body part to help stabilize a structure, promote healing, protect against injury/re-injury, prevent/correct deformity, and/or assist with function. A splint is lightweight, easy to apply and remove, and adaptable. It can be static or dynamic, rigid or flexible and can be used as a coaptation device or solely for therapeutic purposes (Borghese *et al.*, 2013).

A brace is defined as a durable device used for immobilizing a body part. It renders the body part static, rigid, and fixed (Borghese *et al.*, 2013).

Splints The primary functions of a coaptation device include protection, absorption, compression, and stabilization.

- *Air splints* can be used to help a dog to stand while the veterinarian works on them, acting as an extra set of hands to stabilize a joint or limb. Air splints are waterproof and reusable, easy to apply, inflate,

Figure 10.4 Assisted standing with a Hoyer list and therapy ball.

deflate, remove, and clean, making them ideal for in-home use by savvy clients. When inflated, they conform to the animal's limb and are not associated with pressure sores. They are transparent and can be half filled with water, refrigerated, then used as cold packs over an entire limb. http://www.therapaw.com/airpressure splint.aspx

- *Thermoplastic splints* are made of thermal plastic material heated in hot water until it becomes soft. Once soft, the material can be cut and molded into a custom shape for the patient's needs. After the splint is made, it needs to be cooled to become solid. This process can be speeded up by running cold tap water on it or by wrapping a cold wet crepe bandage over the splint. Hook and loop (Velcro) straps hold the splint in place, and padding/liner materials increase patient comfort. The problem with hook and loop is that it needs to be applied correctly to ensure fixation. If it is too loose, the splint will cause friction and abrasions may occur (Prydie and Hewitt, 2015). Thermoplastic sheets are widely used with human patients to make custom splints and braces that partially or totally immobilize a body part. They have now been adapted for use with animal patients (Figure 10.5).

Padding materials are used with splints to protect bony prominences, areas of fragile skin, and less-protected areas of the body. Padding should only be used in the middle part of the splint and not end to end as this will significantly alter the fit of the splint particularly with a large amount of padding. The other consideration when using padding is that it can become wet and trap distasteful smells.

Braces Bracing is used to support and stabilize a body part. Some wraps and braces are not custom-made. These could be termed generic braces.

Cervical neurologic patients (Drum *et al.*, 2014) may need bracing made from thermoplastic or fiberglass cast material that extends from mid-sternum cranially to the chin. The brace prevents ventral flexion of the neck (Figure 10.6). It should be closely monitored for excessive tightness, areas of irritation, and wetness. Many patients will have difficulty eating, so syringe feedings with water and pureed food may be required. For more

Figure 10.5 Thermoplastic sheet for devices.

severely affected cases, surgery is often required to stabilize the joint between C1 and C2. After surgical stabilization, a brace is required for 4–6 weeks postoperatively.

- *L'il Back Bracer*™ (www.lilbackbracer.com/) is an adjustable design for comfortable, stable support when dealing with intervertebral disc disease and other back pain in dogs. It provides comfortable but firm support from above and below to stabilize the dog's spinal column. It prevents further injury and relieves pain for dachshunds and other small-breed dog before or after surgery, sometimes entirely preventing surgery.
- *DogLeggs Therapeutic and Rehabilitative Products* (http://www.dogleggs.com/index.cfm) offer various braces. *DogLeggs' Carpal Support* are indicated for carpal hyperextension, carpal instability/sprain or strain injury, carpal osteoarthritis, immune-mediated joint disease, angular limb deformity, chondrodystrophic dogs in need of carpal support, post-op management of carpal arthrodesis or avulsion fractures. It is made from a closed-cell foam with synthetic rubber material and is laminated with a nylon jersey fabric. It is

Figure 10.6 Neck brace for an Irish Wolfhound.

lightweight yet durable and has incredible tensile strength. The product is machine washable. *DogLeggs' Tarsal Support* is indicated for mild to moderate Achilles tendon disruption, tarsal instability/sprain or strain injury, tarsal osteoarthritis, immune-mediated joint disease, angular limb deformity and chondrodystrophic dogs in need of tarsal support. It is constructed from a three-dimensional fleece-faced, highly breathable, four-way stretch textile with wicking properties. It allows air to circulate while keeping the joint warm. It contains padding to protect the bony prominences of the hock. Hook and loop fastening is used to secure the product. The product is machine washable. *DogLeggs' Shoulder Stabilization System™* is indicated for conservative management of medial shoulder instability, postoperative management of medial shoulder instability or shoulder reconstructions, conservative or postoperative management of certain scapular fractures, postoperative management of certain shoulder luxation repairs, and swimmer puppy syndrome. The system prevents abduction (moving away from the body) of the forelimbs and limits shoulder extension and flexion. The limited extension results in a mildly shortened gait when walking. The shoulder stabilization orthosis is made from breathable neoprene that can be worn continuously.

- *Thera-Paw Assistive and Rehabilitative Pet Products* (www.therapaw.com/) offer a variety of products. *Custom Carpal Wraps* are designed to provide customized support, stability, or immobilization. They come in three thicknesses. The same is true of the *Custom Tarsal Wrap. The Dorsi-Flex Assist™* (Prydie and Hewitt, 2015) can be used to good effect in dogs and cats that knuckle over on their back legs because of reduced neural input from degenerative myelopathy, peripheral nerve injury, or proprioceptive deficits. It can be used in dogs with weakness; however, care needs to be taken to ensure that the dog has enough strength to lift the foot with the boot on and that the dog has enough stability around the hip to control the movement of the leg. The elastic straps are placed under tension and as the animal brings the leg forwards, the elastic aids the foot being moved up into dorsiflexion.
- *Biko™ Progressive Resistance Bands* (www.animotionproducts.com/) (Prydie and Hewitt, 2015) can aid gait where there is bilateral back leg weakness such as degenerative myelopathy, wobblers, or degenerative disc disease with mild to moderate ataxia. They consist of two leg cuffs that have elastic straps clipped onto them. These elastic straps attach onto a chest harness. There are different colors of elastic relating to progressive strengths of elastic and the device works by pulling the foot forwards as the elastic recoils after being stretched by extending the hips. Caution is needed when selecting clients to use this system on as it does not prevent knuckling and it is not appropriate for acute painful conditions. It is also not suitable for patients with unilateral problems as it can increase ataxia, or those with paralysis and no motor function in one or more legs.

Custom Orthotics

Custom orthoses are made from casts of the patient's limb or are fabricated directly on the patient using a moldable thermoplastic polymer (Marcellin-Little *et al.*, 2015). These can be designed for aquatic therapy or to be worn for playing in water. The most common orthoses are used to restrict the excessive joint motion present in patients with ligamentous or tendinous problems, including patients with ruptures of their palmar fibrocartilage or common calcaneal tendon (Marcellin-Little and Levine, 2014). Custom fabrication becomes essential when a standard or semi-custom product (Borghese *et al.*, 2013):

- is not available in the correct size,
- does not meet the specific needs of the patient,

- cannot be altered to meet the patient's needs,
- incorporates a joint or joints not affected by the condition, or
- simply does not exist.

Orthoses may be hinged to enhance their functionality (Levine and Fitch, 2003). Orthoses with passive hinges may enhance limb function because part or all of the motion of the tarsus (or carpus) may be maintained. Orthoses may have dynamic hinges that may be used to enhance the support of weak joints or to stretch contracted joints. Hinges are made dynamic by using springs embedded in the hinges or elastic bands (Marcellin-Little and Levine, 2014) (Figure 10.7).

A custom carpal orthotic would basically eliminate the need for cage rest while tissues are healing but, in contrast to complete immobilization of the carpus, allows some amount of tissue loading and can be removed by an owner to enable provision of passive therapeutic joint motion and daily inspection of the skin for abrasions (Tomlinson and Manfredi, 2014).

Custom orthotics have been used in conjunction with autologous mesenchymal stem cell treatment, as in the case of a 4-year-old Border Collie where the owner elected conservative treatment over surgery. The owner was thoroughly informed about the experimental nature of this method of treatment (Case *et al.*, 2013).

Figure 10.7 Rear, right leg orthosis.

Where Do I Go?

A professional company such as OrthoPets™ (www.orthopets.com/) needs to be employed to make custom orthotics. Examination of the patient, measuring, and continued communication between the rehabilitation veterinarian and the orthotics company helps to ensure custom fit of the device. Courses are available to enable the veterinarian and their rehabilitation veterinary technician to learn how to create a fiberglass mold and send the required materials to the company (http://www.caninerehabinstitute.com/Orthotics_Prosthetics.lasso).

Other companies are:

- *Animal Ortho Care, LLC (*www.animalorthocare.com/)
- *K-9 Orthotics and Prosthetics Inc.* (www.k-9orthotics.com/)
- *Handicapped Pets.com* (http://www.handicappedpets.com/k9-dog-orthotics-prosthetics)
- *My Pet's Brace* (www.mypetsbrace.com/)

Types of Custom Orthotics

- Shoulder orthoses
- Elbow orthoses
- Antebrachial and carpal orthoses
- Hip orthoses
- Stifle orthoses
- Hock orthoses
- Distal limb orthoses (distal to carpus or tarsus)
- Spinal orthoses.

Custom Prosthetics

Not long ago, amputation of a limb for a small animal patient was quite normal when a salvage procedure was needed from trauma

Figure 10.8 Front, left leg prosthetic, lateral view. *Source:* Courtesy of Dr. Douglas Stramel.

or disease. It is now being understood that the consequences of that missing limb or limb segment are not good. Organizations advocating pain management such as the American College of Veterinary Anesthesia and Analgesia, the International Veterinary Academy of Pain Management, the American College of Veterinary Sports Medicine and Rehabilitation and the American Association of Rehabilitation Veterinarians are understanding the importance of biomechanics in normal quadruped locomotion. If a total or partial limb is missing then there can arise limited mobility and endurance, increased metabolic demand, weight gain, support limb breakdown, chronic neck and back pain, and premature euthanasia (Mich, 2014). The re-establishment of quadruped function and structure has been made possible now in veterinary medicine. The end goal is to provide a limb that allows as close to normal ambulation as possible.

Figure 10.9 Front left, leg prosthetic anterior view. *Source:* Courtesy of Dr. Douglas Stramel.

Types of Prosthesis

There are two types of prosthetic limbs available: the socket design and the ITAP (intraosseous transcutaneous amputation prosthesis). Socket-based prostheses provide a socket for the residual limb to reside in. Usually an extension (in the form of a foot or paw) is provided for the limb to make contact with the ground (Figures 10.8–10.10). The socket prosthesis requires owner care and must be put on or removed from the patient.

Figure 10.10 Walking with a front left leg prosthetic, anterior view. *Source:* Courtesy of Dr. Douglas Stramel.

Contraindications for socket prostheses may be linked to the owner, the patient, or the medical condition (Marcellin-Little *et al.*, 2015). Owner-related contraindications include a potential lack of interest, motivation, supervision, or financial ability to get involved. Patient-related contraindications include being difficult to handle because of an aggressive personality (Box 10.1).

ITAP provides an implanted endoprosthesis (into the bone) to which an exoprosthesis (external prosthesis) is attached (Mich, 2014). The clear advantage of an ITAP is direct skeletal integration of the exoprosthesis (Fitzpatrick *et al.*, 2011), and it has been shown that biological integration of osseous and dermal tissues with ITAP is reliable and robust. The tremendous variability in veterinary patients requires adaptability in socket design, components, and prosthetic limb mechanics to accommodate differences in the degree of injury, body type and condition, species, breed, size, lifestyle, sport or activity, and terrain (Kaufmann and Mich, 2014) (Box 10.2).

Examples of Successful ITAP Procedures

Some procedures in which ITAP has been used successfully include:

- total hip replacement (Liska *et al.*, 2009; Vezzoni *et al.*, 2015),
- total knee replacement (Mann *et al.*, 2012),
- canine elbow arthroplasty (Burton *et al.*, 2013), and
- titanium partial limb prosthesis in a white crane (Rush *et al.*, 2012).

Box 10.1 Contraindications for prosthetic devices in cats and dogs

Owner

- Lack of interest
- Motivation
- Supervision
- Financial ability to get involved

Patient

- Difficult to handle because of an aggressive personality

Medical condition

- Highly mobile skin in relation to underlying tissues
- Neurologic deficits
- Compromised joint mobility
- Local neoplasia
- Infection
- Stump pain

Source: Marcellin-Little *et al.* (2015). Reproduced with permission of Elsevier.

Box 10.2 Orthopedic conditions that will adapt to veterinary prosthetic devices

Thoracic limb prosthetics

- Subtotal mid-shaft radius or ulna amputation (40% antebrachium retention required)
- Subtotal radiocarpal disarticulation
- Subtotal intercarpal disarticulation
- Subtotal carpometacarpal disarticulation
- Amelia – a birth defect of lacking one or more limbs
- Congenital limb derangements
- Traumatic limb amputation

Pelvic limb prosthetics

- Subtotal mid-shaft tibia or fibula amputation (40% crus retention required)
- Subtotal tarsocrural disarticulation
- Subtotal level intertarsal disarticulation
- Subtotal level tarsometatarsal disarticulation
- Amelia – a birth defect of lacking one or more limbs
- Congenital limb derangements
- Traumatic limb amputation

Source: Adapted from Kaufmann and Mich (2014).

Follow-Up Care for the Prosthetic Patient

It is critical for the veterinary prosthesis patient to undergo physical rehabilitation. The best way to ensure the highest level of success with a prosthetic device is to follow a rehabilitation plan established by a certified canine rehabilitation professional (CCRT or CCRP). Sensory feedback extends from the top down rather than from the ground up. Through rehabilitation, the prosthesis patient relearns proprioception, balance, gaiting at different speeds, and ambulation over varied terrain (Mich, 2014). Training companion animals to use socket prostheses is similar to managing limb disuse. It relies on habituating patients to tolerate the exoprosthesis at rest and loading it (using it) when standing, when walking slowly (indoors), when walking more rapidly (outdoors), when trotting, when galloping, and then during other activities of daily living (e.g., climbing and walking down steps, climbing and walking down stairs, jumping up, jumping down, playing) (Marcellin-Little *et al.*, 2015). Land-based therapeutic exercise is essential. Balance, proprioception, muscle timing (neuromuscular retraining), and coordination lay the foundation for proper device use (Mich, 2014). These must be mastered on land so that the patient can learn response to normal ground reaction forces and shifts in their total body force vectors (Mich, 2014).

Veterinary orthoses and prostheses are considered durable medical devices. As such, they should never be prescribed or dispensed without client training and a comprehensive follow-up plan. Veterinary orthotic/prosthetic patients should be assessed at least annually (Figures 10.11–10.13). Device adjustment and refurbishment are expected in order to continue meeting therapeutic goals (Borghese *et al.*, 2013).

It is beyond the scope of this chapter to discuss the complete process of the veterinary evaluation, defining therapeutic goals, measuring for the mold cast to be sent to the prosthetic fabricator, communication with the fabricator, delivery of the device, and ensuring proper fit. Manufacturing requires skilled modification of the model by hand or using computer-assisted design to build reliefs, which accommodate limb topography and create appropriate corrective forces when the completed device is applied to the limb. The modified model is the structure on which a thermoplastic shell is vacuum formed. The shell is then hand cut, trimmed, and ground to the final shape. Materials used to pad and line the shell vary. Hinges, straps, pads, and motion-limiting components complete

Figure 10.11 Double limb prosthetics for hindlimbs, lateral view. *Source:* Courtesy of Dr. Douglas Stramel.

Figure 10.12 Double limb prosthetics for hindlimbs, rear view. *Source:* Courtesy of Dr. Douglas Stramel.

Figure 10.13 Double rear limb prosthetics during exercise. *Source:* Courtesy of Dr. Douglas Stramel.

fabrication. The typical custom veterinary orthotic/prosthetic device cost varies with components and materials, but averages US$600–$US1000. This does not include the necessary appointments to ensure proper fit and function along with client education (Mich, 2014).

Where Do I Go?

Professional companies that fabricate these devices are listed at www.animaloandp.com/facilities.asp. Companies that are highly recommended include:

- *OrthoPets*™ (www.orthopets.com/)
- *Animal Ortho Care, LLC* (www.animalorthocare.com)
- *Advanced Care Veterinary Services* (www.stoppetpain.com)
- *Dogs in Motion Canine Rehabilitation; OrthoPets Australia* (www.dogsinmotion.com.au)
- *Equisport Medicine; OrthoPets Washington* (www.equisportmedicine.com)
- *K-9 Orthotics & Prosthetics* (www.k-9orthotics.com)
- *A Loyal Companion; OrthoPets Arizona* (www.aloyalcompanion.com)
- *OrthoPets Europe; Elmtree House* (www.orthopets.co.uk)
- *Pawsitive Steps Rehabilitation Clinic; OrthoPets Michigan* (www.pawsitivestepsrehab.com)
- *Paws on the Go; OrthoPets Southern California* (www.pawsonthego.net)
- *Twin Cities Animal Rehabilitation Clinic; OrthoPets Twin Cities Minnesota* (www.tcrehab.com)
- *Veterinary Orthopedic and Sports Medicine Group (VOSM)* (www.vetsportsmedicine.com)
- *A Well Adjusted Pet; OrthoPets San Francisco* (www.awelladjustedpet.com)
- *Wheat Ridge Veterinary Specialists* (www.wheatridgeanimal.com)

Summary

The use of assistive devices, orthotics, and prosthetics has enabled many animals to continue to enjoy a high quality of life. Patients that might otherwise be at risk for euthanasia can return to an active lifestyle, reducing the risk of obesity and its associated comorbidities. Secondary or compensatory pain can be minimized by correcting or improving gait mechanics and re-establishing quadruped locomotion.

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11

The Disabled Patient Part 2: The Neurological Patient

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CHAPTER MENU

Introduction

A brief review of neurological anatomy is in order. There are three main components to the nervous system: the central nervous system (CNS), the peripheral nervous system (PNS), and the autonomic nervous system (ANS). The PNS consists of the nerves and ganglia located outside the brain and spinal cord. The myelin sheath surrounding the peripheral axons is formed by Schwann cells, whereas CNS axons are myelinated by oligodendrocytes (Thomson and Hahn, 2012). Dorsal and ventral nerve roots attach on each side of the spinal cord and carry sensory and motor axons. Lateral to the spinal cord, the dorsal and ventral roots fuse to form mixed, spinal nerves. Adjacent spinal nerves may fuse, in a plexus, to form named nerves in the periphery. There are 12 pairs of cranial nerves that innervate the head and extend into the body. Areas of sensory innervation of the skin are categorized as dermatomes, cutaneous zones, and autonomous zones.

Physical Rehabilitation for Veterinary Technicians and Nurses, First Edition.
Edited by Mary Ellen Goldberg and Julia E. Tomlinson.

Somatic lower motor neurons innervating striated muscle of the body have their cell bodies sited in the CNS. Their axons travel in the PNS to connect to the muscle at the neuromuscular junction. A motor unit comprises a single lower motor neuron (LMN) and the group of muscle fibers it innervates.

Healing of Nerves

- Nerves are sensitive to oxygen and the glucose level of tissues.
- If conditions are optimal then nerves will regenerate axons. We aim to make conditions optimal with rehabilitation therapy.
- More severe injuries first undergo Wallerian degeneration. This is a degenerative process that occurs when a nerve fiber is cut or crushed. Part of the axon is separated from the nerve cell body and degenerates distal to the injury (Coleman and Freeman, 2010).
- Wallerian degeneration starts 24–36 hours after injury (a patient can lose more nerve function after the initial injury as the axons degenerate).
- Regeneration is slower in the CNS than the PNS. The myelin sheath in the PNS guides axon regeneration.
- In more severe nerve injuries where endoneurial tubes are disrupted, regenerating axons are no longer confined to their original myelin sheaths. They can meander into surrounding tissue, thus failing to reinnervate their proper end organs.
- Aging has been shown to retard the rate of axonal regrowth.

The Neurological Examination

The objectives in the management of an animal with a problem that may be related to the nervous system are to (Lorenz *et al.*, 2011a):

1) confirm that the problem is caused by a lesion in the nervous system;
2) localize the lesion in the nervous system;
3) estimate the severity and extent of the lesion in the nervous system;
4) determine the cause or the pathologic process or both;
5) estimate the prognosis with no treatment or with various alternative methods of treatment.

Taking a History

First steps in diagnosis of the neurological problem is taking a history. History can be taken by questionnaire, but a verbal history should be added. History should include length of the disease process/problem, current medications, prior and current treatments/therapies, and goals. All questions should be framed so that the answer "I don't know" is an acceptable alternative; otherwise the client may hypothesize rather than relate facts (Lorenz *et al.*, 2011a). The technician/nurse will assist the veterinarian in history taking. Most likely, the neurological patient that presents for physical rehabilitation will have been previously diagnosed at their primary care veterinary hospital or specialist.

The client should be asked for an accurate list of current medications or supplements, chronic or recurrent illnesses, and, most important, the level of performance to which the animal is expected or needed to return (Millis and Mankin, 2014). A detailed description of the housing arrangement, including any unique features of the environment and information about the pet's daily routine, is helpful in determining the necessary skill set for a patient. This description should include types of flooring, presence of obstacles such as stairs or pet doors, feeding and exercise schedules, and any other relevant details (Sims *et al.*, 2015). The patient's current ability to function in the home should be determined with thorough questioning (e.g., Can they stand to eat? Is the food bowl raised? Does the surface they stand on to eat have adequate traction?).

Basic Neurological Exam

The physical rehabilitation veterinarian along with their rehabilitation technician/nurse will conduct a thorough neurological examination. The neurologic examination should always be performed in a calm, quiet place with minimal distractions. The aim of the neurologic rehabilitation examination is to assess function (and how that will affect home activities), define current limitations, assess pain, and define goals for treatment. Surfaces of different traction and small obstacles (cavalettis, low step, etc.) should be available to test stability and function. The rehabilitation veterinarian performs a neurological examination to document the current neurological status and become familiar with the patient's responses to measure progress throughout therapy. Sensation, motor function (including ability to stand and support weight and transition between postures), and bowel/bladder function are noted. The technician/nurse will document all findings in the medical record.

The general appearance, behavior, posture, and voluntary movements should be documented while the animal can freely move around the examination room. Interaction with the client, behavior that is normal, aggressive, excited, or apathetic, and a change in mentation should be documented because this may indicate cerebral/thalamic localization. Abnormal postures such as head tilts, head turns, kyphosis, or scoliosis are noted. Assessing posture includes transitions.

When evaluating the gait, we first determine is it normal or abnormal. If it is abnormal, then we describe the patient as ambulatory versus non-ambulatory. From this point, further descriptive terminology will let us know the degree of abnormality. Paretic animals have decreased voluntary movement. The animals can be described as ambulatory, para/tetraparetic or non-ambulatory, para/tetraparetic. Tetraparesis is paresis in all four limbs. Hemiparesis is on one side or the body and paraparesis is of the pelvic limbs. If there is no voluntary movement, the patient is described as plegic.

Baseline objective data such as thigh girth, goniometry, body weight, body condition scoring, stance analysis, force plate, and kinematic analysis (when available) may also be collected and recorded in the patient history during this initial assessment (Sims *et al.*, 2015).

Neurological Examination Overview

The factors that should be assessed in a neurological examination are as follows (Rylander, 2013):

1) Mentation
2) Posture and gait
3) Cranial nerves
4) Postural reactions
5) Spinal reflexes
6) Pain on spinal palpation
7) Pain perception.

An assessment of the patient's *mentation* should be made and recorded. This includes their mental attitude and response to the immediate environment. The client is the best judge of subtle changes in the patient's behavior in the home normal environment. Be sure to explore this issue when you obtain the history (de Lahunta and Glass, 2009) (Box 11.1).

Gait is evaluated if the animal can walk. A video of the patient performing a standard set of tasks (walking over ground, on a treadmill or underwater treadmill, trotting, circling, weaving, and stepping over obstacles) is often the most useful and accurate method for recording gait abnormalities and comparing over time (Olby *et al.*, 2014; Sims *et al.*, 2015). The grade of ataxia (1–4), limb ground clearance, circumduction, dorsigrade placement of the foot (knuckling), ability of an individual limb to support weight in stance phase, or any other abnormal limb motion is noted. Remember to assess the gait using support as necessary to prevent falls. These examinations are performed by the rehabilitation

Box 11.1 Neurological Examination Form

Created by Julia E. Tomlinson BVSc MS PhD DACVS CCRP CVSMT Diplomate, American College of Veterinary Sports Medicine and Rehabilitation and Mary Ellen Goldberg BS, LVT, CVT, SRA CCRA, CVPP, VTA-lab animal and physical rehabilitation

Posture, transitions, strength tests

Basic posture, ability to hold posture, control of postural transitions. Include degree of assistance needed to complete any transition

a) Standing (e.g., kyphosis, lordosis, scoliosis, abduction of rear limbs). Rear sink into flexion in 10 seconds. Head tilt or turn.
b) Sitting posture: ability to hold sit, rear limb position (e.g., extended or abducted), position of spine (e.g., back arched).
c) Stand–sit–stand (e.g., descends controlled for 50% then falls into sit. When standing, pulls with front limbs, head down, needs 3–4 steps forward to gain full rear limb extension).
d) Side laying–sternal: Left and right. Include any limitations in flexibility.
e) Response to perturbations. For example:
   i) Head motion while standing
   ii) Leg lifts
   iii) Side challenge/sway test
   iv) Hop test.
f) Range of motion of spine and limbs, goniometry of limb joints.
g) Voluntary motions.
   i) Cervical – extension, lateral flexion, ventroflexion, rotation
   ii) Thoracolumbar – lateral flexion, extension, ventroflexion
   iii) Squat/sit with full flexion of lower lumbar spine/sacrum.
h) Gait
   i) Grade of ataxia
   ii) Ground clearance of limbs – flat surface, small step or obstacle
   iii) Number of steps before falling (if applicable)
   iv) Knuckling (e.g., intermittent or constant).
i) Cranial nerve assessment – I–XII.
j) Eye position, motion, tracking, menace, palpebral, pupillary light reflex direct and consensual, swallowing, cough reflex to tracheal pinch, cervical muscle tone.
k) Myotactic reflexes – patella, sciatic, tibial, fibular (peroneal), biceps, triceps, extensor carpi radialis, etc. reduced, normal, increased, clonus.
l) Note tremors, resting or when increase weight bearing load (e.g., front leg lifted, rear legs tremor)

Neurological examination form from the American Veterinary Medical Association website

Observation

Mental	Alert	Depressed	Disoriented	Stupor	Coma
Posture Gait Paresis Other	Normal Normal Pelvic Limbs	Head tilt Ataxia Tetra	Tremor Pelvic Limbs Hemi	Falling All 4 Mono	 Circling

Postural reactions

Key: 4=exaggerated, clonus; 3=exaggerated; 2=normal; 1=diminished; 0=none; NE=not evaluated.

	LF	RF	LR	RR
Wheelbarrow Hopping EXT postural thrust Proprioceptive pos Hemistand/walk Placing – tactile Placing – visual				

Spinal reflexes

	LF	RF	LR	RR
Quadriceps Extensor carpi Flexion Crossed extensor Perineal				

Cranial Nerves

	L	R		L	R	Comments
II, VII – Vision menace II, III – Pupils resting Stim L Stim R II – Fundus III, IV, VI – Strabismus, resting III, IV, VI, VIII – Strabismus, position			VIII – Nystagmus, resting VIII – Nystagmus, change V – Sensation VII – Facial mm V, VII – Palpebral flex IX, X – Gag XII – Tongue			

Sensation (Locate and describe abnormal)

Hyperesthesia Superficial pain Cutaneous reflex Deep pain		

What is the problem? Where is the lesion? What are the most probable causes of this problem? What is your plan to establish a diagnosis?

Assessment

Anatomic diagnosis

Problem	Rule out location

Likely location of one lesion

Source: Adapted from the standard neurological evaluation format used by the *Journal of the American Veterinary Medical Association* in the featured title: "What is your Neurological Diagnosis?"

veterinarian while the veterinary technician/nurse is recording or documenting the exam.

A *cranial nerve* examination should be done, evaluating cranial nerves 1–12 systematically.

Postural reactions are tested. These include (Lorenz *et al*., 2011a):

- proprioceptive positioning,
- wheelbarrowing,
- hopping,
- extensor postural thrust,
- hemistanding and hemiwalking (Figure 11.1),
- placing (tactile),
- placing (visual),
- sway test, and
- tonic neck (the tonic neck reaction involves extension of the head and neck so that the nose is directed dorsally).

Spinal reflexes, including myotatic reflexes and flexor reflexes, should be evaluated.

The neurologic examination also includes *palpation for sensation* and particularly for areas that are painful. This is not limited to the muscles and joints of the spine but includes the whole body. The skin dermatomes are tested where applicable using a fabric pinwheel or the end of a hemostat (charts can be found in veterinary neurology texts).

In general, the ability to perceive *pain* is only assessed in patients with loss of motor function; however, young patients presenting with signs of a sensory neuropathy are an exception (Rylander, 2013). Muscles are palpated for tone both resting and in supporting weight where applicable. Muscle atrophy is noted, along with the innervation of that muscle (for example atrophy of sciatic innervated muscles of the left rear is noted).

The temperament of the patient often dictates which treatments and exercises are realistic. If a patient is aggressive or

Figure 11.1 Hemistanding. The therapist uses their legs to support the trunk if needed. Hemiwalking is toward the therapist, support as needed. Level of support is noted.

excessively fearful, it may be difficult for the client or veterinary professional to perform complex exercises (Drum, 2010). Low-stress handling should be used where possible.

Assessment of Transitions

As the patient progresses, the ability to transition, evaluating patient strength and ability to rise independently, should be documented on the form (Figure 11.2). A patient may appear to be incapable of getting up from a down position but with only light support may be able to make the transition, or a patient may need almost full body support to complete the task (Panko, 2014). These details should be noted on the examination form (Figures 11.3, 11.4, and 11.5).

Figure 11.2 Cookie stretch to aid transition. Voluntary movement for a treat is encouraged. Assistance is given as needed and level of assistance noted.

Figure 11.3 Lateral to sternal transition as demonstrated by Jenn Panko. *Source:* Courtesy of *NAVTA Journal*.

Figure 11.4 Sternal to sit transition as demonstrated by Jenn Panko. *Source:* Courtesy of *NAVTA Journal*.

Figure 11.5 Sit-to-stand transition as demonstrated by Jenn Panko. *Source:* Courtesy of *NAVTA Journal*.

Examples of transitions are:

- *Lateral to sternal recumbency* – Guiding the patient into a sternal position will enable it to strengthen muscles used for this task.
- *Sternal recumbency to sit* – Assist them with stifle flexion and with limb positioning and correct foot placement as required.
- *Sit to stand* – From a sit with stifles in flexion and appropriate support, assist patient to stand and back down into a sit; guide only as needed.
- *Stand to assisted walking* – Assisted sling walking is a great way to provide patients with safe ambulation and weight bearing.

Evidence-Based Information About Neurologic Rehabilitation

Looking at the human literature, conditions that require neurological physical rehabilitation include stroke, traumatic brain injury (TBI), spinal cord injury, and Guillain–Barré syndrome (Jorge *et al.*, 2014). Therapy has been proven beneficial and effective for some of these patients (Brody, 1999).

Neurological diseases present unique circumstances in which veterinary rehabilitation therapy has a critical role in maintenance and recovery of function. Dysfunction of the nervous system can cause loss of motor and autonomic function and a range of sensory abnormalities, including loss of sensation (analgesia), abnormal sensations (paresthesia), and heightened sensitivity to stimuli (hyperesthesia) (Olby *et al.*, 2005). Papers published in the veterinary literature support the usefulness of rehabilitation in recovery from neurological injury and non-surgical management of neurological conditions (Drum, 2010). Reports of case management with rehabilitation in the veterinary literature include prolonging survival time for dogs with degenerative myelopathy (Kathmann *et al.*, 2006), having a positive influence on outcomes of dogs with fibrocartilaginous embolism (Gandini *et al.*, 2003), and improving time to return to function in patients with intervertebral disc disease using laser therapy after decompressive surgery (Draper *et al.*, 2012). In addition, electroacupuncture was shown to be more successful than decompressive surgery in a small study of dogs with longstanding severe neurologic deficits from intervertebral disc disease (Joaquim *et al.*, 2010).

As part of the veterinary rehabilitation team, the credentialed veterinary technician under the supervision and direction of a licensed credentialed rehabilitation veterinarian is an integral part of caring for hospitalized recumbent and/or neurological patients. Physical rehabilitation during recovery from neurological disorders is important not only for strengthening, gait retraining, and increasing flexibility, but also for pain reduction and improvement in quality of life (Lorenz *et al.*, 2011b). Understanding the potential complications and risks, and implementing strategies to minimize these, can reduce the duration of hospitalization, improve patient comfort, and promote faster return to function.

Nursing Care of Neurological Patients in Clinic

Neurological patients often present as recumbent. This is usually patients with severe spinal or generalized LMN disorders (Olby, 2010). Recumbency can cause secondary problems associated with the respiratory system, bladder and bowel function, skin and musculoskeletal system, and can affect the patient's ability to eat and drink and its attitude. The principles of managing such patients include (Olby, 2010):

- awareness of potential complications associated with recumbency;
- regular careful assessment of the patient;
- taking appropriate preventative steps; and
- early and aggressive treatment of developing complications.

Bedding for the recumbent patient should be soft to avoid decubital ulcers. Turning frequently lowers the risk of ulcers and decreases the likelihood of complications such as hypostatic pneumonia or atelectasis (Calvo, 2012).

Ambulatory patients presenting with neurological signs characterized by incoordination (ataxia) or weakness (paresis) have the potential to progress to recumbency. As these patients are not steady on their feet, providing high traction surfaces for them to move around on is essential. The top five care tips for recumbent dogs are listed in Box 11.2.

Box 11.2 Top five care tips for down dogs

1) Provide proper bedding
2) Teach bladder management to the client
3) Rotate, massage and provide basic therapies
4) Know nutritional needs
5) Monitor for pain and neurologic changes

Source: Adapted from Weber (2016).

Respiratory System

Recumbency on its own can lead to secondary complications, including atelectasis and aspiration pneumonia, which are independent from the disease process causing recumbency. Hypoventilation can occur when a neurological disease process is severe enough to cause recumbency in all four limbs (e.g., cervical myelopathy or a severe encephalopathy). The respiration centers of the brainstem can be affected. Patients with generalized LMN diseases affecting the laryngeal and pharyngeal muscles and the esophagus (e.g., myasthenia gravis) are particularly predisposed to aspiration pneumonia. Preventative nursing care is crucial to the outcome for these patients (Calvo, 2012).

Assessment of respiration includes the following:

- Regular assessment and recording of the respiratory pattern and rate up to every 4–6 hours in severely affected patients; less often in more stable patients.
- If there is a suspicion of aspiration pneumonia, rectal temperature should be taken at least twice daily to monitor for pyrexia.

Measures to prevent respiratory complications include the following:

- Regular turning of the patient (every 4–6 hours), adopting a sternal position as often as possible using appropriate padding (record each time the position was changed: e.g., from sternal to left lateral to sternal to right lateral to sternal).
- Offer water and food only when the patient is in sternal position. Someone should sit with the patient while eating. It is beneficial for the patient to maintain an upright position for 30 minutes after feeding to decrease the risk of regurgitation and aspiration pneumonia.
- Patients who are at high risk of, or have radiographic confirmation of aspiration or hypostatic pneumonia should undergo coupage each time the patient is turned if aspiration or hypostatic pneumonia is suspected; however, this is not always well tolerated.

Figure 11.6 Coupage is gentle percussion over the thoracic following the lung field using a cupped hand.

Figure 11.7 Coupage on both sides of chest.

Figure 11.8 Manual expression of the bladder is a learned skill that the rehabilitation veterinary technician should know and can teach.

Coupage is gentle percussion over the thoracic cage using a cupped hand (Figures 11.6 and 11.7). It is contraindicated in thoracic trauma patients. Thoracic auscultation should be performed at least once daily to identify abnormalities; these should be reported to the veterinarian immediately. Postural therapy with the patient supported in various positions (e.g., sitting, over a therapy ball rolled between head down–rear elevated and head up–rear down) can also be implemented to aid removal of excess secretions in combination with nebulization and coupage.

Urination

As a rule, recumbent patients should have general bladder care. If they are paretic, they should not have difficulty urinating, but sometimes cannot move away from the urine adequately. If they are plegic, they are likely unable to urinate voluntarily and require bladder assessment or management in the form of catheterization or manual expression (Figure 11.8). In neurological patients, urinary function often returns as soon the patient has voluntary motor function, but this is not a predictable pattern (Olby *et al.*, 2003). This primarily applies to patients with thoracolumbar disease (only pelvic limbs affected). Patients with cervical disease (all four limbs affected) may be reluctant to urinate as they are unable to adopt a posture for urination. Diseases of the lumbosacral spinal cord are a slight exception as these patients

Box 11.3 Bladder palpation and expression

If the patient is recumbent, then the owner must be taught how to palpate the bladder, as well as how and when to express it.

1) Using one or both hands, depending on the patient's size, place fingers on both sides of the abdomen
2) Start just below the ribs and squeeze gently inward
3) Slide fingers caudal until the bladder is located; palpate for size and tone (the bladder has been described as a water balloon in the abdomen).
4) Apply gentle pressure to express the urine

Avoid expression of the bladder if:

- the bladder is small (this will allow it to fill and the patient is more likely to feel the need to urinate); or
- the bladder has a strong tone (it may have lost its elasticity from being overdistended for too long or may be an upper motor neuron bladder that requires medication to relax the detrusor and urethral sphincter muscles).

Note: If the bladder must be expressed frequently then this could be painful.

Adapted from Weber (2016).

have urinary difficulties despite retaining voluntary motor function.

An understanding of the urinary function is critical to judge whether urination is voluntary or not. Each time the pressure in the bladder exceeds that of the urethral sphincter, urine will leak out and this may be misinterpreted as voluntary urination (Box 11.3). Thus, other measures need to be taken to assess the presence of voluntary urination. It is important to teach those caring for the patient how to palpate the bladder and monitor for appropriate urination.

Assessment of the bladder includes the following:

- Palpation to assess bladder size before and after urination (training in palpation of bladders is important).
- Recording of all urination in the medical record noting whether voluntary, expressed manually or via a catheter.
- Preferably urinalysis on admission and testing urine with a dipstick every 2–4 days for the presence of white blood cells and protein.

Appropriate bladder management in recumbent patients includes the following (Box 11.4):

- Regular visits outside to encourage the patient to urinate, at least 3 times daily. A Help 'em Up Harness™ or similar device can be very helpful for maneuvering the recumbent patient if they are medium to large size.
- If unable to urinate, three bladder management options are available: manual expression every-6–8 hours (depending on bladder size), intermittent catheterization every 6–8 hours (depending on bladder size), or placement of indwelling catheter (urine bag to be checked every 4–6 hours and output recorded).

Box 11.4 Monitoring urine stream and quantity

Owners should be asked to monitor their patient's urination by answering a few basic questions:

- Can the pet posture to urinate?
- Does the stream come out normally (forceful) or does it come out in dribbles or sporadic?
- Is this a normal amount of urine or is it decreased?
- Does the urine have an odor?
- Is the urine a normal color?

Note: Any patient that cannot urinate should be reported to the rehabilitation veterinarian immediately.

Adapted from Weber (2016).

- Medications to improve bladder function will be prescribed by the veterinarian if appropriate.
- Bedding must allow liquid to be absorbed and pass through away from the patient's skin (e.g., acrylic bedding). If incontinence sheets are used directly under the patient's skin, they must fulfill this criterion too.
- Keep the patient clean and dry always, clip long hair if required to enable hygiene management and to allow accurate assessment of urine scalding developing/progressing.

Defecation

Fecal incontinence can occur because the external anal sphincter has been anatomically disrupted, or the nerves damaged or destroyed. Nerve damage, spinal cord disease, or a degenerative disorder may reduce or stop sphincter function. Fecal incontinence affects dogs with severe lumbosacral disease, leading to a lack of voluntary control over defecation and severe soiling. Cats with neurological problems have a tendency toward constipation. It is important to keep the patient clean and dry always. Lactulose may be used (especially in cats) to aid defecation if constipation is suspected, as manual evacuation is difficult in cats. Patients receiving opioid analgesia should be monitored closely for constipation due to reduced intestinal motility, and pelvic trauma patients should be monitored for tenesmus. In both cases treatment by the rehabilitation veterinarian to aid in defecation may be needed.

Skin Care

Recumbent patients are at risk of development of dermatitis secondary to urine scald and fecal soiling and the development of decubital ulcers over pressure points. In addition, skin lesions can develop if the patient is dragging themselves or a limb over rough ground.

Complications can be prevented by use of appropriate soft bedding that absorbs the liquid. This includes using incontinence pads; however, care must be taken to avoid placing the pad directly beneath the patient's skin as the urine will only disperse across the pad, resulting in increased contact time and leading to urine scalds. Acrylic absorbent bedding should be placed directly beneath the patient, followed by the incontinence pad. This prevents multiple layers of bedding becoming soiled and avoids the recumbent patient lying in their own urine. Ensure appropriate padding is used around pressure points and perform systematic bony point checks twice daily to monitor for skin redness or early development of decubital ulcers. The patient must be turned regularly (every 4–6 hours) and pressure points massaged to increase local blood flow. If necessary, clip the hair in the perineal region. There should be prompt removal of soiled bedding. See earlier section about appropriate bladder management. The patient must always be kept dry and clean.

Treatment of skin complications includes the following:

- Cleaning of dermatitis with a dilute chlorhexidine solution followed by thorough drying and application of a barrier cream.
- Avoiding excessive moisture around affected areas and the application of thick layers of barrier cream, which will only harbor and insulate bacteria. A thin layer of barrier cream that can be easily wiped off is more suitable.
- Applying a dilute solution of bicarbonate of soda and cooled boiled water. This is very effective as it neutralizes the acidity of urine on the skin so reducing scalds or skin irritation. Carefully make sure it is applied into skin folds (for example those of the testes). The area should be doused and left to dry at room temperature. This can be repeated 3–4 times daily.
- Ensuring that, if decubital ulcers develop, pressure is no longer placed over that region. This can be done by a using a doughnut-shaped cushion (in some cases suturing to surrounding skin).

- Debridement of necrotic tissue.
- Elizabethan collars to prevent the patient licking or chewing the region.

Care of Toenails

Toenails should be checked and trimmed regularly for the comfort of the patient. Excessively long toenails can hinder the patient from standing/walking when and if they can accomplish this task.

Muscle and Joint Problems

Neurological problems with paralysis can cause muscle atrophy and contracture, and deterioration of joints and their associated soft tissues. Muscle and joint pain can occur secondary to these changes.

Management of these problems includes:

- Treatment of pain.
- An individualized rehabilitation plan that should be started as soon as possible. Exercises for the client at home can be developed.
- Passive range of motion (PROM) and massage to help maintain joint mobility.
- A nutritional plan.

Attitude or Demeanor

Recumbency can contribute to frustration and anxiousness, which can be heightened by pain (Lorenz *et al.*, 2011b). Demeanor may be improved by the following:

- Ensuring the animal's comfort through pain management and appropriate bedding. This includes the amount of contact with humans because some patients prefer to be quiet while others prefer to see and have regular interactions with humans.
- Arranging regular contact with the client.
- Taking the canine patient outside regularly. This is not appropriate for cats unless they are used to harness/leash walking. A cat can have a period of free exploration in a secure cat ward under supervision.
- Placing the patient in a standing position, using support as necessary. Additionally, this helps with pulmonary, musculoskeletal systems, and skin.
- Regular manual therapies (PROM, massage, etc.).

Positioning

The rehabilitation team must be cognizant of the risks facing the recumbent patient. Skin and pulmonary integrity can be compromised if the patient is not on a proper turning schedule. Positioning is important and should be noted on patient charts (Francis, 2007). The patient should be on either side in lateral recumbency, sternal recumbency, sitting and standing, if possible.

Pain

Neurological patients experience pain. Many patients are in pain caused by their primary disease, surgical intervention, or secondary effects of recumbency and spasticity (Lorenz *et al.*, 2011b). The level of pain should be assessed 2–4 times daily depending on the patient. A pain scoring system is most useful for consistency (see Chapter 3).

Manual therapy, ice, heat, electrical stimulation, and therapeutic ultrasound may be used depending on the severity and phase of recovery (acute versus subacute) (Francis, 2007). Because pain-free animals are relaxed and cooperative, recover faster and more completely, and clients are much happier and more compliant with recommendations when their pet is comfortable (Thomas *et al.*, 2014), pain medications should be used to allow for patient comfort.

Nutrition

A recumbent patient's metabolic needs differ from those of a healthy patient (Weber, 2016). The following formula is used to calculate daily needs:

$$\text{Resting energy requirements (RER) (kcal/day)} = 70 \times \text{body weight (kg)}^{0.75}$$

Recumbent patients may have reduced appetite or even be anorexic because of pain or depression. The patient needs to be encouraged to eat, although overfeeding of the obese patient needs to be avoided. Extra weight impacts joints and spine when recumbent and can delay return to ambulation because more strength is needed to move a body of higher mass. Do not forget patients' daily water requirements; water intake is important to reduce the risk for cystitis and urinary tract infections in down dogs with bladder impairment. Daily water intake should be 50 mg/kg body weight. Encourage patients to drink by adding small amounts of low-sodium chicken or beef broth to their water. Syringing water or administering subcutaneous fluids may also be recommended in some situations (Weber, 2016).

Risks Affecting Hospitalized Recumbent or Neurological Patients

The recumbent or neurological patient in hospital is at risk of a range of conditions that the veterinary technician/nurse should be alert to (Abramson, 2009):

- Prolonged or permanent loss of mobility and independence secondary to disuse atrophy
- Chronic pain
- Decubital ulcers
- Urine scald
- Depression
- Self-inflicted trauma
- Reduced lung capacity and compliance
- Obesity.

Key Therapeutic Points

In addition, the following key therapeutic points should be noted (Davidson, 2009):

- Bladder care must be initiated for incontinent animals to prevent atony and treat infections.
- Attention to bedding and hygiene helps prevent decubital ulcers.
- Neuromuscular electrical stimulation may be used to strengthen muscle.
- Massage can reduce muscle spasms and pain.
- PROM can be used to maintain joint motion and health.
- Assisted standing, balancing, and various types of exercise can be incorporated, depending on the animal's neurologic status.

Types of Neurological Conditions

It is important that the veterinary technician or nurse is familiar with neurological conditions that affect their patients. Being able to discuss the disease with the client, so that the rehabilitation veterinarian's protocols may be carried out, is imperative. Neurological conditions can affect the animal's mobility, balance, strength, and coordination as well as contributing to pain or discomfort (Price, 2014a).

Canine Conditions

Intervertebral Disc Disease

Intervertebral disc disease is a syndrome of pain and/or neurological deficits, resulting from herniation or protrusion of the disc. Although a normal disc can herniate because of major trauma, typically herniation is secondary to preexisting degeneration of the disc (Jeffery *et al.*, 2016). Disc degeneration is associated with decreased water and proteoglycan concentration (Steinberg and Coates, 2013). This dehydration reduces the ability of the disc to function as a hydraulic cushion and predisposes to displacement of a portion of the disc.

There are two types of disc degeneration: chondroid and fibrous metaplasia. Chondroid metaplasia is most common in chondrodystrophic breeds and causes a progressive transformation of the gelatinous nucleus pulposus to hyaline cartilage. This type of degeneration redisposes to disc extrusion where disc material is displaced beyond the outer edge of the annulus (also called Hansen type I). Fibrous metaplasia is an age-related degenerative process that occurs in any breed but is more common in non-chondrodystrophic dogs 7 years of age and older. It is characterized by a fibrous collagenization of the nucleus pulposus and degeneration of the annulus fibrosus. Fibrous metaplasia predisposes to disc protrusion, in which disc material is displaced from the disc space but is contained within an intact annulus (also called Hansen type II). Non-chondrodystrophic breed dogs can also suffer extrusions and less commonly chondrodystrophic breeds suffer protrusions (Thomas *et al.*, 2014).

Trauma

Automobile accidents, gunshot wounds, falls, and dog fight injuries are common causes of traumatic spinal cord injuries. Spinal injuries may consist of vertebral luxation, vertebral fracture, vertebral fracture/luxation, contusions, concussions, and hemorrhage, as well as traumatic disc herniation.

Peripheral Nerve Injury

Common causes of peripheral nerve injury include fractures (e.g., femoral fracture that damages the sciatic nerve), intramuscular injection (usually affecting the sciatic nerve), traumatic brachial plexus nerve root avulsion, and iatrogenic causes including swelling, trauma to nerve, and hemorrhage that may sometimes occur in surgery.

Neoplastic Disease

Spinal tumors are classified by their location as extradural, subarachnoid (intradural–extramedullary), and intramedullary. Extradural neoplasia is most common and includes osteosarcoma, multiple myeloma, fibrosarcoma, chondrosarcoma, hemangiosarcoma, and lymphosarcoma. Extradural lymphosarcoma is the most common spinal tumor in cats and may be secondary to infection with the feline leukemia virus (Thomas *et al.*, 2014). Subarachnoid tumors include nerve sheath tumors, meningioma, lymphosarcoma, and neuroepithelioma. Intramedullary tumors include glioma, lymphosarcoma, and hemangiosarcoma. Metastatic tumors, including metastatic carcinomas and sarcomas, may occur in any location. Spinal neoplasia is more common in middle-aged or older animals (Thomas *et al.*, 2014).

Degenerative Myelopathy

This is a slowly progressive degenerative disease of the CNS that most severely affects the thoracic spinal cord segments. It is inherited as an autosomal recessive trait and is associated with a mutation in the superoxide dismutase 1 (*SOD1*) gene, like the familial form of amyotrophic lateral sclerosis in human patients (Lou Gehrig's disease) (Awano *et al.*, 2009). Degenerative myelopathy affects older dogs, usually more than 8 years of age. German Shepherds, Rhodesian Ridgebacks, Pembroke and Cardigan Welsh Corgis, Boxers, and Chesapeake Bay Retrievers are most commonly affected, although cases have been documented in several other large-breed dogs and cross breeds (Coates and Wininger, 2010).

Myasthenia Gravis

Myasthenia gravis is a neuromuscular disorder (Khorzad *et al.*, 2011) caused by a reduction in the number of functional nicotinic acetylcholine receptors (AChR) on the postsynaptic membrane of the neuromuscular junction. Myasthenia gravis exists either as a rare congenital disease or more commonly as an acquired autoimmune disease, resulting in a deficiency of nicotinic AChR. Acetylcholine is essential for muscle contraction at the neuromuscular junction. The defect in transmission resulting from AChR loss leads to focal or generalized muscle weakness and exhaustion.

Cervical Spondylomyelopathy

Caudal cervical spondylomyelopathy, or wobbler's syndrome, is a disorder caused by abnormal development of the cervical vertebrae resulting in compression of the spinal cord. Middle-aged (7–9 years) Doberman Pinschers and young (1–4 years) giant-breed dogs (Great Danes, Mastiffs, Rottweilers, Bernese and Swiss Mountain dogs) are most commonly affected (da Costa, 2010).

Fibrocartilaginous Embolic Myelopathy

Fibrocartilaginous embolic myelopathy (FCEM) is an acute infarction of the spinal cord caused by a vascular embolus of fibrocartilage, probably originating from the intervertebral disc. Adult large- or giant-breed dogs and miniature Schnauzers are most commonly affected. This disease is less common in small dogs, chondrodystrophic dogs, and cats. The onset is sudden and often associated with activity such as running or playing. Any region of the spinal cord may be affected, and the spinal cord segments involved dictate the specific neurological deficits. In severe cases, there is loss of deep pain perception caudal to the lesion (Thomas *et al.*, 2014).

Discospondylitis

Discospondylitis is an infection of the intervertebral disc and adjacent vertebral bodies. It is usually caused by hematogenous spread of organisms from sites elsewhere in the body, such as the urinary tract, skin, or mouth. Penetrating wounds, surgery, or plant material migration can cause direct infection of the disc space or vertebra. In certain geographic regions migrating plant material such as grass awns is a relatively common cause of vertebral osteomyelitis and discospondylitis of the L2–L4 vertebrae (Thomas *et al.*, 2014).

Polyneuropathies

Breed-associated polyneuropathies, such as polyneuropathy of hypothyroidism and laryngeal-paralysis associated polyneuropathy are sometimes seen.

Feline Conditions

Intervertebral Disc Disease

Intervertebral disc disease is encountered much more rarely in cats compared with dogs, although both Hansen type I (disc extrusion) and type II (disc protrusion) herniations have been observed (Sharp, 2012b). Type II cases are the more common in cats, though still rarely found clinically, probably due to the slowly progressive nature of the condition and the lack of obvious clinical signs in this species.

Fibrocartilaginous Embolism

This is rare in cats and, as in dogs, is associated with variable clinical signs and prognosis. A full physiotherapy assessment is essential to identify the specific functional problems of the individual animal and allow the selection of appropriate physiotherapy interventions to treat those problems.

Brachial Plexus Avulsion

This type of traumatic neuropathy is common in cats, with clinical signs including muscle weakness (commonly called “dropped elbow”), proprioceptive deficits (dragging of the foot), and absence of spinal reflexes and deep pain perception. The prognosis is often poor for these animals, but the provision of physiotherapy can help to reduce edema, maintain circulation to the affected area, prevent contractures, and maintain activity in muscles (Bockstahler and Levine, 2011).

Trauma

Automobile accidents, falls, being kicked or abused or fighting injuries are common (Sharp, 2012b).

Tail Pull Injuries

“Tail pull injury” or sacrococcygeal subluxation is a common neurological condition in cats and can also occur in dogs, albeit rarely (Davies and Walmsley, 2012). It occurs most frequently because of a road traffic accident and results in a varying degree of trauma to the sacral spinal cord segments and cauda equina. The neurological deficits associated with sacrocaudal luxation can include paraparesis, but this is usually transient. The most severe sequelae relate to anal sphincter and bladder dysfunction.

Establishing Goals

Long-term goals define the patient's expected level of performance at the end of the rehabilitation process. Short-term goals are the component skills established at each phase of rehabilitation that will be needed to attain the long-term goals. This plan helps establish the at-home treatment plan that is given to clients (Sturges and Woelz, 2005).

Goals

The goal with neurological patients is to challenge them without causing excess neuromuscular fatigue, pushing them but in a positive way with lots of praise and encouragement. The purpose of the exercises is to stimulate proprioceptive tracts to aid body positional awareness and balance, improve muscular strength, and attempt to pattern a correct gait as nerves recover. Typical objectives in rehabilitating the patient with neurological diseases are to minimize pain, reestablish normal neural pathways, prevent secondary complications, and, if possible, return the animal to independent function. Therapy also aims to counteract the effects of inactivity by improving joint fluid circulation and enhancing circulation to tissues (McCauley and Van Dyke, 2013). It is essential not to worsen neurologic function or pain in patients with spinal instability (Thomas *et al.*, 2014). A program that is painful or stressful for the patient is unlikely to be effective, may cause the patient to become aggressive, and will potentially damage the human–animal bond between client and patient (Sims *et al.*, 2015).

Passive Manual Therapies for Dogs and Cats

Passive exercises should be performed for neurological patients who lack voluntary movement or strength or whose proprioceptive deficits preclude a normal gait (Olby *et al.*, 2005).

Passive Range of Motion

PROM is commonly prescribed for neurologically impaired patients, and is frequently combined with stretching of the periarticular connective tissues and skeletal muscle. The primary benefit of PROM is protection against stiffening or fibrosis of the joint. Other benefits may include prevention of cartilage atrophy, replenishment of the synovial fluid (primary source of nutrients for the cartilage), improved local circulation, and stimulation of sensory and proprioceptive pathways in the synovium and periarticular structures (Sims *et al.*, 2015). Placing each joint through a normal range of motion will help to maintain joint health in patients who have deficits in voluntary movement.

PROM should be performed with the patient lying in lateral recumbency on a well-padded surface. The uppermost limbs should be put through gentle flexion and extension of each joint within the patent's comfort zone. Once each joint has been put through 15–20 cycles, each limb may be put through bicycling movements for another 15–20 repetitions. The patient is then flipped and the exercise repeated on the contralateral limbs. This exercise should be performed 3–4 times per day in a recumbent patient.

Massage

Massage is another passive therapy with multiple benefits. It can help to alleviate pain and stress associated with recent injury or surgery. Massage aims to improve both local and whole-body circulation and lymphatic drainage, allowing for increased tissue oxygenation and more rapid resolution of edema. Sensory stimulation that could encourage nerve firing in the affected tissues is an added benefit. Massage is clearly pleasurable for most rehabilitation patients and beginning a therapy session with a whole-body massage in a calming environment may improve patient compliance, thereby increasing the effectiveness of the therapy program. Massage of a mildly contracted muscle group may also be beneficial in restoring its function and should be performed 2–3 times per day after pre-warming the region (Olby *et al.*, 2005).

Acupuncture

Acupuncture can be considered a passive therapy because it does not require the active involvement of the patient and relies primarily on direct mechanical stimulation to achieve its effects. The scientific literature is mixed regarding the therapeutic benefits of acupuncture overall, but the evidence may be more encouraging when examining the benefits of acupuncture specifically for neurogenic pain and the facilitation of nerve signaling (Sims *et al.*, 2015). Only the veterinarian certified in veterinary acupuncture may perform this therapy.

Therapeutic Exercise for Dogs and Cats

Therapeutic exercise programs focus on proprioception and balance, muscle strengthening, re-education of normal posture, and gait training. Proprioception and balance work is important for the neurologically impaired patient. Weight shift training is used following an injury or postoperatively, initially training the patient to use the affected limb, and later encouraging appropriate weight distribution during activities of daily living. Strengthening can focus on an isolated muscle, limb, or body region (McCauley and Van Dyke, 2013). Posture re-education addresses the static postures (stand, sit down) as well as the transitions between these postures. Gait retraining addresses the patient that does not properly use one or more limbs or that has developed an abnormal gait behavior or pattern.

The rehabilitation veterinarian will be the one that selects which therapeutic exercises will be used for both short- and long-term goals. The rehabilitation veterinary technician or nurse will carry out these exercises with the patient and will be responsible for teaching the exercises to be used by the client at home.

Targeted exercise therapy aids in the management or prevention of many of the consequences of immobility, including atrophy of soft and bony tissues, stiffening, or fibrosis, maintaining proper proteoglycan matrix in the articular cartilage and stimulating the synovium to replenish the joint fluid (McCauley and Van Dyke, 2013). Exercise therapy stimulates transmission of nerve signals, reinforces proprioceptive and motor pathways, and aids in the restoration of muscle memory for standing, walking, and other activities that require minimal or no conscious effort in the healthy patient (Sims *et al.*, 2015). Exercises that aid in development or preservation of the core muscle groups along the spine and abdomen are particularly helpful in improving a patient's ability to handle transitional movements (Sharp, 2008). The client is often helpful in designing exercises that can be used at home with their own equipment or household items (Box 11.5).

The neurologically impaired animal may require a cart or sling during active assisted range of motion and other exercises. A lift can be used in clinic (Figure 11.9). Support should be used if necessary and may be in the form of splints or orthoses (see Chapter 10).

Therapeutic Modalities for Dogs and Cats

Thermotherapy

Thermotherapy is the use of superficial heat or cold as a therapeutic modality for the treatment of disease or trauma. It may be applied using many different methods (Dragone *et al.*, 2014). It is discussed in detail in Chapter 14.

Therapeutic Ultrasound

The application of therapeutic ultrasound to soft tissues may help to alleviate pain while improving tissue blood supply and speeding

Box 11.5 Therapeutic exercises for the neurological patient

- *Neuromuscular facilitation*–Visualize and perform a passive running pattern with the dog's front or hind leg. Be aware of stimuli under the pad of the foot when appropriate in the cycle. This helps to ingrain the pattern of movement and stimulate the neural pathways connected with this. It can be an aid in neural reprogramming and regeneration (Edge-Hughes, 2013).
- *Vibration*–The use of a small electrical vibrator can help to stimulate muscle contractions in neurological cases (Edge-Hughes, 2013).
- *Ice massage*–Water can be frozen in a styrofoam or plastic cup and then applied to the affected area directly. To perform the massage, the therapist exposes a portion of the ice surface, holds the cup, and applies the ice surface directly to the patient's skin. The ice surface is moved in a continuous, circular fashion across the treatment area for 5–10 minutes (Hanks *et al*., 2015).
- *Tapping*–Fast and steady tapping over a muscle belly can lead to muscle contractions as well as stimulus of neural receptors in muscles and tendons.
- *Weight bearing techniques*–These are discussed in Chapter 19.
- *Postural reactions (these are not reflexes) from perturbations*–Hopping, parawalking, wheelbarrowing, directional rolling over an inflatable therapy ball, tilt table.
- *Land treadmill exercise*–Active assisted range of motion is possible with the therapist seated over the treadmill behind the patient.
- *Underwater treadmill or supported swimming*–This is discussed in Chapter 18.
- *Supported standing*–This is discussed in Chapter 10.
- *Rhythmical stabilizations*–With the animal standing squarely, the therapist places gentle pressure over the pelvis or cranial thoracic region and gently "bounces" the animal up and down. The bouncing motion should be relatively rapid, with only enough recovery time to regain the normal standing position. This generates rapid firing of postural muscles in an isometric fashion, which is ideal for weakly ambulatory or significantly ataxic patients (Drum *et al*., 2015).
- *Tensor bandaging*–Wrap an Ace™ bandage loosely around the thoracic and pelvic limbs. This helps to create awareness and connection between the front and hind end.
- *Joint compressions* (veterinarian or physical therapist only)–Place one hand above the joint and the other hand below the joint. Push the two joints together.
- *Tactile sensory stimuli*–Any sensory stimuli you can provide to the superficial skin receptors can be helpful. Examples include brushing, gently pulling hair, or rubbing the hair in the wrong direction, zigzag petting or tapping, pinching, or picking up the skin, thermal stimulus using ice or a hot pack (with care). *Clapping over body*–Use your hand in a cupped position so that you do not slap the patient. *Wringing the limb*–Gently move your hands circumferentially around the limb of the patient as though you were wringing out a wet towel, up and down the limb (Edge-Hughes, 2013). *Acupressure*–This involves application of pressure at acupuncture points. Laser can be used on acupuncture points.

up healing. Ultrasound may be beneficial for epaxial muscles that are experiencing muscle spasms. Its use is contraindicated over an exposed spinal cord, and continuous mode ultrasound is not recommended in postoperative neurosurgical patients (Olby *et al.*, 2005). This technique is discussed in detail in Chapter 17.

Neuromuscular Electrical Stimulation

The application of neuromuscular electrical stimulation (NMES) in patients with acute spinal cord disease may be beneficial to increase tissue perfusion, decrease pain, and delay the onset of disuse muscle atrophy. In patients

Figure 11.9 Working on a patient in a Hoyer lift.

with LMN disease, stimulation of the affected muscle groups will delay the onset and severity of neurogenic muscle atrophy (Olby *et al.*, 2005). The use of electrical stimulation is preferred for muscle groups that are not already experiencing spasms. It is contraindicated over surgical sites following a laminectomy or pediculectomy until adequate healing has taken place. NMES should be applied to the muscle groups of affected limbs once a day for 15 minutes each until the patient is ambulating with mild-to-moderate ataxia. This technique is discussed in detail in Chapter 16.

Laser Therapy

Laser therapy has been increasingly incorporated into rehabilitation programs for a variety of conditions, including skin wounds; muscle, tendon, and ligament injuries; neurologic conditions; arthritis; and pain (Millis and Saunders, 2014). This modality is discussed in detail in Chapter 15.

A Special Word About Cats

One must think like a cat to have success. The treatment room must be calm. A peaceful environment encourages a relaxed mood in preparation for rehabilitation treatment. Rehabilitation programs can benefit from using a cat's love of play and its natural hunting instincts. This may allow a more hands-off approach, which is beneficial for cats that are particularly aggressive or fearful (Sharp, 2012b).

Keep it Short

All rehabilitation sessions should be kept short to maintain interest and prevent boredom (Price, 2014b). Activities should be introduced at a level appropriate to the recovery of the cat, and progressed to accommodate the cat's improvement.

Make it Fun

Devices that demand activity to variously release food (treat balls), encourage the tracking/hunting instinct (toys, motorized units), or that involve reaching observational positions (climbing towers, window sills) can all be beneficial if used appropriately. Placing or hiding food in positions that encourage activity to access it (top of stairs, top of climbing frame, requiring climbing over/under obstacles and/or through tunnels), or simply moving food regularly between rooms can all increase activity levels (Sharp, 2012b). Play combines elements of predatory behavior, including exploration, investigation, stalking, chasing, attacking, pouncing, leaping, swatting, and grasping, and the cat can be provided with a variety of targets (Figure 11.8). Toys that bounce or move in ways that entice the cat to play can be usefully provided, and successful interactive toys might include zigzag balls, mice on elastic string, or fishing rod toys with fur or feathers. Moving spots of light produced by mirrors, laser pointers, or torches might stimulate some cats to chase, although limiting play just to chasing lights can lead to frustration as the chase is never successfully concluded and the cat is never able to catch and "kill" the target.

Create an Enriched Environment

The development of an enriched environment can provide a valuable means of exercising cats in a "hands-off" manner. Creating a small area (or using a small room) filled with obstacles, as well as hidden treats or toys, may encourage an inquisitive cat to explore and find the hidden "gems" (Sharp, 2012a). A variety of obstacles should be included that require the cat to climb over, crawl under, and creep through them to promote joint mobility, balance, and general activity. Scratching posts can encourage joint flexibility and strength (Sharp, 2012b). The inclusion of various surfaces (bean bags, cushions, pillows) can provide sensory input as well as promoting strength and balance as the cat walks over them to explore the area.

Client Education and Support During Home Therapy

The approach is to teach as much as you can to clients so that the treatment of their pet can be carried over into the home. Time is taken to educate clients about their pet's condition and home exercises and instructions are given so they can help their pet recover faster at home. The rehabilitation veterinary technician or nurse plays a key role in teaching the client how to manage the needs of a patient with limited mobility, possibly more so than any other clinician involved in the medical management of patients with neurologic injury or disease (Sims *et al.*, 2015). Clients bear the greatest responsibility for patient care once discharged from the hospital. They should be informed about the patient's nursing care needs and signs of complications that need to be addressed by their primary veterinarian. A thorough description, ideally with visual or written aids, of any home therapies will improve the client's confidence and increase compliance.

The technician should help the therapist evaluate the client's ability to understand and safely perform the recommended treatments. Financial, physical, or scheduling restrictions facing the client or pet in the home environment should be discussed because they impact the type, number, and frequency of any prescribed treatments. In cases where the family schedule or home environment cannot accommodate the needs of the patient in the near term, the therapist may recommend hospitalizing or boarding the patient for inpatient care during the initial phases of the physiotherapy program. The use of readily available or inexpensive materials minimizes the burden on the client to seek out or develop equipment for their pet's therapy.

It is important to include information such as a description or demonstration of the activities to be performed, how frequently the treatments should be performed, signs that indicate a treatment is not well tolerated or ineffective, a basic understanding of relevant anatomy, and an approximate timeline for the anticipated results. The rehabilitation team should be prepared not only to provide guidance on medical and nursing care, but also to address concerns related to patient welfare, related to the emotional, physical, and financial burdens of managing a pet with special needs, and related to quality-of-life and end-of-life decisions.

Many clients are overwhelmed with the degree of their pet's disability and the tremendous impact of their care on the home routine. Often, clients do not reach a full realization of their new responsibilities until several days or weeks after the diagnosis is obtained and the patient is discharged from the hospital. The therapist needs to set realistic expectations for the client pertaining to recovery or the rate of decline expected. Clients will greatly benefit from referral to a rehabilitation team who can help manage the emotional fallout from caring for a paralyzed or debilitated pet (see also Chapter 12).

Conclusions

Neurological rehabilitation can be among the most challenging and rewarding work for the veterinary rehabilitation team. Determining time for recovery is often the most difficult task. It is important to remember that recovery times can be extremely variable, and are intrinsically linked to the neurologic condition, underlying medical conditions, and neurologic status upon presentation for rehabilitation (Drum, 2010). One must consider time available for treatment, both for the veterinary team and the client, as it is often not feasible to perform all exercises and modalities in a single patient. Some exercises may not be applicable or possible for some patients. Each patient requires a rehabilitation protocol that is specifically designed for that patient's neurologic condition, client expectations and level of participation, and expertise of the veterinary team.

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12

The Disabled Patient Part 3: Special Considerations for Geriatrics

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CHAPTER MENU

Introduction

Gerontology is the study of aging. As veterinary patients age, they experience senescence (the condition or process of deterioration with age), characterized by decreased function and degeneration (degradation) of their bodies. These changes cause a slow decline and can lead to functional issues such as reduced fine motor control and weakness. The aging process is not a disease process but a decline in reserves and strength as well as other changes in all body systems which increases the likelihood of a patient developing disease. Medical issues commonly encountered in geriatric patients include obesity, degenerative joint disease, neoplasia, and endocrine disease.

A comprehensive medical evaluation is an important requirement in planning rehabilitation for geriatric patients regarding expected

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progression of their physical limitations and how they will respond to physical rehabilitation. In addition to a thorough examination for concurrent disease, nutritional assessment and evaluation of the patient's pain level is important in guiding therapy. Clients with geriatric animals will likely be concerned with quality of life issues, such as mobility, pain level, fecal and urinary continence, appetite, and maintenance of human–pet interaction within the household. These issues can be further complicated by behavioral changes or cognitive dysfunction (Hedges, 2014).

Physical rehabilitation for the geriatric patient entails addressing issues such as pain with care, to avoid exacerbation of weakness and any cognitive signs. Rehabilitation aims to improve mobility and function (via assistive devices or treatments targeted at improving muscle strength and coordination), and address medical and nursing care issues (such as providing adequate bedding and maintaining patient cleanliness in the household). Creating a geriatric wellness program may be beneficial in the physical rehabilitation environment. Marketing aimed at geriatric patients can be targeted to clients interested in maintaining quality of life for their elderly pets, patients with degenerative joint disease, patients with neurogenic issues, and those in need of hospice care.

The Aging Process

Aging is a term that refers to a complex set of biological changes that result in a progressive reduction of the ability to maintain homeostasis when exposed to internal physiologic and external environmental stresses (Goldston, 1995; Bellows *et al.*, 2015). These changes ultimately lead to decreased vitality, increased vulnerability to disease, and eventually death. The landmark study in the *Journal of the American Veterinary Medical Association* looked at large- and medium-breed dogs and identified normal age-related changes (Bellows *et al.*, 2015).

When Do Dogs and Cats Qualify as Senior or Geriatric?

Veterinary professionals consider dogs to be senior at an earlier age than pet owners. Small, medium, and large dogs were all considered senior at around 7 years old by veterinary professionals, with giant-breed dogs hitting the senior mark around 5. Veterinary professionals considered small and medium dogs to be geriatric around 11, large dogs near 9, and giant breeds around 7 (Seymour, 2014) (Table 12.1). The highest percentage of veterinary professionals considered cats to be senior around 9 years old and geriatric around 13 (Seymour, 2014) (Table 12.2). More than 77% of veterinary professionals and pet owners alike said there was a difference between the terms "senior" and "geriatric" (Seymour, 2014).

Physiologic Changes in Aging Dogs and Cats

Aging affects the entire body and its functions (Bellows *et al.*, 2015). There is a loss of lung elasticity and lung capacity is decreased in older pets. The brainstem control of breathing also changes with age and this results in reduced ability to respond to increased demand; older patients become less tolerant of exercise. Panting tends to become less efficient with age. It is harder for older dogs to cool themselves, and this needs to be considered when exercising an elderly dog. Cardiac output starts to decline in mid-life in dogs and again ability to respond to the stresses of exercise may be reduced. Chronic heart valve disease is found in around 30% of older dogs (Box 12.1).

Changes to the integument include changes to skin and nails, such as callous formation, resulting in painful weight bearing and altered foot placement (Figure 12.1), and a tendency to form lumps and bumps such as lipomas, adenomas, etc. Many organ systems are known to decline with age. Changes

Table 12.1 How old is my dog in human years?

Dog's age	0–20 lb (0–9 kg)	21–50 lb (9–23 kg)	51–89 lb (23–40 kg)	>90 lb (>41 kg)
5	36	37	40	42
6	40	42	45	49
7	44	47	50	56
8	48	51	55	64
9	52	56	61	71
10	56	60	66*	78*
11	60	65	72*	86*
12	64	69*	77*	93*
13	68	74*	82*	101*
14	72*	78*	88*	109*
15	76*	83*	93*	115*
16	80*	87*	99*	123*
17	84*	92*	104*	
18	88*	96*	109*	
19	92*	101*	115*	

* = geriatric.
Source: Adapted from Tomlinson (2016).

occur in the gastrointestinal system (reduced elasticity of the colon and rectum), and drug metabolism and elimination by the liver and kidneys becomes slower.

Changes in the immune system result in reduced ability to combat infection and healing can take longer. Geriatric patients are more prone to developing chronic urinary tract infections, for example. Metabolic systems are more likely to be affected with age, for example the adrenal glands undergo changes resulting in altered stress response via increased cortisol production. There may also be changes in electrolyte balance. Other endocrine changes shown by many aging dogs include a dip in thyroid levels. There is also an age-related decrease in basal metabolic rate so obesity risk is higher (Boxes 12.2 and 12.3).

As the nervous system and associated special senses age, changes are commonly seen. Some age-related diminished hearing may occur, although this is difficult to assess in dogs and cats as equipment to test hearing is not widespread. There can be age-related retinal degeneration. Night vision loss is very common in older dogs and close questioning of the client can establish this. Home adaptations using lighting can help the pet remain active and healthy.

Brain size reduces with age due to atrophy of the cerebral cortex. This is the part of the brain that controls the body's voluntary actions, so patients may be slower to react and slower to learn. There is a loss of fine motor control and decreased body awareness (proprioception). This may result in difficulty with balance and coordination, along with changes in gait. Aged dogs can have slower movements; however, ataxia is never a normal age-related change (Box 12.4).

Mobility and strength decline naturally with age. Sarcopenia is the term for loss of muscle mass due to degeneration with age and this has been confirmed in a study of Labrador Retrievers (Hutchinson *et al.*, 2012). The number and size of muscle fibers decreases and it takes muscles longer to

Table 12.2 How old is my cat in human years?

Life stage	Age of cat	Human equivalent
Kitten (birth to 6 months)	0–1 month	0–1 year
	2–3 months	2–4 years
	4 months	6–8 years
	6 months	10 years
Junior (7 months to 2 years)	7 months	12 years
	12 months	15 years
	18 months	21 years
	2 years	24 years
Adult (3–6 years)	3 years	28 years
	4 years	32 years
	5 years	36 years
	6 years	40 years
Mature (7–10 years)	7 years	44 years
	8 years	48 years
	9 years	52 years
	10 years	56 years
Senior (11–14 years)	11 years	60 years
	12 years	64 years
	13 years	68 years
	14 years	72 years
Geriatric (15 years+)	15 years	76 years
	16 years	80 years
	17 years	84 years
	18 years	88 years
	19 years	92 years
	20 years	96 years
	21 years	100 years
	22 years	104 years
	23 years	108 years
	24 years	112 years
	25 years	116 years

Source: Adapted from International Cat Care (2016).

Box 12.1 Cardiopulmonary changes in geriatric patients

- Declining cardiac output
- Decreased elasticity of pulmonary tissue
- Increased fibrosis of pulmonary tissue
- Decreased cough reflex
  - Pulmonary secretions have low viscosity
  - Increased chance of respiratory disease
- Monitor for pneumonia
- Pulmonary fibrosis in West Highland White Terriers
- Chronic bronchitis in older small breed dogs
- Congestive heart failure exercise intolerance and slowly progressive cough
- Atrioventricular valve thickening in 75% of dogs over 16 years old
- Laryngeal paralysis – can be associated with polyneuropathy, neoplasia, and hypothyroidism
- 32 dogs with idiopathic laryngeal paralysis – 100% had esophageal dysfunction
- 1 year later of the 24 dogs evaluated 100% had neurologic signs (ataxia, weakness, CP (conscious proprioceptive) deficits, muscular atrophy)
- Therefore, start exercise at diagnosis.

Source: Adapted from McCauley (2016a).

Figure 12.1 Callus formation can result in painful weight bearing. A coarse file or sanding tool used lightly can remove callus build-up for more comfortable weight bearing.

Box 12.2 Metabolic changes in the geriatric patient

When creating programs, it is important to take into account:

- Decreased metabolic rate
- Maintenance energy requirement decrease by approximately 20%
- Senior diets typically have reduced calories, but need to provide increased highly digestible protein

Source: Adapted from McCauley (2016a).

Box 12.3 Immune changes in the geriatric patient

- Immune compromise
- Decreased bone marrow proficiency
- Diminished phagocytic ability of neutrophils
- Fewer white blood cells and peripheral lymphocytes
- Lymphocytic proliferation responses to stimulation decline
- Decreased CD4:CD8 (helper T:cytotoxic T cell) ratio
- Decreased cellular immunity
- Slower wound healing
- Changes in hair coat
- Aged dogs maintain humoral immune response
  - Respond to vaccines
  - Respond to novel antigenic stimulation

Source: Adapted from McCauley (2016a).

respond to exercise. Old dogs frequently adopt a movement pattern of either moving or laying down; they rarely stand in one place. The first muscles to atrophy are the slow twitch postural muscles (e.g., spinal epaxial muscles) as these are very sensitive to reduced load. With atrophy comes decreased ability to maintain a posture and so the process becomes cyclical (Boxes 12.5 and 12.6).

Cognitive Impairment and Other Behavioral Issues

Cognitive dysfunction is a neurodegenerative disorder of senior dogs and cats that is characterized by gradual cognitive decline over a prolonged period (18–24 months or longer) (Landsberg and Araujo, 2005). Diagnosis of cognitive dysfunction syndrome (CDS) is based on recognition of behavioral signs and exclusion of other medical conditions and drug side-effects, which in some cases can mimic or complicate CDS (Warnes, 2015a). Clinical categories include disorientation, alterations in social interactions, sleep–wake cycles, elimination habits, and activity, as well as increasing anxiety. Deficits in learning and memory have also been well documented (Landsberg *et al.*, 2012) (Box 12.7). The diagnosis of CDS was initially

Box 12.4 Nervous system changes in the geriatric patient

- Coordination and proprioception decline
- If muscle strength declines then ataxia may occur (increase falls in humans)
- Loss of vision and vestibular input
- Changes in muscle spindle cells, which provide input on joint position and muscle length for coordinated movement
  - Muscle spindle cells become less sensitive
  - Large myelinated nerve fibers that carry the message from the muscle spindle cell to the spinal cord decline
  - Nerve conduction velocity slows (advanced age)
  - Tactile sensitivity diminishes in the distal extremities
- Loss of vision due to
  - Cataracts or luxation of the lens
  - Corneal issues, such as keratoconjunctivitis sicca
  - Trauma
  - Retinal issues (degeneration or detachment)
- Loss of hearing.

Source: Adapted from McCauley (2016a).

Box 12.5 Musculoskeletal changes in the geriatric patient

- Sarcopenia – Muscle fibers are replaced with first fat (no loss of muscle circumference), then with fibrous tissue (physical loss of muscle circumference). This causes increased stiffness.
- Reduced oxygenation of muscle fibers
- Loss of strength of muscles and tendons
- Sarcopenia causes
  - Decreased support of the joints
  - Decreased chondrocytes
  - Reduced ability to respond to growth factors
- Can be slowed down by concentric but not eccentric exercises
- Underwater treadmill, balance board, limb weighting, isometric exercises
- Dog study
  - With cage rest see significant atrophy of tibia especially at the insertion of the collateral ligaments
  - Aging decreases tensile strength of ligaments secondary to loss of collagen
- Fun bone facts
  - Animals fully change bone content every 5 years
  - Lifetime of weight bearing exercises decrease bone loss normally seen with aging
  - Weight bearing training before a bone fracture has faster healing times
  - Shockwave therapy may aid bone healing specifically in geriatric dogs
- Water content in the cartilage decreases
  - Thinning of cartilage layer
  - Chondrocytes synthesize smaller, less uniform aggrecan molecules and less functional link proteins
  - Decreased mitotic activities
  - Decrease response to anabolic mechanical stimulants and growth factors
  - Combined with stress on joints secondary to loss of muscle strength leads to eburnation of subchondral bone and osteoarthritis
- Don't see osteoporosis, but bones become more brittle due to infiltration of fat into bone marrow and thinner cortexes
  - Fracture healing is slower
  - More difficult to form a callus
  - Obesity and brittle bones exacerbate progression of osteoarthritis

Source: Adapted from Tomlinson (2016) and McCauley (2016a).

Box 12.6 Muscle changes in the geriatric dog

- Lactic acid builds faster
- Glycogen depletes faster
- Decreased creatine phosphate (used first in muscle use)
- Cannot build muscle strength or endurance to compare to younger dogs
- Muscle capillarization decreases
- Decreased oxygen to muscles
- Decreased endurance
- Type II muscle fibers decrease by ~25%, leading to reduced strength
- Type I muscle fibers can increase or stay the same. These are endurance and postural muscles
- Disuse atrophy – Decreased type I muscle, especially those that cross one joint or postural muscles.

Source: Adapted from McCauley (2016a).

based on clinical signs represented by the acronym DISH, representing Disorientation, altered Interactions with people or other pets, altered Sleep–wake cycles, and House soiling (Landsberg *et al.*, 2013a).

Signs of Cognitive Impairment

Common signs of cognitive impairment include:

- confusion,
- altered relationships and social interactions,
- altered response to stimuli,
- changes in activity: increased anxiety, pacing, repetitive behaviors (vocalizing, pacing),
- changes in activity: apathy, depression,
- altered sleep–wake cycles; reversed day/night schedule,
- learning and memory problems: house soiling,

Box 12.7 Cognitive dysfunction changes in the geriatric patient

- Cognitive changes in the brain – increased oxidative stress
- Deposition of B-amyloid plaques (like in Alzheimer's patients in humans)
- DNA fragmentation or damage
- Changes in intracellular signaling leading to a loss of neurotrophic factors
- Anatomic changes in the brain
  - Cortical atrophy
  - Increased ventricular volume
  - Reduced neurogenesis in hippocampus (responsible for learning and memory)
- Progressive neurodegenerative disorder
- Diagnosis of exclusion
- Clinical signs include
  - Change in sleeping habits
  - Lack of environmental recognition
  - Decreased interaction with human and animal family
  - Restlessness
  - Apathy
  - Anxiety
  - Altered appetite
  - Aggression or irritability
  - Vocalization
  - Incontinence
- Therapy includes
  - Antioxidants – Vitamin B, C, and E; fruits and vegetables
  - Fatty acid supplementation
  - Mitochondrial co-factor supplementation – carnitine, alpha lipoic acid (omega 6 fatty acid), coenzyme Q10
  - Phosphatidylserine (phospholipid that improves cognitive deficits and memory)
  - Ginkgo biloba – a monoamine oxidase inhibitor (MAO-A and MAO-B)
  - Increases dopamine levels and protect neurons from apoptosis induced by B-amyloid
  - Selegiline – an MAO-B inhibitor (Anipryl, L-deprenyl).

Source: Adapted from McCauley (2016a).

- learning and memory problems: deficits in work, tasks, and commands, and
- getting stuck behind doors.

Behavioral signs are often the first, or only, signs of pain, illness, and of cognitive decline and so discerning the contributing factors can be a challenge for the family, and for the veterinary team. Senior pets may be less able to cope with stress, which may make them more susceptible to changes in their environment (for example a new cat, a house move). It is the job of the veterinarian and the rehabilitation team members to help to discern pain from stress and anxiety, even in a patient with CDS. When in doubt, treat for pain as a trial. Pain assessment, response to pain medications, and the overall wellbeing of the pet depend heavily on the measurement and assessment of the pet's behavior (Mathews, 2000). A wide range of behavior problems, ranging from avoidance, decreased activity, and inappetance to irritability, restlessness, and aggression could be due to underlying pain. In fact, any change from normal behavior and the development of new and abnormal behaviors can also be due to underlying pain or disease (Landsberg *et al.*, 2013b).

Monitoring both age-associated cognitive and physiological changes should be conducted at least annually in dogs (starting at 5–8 years for larger breeds and 8–10 years for smaller breeds) and cats (starting at 10–12 years) (Hammerle *et al.*, 2015). Clients with elderly animals will not always mention behavior changes during veterinary visits, so veterinary technicians should be asking clients about any changes in their pets' behavior whenever they see dogs from 8 years of age and cats from 10 years at the latest (ideally they should do this from puppy- or kitten-hood onwards!).

In cats, thorough medical and behavioral history is required for diagnosis. Cognitive and motor performance appears to decline from approximately 10–11 years of age for cats, but functional change in the neurons of the caudate nucleus in the brain have been observed by 6–7 years (Landsberg *et al.*, 2010).

Signs of Cognitive Dysfunction Confused with Weakness or Pain Issues

The following signs of cognitive dysfunction may be confused with the effects of weakness or pain:

- Reduced mobility – especially negotiating obstacles (thresholds, car entry)
- Urinary or fecal accidents in the house
- Change in appetite
- Decreased alertness
- Change in interaction with the family.

What can Influence Behavior in Geriatric Patients?

Behavior in geriatric patients may be influenced by many factors, including the following:

- *Anxiety* – CDS can increase anxiety and the likelihood of a patient developing fear- and anxiety-related behavior problems (Overall, 2013).
- *Reduced mobility* – If movement is difficult this can increase the likelihood of patient's toileting in inappropriate places because they are unable to reach a more appropriate toileting area in time. Animals with reduced mobility also find it harder to move away from people or other animals if they feel threatened, which will further increase the likelihood of them showing defensive aggression (Landsberg *et al.*, 2013b).
- *Restlessness* – CDS patients often find it difficult to rest, which can result in them being unsettled both during the day and at night (Landsberg *et al.*, 2013b). This can slow progress during rehabilitation.
- *Reduced interaction with owners* – Geriatric patients may not want to play or enjoy other interactions with their family, such as petting or going for walks (Overall, 2013). This can negatively affect the pet–client relationship, and if pain is unrecognized and/or untreated this may be a risk factor for relinquishment or euthanasia.
- *Polydipsia and polyuria* – Conditions associated with polydipsia and polyuria such as diabetes mellitus, hyperadrenocorticism,

Table 12.3 Feline mobility/cognitive dysfunction questionnaire.

My cat…	Yes	Maybe	No
Is less willing to jump down			
Will only jump up or down from lower heights			
Sometimes shows signs of being stiff			
Is less agile than previously			
Shows signs of lameness or limping			
Has difficulty getting in or out of the cat flap			
Has difficulty going up or down stairs			
Cries when they are picked up			
Has more accidents outside the litter tray			
Spends less time grooming			
Is more reluctant to interact with me			
Plays less with other animals or toys			
Sleeps more and/or is less active			
Cries loudly for no reason/to try to gain my attention			
Appears forgetful			

NB. Need to ensure there are no environmental reason(s) for these behavior changes.
Source: Adapted from Gunn-Moore (2011, 2014).

or chronic kidney failure will increase the likelihood of a geriatric patient house soiling or waking their owners at night to ask to be let outside (Landsberg *et al.*, 2013b; Overall, 2013).

- *Neurological and circulatory disorders* – Medical problems affecting the central nervous system (e.g., brain tumors) or the circulatory system (e.g., hypertension) can cause or contribute to cognitive decline (Gunn-Moore, 2011; Landsberg *et al.*, 2011).
- *Some medications* can also increase the likelihood of animals showing behavior problems. For example, corticosteroids can be associated with increased appetite, urine output, restlessness, and reactivity to stimuli, which can increase the likelihood of an animal showing problem behaviors including housesoiling, wandering, and pacing and also aggression to owners or other pets (Landsberg *et al.*, 2012).

Cognitive function screening questionnaires can be used to check for CDS. An example of a canine questionnaire can be found at: http://merrimackvet.evetsites.net/sites/site-3774/documents/CDS_checklist.pdf and an example of a feline mobility// cognitive dysfunction questionnaire is given in Table 12.3.

It can be difficult to differentiate between the signs caused by CDS and those caused by osteoarthritis-related mobility issues. Both conditions often occur concurrently in old cats and many of the treatments for one condition will also help the other.

Management Strategies to Improve Quality of Life

There are many management strategies that can improve the quality of life for elderly animals with mobility problems, including conditions associated with chronic pain, sensory deficits, and cognitive dysfunction. Geriatric animals need to be able to navigate their surroundings easily. This can be particularly challenging for animals with medical problems affecting their mobility, including conditions associated with chronic pain such as degenerative joint disease and spinal problems. Conditions that reduce sensory abilities, for example vison and hearing loss or cognitive dysfunction, can be associated with impaired spatial awareness and navigational ability. Important resources that need to be accessible include food, water, comfortable resting places, toilet locations and, for cats, places to withdraw to or hide if they do not wish to interact with people or other animals in the home (Warnes, 2015b). Cats like to have food, water, and toilet areas kept separate. These must be easily accessible from the cat's resting area. If a cat spends time on different floors in the home it is sensible to locate a full set of resources, including a litter tray, on each floor.

Once resources have been located appropriately they should always be kept in the same places so animals can find them easily. If other animals are in the home, then it is imperative that there is no unnecessary competition for these resources (Table 12.4).

Other Considerations for Geriatric Pets

Introducing a new pet into the household can be extremely stressful for an older animal with mobility problems, and especially for one with cognitive dysfunction. Client may be better advised not to do this, especially with cats and any dog that does not have good social skills or is showing severe cognitive dysfunction.

Play can be associated with a positive emotional response and increasing aerobic activity will also boost circulation, increasing oxygen supply to the brain and muscles. Low-impact games such as gentle throw-and-fetch or search games are appropriate for most elderly dogs, and for dogs with vision loss. Search games to find food or toys are particularly suitable. Short play sessions with fishing rod toys or toys that roll and/or make sounds will suit most cats. Older pets can become bored with toys quickly, so the toys need to be rotated every few days.

Dogs with mobility problems can be taken out in the car and then given a short walk in a new location, or can accompany owners on longer walks by riding in a modified baby stroller. Some elderly cats prefer to remain indoors, but if cats do want to go outside their safety can be improved by using a harness or possibly by fencing the garden to prevent the resident cat leaving and other cats entering. Screened back porches are excellent for environmental stimulation.

Animals with severe cognitive dysfunction or anxiety must have an environment that remains stable and is unchanging. Highly anxious animals, especially cats, may cope best when restricted to a single room containing food, water, a litter tray, and resting and hiding places. It is important to keep furniture and resources in the same places and to avoid big changes in the scent profile of the room, for example by not using strongly scented cleaning products, as these can be very challenging for cats. It also helps to maintain a consistent routine, ensuring that important events occur in the same order and at approximately the same times every day.

Common Presentation

Dr. Julia E. Tomlinson states, "There are two main aged populations in my practice. Those that are overweight who have varying mobility issues along with the potential for co-morbidities; and the frail pet with weight loss, marked muscle atrophy, and weakness." Frailty syndrome is a decline in the body's functional reserve, lower energy metabolism, smaller muscle cells, and altered nervous, hormonal, and inflammatory functions (Figure 12.2). It is not a disease process but it does lead to increased susceptibility to disease and functional dependency. It is characterized by decreased muscle mass and loss of strength and endurance (Tomlinson, 2016).

Table 12.4 Suggestions for improving the environment and increasing access to resources for elderly cats and dogs.

Resource	Dogs	Cats
Food and water	Raising bowls off the ground will help dogs with joint and spinal problems to eat and drink more comfortably Non-slip matting underfoot will prevent dog slipping when eating or drinking	Need to be in separate locations Raise bowls off ground by a few inches to enable cats with joint and spinal problems to eat and drink more comfortably Cats used to being fed on raised surfaces, e.g., windowsills or worktops may need a ramp or steps to enable access, or food and water should be provided in more accessible locations
Toileting areas	Dogs with mobility problems may need to learn to use a toileting area closer to the house, or even be provided with a toileting area indoors, e.g., by placing puppy pads in a large tray Owners may need to encourage dogs to go to their toilet area regularly because they may no longer indicate when they need to toilet	Needs to be separate from feeding and drinking locations Cats with mobility problems will prefer large, low-sided litter trays, or equivalents such as gardeners' potting trays Finer grained litters are easier to stand on and dig than coarser litters Cats that have previously toileted outside may no longer be able to access these locations, and will need to be provided with litter trays indoors
Sleeping areas and beds	Beds should be comfortable and supportive, e.g., memory foam, easy for animal to get into and out of, and large enough for them to lie out flat if they wish Elderly animals can become cold very easily: sleeping areas should be kept warm especially at night in the winter. Electrically heated beds may be welcomed An Adaptil™ diffuser plugged in close to the bed may help reduce anxiety and help dogs settle better at night Items containing the owner's scent may also help some dogs settle better at night	Beds should be comfortable and padded, easy for animal to get into and out of, and large enough for them to lie out flat if they wish Cats prefer to rest in raised places, but animals with mobility problems may need ramps or steps in order to access these locations. Elderly animals can become cold very easily: sleeping areas should be kept warm especially at night in the winter. Electrically heated beds may be welcomed A Feliway™ diffuser plugged in close to the bed may reduce anxiety and help cats settle better at night
Moving around inside and outside home	Non-slip matting or carpet in locations of important resources and on the walkways between important areas can improve accessibility for elderly animals with mobility problems Non-slip ramps can help dogs navigate steep steps outside the home and also get into and out of cars Specially designed harnesses can be helpful for supporting dogs with mobility problems to enable exercise and access to toilet areas	Non-slip matting or carpet in locations of important resources and on the walkways between important areas can improve accessibility for elderly animals with mobility problems Most cats prefer raised resting places where they can feel safe and observe household activity from a safe distance. Providing ramps or steps may enable cats with mobility problems to continue to use withdrawal as a way of avoiding things that scare them Cats with mobility problems may no longer be able to use a cat flap so owners will need to let them in and out unless they prefer to stay indoors

Adapted from Warnes (2015b).

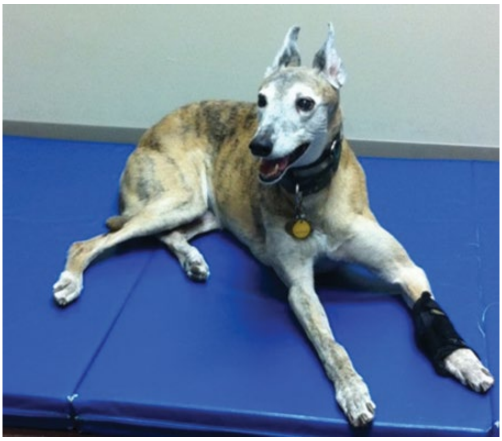

Figure 12.2 A frail canine patient. The patient is 15 years old. She has normal blood work and cognition but is weak and slow to move.

Geriatric patients often present to the rehabilitation veterinarian because of difficulties performing the activities of daily living, for example difficulty on stairs or getting into and out of the family vehicle. Another, often concurrent presentation is for management of chronic pain. The goal of the examination and treatment plan is to explore possible therapeutic options that will effectively improve strength, balance, and comfort without fatiguing the patient with resultant worsening home mobility problems. Slow, steady progress is the aim of any geriatric rehabilitation plan, and must include home assistance and nursing care regardless of the relative stability or functionality of the patient.

Health Benefits of Rehabilitation for the Geriatric Patient

The health benefits of rehabilitation for the geriatric patient should include (Edge-Hughes, 2009):

- improved daily function,
- reduced pain,
- improved strength,
- better oxygen transport and oxygen capacity,
- reduction in osteoporotic changes,
- reduction in blood pressure,
- improved breathing capacity,
- improved joint mobility,
- tranquilizing effect that reduces neuromuscular tension and anxiety, and
- greater capacity for human interaction.

Physical Rehabilitation and Function

Before any physical rehabilitation is undertaken, the patient must have an analgesic plan in place, most likely controlled with analgesic medication(s). There are four key areas of physical rehabilitation available to the geriatric patient: manual therapy; electrotherapy; hydrotherapy; and clinical/home exercise programs (Cottriall, 2014).

Absolute precaution: "The patient should feel better, move better, and have better normal daily function when done with exercises. If they are more lame, sore after resting, or change transitions or posture for the worse, after exercises are done, then the plan needs to change" (McCauley, 2016a).

Manual Therapy the Veterinary Technician/ Nurse can Perform

Massage can provide relief from pain and spasm of muscles but should be exercised with caution in patients with low muscle mass. Elderly, frail patients may not enjoy massage or even light grooming. Active or passive muscle stretches may be prescribed and performed only in clinic for some patients, at least initially; other patients may be well enough for clients to be taught to use them at home. This can ensure flexibility and muscle length is maintained between treatments. Both joint range of motion and muscle length can also be supported with passive range of motion (PROM) exercises.

The PROM should be graded and only carried out after the client is cautioned to work within a limited range of motion if pain is likely to be an issue (Cottriall, 2014) (see Chapter 5 for more information).

Electrotherapy

Elderly patients may be slower to respond with discomfort during electrotherapy and so these modalities should be used with great caution. Thin skin, less muscle thickness and lower body fat can affect absorption of modalities such as laser and therapeutic ultrasound, so watch for discomfort. Reduced special senses and cognitive impairment may also mean that patient signals of discomfort will change or be more subtle (Figure 12.3). The therapist needs to be aware of this. These modalities are discussed in detail in Chapters 15–18.

- *Laser therapy*: This photobiostimulation increases cellular ATP and decreases nerve signaling of pain. Caution if the modality heats, patients with thinner skin and less muscle can experience burns more easily. Obese patients may "hold in" the heat of a laser in the fat layer and fat necrosis may occur.
- *Therapeutic ultrasound* uses thermal and non-thermal effects to reduce pain/spasm and increase tissue extensibility. Caution with patients that have low lean body mass; heating the periosteum with resultant damage and discomfort may occur.
- *TENS* (transcutaneous electrical nerve stimulation) is low-level electrical current which disrupts the normal pain perception pathways and can help to manage chronic pain. The first few sessions should always be supervised in clinic. Then a home unit can be prescribed with detailed instructions for use. If in doubt about possible discomfort during TENS, cease therapy and reassess with the veterinarian.
- *Shockwave therapy* uses high-energy sound waves to stimulate tissue repair and reduce neuropathic pain. This modality is very effective for arthritic pain but causes some discomfort during therapy sessions and temporary exacerbation of pain for a few days in some cases. Be careful about treating multiple joints in one session as mobility at

Figure 12.3 An elderly patient receiving neuromuscular electrical stimulation. The patient has thin skin, poor muscle thickness, and low body fat. The treatment must be applied with great care and the therapist should watch very closely for discomfort.

home may become temporarily much worse. Counsel clients about the risks of a pain flare and weigh the pros and cons with them.

- *PEMF* (pulsed electromagnetic field) therapy can help with pain, inflammation swelling, and wound healing. PEMF mats are available for home use (purchase or rental). Whole-body PEMF therapy should be avoided in patients with a history of seizures.
- *NMES* (neuromuscular electrical stimulation) is used to build muscle and has been shown to reduce muscle mass loss, increase its strength, and improve functional muscle use following orthopedic surgery (Cottriall, 2014). It may be painful over a severely atrophied muscle. Atrophy due to disuse maintains sensory innervation and so it is important to be cautious and err on the side of a lower level of muscle contraction in an elderly patient.

Approach to Exercise Therapy

All patients should benefit from warm-up exercises but they can be particularly helpful in stiff, elderly patients. The warm-up should aid muscle action and loosen stiff joints while avoiding too much active exercise and resultant fatigue before the targeted therapeutic exercises. The rehabilitation technician/nurse can give a brisk light massage up and down limbs and back to increase circulation and use range of motion to decrease stiffness. If the patient is very stiff, heat packs or warm towels/blankets should be placed on affected joints or whole body.

Once standing, cookie stretches and rhythmic stabilization exercises can be practiced. Assisted standing is used if the patient cannot stand on their own.

If the patient has low endurance, then give appropriate rest periods between repetitions and between exercises. Examples of exercise are walk to mailbox and back, rest 3 minutes to an hour, repeat, rather than walk twice as far at one time. Sit to stand rest example: 1 sit to stand, walk 5–20 feet (1.5–6 m), 1 sit to stand, rather than 2–5 in a row. The patient may work up to 10–25 total.

Improving flexibility should be concentrated on early on in the program. Practicing range of motion and stretching is important. It is important to educate the client. Have owner keep a daily diary. Input information such as challenges – walk on uneven surfaces, over broom handles, core strength – sit pretty, diagonal leg lifts, flexibility – treat stretches, range of motion. Take special note of how they sit and get up from the down position.

Make sure the patient stays in the pain-free range.

Some geriatric patients may need assistance with mobility for therapeutic exercises. (Figure 12.4). Assistive devices include:

- Harnesses
- Lifts
- Slings
- Carts.

For more information about assistive devices see Chapter 10.

Therapeutic Exercises for Geriatric Patients

- *Weight-shifting/postural perturbations* help to improve strength, balance, and control, but the therapist should make sure that the patient is standing on a high traction surface. Be sure to counsel clients about gentle motions being effective and to avoid unbalancing their pet to the point of a fall risk. Gentle, more prolonged resistance to perturbation can be incorporated as the patient improves.
- *Cavalettis or poles* placed on the ground will help balance and coordination, even in sight-impaired patients. Go slowly and do the exercise in well-lit areas, avoiding bright sunlight as pupil constriction can

Figure 12.4 Some patients may need assistance with mobility. This patient has weak front limbs and the cart is used to aid mobility for longer walks which enhance quality of life.

impair vision further in patients with diminished sight.

- *Placing paws on targets* improves accuracy as well as subtle strengthening. Start with low targets such as a rubber mat and move on to a higher step, squishy foam pad, or even a balance disc.
- *Weaving* around obstacles in a figure-of-eight pattern can improve balance and control as well as spinal flexibility. Side steps are another strength and balance exercise. Competence with these two exercises can improve ability to turn in tight spaces in the house.
- *Backing up practice* (backwards walking) can also help home mobility.
- More capable pets can *balance* with one or even two legs lifted.
- Practicing sits ranges from assisted *transitions* (assisting joint motion and strength as needed) to holding a sit. Start with a small guided squat (half-sit) to standing exercise if needed. A raised platform can help a pet to keep limbs tucked in flexion and good posture for correct spinal alignment and muscle recruitment in a sit.
- *Active stretches for treats* (cookie reaches) will improve flexibility but also challenge balance and subtly strengthen. Stretches can be nose to hip, for example, down between front legs to arch back from a standing position (crunches), nose to rear toes.
- *Tail exercises* can help to improve rear awareness and strengthen the pelvic floor muscles. Stimulate tail motion with brushing the fur back at the tip of the tail, gentle squeezing, or even with happy talk.
- *Walking on uneven surfaces* can be a challenge for older pets but can also be used as a therapeutic exercise.
- Pets can also practice for *stair climbing by hill climbing* (serpentine up the hill first if easier) combined with step up and over low obstacles and progressing to practicing low stairs in the clinic or at home. Finally steeper steps are an option.
- *Getting into a vehicle* and onto furniture can be broken down into learned steps. A pet can be taught to step their front feet up on a raised level (equivalent of the bed, couch, or car) and then wait for assistance in the rear.

Special Considerations for Hydrotherapy

Hydrotherapy for the geriatric canine must be approached with caution due to the medical constraints that may prevail. It can be hugely beneficial as it will reduce concussive forces on joints and enable standing exercises to be carried out on patients with compromised mobility (Cottriall, 2014) (Box 12.8). The water treadmill ensures steady-paced

Box 12.8 Benefits related to hydrotherapy

- Decreases pain
- Osteoarthritis (chronic and acute on chronic)
- Cancer
- Decreases weight bearing stress
- Weight off the joints
- Muscle relaxation
- Enhances the ability of the muscles to contract and stretch
- Reduces edema in distal limbs
- Enhances coordination and balance
- Opportunity to strengthen core
- Area of weakness for a geriatric dog
- Increase metabolism
- Beneficial for overweight dogs
- Improves muscle tone and strength
- Works forelimbs, rear limbs, and trunk
- Metabolic weakness
- Water is a great medium for PROM/stretches
- Increased flexion of forelimb and rear limb compared to land treadmill or walking
- Wound healing if not full thickness
- Sanitizers clean "hot spots"
- Dry well after therapy and apply topical remedies or medications
- Increases superficial circulation

Source: Adapted from McCauley (2016b).

walking is achieved against resistance. Buoyancy aids, limb or body facilitation, and proprioceptive aids can all be applied to enhance the treatment. Only very short periods of therapy may be tolerated and respiratory rates must be monitored to avoid overexertion, especially in patients with compromised airway function such as those with laryngeal paresis. Muscle building and improvement in cardiovascular and aerobic fitness appear to be slower in elderly veterinary patients although gains can certainly be made. The goal is to maximize the therapy in terms of physiological and psychological outcomes. Watch for fatigue, both physical and mental.

Elderly patients are more likely to have some level of incontinence. Fecal contamination of water is possible, and urinary tract infections appear to be more common as full bladder emptying may not occur. It is a good approach to evacuate and express the bladder before therapy if there is potential for issues. Failure to achieve effective defecation if an elderly patient is too weak to posture can lead to anal gland issues. After hydrotherapy, many dogs need to urinate again. Be sure to allow them to walk outside to relieve themselves.

Increased abdominal pressure in patients with intra- or extra-abdominal masses can indirectly affect breathing. A full veterinary examination just prior to beginning therapy is recommended.

Swimming can be a good therapy for the elderly patient with the same caveats, but is probably more suitable for an elderly patient who has been a competent swimmer, as the stress and energy consumption levels will be too arduous for the inexperienced swimmer (Cottriall, 2014) (for more details see Chapter 19).

Physical Medicine and Rehabilitation for Patients in Palliative and Hospice Care

Veterinary patients in palliative and hospice care experience progressive medical diseases and can often benefit from physical medicine and rehabilitation (Tinkel and Lachmann, 2002; Downing, 2011). The patient with a progressive disease can often benefit from the application of physical medicine and rehabilitation techniques, not with the intention of curing the issue at hand, or necessarily reversing the disease process, but rather to maximize both comfort and function. Comfortable animals are more likely to continue to engage in normal, expected activities of daily living (ADLs). In addition, comfortable animals maintain their relationships more easily with their human companions. (Downing, 2011). The most commonly applied physical medicine and rehabilitation techniques that lend themselves well to the hospice and palliative care setting include the following:

- Thermal modalities (cold/heat/therapeutic ultrasound)
- Massage
- Range of motion
- Stretching
- Chiropractic
- Joint mobilization
- Acupuncture
- Myofascial trigger point release
- Therapeutic laser
- Electrical stimulation
- Targeted pulsed electromagnetic field therapy (tPEMF)
- Therapeutic exercise.

For more details about each therapy see Chapters 5, 14–16, 19, 20, and 23.

Conclusion

Rehabilitation objectives for the geriatric patient include managing pain, improving mobility and strength, providing appropriate assistive devices to promote independent ambulation, and modifying the patient's home environment to provide adequate traction, bedding, and obstacle-free space for ambulation (Starr, 2013).

Aids to Graceful Aging

There are five suggestions to helping the pet age gracefully. They are:

- manage weight,
- provide adequate nutrition – macro and micronutrients,
- recognize and treat pain,
- modify environment as needed to assist, and
- ensure appropriate exercise – strength, balance, flexibility.

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13

The Disabled Patient Part 4: Home Nursing Care

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CHAPTER MENU

Introduction

People face many challenges when caring for a disabled pet. Challenges can begin on the first day of the injury or disease, or they may develop over time despite the best efforts of both the veterinary team and owner to avoid or overcome them. Clients/caregivers need to gain a thorough understanding of their pet's diagnosis and the prognosis for recovery of function. Accurate prognosis can be very difficult to give in patients with neurologic issues. In our experience, recovery of an injured nervous system tends to be slow, with sporadic improvements and long plateaus and sometimes regressions (temporary or permanent). The patient that comes out of surgery for a disc fenestration/decompression able to walk when they could not do so before surgery certainly has a good prognosis, however mild residual neurologic deficits can remain for life. Conversely, in a 2003 study by Olby *et al.* of dogs with spinal cord compression and loss of deep pain prior to surgery (traditionally thought of as having a poor prognosis; Lawson, 1971) a fair to good prognosis for return to ambulation was revealed.

Understanding that some pets are disabled for a brief recovery period, whereas others may remain disabled in the long term can help caregivers to be equipped mentally and physically at home and to think about home-life adjustments. An optimistic but pragmatic approach to the challenges ahead mentally equips people for the long-term care needs of their disabled pet. Understanding their pet's unique limitations and identifying how to help their pet function maximally with

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adequate assistance can help to minimize the development of additional problems. For example, large dogs that are suddenly unable to support their own weight obviously can present a challenge when moving them around the home, even if the house is only one level. A home with stairs at each exit, along with up to the bedrooms and down to the basement will present significant obstacles. It may be extremely difficult to facilitate even the most basic of activities for the larger pet, whereas a small pet can be lifted and carried when needed.

The caregiver will need some help with caring for themselves. It is physically and emotionally draining to care for a disabled individual. Proper body mechanics should be explained in an effort to guard against injury (e.g., muscle strains).

Proper Body Mechanics

Body mechanics is a broad term used to denote an effort coordinated by the muscles, bones, and nervous system. It can either be good or bad and can be directly related to the occurrence of back pains.

The following rules should be applied when transferring or moving your patients to protect your back:

- Keep the lower portion of your back in its normal position at all times.
- Move as close to the patient as you can.
- Do not twist your body. Always do a side step or a pivot.
- Set your feet into a comfortable and solid wide base of support when lifting.
- Keep your abdominal muscles contracted, bow slightly using the hips and squat.
- Keep the head upright and hold your shoulders up.

Pushing up from the knees and using your own momentum will help you lift the patient (Figure 13.1).

Elderly or disabled caregivers may encounter more challenges when caring for even the smallest of pets. Part of our job when providing rehabilitative care is to understand the logistics and limitations of the patient, of the home environment, and of the caregiver

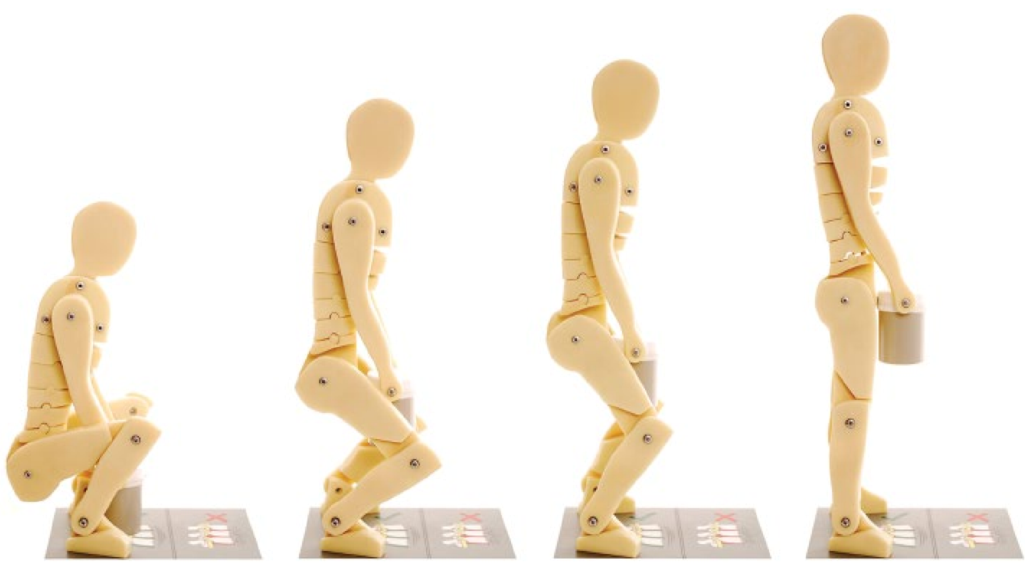

Figure 13.1 Use of proper body mechanics.

themselves and then to apply this to a realistic home care plan.

Even under the best circumstances and with the most capable caregiver caring for the easiest patient, issues can develop that interfere with caregiver compliance. This, for example, may be a conflict of work schedules, lack of available helpers, or a case of compassion fatigue. It may be other outside influences. Sometimes, friends or acquaintances with strong but well-meaning opinions can have an effect which further burdens the caregiver with pressure to make a decision, or to do things differently. Caregivers need friends and family to provide mental and practical support in order to help them care for their disabled pet. When the support system of understanding family and friends is not available, caregivers can quickly become overwhelmed. They may even feel totally absorbed by their pet's problems, and as a result ultimately guilty for keeping their pet alive in their prolonged disabled state. Compassion fatigue is a natural response to a traumatizing effect experienced by someone close to you, the stress resulting from helping a suffering individual (Figley, 1995). The risk of compassion fatigue increases with ongoing exposure to suffering and with unexpected disruptions to the caregiver's life; this can be particularly common when there is a loss of hope for patient recovery (Sabo, 2011).

Preventing and treating compassion fatigue starts with identifying the risk and providing information to clients. A good place to start is the Compassion Fatigue Awareness Project (www.compassionfatigue.org) and Wrong Side of the Rainbow (www.wrongsideoftherainbow.com).

Respite care (see later in this chapter) is a way that the caregiver can take a short break from the constant daily care routine while knowing their pet is well cared for.

Teaching home care techniques can be difficult. Each person learns a little differently and it is important to approach the task with several different ways of teaching care (National Research Council, 2000). Verbal and written explanations are a good start, and handouts with pictures can be referred back to later. However, many people learn best by doing the task. Demonstrations should be followed by giving the caregiver an opportunity to go through the motions. This is essential to determine potential success with a procedure and to ease a nervous caregiver into an "I can do it" attitude. Analogies can be helpful. For example, the bladder can be compared to a water balloon when teaching someone how to express it. You can send home samples of materials needed, like absorbent "potty" pads (Figure 13.2) and this may help to get care started in the right way. A list of resources (websites) should be provided for mobility help, safety confinement, ramps, steps, or other care items.

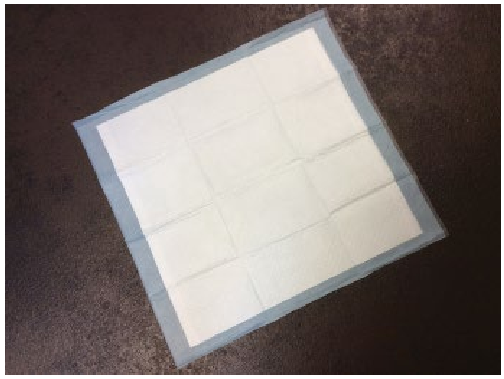

Figure 13.2 Absorbent diaper pads.

Goals of Nursing Care

Maintaining Hygiene

This is a continuous process and with an incontinent patient can be viewed as a constant battle. Counsel caregivers that even a continent patient will have accidents, as a poorly mobile pet will not be able to easily signal their need to go outside. Gentle shampoo should be on hand for frequent bathing. Paper towels should be within reach of the caregiver but not the pet. Wet wipes can be useful but can be harsh and

Box 13.1 Hygiene care for the incontinent pet

Products list for maintaining hygiene:

- Gentle shampoo
- Astringent free wet wipes
- Absorbable diaper/pee pads (e.g., Chux)
- Emollient or barrier creams (diaper creams)
- Paper towels
- Waterproof bed liners

contain alcohol. Remember that frequent mechanical wiping can irritate skin, and sometimes rinsing is kinder and gentler. A hand-held shower attachment for the tub is a handy thing to have both inside (and outside when the weather is warm enough). Skin protectants and emollients can help to prevent issues and provide a barrier for areas of skin that are frequently wet or soiled. Stacking absorbent pads under the patient can allow for a quick easy clean-up in a time crunch situation; if an accident happens, simply remove the soiled top pad (Box 13.1). Multiple waterproof bed liners can help as they can be exchanged and protect underlying padding. Trimming excess hair from the area surrounding the anal opening helps to prevent stool blockage and ultimately constipation.

Assisting Mobility

The disabled pet will need varying levels of assistance in order to be mobile. Slings can be helpful and can be purchased in different sizes both with and without padding/linings for comfort. You can also make a sling by cutting the sides from a canvas bag. Simply cut one side of the bag, including the handle, from the top of the bag to the bottom and then the other side of the handle from top to bottom. Keeping the handles intact, you end up with a long strip of canvas with handles at each end (Figure 13.3). This simple homemade sling is lightweight, inexpensive, and easy to use. However, there is no padding so it should be used for brief periods only. Harnesses that are padded are much more suitable for long-term use, though they should be removed daily and the skin checked for sores. An example is the Help ’em Up Harness™ (Figure 13.4).

It is important to counsel caregivers using any assistive lifting device about how to provide the minimum necessary assistance while allowing for some patient effort (Figure 13.5). Carrying the patient like a suitcase is uncomfortable for pet and caregiver and will not aid return of mobility.

Providing surface traction is a mobility aid that may be easily overlooked. Caregivers should be questioned about the home environment, including flooring. As a patient starts to regain some functional mobility, traction issues can prevent him or her from getting into a stand or from maintaining the limbs in adduction without slipping. Providing rugs on the floors, trimming nails and hair on feet (as better grip is obtained with foot pads), fitting boots or socks with grip bottoms (Figure 13.6), or toenail grips (Figure 13.7) can be instrumental in preventing unnecessary falls and allowing some mobility. Other mobility aids such as carts are discussed in Chapter 10.

Preventing Complications

Benjamin Franklin said “An ounce of prevention is worth a pound of cure” (Franklin, 1735). This statement can be applied to a disabled pet. The caregiver needs to be mindful of preventing contracture of muscles and connective tissue, including joints, protecting against skin sores and other injuries and treating pain that occurs from immobility and possible infection. Routine hygiene should always apply, for example removing feces in a timely manner and washing hands to avoid contamination spread.

When speaking of prevention of injury for the disabled pet, the whole home needs to be examined from the perspective of the patient. Confining the patient to a safe area away from potential falls or other injury is an important

Figure 13.3 Handmade sling.

Figure 13.4 Help 'em Up Harness.

Figure 13.5 Correct way to lift a dog in sling or harness.

Figure 13.6 Power Paws grip socks.

Figure 13.7 Dr. Buzby's ToeGrips™.

place to start. Remember that as a pet becomes more mobile, low barriers may be inadequate and further modifications may be needed. Bedding should be kept clean and dry and well padded. Clean dry bedding with waterproof pads beneath it is ideal, or absorbent disposable pads can be placed on top of the bed. Placing mats in the rest of the patient area can help to prevent sores from a patient dragging themselves around. Yoga mats or padded play mats are ideal and are easy to keep in place so that they do not slide with the pet. They also wipe clean relatively easily.

A recent addition to the plethora of assistive devices for disabled pets is a "bag" which protects the rear limbs of patients who drag their rear around in a sit (scoot). The authors do not condone the use of this bag in most cases, because allowing a patient to gait pattern in a scoot reinforces this pattern as the "normal" gait and makes it harder to encourage walking with assistance (the ultimate goal of which is return to full mobility). However, in patients with no possibility of return to functional gaiting the bag can help to protect the skin of the rear limbs, but it must only be used when the patient is confined to a small space.

Recumbent patients should have their position changed, preferably every 4 hours. Prop aids, such as a pillow or rolled-up blanket or towel taped in a roll, can keep a patient in the sternal position to allow full inflation of both lungs and to improve venous return (Lamm *et al*., 1994; Walther *et al*., 1998). Upright positioning (sternal or assisted standing) for eating and drinking aids in digestion and can prevent problems with regurgitation and aspiration pneumonia. Food intake should be decreased to avoid weight gain due to less activity. A lower calorie food with the same micronutrient density and adequate protein intake to prevent muscle loss is ideal in our opinion. Lower fat, higher fiber diets can provide good satiety while keeping calories low and intestines healthy and regular. Conversely, sometimes we need to switch the patient to a low-residue food in order to decrease the number of times stool is passed or the amount of feces in each stool passed by an incontinent patient.

Preventing tissue contracture is achieved with manual therapies both in clinic and for the caregiver to perform at home. Therapies suitable for use at home include passive range of motion (PROM), massage, and stretching. This touch is important as it helps pain management, strengthens the human–animal bond on both sides, and provides the motion that joints and muscles need to maintain health. Therapies such as these should be performed at home a minimum of twice daily as joint health is dependent on moving through a full range of motion every 8–12 hours (Matsuzaki *et al.*, 2013; Kojima *et al.*, 2014).

Maintaining Functional Elimination

It is our opinion that a regular schedule is the key to managing incontinence; using the natural gastro-colic reflex to stimulate stool passing can help to control accidents. We advise that after a patient eats, a caregiver should wait about 10 minutes then stimulate their pet by gently touching the perineal area with a cotton swab to stimulate anal sphincter contractions. This in turn will stimulate rectal contractions and passage of stools. If weather permits, it is good to take the patient outside to pass stools, even if they are minimally aware of their passing. Mimicking the old routine, with time of day and location can help to restore some conscious awareness of stool passing, if there is any residual sensation.

You and your supervising veterinarian can discuss changing dietary fiber in order to modify stools, either to more or less volume and firmer or softer consistency depending on the patient. This option should be tried before laxatives are introduced in the case of constipation, as an unfortunate side-effect of loose stools and urgency from treatment with laxatives can cause very difficult problems for the disabled pet.

Bladder emptying needs can vary. It is best to allow as much bladder function (contraction) as possible. For example, the caregiver can initiate urination with gentle pressure on the bladder to stimulate emptying and then allow the patient to continue urination until it slows. Once the stream of urine has slowed and then stopped, the caregiver ensures complete emptying with full expression. Medications can help to improve bladder muscle and sphincter activity in some cases and will be prescribed by the veterinarian. Caregivers need to be counseled about the risk of urinary tract infections due to incomplete bladder emptying (Stiffler *et al.*, 2006). Having good access to drinking water so that urine production is adequate and assisting the flow if the stream is intermittent can help to prevent infections. Frequent urine samples should be taken. The provision of test dipsticks for home use is recommended as an unnoticed infection can cause further problems, including pain and more extensive infections.

Managing Pain and Comfort

Recognizing pain can be difficult for caregivers. Many signs of pain (such as being reluctant to move, stiffness getting up, and restlessness) are not apparent in an already immobile or less mobile pet. Helping caregivers to recognize subtle signs of pain can improve patient advocacy and so quality of life. A home pain scoring method is not always necessary but a checklist of some sort can help caregivers to maintain a pet's comfort. Keeping note of appetite, enthusiasm of greeting, sleep patterns, and demeanor in a daily diary is useful as it can detect patterns of comfort. Sometimes the most enthusiastic rehabilitation exercises aimed at regaining mobility can result in weakness and pain next day. The benefits of working hard to regain gait need to be balanced with everyday comfort and adequate pain management. Step one is enlisting the home caregiver to recognize and communicate that.

Pain scoring should be performed at every therapy visit. Do not assume that a patient with poor limb function has no pain just because they have reduced sensation (see Chapter 3 on pain management for more details).

A comfortable environment includes adequate access to food and water, clean padded surroundings, climate control, and good pain management. Bedding can be raised off the ground (hammock bed) to allow ventilation (and drainage if urinary incontinence is present). A chilled gel liner placed under bedding can improve cooling, and a small fan placed just outside the confinement area can also provide some cooling. Be sure to avoid a constant direct breeze. Thin patients with low muscle mass from atrophy can benefit from heat-reflecting blankets.

Management of bed sores can be very challenging. Rotational use of multiple different bedding surfaces including memory foam, textured foam, and mesh hammock beds can help to change pressure distribution and prevent or relieve sores. Counsel caregivers about regularly inspecting the skin over bony prominences and alerting the rehabilitation team about any change, even hair loss. Early intervention can prevent full thickness wounds. Deep sores (full thickness skin defect) will need regular veterinary care. Foam pads can be applied or affixed directly to the skin around bony prominences. Bandages need to be changed daily, and education for home bandage changes will be of paramount importance. Digital pictures can be used to communicate progress (or lack of) when the patient is not in the clinic.

Assessing and Improving Quality of Life

It is an unfortunate reality that a disabled patient's life is somewhat restricted when compared to a patient with normal mobility. We have worked with disabled patients who become depressed. The good news is that the depression can be relieved with therapeutic intervention and some minor changes in home routine. Your supervising veterinarian may choose to provide antidepressant medications or to change pain medications that have a depressive effect. More importantly, home environment and mental stimulation can be changed (see Box 13.2).

Mental stimulation is key in preventing depression and boredom. Enriching the home environment is a relatively simple process. Mental stimulation can be improved by keeping the pet in the room which is the main hub of activity or by periodically changing rooms to change the scenery. Visual stimulation can be improved by propping the pet in front of a window. Smaller pets can be taken for walks in a stroller; larger pets in a wagon or cart. We have even had a disabled Great Dane patient who spent a lot of time outside in his large wagon cushioned with a dog bed. Toys can be stimulating for patients (who don't like to eat them). Storing toys and switching them from time to time can make old toys exciting again. Puzzle toys can be mentally stimulating and can be incorporated with meal time.

Motivation needs to be stimulated both at home and during in-clinic therapy sessions. Home rehabilitation exercises should include a special treat saved only for this time as this can improve motivation. Praise from family is also much needed for patient happiness and motivation. Purchasing a cart for the patient may improve the depressed patient's demeanor because some mobility is restored (see Chapter 10).

Improving mobility in the neurologic patient can take months or even longer. Neurologic patients usually have plateaus. Look for small triumphs to celebrate and praise. Small achievements are a big deal for

Box 13.2 Questions to ask owners about the patient

Ask the caregiver(s) and their family questions about home behaviors so that you can use this to assess patient demeanor.

- Are they happy and interactive when they greet family members?
- Strangers?
- Does their pet seem to recognize and respond to loved ones, familiar voices and/or touch?
- Do they have normal sleeping habits?
- Are they attention seeking constantly due to boredom, or are they ignoring most people due to depression?

neurologically challenged pets and all of the rehabilitation team should show enthusiasm to help patient and caregiver motivation. Rehabilitation can have a great impact on the life of a disabled pet, especially with early intervention, even if return to full mobility is not achieved. The rehabilitation team will need to provide moral support for caregiver and pet. Creativity is key in both at-home and in-clinic therapies, but sometimes creativity is as simple as making the old new again.

Disabled patients that have orthopedic problems generally return to adequate function more quickly than neurologic patients. The therapy plan should include addressing pain from compensatory issues as well as the primary injury/surgery site. Home therapy can be a large part of this pain management using massage, PROM, and stretching; thermotherapy can also be provided at home. Caregivers need to be compliant with both restrictions in activity and with home exercise recommendations. Caregivers of pets with orthopedic problems may be less aware of, and therefore less careful with subtle disabilities. During therapy visits, the team can help caregivers to understand the need for continued restrictions in order to prevent further injury or worsening the existing injury. Counsel caregivers about the importance of following exercise recommendations in order to progress recovery in a timely manner and to achieve the best possible recovery.

Improving quality of life for the disabled geriatric pet can be challenging. Reduced vision or hearing may have already reduced environmental stimulation and interest; loss of sense of smell can affect appetite. Older patients can benefit from learning new behaviors and from changes in environment, even if this means a car ride rather than a walk in a new place. Patients may have been inactive before the onset of their disability and so can lack adequate strength and fitness needed to compensate for even minor disabilities. Muscle loss (sarcopenia) occurs with advancing age and with that strength is also lost (Bellows *et al.*, 2015a). Patients of very advanced age can suffer from frailty syndrome – a decline in the body's natural reserves which results in increased susceptibility to disease and weakness (Bellows *et al.*, 2015b). Inactivity from injury or disability can lead to reduced strength and muscle mass, which feeds into poor mobility and can also lead to obesity. Even a small amount of weight gain can exacerbate lameness or weakness (Mlacnik *et al.*, 2006; Marshall *et al.*, 2010). Loss of functional reserve includes declining cardiovascular and respiratory fitness (Chen *et al.*, 2014). In our practice we see two main populations of aged patient: the thin, frail pet with poor muscle coverage and reduced appetite and the obese, unfit pet with or without concurrent disease. In both cases, the scales are tipped in the favor of morbidity and a small problem such as a low-grade bladder infection can be enough to result in a marked increase in weakness.

Caring for the aged pet at home involves supporting comfort and mobility. Comfort is addressed in many ways, from adequate footing and bedding, foot and nail care and managing weight, to providing pain relief. Moving water dishes or adding water sources near to where a patient is resting can help to maintain adequate water intake. Placing a mat in the kitchen where the pet eats can provide better traction and so eliminate some discomfort when eating. Raising the food bowl height can also improve comfort and ensure standing during eating (a good strengthening exercise). Mobility aids range from home environment modifications (ramps and steps to furniture, blocking off difficult stairs) to patient modifications (toe grips, harnesses).

Nursing care includes bowel and bladder care; keeping skin clean and unsoiled is important. Sometimes elderly pets need to eliminate more frequently and so require outside access more often. A geriatric pet may not be able to hold their tail up fully when eliminating, and may contaminate their skin. Posturing to eliminate may be difficult and so full evacuation may not occur, which predisposes to bladder infections and constipation. Mobile disabled cats may have trouble getting into a normal litter box and so using a low-walled structure such as a baking pan can provide easier access. Anal sacs may become full and uncomfortable from chronic inadequate expression. Owners need to be counseled about subtle signs to look for, areas of skin to check, and tell-tale signs of problems such as urinary tract infections. Improving the quality of life in the geriatric pet is often about the little things. Just having a weak, old pet stand still for a minute can improve stamina, cardiac output, and respiratory function.

Modifying the Home Environment

As stated earlier, environmental enrichment is very important. Home modifications may or may not be necessary to aid mobility depending on pet size and the amount of assistance needed. Preventing slipping in low traction areas is necessary. A simple solution is rugs or runners placed on the floor surface. Ensure that the rug grips the floor and does not slide with the pet. Inexpensive mats and runners are available from home improvement stores. Confining the disabled patient is strongly advised when supervision is not available. A small room with high traction flooring and low to no furniture is ideal if the patient has some mobility. Yoga mats can provide temporary flooring with grip. A crate or kennel is advised for pets with inadequate or no motion in the rear limbs who pull themselves around dragging the rear ("scooting"). This confinement helps to avoid the scooting motion becoming the "normal" efficient gait for the pet, so reducing motivation to ambulate on four legs, even with assistance. Baby gates can be used to prevent access to stairs and to confine a pet to a small room. Higher barriers, such as a screen door, may be needed for larger and stronger pets. Ramps can be useful if a home has just a few stairs and also can be used for getting into the car. Be cognizant of the incline and

Box 13.3 Guide to caregiving at home

- Make a handout with pointers to help caregivers at home. Recruit previous clients for tips
- Include bowel and bladder care, bedding and hygiene advice
- Add helpful hints – "keep paper towels in every room for quick clean-up"
- State when a caregiver should contact the clinic for red flags such as bed sores

choose a suitable length of ramp. Carts are a great way of improving patient mobility, however owners need to be mindful of the width of the cart and wheels compared to the home hallways and potential limitations of actual space needed to maneuver a cart in the home. It may be better for carts to be used outside only.

Other owners of disabled pets are a great resource for home care tips. In our clinic we asked owners of long-term disabled pets to help us to prepare an "at home" guide to caregiving. This helped us to gain a fresh perspective and we prepared a handout for owners (Box 13.3).

Respite care is the provision of short-term accommodation in a facility outside the home in which a loved one may be placed. This provides temporary relief to those who are caring for family members, who might otherwise require permanent placement in a facility outside the home. Finding such a facility for a disabled pet can be a challenge. We have one boarding facility in our large metro area that provides the necessary level of care; the alternative is in a veterinary clinic. This highlights the need for more pet boarding facilities with nursing capacity.

Administering Medications to the Disabled Patient

Administering pills can be as simple as putting in them in the food bowl with daily rations, but sometimes giving medication can be extremely challenging. Some pets can be very creative at avoiding actually swallowing their medicine. Custom treats designed to mask a pill can be useful. An alternative is to hide the pill in tasty people food. One thing many people do not know is that fat masks taste: a bitter pill may be easier to give in cheese or peanut butter (take care regarding patients sensitive to fats, such as those prone to pancreatitis). Liquid formulas can help. Medications can also be compounded into chewable taste tablets in some cases. Whole foods stores and coops often sell gel capsules that can be used to disguise a nasty-tasting pill. We often recommend giving two treats – the first treat is untainted by a pill and the second treat contains the medication. This way the pet may be less suspicious. It is best to follow a pill with water or food (especially one administered alone without a treat) in order to ensure that the pill does not remain in the esophagus, causing irritation. This is a particular issue with cats but may also be a problem in disabled pets who are immobile and unable to prop themselves up for long periods. A colleague administers pills to cats by following them with a "chaser" of water dripped into the mouth from a gauze sponge, which induces swallowing. If owners can restrain their cat then this is an excellent method of administration. With dogs, a snack is usually enough following pill administration.

Medication schedules can be challenging for many owners; your supervising veterinarian needs to take this into account. Some medications can be administered 2–3 times daily and maybe the middle day dose has to be skipped on some days due to work or life schedules. Choosing a pain medication takes into account many factors, one of which should be ease of administration at home, including caregiver schedule. This improves compliance. Making a medication chart that can be checked off or initialed when medications are given is a good idea in a situation where multiple caregivers are involved. Pill cases with daily cups that can be filled for a week at a time can also help. These pill cases can be purchased for once, twice, or three times a day dosing. Both charts and weekly pill cases can help to prevent double dosing. Sometimes medication will need to be given in injectable form. Caregivers can be taught to administer subcutaneous injections at home, using sterile saline for practice during teaching sessions. A daily dosing chart is advised.

Side-effects vary with each medication and caregivers should be given detailed information any about potential side-effects related to the patient's medications. In the case of rehabilitation patients, the primary care veterinarian, specialist veterinarian, and supervising rehabilitation veterinarian may have all prescribed medications. The patient record needs to be kept up to date with all medications and any medication changes or dosage changes. This way any veterinarian involved in the case will be aware of potential side-effects and interactions. As the supervising rehabilitation veterinarian will see the patient on the most frequent basis during in-clinic rehabilitation, this is the person best suited to manage and oversee all medications, and to make changes regarding pain management or other concerns. The rehabilitation veterinarian will always keep the primary care veterinarian informed of any changes.

As a side note, it is best to avoid changing medications just before a weekend, when the clinic staff are not easily available to answer questions about medications and potential side-effects. The emergency veterinarian on duty may not be familiar with the case.

In-Home Hospice Care

Hospice care at home is nursing care for a patient in the final stages of life or a disease process that will end in loss of life. Caregivers of disabled pets will be already equipped to provide for their pet's needs when the end of life is near as they have been previously providing nursing care, often including bowel and bladder care. Practical and

Box 13.4 Compassion fatigue

Compassion fatigue is fatigue, emotional distress, or apathy resulting from the constant demands of caring for others. For more information and resources visit www.compassionfatigue.org

emotional support through home visits from veterinarians is variably available. The International Association for Animal Hospice and Palliative Care can provide more details (www.iaahpc.org) (Box 13.4).

Remember that even if it is no longer feasible to transport the pet for regular in-clinic care, recheck visits every 2–3 weeks can be a big help to aid home care. Providing support via telephone or email can bridge some of the gap between visits (though no veterinarian can make a full diagnosis without the patient present, ongoing care can be provided remotely to some extent).

Conclusions

Nursing care is a large portion of the rehabilitation veterinary technician's job. As an animal's nurse you are their advocate and care provider both in clinic and at home through your education of the primary caregiver and their family. A successful rehabilitation plan should always include consideration of the home environment and necessary adaptations and nursing care.

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Resources

Back on Track heat reflective mesh sheet or blanket (www.backontrackproducts.com)
Chillow. Soothsoft Innovations (www.chillow.com)
Discount ramps (www.discountramps.com)
Pill Pockets (www.greenies.com)
Pill Pals (https://www.henryscheinvet.com)

14

Modalities Part 1: Thermotherapy

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CHAPTER MENU

Introduction

Thermotherapy consists of application of heat or cold (cryotherapy) for the purpose of changing the cutaneous, intra-articular, and core temperature of soft tissue with the intention of improving the symptoms of certain conditions. Thermotherapy is a useful adjunct for the treatment of musculoskeletal injuries and soft tissue injuries. Using ice or heat as a therapeutic intervention decreases joint and muscle pain. Heat and cold have opposite effects on tissue metabolism, blood flow, inflammation, edema, and connective tissue extensibility. Thermotherapy can be used in rehabilitation facilities or at home (Brosseau *et al.*, 2003; Nadler *et al.*, 2004; Hurley and Bearne, 2008; Petrofsky *et al.*, 2013a).

Purpose

The goal of thermotherapy is to alter tissue temperature in a targeted region over time for the purpose of inducing a desired biological response. The majority of thermotherapies are designed to deliver the thermal therapy to a target tissue with minimal impact on intervening or surrounding tissues. The use of superficial thermal agents aims to decrease pain, alter blood supply (e.g., reduce swelling), and temporarily

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change tissue properties (e.g., extensibility). Extensibility means that muscles can be stretched to their normal resting length and beyond to a limited degree. They are often the most convenient modalities as they are readily available, involve minimal expense, and are frequently safe to use as part of a home treatment program (Niebaum, 2013). The primary goal of any thermal modality is to facilitate the rehabilitation plan of regaining maximal function (Dragone *et al.*, 2014).

Heat

By increasing the temperature of the skin/soft tissue, the blood flow increases by vasodilatation. Heat increases oxygen uptake and accelerates tissue healing. It also increases the activity of destructive enzymes, such as collagenase, and increases the catabolic rate (Kellogg, 2006) (Boxes 14.1 and 14.2).

Cold

By decreasing the temperature of the skin/soft tissue, the blood flow decreases via vasoconstriction. It will be followed afterwards by a vasodilatation. Tissue metabolism temporarily decreases under the influence of cooling affecting neuronal excitability, inflammation, and conduction rate (Boxes 14.3 and 14.4). Tissue extensibility also decreases under the influence of cooling due to increased tissue viscosity and decreased mobility of non-elastic tissues (Petrofsky *et al.*, 2013b). At joint temperatures of 30 °C (86 °F) or lower, the activity of cartilage-degrading enzymes, including collagenase, elastase, hyaluronidase,

Box 14.1 Effects of local application of heat – decreases

Local application of heat decreases:

- Blood pressure (if heat is applied for a prolonged time or over a large surface area)
- Muscle spasm
- Pain

Source: Adapted from Hayes (1993).

Box 14.2 Effects of local application of heat – increases

Local application of heat increases:

- Body temperature, respiratory rate, and heart rate if heat is applied for a prolonged time
- Capillary pressure and permeability (which can promote edema)
- Leukocyte migration into the heated area
- Local circulation (promoting healing in subacute and chronic inflammation)
- Local metabolism
- Muscle relaxation
- Tissue elasticity

Source: Adapted from Hayes (1993).

Box 14.3 Effects of local application of cold – decreases

Local application of cold decreases:

- Blood flow because of vasoconstriction
- Edema formation
- Hemorrhage
- Histamine release
- Local metabolism
- Muscle spindle activity
- Nerve conduction velocity
- Pain
- Spasticity
- Response to acute inflammation or injury

Source: Steiss and Levine (2005). Reproduced with permission of Elsevier.

Box 14.4 Effects of local application of cold – increases

Local application of cold increases:

- Connective tissue stiffness (with decreased tensile strength)
- Temporary muscle viscosity (with decreased ability to perform rapid movements)
- Activation threshold of tissue nociceptors

Source: Millis (2015). Reproduced with permission of Elsevier.

Table 14.1 Pathophysiologic effects of topical modalities.

	Heat	Cold
Pain	↓	↓
Spasm	↓	↓
Metabolism	↑	↓
Blood flow	↑	↓
Inflammation	↑	↓
Edema	↑	↓
Extensibility	↑	↓

↓ = decrease; ↑ = increase.
Source: Adapted from Nadler *et al.* (2004).

and protease, is inhibited. The decreased metabolic rate limits further injury and aids the tissue in surviving the cellular hypoxia that occurs after injury (Bleakley *et al.*, 2004; Hubbard and Denegar, 2004) (Table 14.1).

Types of Thermotherapy

Heat

Heating agents are classified as superficial or deep heating. Superficial heating agents penetrate up to approximately 2 cm depth, whereas deep heating agents elevate tissue temperatures at depths of 3 cm or more (Steiss and Levine, 2005). Heat sources are classified as radiant, conductive, or convective. An infrared lamp is an example of a radiant superficial heating device, a hot pack is an example of a conductive superficial heating device, and a whirlpool is an example of moist heat delivered by conduction and convection.

Superficial Heat

Superficial heating agents may include: hot packs, heat wraps, hosing with warm water, whirlpools, paraffin baths, circulating warm water blankets, electric heating pads, and infrared lamps (Dragone *et al.*, 2014). Another common form of superficial thermotherapy is heated beds for dogs, which have been used for comfort or conditions such as arthritis (Box 14.5).

Box 14.5 Indications for heat therapy

- Subacute and chronic traumatic and inflammatory conditions
- Decreased range of motion attributable to stiffness and/or contracture (basis for the principle of "heat and stretch")
- Pain relief, because heat may render sensory nerve endings less excitable

Source: Steiss and Levine (2005). Reproduced with permission of Elsevier.

Deep Heating

Deep heating agents include therapeutic ultrasound and shortwave diathermy. Diathermy is a therapeutic treatment most commonly prescribed for joint conditions such as rheumatoid arthritis and osteoarthritis. In diathermy, a high-frequency electric current is delivered via shortwave, microwave, or ultrasound to generate deep heat in body tissues (Giorgi and Crucik, 2013). It is unknown to this author if diathermy is used in veterinary medicine. The patient would need to be very still because movement can change amount of heating. Therapeutic ultrasound is dealt with in detail in Chapter 16.

Superficial Heating Agents

Hot Packs Hot packs come in a variety of sizes and shapes. They can be heated sacks with a canvas covering that may be filled with cracked corn, beans, bentonite (hydrophilic silicate gel), or other inert materials. Other hot packs are electric heating pads, damp microwaved towels, or circulating warm water blankets (Box 14.5).

Water Water may be applied directly to the area being treated. Towels heated with warm water may be used, or the affected segment may be immersed in a warm water bath or a whirlpool. If a whirlpool is chosen, be mindful that systemic heating with a warm bath may decrease blood pressure and increase the heart rate (Dragone *et al.*, 2014). Whirlpools have the advantage of also providing increased hydrostatic pressure to submerged body parts, which may reduce edema. Increased hydrostatic pressure helps to increase lymphatic and venous flow from a distal to proximal direction. The temperature of a whirlpool is based on the needs of the individual animal. For example, patients with chronic conditions may be treated with warmer water than patients with more acute disorders.

A system employed by Dr. Rick Wall at The Center for Veterinary Pain Management and Rehabilitation (Woodlands, TX, USA) is bioelectric whirlpool therapy. This is a treatment combining the benefits of hydrotherapy using VetSystem's™ warm water whirlpool and the pain management benefits of electrical stimulation using ASP's Omnistim 500 Pro®. When the two are combined it gives a time-saving full-body treatment. This offers an avenue in providing pain relief and shortened recovery times for a variety of conditions. In their clinic, with a combination of physical medicine, the bioelectric whirlpool has assisted in the treatment of animals recovering from orthopedic joint surgeries, osteoarthritis, edema, chronic pain, and acute injuries such as sprains, tears, and muscle fatigue. The warm water and jets from the whirlpool deliver a comfortable massage to the animal, increasing blood flow, promoting endorphin release and general relaxation (Figures 14.1–14.3).

Paraffin Baths This procedure is uncommon in veterinary medicine because it is messy. Details can be found in Rothstein *et al.* (2005).

Infrared Lamps Infrared lamps emit infrared light that penetrates the skin to promote increased blood flow and circulation. This method of thermotherapy is used to warm large areas of the body. The lamps are positioned 30–40 cm from the affected area. The therapist should place his or her hand under the heat lamp for several minutes at the desired height to be sure that the temperature is comfortable. Because the patient needs to remain stationary during treatment, this method of heating is uncommon (Dragone *et al.*, 2014).

Ceramic Agents Some products use ceramic to reflect the wearer's body heat and so warm a body part. Back on Track® products are used to keep muscles warm in canine or equine athletes, but are also used for the symptomatic relief of painful stiff joints. These products are made from a fabric which contains polyester thread embedded with a fine ceramic powder. They have been used in the authors' clinic to keep the muscles of

Figure 14.1 Whirlpool bath control. *Source:* Courtesy of Kari Koudelka.

Figure 14.2 Vet Systems whirlpool bath and control. *Source:* Courtesy of Kari Koudelka.

Figure 14.3 Kari Koudelka with a patient in the Bioelectric Whirlpool.

athletic dogs warm between activities and some clients have reported pain relief for their older dogs when wearing the products. The company claim that the reflection of body heat is through far-infrared waves.

It has been claimed that far-infrared waves (Masuda *et al.*, 2005; Yu *et al.*, 2006):

- increase blood circulation and oxygen supply to tissues,
- reduce inflammation and swelling in muscles and joints,
- ease muscle pain and tension,
- speed up the healing process, and
- warm the muscles prior to exercise, thereby reducing the risk of strain and injury.

Cryotherapy

Cryotherapy is the therapeutic application of cold in rehabilitation and physical therapy. Cold can be applied through a variety of mechanisms including cold packs, ice massage, cold water baths, mechanical and electrical compression units, and vapocoolant sprays. Cryotherapy can be used throughout the rehabilitative process to

Box 14.6 Indications for cold therapy

- In animals with acute injury, rest and ice can be readily used. Application of cold to minimize postsurgical swelling is also recommended
- The reduction in pain and inflammation with cryotherapy may lead to increased range of motion in affected joints
- Local cold application may reduce spasticity in spinal cord disorders
- Cooling may inhibit the extension of tissue damage with thermal burns, with greatest benefit occurring when a coolant is applied immediately after burn injury

Source: Hanks *et al.* (2015). Reproduced with permission of Elsevier.

mitigate negative effects of inflammatory responses (Hanks *et al.*, 2015). The sensations reported by people after ice application are an initial sensation of cold followed by burning, aching, and eventual numbness (Rintamäki, 2007). Cold penetrates deeper and lasts longer than heat because of the decreased circulation resulting from cold application (Steiss and Levine, 2005). The primary method of providing physical control of pain and inflammation in the immediate postoperative period is cryotherapy (e.g., application of ice). Cryotherapy is used during the acute phase of tissue injury and healing to mitigate the effects of tissue injury. Cryotherapy is also used after exercise during rehabilitation to minimize adverse secondary inflammatory responses (Millis, 2004) (Box 14.6).

Cryotherapy may be achieved by the following physical mechanisms (Dragone *et al.*, 2014):

- Conduction (ice/cold packs, iced towels, ice massage, contrast bath, cold compression units)
- Convection (cold baths)
- Evaporation (vapocoolant sprays).

Cryotherapy Agents

Ice or Gel Packs Examples of ice packs/cold packs are crushed ice placed in a moist towel; a plastic bag wrapped in a moist towel; or water and rubbing alcohol of a 3:1 ratio in a sealed plastic bag and placed in a freezer (this should result in a slush-type consistency) (Burnett and Wardlaw, 2012). When using a plastic bag filled with ice or a gel pack, cover it before application with a thin, wet layer of fabric to improve temperature exchange between the tissue and cold agent. Do not use a thick layer of fabric, such as a towel or blanket, because therapeutic temperatures may not be reached in deep tissues.

Ice Massage Freezing water in cups or any other form of cylinder can be used to form an ice massage medium. To apply the massage, the therapist holds onto the cup, exposes the ice surface, and puts it in direct contact with the patient's skin. Treatment time is generally 5–10 minutes or until the affected area is erythematous, slightly pink or red, and numb (assess by pricking with a small gauge needle). This technique can be useful for small, irregular areas (Dragone *et al.*, 2014). Ice popsicles can also be made by placing a handle, such as a tongue depressor, into the water before freezing. The general recommendation for treatment duration is 5–10 minutes (Niebaum, 2013).

Towels in Ice Water Multiple towels must be used because a single towel will not maintain adequate therapeutic temperatures long enough to be effective. An effective method of using towels is to immerse two towels in ice water and alternate application when the towel being used becomes too warm for therapeutic effectiveness (Bockstahler *et al.*, 2004).

Contrast Baths This technique is used by alternating cold and warmer water. It is generally used to decrease edema because of the alternating vasoconstriction and vasodilation. An example of this would be immersion in the cold water for 3 minutes and then immersion in warm water for 1 minute (Dragone *et al.*, 2014). The treatment therapy should end with cold.

Cold Compression Units These devices are commercially available and use a combination of controlled pressure with a continuous flow of cold water to help minimize swelling and pain postoperatively. The device usually consists of a sleeve with tubing running throughout that alternately circulates cold water and air. The combination of compression and cooling is effective in treating tissues in the acute phase of healing. An example of such a unit is the Game Ready®. This technology was developed for canine and equine patients from a human technology. Detailed information can be found at www.gamereadyveterinary.com/ (Figure 14.4).

Cold Bath/Immersion In this type of application, the patient typically stands with the affected limb immersed in a container of cold water at 2–16 °C (35–60 °F), and the treatment generally lasts for 10–20 minutes. Rapid and significant tissue cooling occurs, but is difficult to apply because of poor patient compliance (Hanks *et al.*, 2015). This therapy is used more frequently with horses, especially for soaking feet that are possibly laminitic. Andrew Van Eps and Christopher Pollitt studied the best methods for adequately cooling the feet of at-risk horses (Van Eps and Pollitt, 2004). It is generally accepted that cold therapy should be continuous for 48–72 hours during the entire developmental phase and for another 24 hours beyond the end of clinical signs of the primary disease. It is important to include the foot, pastern, fetlock, and distal cannon region in the cold therapy for the best results and to maintain intimate cold contact with the limb to achieve therapeutic temperature ranges (Figure 14.5).

The suggested range for therapy is from 5 to 10 °C (41–50 °F). To achieve intimate contact, crushed ice is preferable to ice cubes. Ice wraps were not suitable because of their size and the air space created between the wrap and the leg. Dry cold therapy provided by a Game Ready® Equine system (CoolSystems Inc.) provided the most intimate contact and also provided intermittent pressure that may aid in blood and lymphatic flow. Treatment should continue 24 hours beyond resolution of the primary disease. New studies are demonstrating the benefit of cryotherapy in the early acute phase (Hyman, 2015).

Vapocoolant Sprays These sprays are used for a brief and rapid effect when applied to the skin. An example is ethyl chloride spray. This can be a difficult modality to apply to dogs because of the hair covering

Figure 14.4 Game Ready System cryotherapy and compression unit.

Figure 14.5 Boot for cryotherapy in a horse. *Source:* Courtesy of Dr. Chris Pollitt.

the skin surface. Also, some of the commercially available sprays may be harmful to animals if they contact an animal's eyes or are ingested. They are used in humans for treating myofascial trigger points (Dragone *et al.*, 2014). They are excellent for venipunctures once the skin has been shaved.

Mechanism of Action

Skin blood flow is controlled by two branches of the sympathetic nervous system: a noradrenergic vasoconstrictor system and a cholinergic active vasodilator system (Charkoudian, 2003). These dual sympathetic neural control mechanisms affect the major aspects of thermoregulatory responses over most of the body's surface. During periods of hypothermia, falling core and skin temperatures lead to reflexive increases in sympathetic active vasoconstrictor nerve activity to reduce skin blood flow and conserve body heat (Sluka *et al.*, 1999). During periods of heat stress, increasing core and skin temperatures lead to reflexive increases in sympathetic active vasodilator nerve activity to increase skin blood flow (Charkoudian, 2003). Heat has an analgesic effect via heat-sensitive calcium channels, which respond to heat by increasing intracellular calcium. This generates action potentials that in turn increase stimulation of sensory nerves, causing the feeling of heat in the brain. These channels are part of a family of receptors called TRPV receptors. TRPV1 and TRPV2 channels are sensitive to noxious heat, while TRPV4 channels are sensitive to normal physiological heat (Holowatz *et al.*, 2005). Their multiple binding sites allow a number of factors to activate these channels. Once activated, they can also inhibit the activity of purine pain receptors (Liu and Salter, 2005). These receptors, called P2X2 and P2Y2 receptors, are mediated pain receptors and are located in the peripheral small nerve endings. For example, with peripheral pain, heat can directly inhibit pain. However, when pain is originating from deep tissue, heat stimulates peripheral pain receptors which can alter what has been termed "gating" in the spinal cord and reduce deep pain.

Studies have suggested that temperature can affect the exchange between Ca^{2+} and Na^{+} in neural cells (Swenson *et al.*, 1996). An increase in both pain threshold and pain tolerance with the use of cooling has been documented. Increased superficial tissue temperature results in the release of chemical mediators such as histamine and prostaglandins, which results in vasodilation and increased blood flow in some tissues. These vasodilatory mechanisms do not significantly affect blood flow in skeletal muscle since skeletal muscle blood flow is heavily influenced by other physiologic and metabolic factors. Exercise is the best means to increase blood flow to skeletal muscle.

Physiologic Effects

Many of the local physiologic effects of heat and cold have been studied thoroughly. Heat increases skin and joint temperature, improves blood circulation and muscle relaxation, and decreases joint stiffness. Cold numbs pain, decreases swelling, constricts blood vessels, and blocks nerve impulses to the joints (Oosterveld and Rasker, 1994; Sluka *et al.*, 1999; Brosseau *et al.*, 2003).

Deep heating, such as through thermal ultrasound (Dorn, 2015), is thought to lessen nerve sensitivity, increase blood flow, increase tissue metabolism, decrease muscle spindle sensitivity to stretch, cause muscle relaxation, and increase flexibility. Heat stimulates the cutaneous thermoreceptors that are connected to the cutaneous blood vessels, causing the release of bradykinin, which relaxes the smooth muscle walls resulting in vasodilation. Muscle relaxation occurs as a result of a decreased firing rate of the gamma efferents (sending signals away from the central nervous system), thus lowering the threshold of the muscle spindles and increasing afferent activity. There is also a decrease in firing of the alpha motorneuron to the extrafusal muscle fiber, resulting in muscle relaxation and decrease in muscle tone (Prentice, 1982; Peres *et al.*, 2002).

Veterinary Evidence for Both Hot and Cold Therapy

Evidence-based medicine for veterinary physical rehabilitation comments that heat is used to increase blood flow, increase collagen extensibility, and perhaps provide some mild analgesia (Millis and Ciuperca, 2015). A study of 10 healthy dogs that measured tissue temperatures measured at various depths of the lumbar, epaxial region found that application of a warm compress should be performed for 10 minutes (Millis and Ciuperca, 2015).

Cryotherapy is often applied in the early postinjury or postoperative period to reduce blood flow, inflammation, swelling, and pain (Swenson *et al.*, 1996). Skin and superficial tissues are cooled to the greatest extent. Deeper tissues have a gradual decrease in tissue temperature during time exposed to cold. Rewarming after removal of the cold/ice pack is slower in deeper tissues. The rewarming rate of tissues depends on the duration of therapy and type of cryotherapy application. The greatest decrease in intra-articular temperature in dogs occurred with ice water immersion (Bocobo *et al.*, 1991). Rewarming of the canine stifle also took the longest after ice water immersion. The application of 10–20 minutes of ice water immersion caused a further significant temperature change at only the middle tissue depth; however, for maximal cooling, the minimum time of application should be 20 minutes. For postoperative extracapsular repair for cranial cruciate ligament rupture, cold compression and cold compression with bandaging were found to be equally beneficial in reducing stifle swelling in the first 72 hours. Cold compression was applied for 20 minutes by wrapping the leg from the stifle to the hock with a large cold pack and holding it in place with an elastic bandage once daily. Commercial canvas packs kept in a freezer or Ziploc® bags of ice wrapped in a towel are often used for 10–20 minutes every 6–8 hours while the patient is hospitalized (Corti, 2014).

General Recommendations for Heat

Heat should be applied for no more than 15–20 minutes at a time. Hot packs are relatively safe because they cool during treatment, minimizing the risk of burns. Padding is applied around the pack. The pack retains heat for approximately 30 minutes. The heat is absorbed mostly by the skin and subcutaneous fat. Wrapping of the hot pack with a towel or drape material is essential so the pack does not come in direct contact with the patient's skin. Heat wraps are marketed for people. Some products provide up to

Box 14.7 Contraindications for thermotherapy

- Electric heating pads and infrared lamps have a higher risk of burns. Electric heating pads should never be placed under an anesthetized patient or a patient with decreased superficial sensation. In general, a patient should never be left unattended during treatment, and the skin should be monitored frequently
- Do not use heat in an actively bleeding patient
- Acute inflammation
- Cardiac insufficiency
- Decreased impaired circulation in the area to be treated (to avoid overheating)
- Neurologic patients may not feel that it is becoming too hot
- Fever
- Malignancy
- Poor body heat regulation
- Pregnancy

Source: Batavia 2004. Reproduced with permission of Elsevier.

8 hours of continuous low level heat and could be used for small animals. Whirlpools have the advantage of also providing increased hydrostatic pressure to submerged body parts, which helps to increase lymphatic and venous flow from a distal-to-proximal orientation. Agitation within a whirlpool decreases the thermal gradient so that the temperature of the water in the tank is consistent throughout. The temperature of a whirlpool is based on the needs of the individual animal. For example, patients with chronic conditions may be treated with warmer water than patients with more acute disorders.

Precautions when Using Thermotherapy

Test the temperature of the modality you want to use or have the client test the temperature before applying to their pet. Heat packs especially can vary in temperature depending on ambient conditions. There is risk of overheating in dogs immersed in a heated whirlpool. They should be observed and their rectal temperature measured if in doubt. If there is reduced sensation because of nerve damage or even patient compromise in reaction time (sedation, reduced cognition), then caution should be used. Long-haired animals may heat less quickly than short-coat or clipped patients. A hot or cold pack can be heavy when placed on the animal, so check for this by watching respirations or if the patient becomes irritable. In some instances, the pack can be placed under the area to be treated. Seek the advice of the supervising veterinarian if there are open or infected wounds (Box 14.7).

General Recommendations for Cold

A general rule for deciding when to apply cold versus heat is that cryotherapy should be used for the first 24–72 hours after acute injury when the acute signs of inflammation are present (swelling, redness, heat, and pain) (Steiss and Levine, 2005). If in doubt, use cold. If range of motion is decreased because of pain, apply cold; if range of motion is decreased because of stiffness, apply heat. Ice packs should be covered with a single layer of wet towel (moisture enhances heat exchange) or nothing between the skin and the ice pack. Otherwise, therapeutic temperatures may not be reached. Apply ice packs for up to 10–20 minutes. The duration may vary for different types of commercial ice packs. The recommendations on how often to apply ice vary. It is recommended not to apply cold to open wounds after 48–72 hours because of the vasoconstriction that occurs with cryotherapy. The supervising veterinarian should be asked for instructions concerning application of cold to individual patients.

Box 14.8 Contraindications for cryotherapy

- If there is a history of frostbite to the area, further cold application is contraindicated
- Cold should not be used in animals with generalized or localized vascular compromise or who possess an impaired thermoregulatory capacity

Precautions for Cold Therapy

The primary precaution is avoidance of frostbite. To be safe and to avoid prolonged application, use a timer and inspect the skin every few minutes. Observe for signs of frostbite during and after cryotherapy application (Millis, 2015).

Caution should be exercised when applying cryotherapy around superficial peripheral nerves because cases of cold-induced nerve palsy of the ulnar and superficial peroneal nerves have been reported in humans (Fox, 2014). Use caution in applying cold over open wounds, areas of poor sensation, or in very young or old dogs (Box 14.8).

A Word About Cats

Often it is assumed that cats will not tolerate rehabilitation due to temperament, lifestyle, or age. In fact, cats respond well to rehabilitation techniques, and often enjoy the mental stimulation of therapeutic exercise, stretching, and massage in the hospital and at home (Wright and Rychel, 2013).

Cryotherapy can be applied to regions of inflammation, particularly with an acute or chronic injury, to reduce hyperalgesia and slow local metabolism (Sluka *et al.* 1999). Heat therapy is also valuable, and often appreciated by feline patients. Application of a superficial hot pack over a tense muscle or region of chronic discomfort can help ease muscle spasm, improve blood flow, and reduce pain-associated behaviors (Sluka *et al.*, 1999; Lane and Latham, 2009).

Heat for Cats

Most cats like the application of heat, especially the use of infrared lamps, whereas the use of hot packs is sometimes difficult because cats often object to lying quietly with a hot pack on a joint or the back (Drum *et al.*, 2015). Many sociable cats prefer to lie in a lap or be held while hot packs are applied. A swaddling technique with a towel is useful as a low-stress restraint technique for hot-pack application.

Cold for Cats

It may be difficult to place the cold pack on the target area because cats sometimes refuse to lie quietly for more than a few minutes. Nevertheless, the therapist should try to use cold, especially in the early phase after surgery.

Conclusion

Selection of the appropriate modality depends largely on an understanding of the diagnosis, an accurate assessment of the stage of tissue healing and repair, an accurate clinical assessment of the functional limitations, the established treatment goals, and continued reevaluation of the patient. The physical rehabilitation therapist/practitioner will be the one deciding which therapy should be applied and when. The rehabilitation veterinary technician/nurse will be carrying out the instructions that the veterinarian provides. Cryotherapy is most useful during the acute inflammatory stages of tissue healing to cause vasoconstriction and to decrease edema and pain (Hanks *et al.*, 2015). Using heat too soon in the inflammatory process may exacerbate the inflammatory process and slow healing. Heating modalities (both superficial and deep) are most commonly used to cause vasodilation and increase tissue extensibility, and to decrease pain and muscle spasm (Hanks *et al.*, 2015).

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15

Modalities Part 2: Laser Therapy

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CHAPTER MENU

Introduction

Lasers were first used surgically in high doses to cut or seal tissue. The first report of lasers used for a biomodulatory (therapeutic) purpose was in 1963, by a team of researchers in Boston (Tunér *et al.*, 2007). This group used a laser to shrink tumors in hamsters, but the mechanism of this action was unknown. Shortly thereafter, Endre Mester, a Hungarian scientist, published several reports describing the ability of lasers to promote cutaneous wound healing in rats. It was also observed at this time that too little laser radiation would produce no effect and too much would be detrimental to healing. In 1967, Carney *et al.* showed that irradiation of skin tissue cultures resulted in increased collagen production. Thousands of others reports have since been published, both supporting and refuting the effects of laser therapy. It is only recently that therapeutic lasers have gained wide recognition in veterinary medicine.

The purpose of this chapter is to describe basic laser physics, discuss the mechanisms behind "photobiomodulation" (modifying a biologic process by application of light), and describe the practical use of lasers in veterinary rehabilitation patients.

Laser Physics 101

Lasers, along with the sun, ordinary light bulbs, x-ray machines, and microwave ovens, emit electromagnetic radiation. Energy from these sources travels at the speed of light in packets known as photons. Photons travel in

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waves, not unlike sound waves, and the type of radiation is distinguished by its wavelength. Electromagnetic radiation is typically described as a spectrum from very short (gamma rays, 1000–1 fm) to long (radio waves, 1000–1 m) wavelengths. In the middle of this spectrum lies visible light (400–800 nm) and infrared (1000–0.8 μm), and laser radiation falls within these wavelengths (Tunér *et al.*, 2007).

Laser is an acronym for "light amplification by stimulated emission of radiation." In this process of light amplification, electromagnetic energy is harnessed into an intense, coherent, monochromatic beam of light. The properties of monochromaticity (all waves are same length/color) and coherence (all waves in phase) are characteristics of all lasers. This is in contrast to light-emitting diodes (LEDs), which do not emit coherent light. The biomodulatory effects of lasers are believed to be due, in part, to their coherence, but there is some limited evidence to suggest that LEDs are as effective as lasers in photobiostimulation (Lubert *et al.*, 2000).

A laser is made using a material (gas, liquid, solid) that when stimulated by an external energy source, such as electricity, will release photons of a single color or wavelength. For example, a helium–neon (HeNe) laser will emit only wavelengths of approximately 633 nm, which fall within the visible light spectrum and produce the color red. Gallium arsenide (GaAs) lasers emit wavelengths of 904 nm, and are thus invisible within the infrared portion of the spectrum.

It is important to note that wavelength is inversely proportional to energy. This can be appreciated by recognizing differences between harmless radio waves (long wavelength, low energy) and gamma rays that are used in cancer radiation therapy (short wavelength, very high energy). Wavelengths between 300 and 400 nm represent UVA and UVB rays (Tunér *et al.*, 2007). These rays possess dangerous ionizing properties that cause sunburn. The wavelengths of therapeutic lasers typically all fall between 650 and 980 nm (Tunér *et al.*, 2007).

Therapeutic lasers are commonly referred to as "low-level lasers" or "cold lasers," in contrast to high-powered lasers that are used to cut tissue. Therapeutic or low-level lasers have a power output less than 500 milliwatts (mW) and cannot cut tissue. Power output is significant, because a laser with a higher wattage will reach the desired dose more quickly. Among low-level lasers, power output (watts, W) varies greatly, anywhere from 3.5 mW to 500 mW. Lasers with power output greater than 500 mW (typically as high as 10 W) are available as therapeutic lasers. These lasers are not considered "low-level" or "cold lasers" because they have the capacity cause considerable tissue heating.

There are several other parameters that can differ between lasers. Lasers can be continuous or pulsed. When a laser is pulsed, the power output will reach a peak and return to zero at varying frequencies (Hz), or duty cycles. Therefore, the amount of power delivered will be the average power output.

Power density, or intensity, is the amount of power concentrated on a given area and is measured in W/cm^2. If the laser beam is spread over a larger area (larger spot size), the amount of energy at each point becomes less, compared to concentrating the energy at a single, small point (Mester *et al.*, 1968). This will be influenced by the beam diameter (mm) and spot size (cm^2) that are specific to each laser.

Laser Classes

Lasers are divided into four safety classes with additional subclasses (I, II, IIIa, IIIb, and IV). A common misconception is that these classes distinguish the efficacy or quality of the laser. Rather, laser class is determined by the ability to cause eye injury and is based on power output, parallelism, diameter of beam, exposure time, and wavelength. Class I–IIIa lasers include supermarket scanners, laser pointers, and remote controls. Class IIIb lasers pose a risk of eye injury, and eye protection is recommended (Mester *et al.*, 1968).

Any laser with greater than 500 mW of average power falls into class IV, which is considered to be an acute hazard to the skin and eyes from direct and scattered radiation.

Dosage (also known as energy density or fluence) appears to be the most important laser parameter in clinical application. Dosage is measured in joules per centimeter squared (J/cm^2), and can be calculated using the following formula:

$$\text{Dose} = \frac{P \times t}{A}$$

where P is the laser's output power (W), t is treatment time (seconds), A is area treated (cm^2), and 1 joule = 1 W/s.

The usefulness of this formula is evident: By adjusting treatment time in relationship to a laser's output power, a practitioner can deliver the intended dosage. However, it should not be assumed that this relationship is linear; that is, faster delivery of an intended dose may not always equate with the same outcome as the equivalent amount of energy delivered over a longer period of time. This is an area of research that will have important implication in veterinary patients.

Lasers that are available commercially and marketed for medical or veterinary use will likely come with recommended doses for various conditions preprogrammed into the unit or listed in the instruction manual. Although the optimal treatment dose has not been established for any condition, generally recommended doses fall between 2–10 J/cm^2 of energy recommended at the target tissue depth.

One last consideration is the depth of laser penetration. This depends on the wavelength of the laser, with longer wavelength resulting in deeper penetration. A GaAs laser (904 nm) can reach tissue depths of 3–5 cm, while a HeNe (633 nm) will have more superficial penetration, near 1 cm (Corazza *et al.*, 2007). Other factors may influence the depth of penetration, including hair coat, skin pigmentation, and tissue composition (Bjordal *et al.*, 2006b). Much of the radiation energy may be absorbed by hair, dark pigmented skin, and highly vascular tissue such as muscle, so energy is attenuated before it reaches deeper tissue. Energy output from class IV lasers with heating capacity can also be absorbed by fat, which acts as a thermal insulator. This has to be taken into consideration by your supervising veterinarian when treatment dose is calculated. Note, unlike sound waves, laser waves (electromagnetic radiation) can penetrate bone.

Photobiomodulation: Proposed Mechanisms of Action

Photobiomodulation is the application of light in order to modify a biologic process. Depending on the wavelength, power, and other factors, light can cause beneficial or harmful effects in cells and tissue (Bjordal *et al.*, 2006a). Therapeutic lasers can be used to stimulate favorable effects in tissue, including enhanced wound healing and modulation of pain (Medrado *et al.*, 2008). There have been numerous experimental animal and human studies investigating the mechanisms of action of lasers in these conditions (Hawkins and Abrahamse, 2006). Currently, there are very few peer-reviewed published research studies of laser use in small animal veterinary patients, so we are left to extrapolate how lasers work and how best to use laser therapy from the currently available evidence.

Laser therapy can affect each stage of tissue healing (inflammation, proliferation, maturation) (da Silva *et al.*, 2010). The role of laser in the inflammatory phase is that of immunomodulation. Some studies that have shown enhancement of the inflammatory response and increased production of growth factors such as transforming growth factor beta 1 (TGF-β1), while others show a reduction of inflammatory cytokines such as tumor necrosis factor alpha (TNFα) and prostaglandin E2 (PGE2) (Callies *et al.*, 2011). Studies have demonstrated acceleration (shortening) of the inflammatory phase, with rapid progression into the proliferative phase of healing (Mester *et al.*, 1971). Furthermore, laser therapy has been shown to reduce inflammatory mediators, such as COX-2 and PGE, and to decrease inflammatory cell numbers in a tissue, and edema (Mester *et al.*, 1970). It is clear from a large number of studies that the proliferative phase of wound healing is greatly enhanced by therapeutic lasers (Mester *et al.*, 1968). Research conducted on cell cultures has found that various wavelengths and doses are effective at increasing fibroblast proliferation (Wong-Riley *et al.*, 2005). Similar findings have been demonstrated in research animal models of wound healing (Fulop *et al.*, 2009). However, Kurach *et al.* (2015) more recently reported no apparent benefits of low-level last therapy in a model of acute wound healing in dogs.Furthermore, it has been shown that laser therapy can stimulate epithelialization and collagen deposition in animal models of diabetes and glucocorticoid excess, where wound healing is usually retarded (Woodruff *et al.*, 2004). The final phase of wound healing is maturation or remodeling of scar tissue. Lasers influence this phase by enhancing the organization of collagen fibers within wounds (Montesinos, 1988). While these results are promising, at the time of writing this chapter none of these effects have been confirmed in clinical veterinary patients.

The mechanisms by which laser decreases pain are not as well understood. One of the primary means of decreasing pain is by decreasing the production of inflammatory products. Laboratory studies have shown the ability of laser to decrease the production of inflammatory products such as PGE2 and TNFα, and inhibit COX-2 (Viegas *et al.*, 2007). Besides decreasing inflammation, laser therapy is believed to reduce pain through several other mechanisms that are particularly important when treating chronic pain. Photochemical reactions take place on a subcellular level and lead to increased ATP and stabilization of cell membranes and ATP-mediated pumps. This in turn results in restoration of the cell membrane electrochemical gradient and resting membrane potential of nerve cells (Wakabayashi *et al.*, 1993). Excessive or inappropriate depolarization of peripheral nociceptors is minimized and the conduction of pain along C fibers is slowed (Sakurai *et al.*, 2000). Other postulated mechanisms of pain relief include increased release of beta-endorphins and serotonin, and enhanced removal of inflammatory mediators from the site injury due laser-induced changes in local hemodynamics (Mendez *et al.*, 2004).

It is important to note that a therapeutic window exists for photobiostimulation, which likely explains the discrepancy in results between various studies. At subtherapeutic doses, cells will not be stimulated and no reactions will occur; at extremely high doses, detrimental effects can be seen (Arany *et al.*, 2007). The modulatory effects may also be wavelength-specific and vary with other laser parameters such as polarization or pulse frequency.

Contraindications

Because laser is recognized to enhance neovascularization, irradiation of tumors or wounds that may contain cancer cells is considered contraindicated, despite there being a small body of evidence that laser can reduce tumor growth (Tunér *et al.*, 2007). Furthermore, lasers pose a known risk to the eye, so irradiation of or near the eye should not be performed. Additional contraindications include irradiation over a pregnant uterus and open growth plates (Oliveira *et al.*, 2012).

Laser Safety

While administering a laser treatment it is important to take precautions to protect yourself and the patient, as well as being mindful of others in the room. All class IIIb and IV lasers should come with their own set of safety glasses.

Figure 15.1 Wavelength-specific safety goggles. Note the stamp in the upper corner indicating wavelengths the goggles have been tested and approved for.

Figure 15.2 This patient would not tolerate safety goggles so a soft, blue e-collar was used. Ideally the collar should be flipped up to shield the face completely from potential reflection or scatter from laser beam. Liz Brown in image.

These glasses have wavelength-treated lenses that are specific to the laser. They will have stamping on the corner of the lens indicating what wavelengths are covered (Figure 15.1). It is important to note that no other shaded glasses can block out laser irradiation, including sunglasses or surgical laser glasses.

Some laser companies provide pet safety glasses as well, or "doggles." Make sure they have the same wavelength stamping the human glasses do before relying on them to block laser during emission. As safe as they are stylish, it can be a challenge getting your patient to wear these without a struggle. If they refuse to wear the doggles, ensure their head is facing away from the laser beam. A towel or e-collar may be useful to keep patients from turning their head (Figure 15.2).

The ideal location for a laser treatment is a small, windowless exam room with a comfortable bed on the ground for you and your patient to sit on. There should be a "Do Not Disturb; Laser in Progress" sign on the door. Everyone present in the room should be wearing safety glasses. If this scenario is impossible in your hospital make sure the laser operator and everyone within range of the beam is wearing their protective glasses. Then, take a look at your surroundings. Are there metallic surfaces nearby (e.g., a "wet" table)? If so, cover them with a towel or blanket (Figure 15.3).

Laser has the ability to reflect once it comes in contact with metal. This can be hazardous to others in the room that are not protected. For this reason, treating a patient inside of a stainless steel cage is strongly discouraged, as the risk for scatter is too great. Also, it is recommended to remove metallic rings, watches, bracelets, and dog collars or harness with tags and metallic claps or adornments (Figure 15.4).

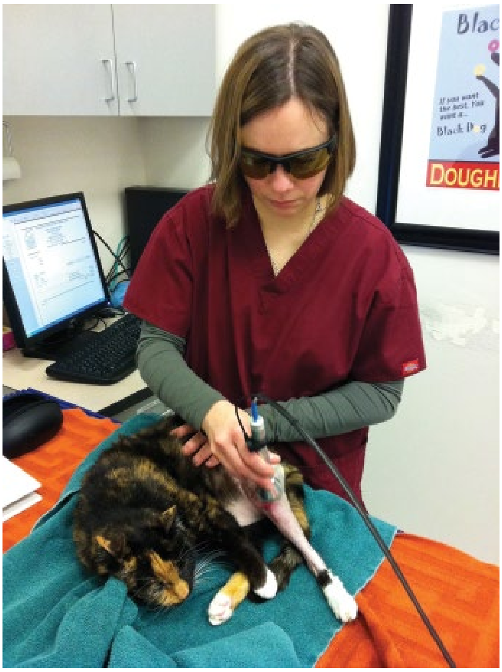

Figure 15.3 This patient is being treated on a stainless steel table. Blankets and towels have been placed to cover the surface to minimize the risk of laser beam reflection from the steel surface. Ideally this patient should have on safety goggles or other method of protecting the eyes. Liz Brown in image.

Figure 15.4 What *not* to do: This patient's collar has metallic adornments and tags. The laser is not in full contact with the skin and is angled toward the collar, resulting in invisible but hazardous reflection of radiation. When treating the neck and shoulder you should remove all metallic dog collars and ensure that the laser is held perpendicular to the tissue. Not all lasers can be held in contact with the skin (i.e., those that generate heat should not be used in contact mode).

Laser therapy is often performed over metallic orthopedic implants. In order to reduce reflection of the laser off the metallic implants within the body, the laser beam should be angled away from metal implants as much as possible. A laser that does not produce heat should be considered. It is essential that the technician or veterinarian administering laser therapy has a good understanding of anatomy and the location of orthopedic implants. Your supervising veterinarian will guide you.

There are not many federal regulations regarding therapeutic lasers in the United States. Those regulations that do exist for lasers are directed toward industrial lasers. At the state level, very few deviate from the federal regulations that are in place for industrial lasers. Your veterinarian should have a clinic policy regarding laser use and will need your help keeping that implemented. The Occupational Safety and Health Administration (OSHA) in the United States recommends a laser use log be kept, separate to the patient record. This will be similar to an x-ray log (https://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_6.html).

Read the owner's manual carefully. Many companies will provide their own resources for safe operation.

- You can find more information on the consensus standard (Smalley, 2011) by getting a copy of ANSI Z136.1 from the Laser Safety Institute of America's website (https://www.lia.org/store/ANSI%20Z136%20Standards).
- For international standards, go to World Association of Laser Therapy (WALT; http://waltza.co.za/).

Using a Therapeutic Laser in Practice

There are many different lasers available in the veterinary market today, and while the basic mechanism of action is similar, they all function differently. User competency is a big variable in the outcome of your treatment, so it is important that each operator has been properly trained on the device before administering laser. One of the veterinarians in your practice should be assigned as the laser expert. This person will ensure that all new staff are trained and comfortable with the laser. An excellent knowledge of anatomy is crucial; the veterinarian needs to be able to get a realistic estimate of target tissue depth as well as likely attenuation levels. There are many supportive resources available online, including supportive websites from several veterinary laser manufacturers.

Once all staff have been trained, the next step is implementing the laser into daily practice. Treatments should be first prescribed by a veterinarian. Laser protocol and number of treatments are decided upon by the overseeing veterinarian, and then generally performed by a team member. Assistants can administer treatments as long as they have been trained on the machine and adhere to all safety precautions.

Positioning your patient can be tricky, since you will often be chasing a moving target. The more comfortable and relaxed the animal is, the easier your job will be. Most animals feel more secure on the ground instead of up on a table. Whether you are using the scanning or point-to-point technique, you will want to make sure the probe is kept at a 90-degree angle to your target area to ensure even and optimal laser emission and penetration (Figure 15.5).

Figure 15.5 The laser probe should always be perpendicular to the target tissue. Lasers that do not generate substantial heat can be placed in contact with the skin/hair and a point-to-point method used to administer treatment. Heat-generating/high-powered lasers should not be used in contact and may need to be continuously moved (scanning) to avoid burning the tissue. Even with scanning, the probe should remain at a 90-degree angle to the body surface.

Having knowledge of muscle anatomy and boney landmarks enables accurate treatment and makes it easier to follow your supervising veterinarian's instructions. A rehabilitation certification course will help you to understand bone and soft tissue anatomy as it applies to laser therapy. For example, a 10-year-old Labrador who had a tibial plateau-leveling osteotomy (TPLO) surgery performed when he was 2 years old has now developed moderate osteoarthritis in the joint. The veterinarian has prescribed laser to help with the pain and inflammation and should have given you specific instructions for probe placement. But what if they did not? You have your diagnosis and your treatment plan of action. Now, where to place the probe? First you should be comfortable palpating and identifying the metal plate used in the surgery. Next you need to find the joint margins where the joint capsule attaches. The joint capsule is your primary target when treating osteoarthritis because it is the tissue that contains nerve endings and inflammatory mediators (Bjordal *et al.*, 2003). If you were treating a dog within the first few months after TPLO, your target tissues would be the joint capsule, as well as surgical incision, and the bone where the TPLO cut was made, remembering to direct your laser around the metal plate.

Table 15.1 Common conditions treated and protocols used by the authors. At the time of writing, there are no research studies confirming the optimal laser treatment protocols in veterinary patients; the protocols listed are based on WALT guidelines and the authors' clinical experience. It is important to note that these are guidelines and each patient is treated as an individual, including adaptations of protocols, inclusion of other treatment sites, and in all cases, additional rehabilitation modalities including manual therapy and therapeutic exercise.

Indication	Target tissue	Treatment frequency	Dose (J/cm^2)
Cranial cruciate ligament rupture: post surgery	Incision and areas of surgical tissue manipulation, joint capsule (medial and lateral), patellar tendon; sartorius/quadriceps if tight or atrophied	Immediately postoperatively and again the following day; then beginning 2 weeks post surgery, 2–3 times/week for a total of 8–10 treatments, then once monthly for maintenance. Repeat loading dose as needed	2–4
CCLR chronic or non-surgical	Joint capsule, sartorius, quadriceps, gastrocnemius origin	2–3 times/week for a total of 8–10 treatments, then once monthly for maintenance. Repeat loading dose as needed	2–8
Intervertebral disc disease (hemi-laminectomy; ventral slot)	Surgical incision, spinal column over lesion; articular facets surrounding lesion (plus 2 cranial and 2 caudal); surrounding thoracic, lumbar, and cervical muscles according to localization; consider treating hypertonic muscles, path sciatic and femoral nerves	Acute: 24 hours postoperatively and daily as long as hospitalized. Chronic: 2–3 times/week for 4–6 weeks or as long as needed based on recovery and rehabilitation plan	Acute: 2–4 Chronic: 4–6
Hip dysplasia	Gluteal muscles, pectineus, epaxials, quadriceps and hamstrings if tight or atrophied; joint capsule (may be too deep to reach in large dogs); ± LS space and SI	2–3 times/week for a total of 8–10 treatments, then once monthly for maintenance. Repeat loading dose as needed	4–10
Shoulder tendinopathies	Supraspinatous insertion and musculotendinous junction, origin of biceps tendon ± belly of biceps and insertions at elbow; deltoids, triceps muscles if tight or atrophied	2–3 times/week for a total of 8–10 treatments, then once monthly for maintenance. Repeat loading dose as needed	4–8

Table 15.1 lists common uses of therapeutic laser in veterinary rehabilitation, the target tissue(s), and protocols used by the authors.

Conclusion

Integrating laser into physical rehabilitation can be tremendously rewarding. Often times the patient will even enjoy the session. Like other treatment, it will work wonders for some patients while others may not display obvious signs of benefit. At this time, there is very little research in clinical veterinary patients as to the optimal laser treatment protocols. The World Association of Laser Therapy (http://waltza.co.za/) provides recommended treatment protocols for class IIIb lasers for treating a variety of musculoskeletal conditions in human patients. Many veterinary therapeutic lasers are preprogrammed with treatment settings, and some are based on the WALT recommendations. Until more research is available that identifies the best treatment protocols in veterinary patients, we can use the WALT guidelines, laser company settings, and ultimately a “do no harm” approach to guide our laser treatments. Frequent veterinary reassessment is need to monitor the effectiveness of laser therapy and to modify treatment as needed. The veterinary technician/nurse can help assessment of therapeutic effect by taking an accurate history of home behavior since last therapy visit and by carefully palpating the affected area to monitor pain level (analgesic effect).

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16

Modalities Part 3: Electrotherapy and Electromagnetic Therapy

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CHAPTER MENU

Introduction

Electrotherapies are commonly utilized in canine rehabilitation. Electrotherapy uses electrical stimulation to apply therapeutic levels of electric currents in various and specific waveforms to decrease muscle atrophy, assist in muscle re-education, improve muscle tone, reduce edema, facilitate wound healing, and reduce pain. When used appropriately, this non-pharmacological therapy can be a valuable and effective adjunct to the treatment plan.

The terminology associated with electric stimulation can be confusing. It is a good idea to review specific definitions pertaining to electrotherapy.

Electrical Stimulation

Electrical stimulation can be used as an adjunct to manage many disorders, including musculoskeletal, soft tissue, vascular, and neuromuscular injuries (Hecox *et al.*, 1994). The most commonly used forms of electrical stimulation are neuromuscular electrical stimulation (NMES) – a term used interchangeably with electrical stimulation, transcutaneous electrical nerve stimulation (TENS), and functional electrical stimulation (FES). Alternating current (AC), is an electric current in which the flow of electric charge periodically reverses direction, whereas in direct current (DC, also dc), the flow of electric charge

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is only in one direction. There are three types of therapeutic electrical stimulation currents: direct (or monophasic) current, alternating (or biphasic) current, and pulsed current (may be mono- or biphasic) (Niebaum, 2013).

To use terminology accurately, almost all electrical stimulators are TENS units, as they work transcutaneously via surface electrodes to excite nerves. In the typical scenario where the muscle is innervated by a motor nerve, NMES is the appropriate terminology (as it is the nerve supplying that muscle that is stimulated in order to activate the muscle), and when a muscle is denervated and requires direct muscle fiber activation through electrical stimulation, the term EMS is used (Levine and Bockstahler, 2014). Functional electrical stimulation (FES) is a technique that uses electrical currents to activate nerve trunks innervating extremities (more than one muscle innervated) affected by paralysis resulting from spinal cord injury, head injury, stroke, and other neurological disorders (Delitto and Robinson, 1989). FES is primarily used to restore function in people with disabilities. It is sometimes also referred to as neuromuscular electrical stimulation (NMES) (Ferrari de Castro and Cliquet, 2000).

Direct Current

Direct current (DC) electrical stimulation is used to stimulate denervated muscles, for wound healing, and for iontophoresis. It creates a unidirectional flow of charged particles with a waveform usually using 20–200 microamperes at a low voltage (Gardner *et al.*, 1999; Cameron, 2003).

Alternating Current

Alternating current (AC) is a bidirectional flow of charged particles using low-voltage milliamperage (mA). The charges are equal in the two symmetrical phases of each pulse (a pulse is a burst of electromagnetic energy). Therefore, the accumulation of charge in the tissues is zero. TENS is an example of an AC therapy. Alternating currents are delivered at various pulse widths depending on the muscle. Recommendations have been made for dogs based on research (Johnson *et al.*, 1997; Sawaya *et al.*, 2008) (Table 16.1).

Table 16.1 Recommended pulse duration for neuromuscular electrical stimulation in dogs.

Muscle	Recommended pulse duration in dogs (ms)
Supraspinatus	150–190
Infraspinatus	130–170
Deltoideus	160–200
Triceps brachii	200–240
Gluteus medius	160–200
Biceps femoris	180–220
Semitendinosus	150–190
Vastus lateralis	210–250
Tibialis cranialis	210–250
Erector spinae	180–220

Source: Adapted from Sawaya *et al.* (2008).

Pulsed Current

The output of this therapy is one of short paired pulses with a long interval of no pulses between and is typically delivered at 75–200 V and 80–100 pps. The current flow may be one direction (like DC) or bidirectional (like AC). If one direction, it is referred to as monophasic pulsed current. If current flows in two opposite directions, it is referred to as biphasic pulsed (Gardner *et al.*, 1999; Cameron, 2003).

Basic Terminology

To help the technician/nurse understand the benefits that electrical stimulation may provide in veterinary practice, a basic explanation and definition of the electrical current parameters (Canapp, 2007) used are summarized in Box 16.1. Each session lasts between 5 and 20 minutes depending on the degree of muscle fatigue (Prydie and Hewitt, 2015).

Box 16.1 Current classification

There are three basic waveforms used in commercial therapeutic electrical stimulation units: direct current, alternating current, and pulsed current.

Direct current (DC)

- Continuous unidirectional flow of charged particles with a duration of at least 1 s
- One electrode is always the anode (+) and one is always the cathode (–) for the entire event
- There is a build-up of charge since it is moving in one direction causing a chemical effect on the tissue under the electrode

Alternating current (AC)

- Uninterrupted bidirectional flow of charged particles changing direction at least once per second
- Electrodes continuously changes polarity each cycle, therefore no build-up of charge under the electrodes
- Often used in interferential or Russian commercial stimulators

Pulsed current (pulsed)

- Can be unidirectional (like DC) or bidirectional (like AC)
- Flow of charged particles stops periodically for less than 1 s before the next event
- Pulses can occur individually or in a series

Amplitude or Intensity

Measured in milliamperes (mA), amplitude is the amount of the current being delivered and describes the total magnitude of the electrical wave. A higher amplitude will result in a stronger muscle contraction due to recruitment of a greater number of muscle fibers. Higher intensities have been shown to promote strength gains in people (Gondin *et al*., 2011).

Pulse Duration or Pulse Width

Pulse width is measured in microseconds (μs). Electricity produced in electrotherapy flows in a waveform, each wave corresponding to a rise in the current of electron flow followed by an abrupt cessation, or a slow decline in electron flow to zero before the next wave follows. The time during which the electric current flows is known as the pulse duration or width. A longer pulse duration may stimulate more nerve fibers that mediate pain, but has the benefit of requiring a lower amplitude of current to achieve a muscle contraction (Niebaum, 2013). Shorter pulse widths tend to be more comfortable, but a longer pulse width can potentially recruit more muscle fibers to compensate for fatigue (Lagerquist and Collins, 2010). Wider pulse widths (300–400 ms) have been shown to produce stronger muscle contractions (Badylak *et al*., 1990) and penetrate to deeper layers of muscle tissue. So, when trying to affect deeper tissue layers, a longer pulse width should be used (Bracciano, 2008). However specific pulse durations have been calculated for comfort and effectiveness in the dog (Sawaya *et al*., 2008) (see Table 16.1).

Frequency or Pulse Rate

Frequency is measured in hertz (Hz) and is the number of pulses produced per second (pps) during the time the current is flowing. The best frequency will vary depending on the goal of therapy. Frequencies as low as 20 Hz will produce tetanic (whole sustained) muscle contractions (Spurgeon *et al*., 1978; Levine and Bockstahler, 2014) but only submaximal forces of contraction are typically produced in this range. Maximal contraction force is generally achieved at frequencies between 60 and 100 Hz in humans (Duchateau and Baudry, 2014). As frequency of the therapy increases, the likelihood of muscle fatigue also increases. A lower frequency (35–50 Hz) will provide strong muscle contractions while reducing muscle fatigue and discomfort (Windsor *et al.*, 1993; Nelson *et al.*, 1999; Levine and Bockstahler, 2014). An alternative with veterinary patients that are not very tolerant of electrical stimulation would be to use a low frequency (<10 Hz), which will provide only a twitch (localized) contraction, but will possibly be more easily tolerated while still stimulating some function.

On/Off or Duty Cycle

The duty cycle is stated in seconds or in a ratio form of "on-time" and "off-time." Common clinical parameters for on/off times are 1:3, or 10 seconds on:30 seconds off, but can be modified to accommodate the patient's needs and goals of treatment (Bracciano, 2008; Levine and Bockstahler, 2014). The duty cycle settings can be used to decrease the likelihood of premature muscle fatigue during a therapy session. The "on-time" is when the series of pulses are being delivered. The "off-time" is the time between sequential on-times and during this no current is being delivered. The off-time phase allows the muscle tissues to recover (relax and reset for next contraction), adequate recovery time decreases the chance of muscle fatigue. During this reset period, the adenosine triphosphate (ATP)/adenosine diphosphate (ADP) are replenished. Intermittent electrical simulation is commonly used to increase the comfort level of the patient (Lake, 1992; Doucet *et al.*, 2012). On–off cycles are not a part of continuous flow electrical stimulation (Box 16.2).

Ramp

This is the gradual increase or decrease of time from when the stimulus reaches peak amplitude and is usually measured in seconds (Kloth and Cummings, 1991). Off-time is the time between on-times. At the onset of the electric current, a gradual increase in flow is designed to slowly increase the force of muscle contraction by gradually recruiting motor units. A steady decrease in current at the end of the peak amplitude results in a smooth decline in muscle force. A 1–3 second ramp time is commonly utilized in clinical applications and the amount of time is based on patient comfort. If a patient has increased muscle tone that may create resistance against the stimulated movement, then a longer ramp is utilized (Bracciano, 2008). In some situations, using a ramp time may

Box 16.2 Typical parameters available in neuromuscular electrical stimulation devices

- *Waveform*: The shape of the visual representation of pulsed current on a current/time plot or voltage/time plot. Can be symmetric, asymmetric, balanced, unbalanced, biphasic, monophasic, or polyphasic
- *Amplitude*: The current value in a monophasic pulse or for any single phase of a biphasic pulse
- *Phase/pulse duration*: The duration of a phase or a pulse, usually measured in microseconds
- *Pulse rate or frequency*: The rate of oscillation in cycles per second, expressed as pulses per second (pps) or hertz (Hz). Often labeled as pulse rate or pulses per second, or frequency on stimulators
- *On/off time*: The amount of time the stimulator is delivering current compared with the rest period between contractions, usually measured in seconds
- *Ramp*: The time in seconds from when the current begins to the peak current (e.g., 3-second ramp up, 6-second contraction, 2-second ramp down)
- *Polarity*: Electrode may be either the anode (+) or cathode (–) (not relevant when using AC)

Source: Adapted from Levine and Bockstahler (2014).

Figure 16.1 A portable NMES unit on a patient. The accuracy of electrode placement is affected by the mobility of the skin at the treatment site – even an electrode taped to skin may move with the skin and not stay over the desired muscle.

inhibit muscle activity. For example, during gait training or standing exercises, the required movement assisted by muscle recruitment from electrical stimulation may be rapid enough to be completed before the peak amplitude is reached (Knaflitx *et al*., 1990). A patient does not get adequate benefit from increased force of contraction when it is needed. In contrast, a patient with spasticity may need a longer ramp time of 4–8 seconds to avoid stimulating an excess increase in tone (Cameron, 2003). Ramp is not a parameter applicable to continuous flow forms of electrical stimulation. Many clinicians start with duty cycle ratios between 1:2 and 1:5 and watch for signs of fatigue, which indicates the need for a longer off-time (Levine and Bockstahler, 2014).

Patient Preparation

It is advisable to clip the patient's hair for optimal contact of electrodes with skin, although in short-haired patients this may not be necessary. The clip patches also act as a guide for electrode placement in the case of home therapy being assigned using portable electrical stimulation units. The accuracy of electrode placement on clipped patches does also depend on the mobility of the skin at the treatment site – even an electrode taped to skin may move with the skin and not stay over the desired muscle. A coupling medium is necessary to transmit the electrical current from the electrodes to the tissues. Some electrodes are carbon silicon-rubber and need to be used with an aqueous gel, while others are coated with a conductive polymer. Commonly used coupling media include gels, moistened sponges, or paper towels; sponges and paper towels tend to dry out, and rewetting is necessary every 30 minutes. Conductive performance of any electrode decreases over time. Electrodes should be of the appropriate size to stimulate the desired muscle without stimulating unwanted muscles. The smaller the electrode, the higher the current density that enters the muscle, and the more uncomfortable the stimulus may be (Figure 16.1).

Precautions and Contraindications of Electrical Stimulation

The safety of the clinician and patient is of utmost importance when working with animals. A patient who is surprised by a sudden muscle contraction or who is painful may respond with a bite, scratch, or a kick. Most canine patients have bite inhibition and will provide warning, however it is wise to provide adequate restraint and to keep away

Figure 16.2 The use of NMES following hemilaminectomy surgery. Notice that a rolled towel may be helpful to support the patient if they can stand.

Figure 16.3 Looking down on the placement of the conduction pads. Notice the tube of gel in the right corner of the image that is used for the coupling medium.

from the patient's head (or species-appropriate danger zone). It is our obligation in veterinary medicine to understand and read patient stress, to minimize stress and pain, and to err on the side of caution rather than administering a painful therapy (Niebaum, 2013). It cannot be emphasized enough to utilize low-stress handling techniques such as those developed by Dr. Sophia Yin (Yin, 2009).

Caution must be used always when treating a patient with electrical stimulation because of the potentially harmful effects it may have if applied inappropriately (Figure 16.2). The canine patient may not be able to communicate the intensity of an electrical stimulus or completely sense the stimulus in situations where neurologic impairment is present (Figure 16.3). Burns from electrical stimulation have been reported and are associated with too high levels of stimulation and usually over areas if diminished sensation or high adipose content. Thus, precautions for the use of electrical stimulation need to be considered when treating areas with diminished sensation, directly over open wounds, areas of dermal irritation, and over areas of high fat content (Figure 16.4) (Hecox *et al.*, 1994; Cameron, 2003; Niebaum, 2013).

Figure 16.4 Initial placement of the electrical pads prior to additional tape placement. Notice positive (black wire) and negative pads (red wire) are placed opposite each other.

One contraindication of electrical stimulation is stimulation directly over the carotid sinus in the neck just behind the vertical ramus of the mandible, or over the pharyngeal area. Stimulation to this area may induce a rapid fall in blood pressure, which could cause syncope. Another area where the placement of electrical stimulation is contraindicated is over the heart. Electrical stimulation in patients with pacemakers may interfere with the functioning of the pacemaker device, altering heart rate or rhythm. Likewise, electrical stimulation should not be used in patients with seizure history as the electrical currents may induce a seizure episode. Since the effects of electrical stimulation to the developing fetus and pregnant uterus are unknown, use of electrical stimulation over the trunk, abdomen, low back, hips, or pelvis during pregnancy is contraindicated. Areas of thrombosis, suspected thrombosis, or thrombophlebitis should be avoided because of the potential risk of the embolus releasing (Box 16.3). This is of importance in cats with rear limb pain or weakness and without a definitive diagnosis; femoral arterial blood flow should be verified with diagnostic ultrasound before considering using electrical stimulation in a cat with weak or painful rear limbs. Also, considering the circulation changes associated with electrical stimulation, it is contraindicated to use

Box 16.3 Indications and contraindications for electrical stimulation

Contraindications

- Pregnancy
- Wounds
- Malignancy
- Pacemaker patients
- Over laminectomy site
- Seizure patients
- Areas of thrombosis
- Pharyngeal area
- Carotid sinus
- Where there is movement (i.e., fracture)

Indications

- Increasing muscle strength
- Increasing range of movement (ROM)
- Decreasing acute pain
- Decreasing chronic pain
- Reducing muscle spasm
- Promotion of soft tissue healing
- Promotion of fracture healing

Source: Adapted from Hanks *et al.* (2015).

over areas of infection because of the theoretical potential to cause sepsis. Another contraindication concerning the circulatory effect is over a malignancy, though occasionally electrical stimulation is used to control pain in patients with malignancies when quality of life outweighs the possible risks of the treatment (Hecox *et al*., 1994; Cameron, 2003; Niebaum, 2013). The use of electrical stimulation should be avoided in any situation where active movement of the area is contraindicated, such as over an unstable fracture. Electrical stimulation should never be used over the eyes.

Adverse Effects

There are very few adverse effects of electrical stimulation, but electrical burns, skin irritation, and pain can occur if the electrical stimulation is applied inappropriately. If there is not enough conduction medium, the risk of a burn increases due to inadequate conduction in to the tissues. Electrical burns are most common with the use of direct current due to the constant delivery of the current. Skin irritation can occur if the patient has skin sensitivities or is allergic to the contact surface of the electrodes, which is rare. In this case a different type of electrode can be tried. Some patients find electrical stimulation painful. In those cases, decreasing the pulse width, increasing the ramp time, and/or increasing the intensity slowly over time may help their tolerance. If it is still painful, other forms of treatment should be utilized (Cameron, 2003).

Neuromuscular Electrical Stimulation for Muscle Strengthening

Neuromuscular electrical stimulation (NMES) is a non-pharmacological treatment method that can be used to address muscle weakness or atrophy with patients who are unwilling or unable to actively contract a muscle. It is usually applied at higher frequencies (20–50 Hz) with the goal being to achieve muscle tetany and contraction that can be used for functional purposes (Valenti, 1964; Tacker *et al*., 1991). The goal is to provide an electric potential to a muscle to elicit a non-voluntary contraction. The electrical current creates a muscle contraction by depolarizing the motor nerve (Niebaum, 2013).

Adverse changes in muscle strength and function have been reported following injury or surgery. The primary injury alone will create changes in muscle activity and motor control that are initially thought to be protective. However, unless specifically addressed, these changes in motor control will persist long after pain has resolved and tissue healing has taken place (Ichihara *et al*., 2009). Surgery and its resultant inflammation during healing time can further compromise muscle activity and motor control (Ocal and Sarierler, 2007). These changes include reduced muscle contractility, delayed onset of contraction (poor muscle timing), and atrophy of muscle tissue (Ocal and Sarierler, 2007; Niebaum, 2013). This inhibition of muscle function, if left unattended, has been shown to contribute to injury of an area (whether repeat injury or injury to other body parts). If muscle activity is decreased because of neurological compromise from injury or surgery, the muscle will atrophy and significant loss of strength and fine motor control will occur. Changes at the cellular level also occur in muscles that atrophy; atrophy is particularly rapid when neurogenic. A reduction in mitochondria, glycogen stores, enzymes associated with muscle building, and the number of functioning muscle cells is reduced, leaving a smaller, metabolically deficient muscle unit. The patient will be at a disadvantage when trying to return to normal function, even if resolution of the neurological compromise occurs. Many of the functional problems associated with a neurologically impaired patient can be found to be due to the detrimental changes associated with a lack of normal exercise. If the muscle is not used as much, some atrophy ensues.

Box 16.4 Current parameters for strengthening

- *Frequency*: Generally between 25 and 50 Hz (these have been shown in humans to produce strong tetanic contractions while minimizing fatigue). An alternative in dogs that are not very tolerant of electrical stimulation is to use a low-frequency (<10 Hz). This will provide a twitch contraction and is better tolerated in some cases
- *Waveforms*: Many waveforms exist; any waveform capable of depolarizing the muscle is acceptable
- *Pulse or phase duration*: Between 150 and 250 μs
- *Ramp up/down (rise and decay time)*: Adjust between 2 and 4 s up to increase comfort; 1–2 s down
- *On/off time*: A 1: 3 or 1: 4 ratio; 10 s on, 30 or 40 s off is commonly used. This may be decreased as muscle strength improves. A 1: 1 or 1: 2 ratio is usually used for muscle endurance training. To prevent atrophy 1:1 (15 s on:15 s off) (Gersh, 1992)
- *Treatment time*: 10–20 minutes
- *Frequency of treatment*: 3–7 sessions/week
- *Amplitude*: Sufficient to cause a strong muscle contraction
- *Position*: Initially, the dog may be more comfortable in a relaxed position but as it becomes more familiar with the sensation, using it in a functional position may result in improved strength gains (Niebaum, 2013)

Source: Adapted from Levine and Bockstahler (2014).

These changes in the muscle can be found even in animals without neurological compromise (Box 16.4). Immobilization, such as splinting during the healing time of a fracture, causes atrophy and its associated consequences.

Since NMES can stimulate muscle contraction without patient contribution (Gruner, 1986), if the patient is unable to maximally contract a muscle, an electrically induced muscle contraction may create a bigger "top off" force and therefore improve muscle activity over patient activity alone (Figure 16.5) (Fitzgerald *et al.*, 2003). However, studies have shown that electrical stimulation is not superior to voluntary strength training, and is more effective when coordinated with voluntary muscle activity (Currier and Mann, 1983; Laughmann *et al.*, 1983; McMiken *et al.*, 1983; Selkowitz, 1985; Wolf *et al.*, 1986). A systematic review on the effects of NMES applied to the quadriceps muscle following anterior cruciate ligament reconstruction in human patients showed that combined with

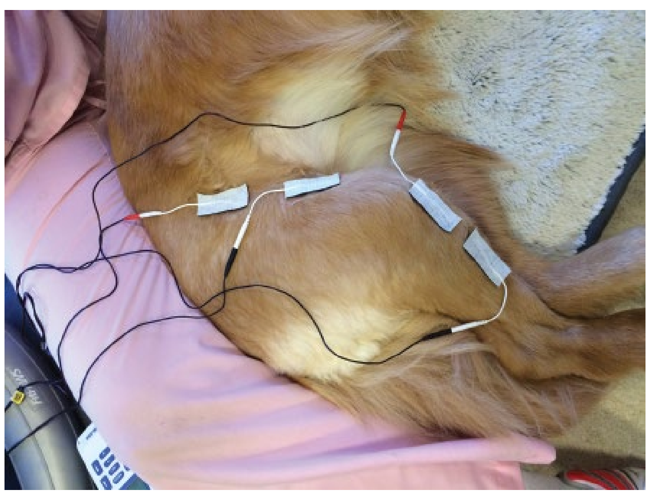

Figure 16.5 Shows use of pads that do not require taping because they have a sticky adhesive on their back.

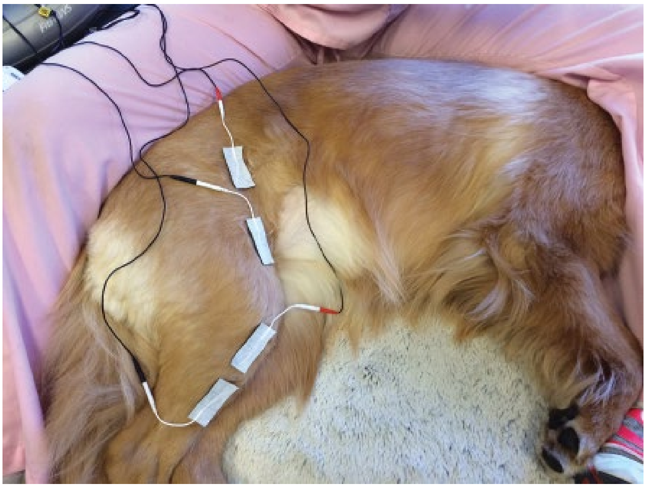

Figure 16.6 Additional view of pad placement without taping.

exercise, NMES may be more effective in improving quadriceps strength than strengthening through exercise alone (Figure 16.6) (Kim *et al*., 2010). A study of dogs with experimentally induced cranial cruciate tears was performed with the dogs undergoing NMES 3 weeks after surgical stabilization. Those dogs had significantly better lameness score and larger thigh circumference than control dogs (Johnson *et al*., 1997).

Neuromuscular Electrical Stimulation for Edema

NMES can also help to decrease tissue edema. Muscle contractions during normal movements provide a pumping action, which helps with venous return (Naamani *et al*., 1995). Weakness, pain, trauma, bed rest, or other neuromuscular issues can interfere with venous return. Muscle pumping can be achieved either by using low-frequency (10 pps) twitch-like contractions on a continuous setting or tetanic contractions (frequency greater than 25–30 pps) with a rapid on–off cycle (less than 5 seconds on-time). Electrical stimulation applied to the affected muscles may also generally improve circulation to a compromised area by increasing muscle pumping action (Figure 16.7). However, the induced muscle contraction should only be strong enough to produce an

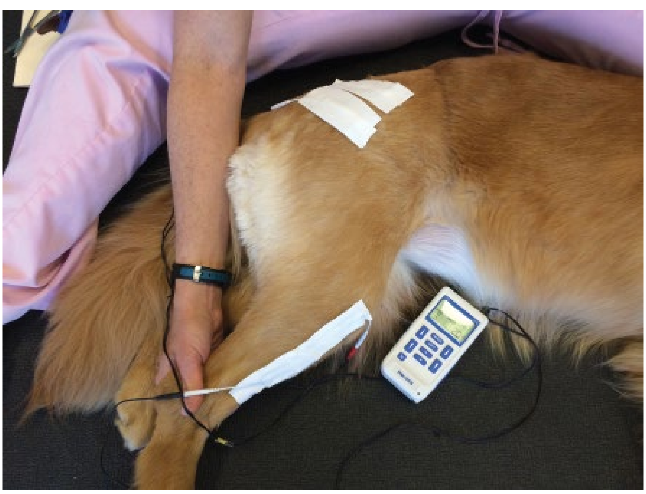

Figure 16.7 Pad placement along stifle and hip.

Box 16.5 Electrical stimulation parameters for edema

- *Frequency*: Between 35–50 Hz or pps
- *Pulse duration*: Between 150 and 200 ms for small muscles and 200–350 ms for large muscles
- *Ramp up and down time*: At least 1 s
- *On/off time*: Equal on and off times or 1:1 ratio
- *Treatment time*: 30 minutes
- *Frequency of treatment*: 2 times/day
- *Amplitude*: To visible contraction (Griffin *et al*., 1990)
- *Position*: How the dog is most comfortable and preferably with the affected area elevated

initial, low-level, visible contraction since strong contractions may impede venous blood and lymph flow (Lake, 1992).

When using electrical stimulation to reduce edema it is best applied to major muscle groups around the edema to promote reciprocal contraction and relaxation of the agonist and antagonist muscles (Box 16.5). This alternating contraction will aid in the pumping mechanism that venous return relies upon. The electrode pads can also be placed proximal and distal to the affected area with the same type of intermittent stimulation (Hecox *et al*., 1994). Studies have shown significant edema reduction after a single 15- to 30-minute treatment in human patients (Lake, 1988; Griffin *et al*., 1990).

Electrical Stimulation for Wound Healing

The use of electrical stimulation is indicated to assist in wound healing. It is best to ask the supervising veterinarian before applying this technique over any wounds. Significant caution needs to be taken when applying electrical stimulation over areas of diminished sensation. The person carrying out the therapy should have a good understanding of the intensity of stimulation provided over a region with neurological compromise. The intensity of electrical stimulation units can be turned up far beyond what may be tolerable to a neurologically intact veterinary patient. High-intensity electrical stimulation will cause burns to the skin. Different waveforms will be tolerated at different intensities. The veterinary technician should have a good understanding of what a specific waveform and intensity feels like before placing it on a patient with sensory compromise to ensure an appropriate and safe intensity is used for treatment.

Box 16.6 Parameters for wound healing

- *Frequency*: 60–125 Hz or pps
- *Pulse duration*: 40–100 ms
- *Amplitude*: High enough to elicit a comfortable sensory response
- *Treatment time*: 45–60 minutes
- *Polarity*: Negative if treating infected area, positive if treating clean area (Cameron, 2003)

Remember that adipose tissue is a poor conductor of electricity. This lack of conduction through the fat cells will cause heat to build up in the tissues, predisposing these areas to a higher likelihood of an adverse event occurring with the use of electrical stimulation (Hecox *et al.*, 1994; Cameron, 2003; Niebaum, 2013).

Electrical stimulation at the site of a wound has been shown to be effective in promoting tissue healing by increasing local circulation, retarding bacterial growth, and stimulating tissue repair mechanisms (Box 16.6). It is believed to aid the wound-healing process by mimicking natural electrical currents in the skin that occur when skin is injured (Foulds and Barker, 1983). The current stimulates and directs migration of macrophages and neutrophils (Eberhardt *et al*., 1986) and stimulates fibroblasts (Alvarez *et al*., 1983). Many different types of electrical current have been shown to improve wound healing. In 1999, a meta-analysis was done on the effects of various waveforms of electrical stimulation on chronic wound healing in human patients. The clinical trials analyzed the use of four types of currents: low-intensity direct current (LIDC), alternating current (AC), high-voltage pulsed current (HVPC), and transcutaneous electrical nerve stimulation (TENS). The results showed that all types of electrical stimulation utilized were found to be an effective adjunctive therapy for chronic wound healing (Gardner *et al.*, 1999).

Physiologically, the effects of electrical stimulation on wound healing can be explained by the electrical properties of the skin. After an injury to the skin, an LIDC has been found to occur, which is thought to contribute to promoting the healing response found in healthy, injured skin tissue (Nuccitelli, 2003; Ojingwa and Isseroff, 2003). Electrical stimulation is thought to be able to magnify this potentiated normal endogenous biological healing response in the skin, promoting tissue proliferation and improving the rate of healing (Nuccitelli, 2003; Huttenlocher and Horwitz, 2007). Improvements in wound healing with the use of electrical stimulation have been demonstrated in full thickness wounds (Carely and Lepley, 1962) and surgical incisions (Taxskan *et al.*, 1997; Demir *et al.*, 2004) in animals as well as when used on pressure ulcers (Reger *et al.* 1999), burns, diabetic ulcers (Greenberg *et al.*, 2000; Thawer and Houghton, 2001), and ulcers associated with ischemia (Morris *et al.*, 2009).

Electrode Size and Placement for Neuromuscular Electrical Stimulation

Correct electrode placement is crucial to obtain the best muscle contraction. The technique is to place electrodes over the belly of the muscle(s) to be stimulated, with one of the electrodes placed over a motor point. The motor point is the point over the muscle belly at which the smallest amount of current is required to produce the muscle contraction (Lake, 1992). The distance between electrodes influences the depth and course of the electrical current. The greater the distance between electrodes, the deeper the current travels, and conversely the closer together the electrodes are the more superficially the current travels and so less muscle fibers are stimulated (Cameron, 2003). It may be beneficial to have different types of electrodes in the clinic in case a patient demonstrates an allergy to a certain electrode or there is difficulty keeping one type adhered to the patient. In dogs with thicker coats, the fur needs to be clipped or shaved for adequate contact (Niebaum, 2013). The authors prefer to use tape or flexible bandaging to hold the electrodes in place to maintain good contact with the skin throughout the treatment, especially if the patient moves (Box 16.7).

The size of the electrodes should match the muscle(s) being targeted. Small electrodes are available to accommodate smaller treatment areas, but the current density produced over a small surface area can cause discomfort when used at higher treatment amplitudes. In contrast, electrodes that are too large can cause the current to spread to other muscles. In addition, the electrodes, and their coupling medium, should not encounter each other, as this will result in the current flowing directly from one electrode to the other instead of in to the targeted muscle tissues (Lake, 1992; Niebaum, 2013).

Box 16.7 Criteria for electrodes

The main criteria in choosing electrodes are as follows:

- Flexible enough to conform to the tissue
- May be trimmed to a specific size
- Have a low resistance
- Are highly conductive
- May be used many times
- Are inexpensive

Source: Adapted from Levine and Bockstahler (2014).

Electrical Stimulation for Pain Control

When used for pain control, TENS can be a beneficial modality. It is an alternate form of electrical stimulation that has been historically administered at high frequencies to provide pain relief (Deyo *et al*., 1990) but is now used at very low frequencies (2–10 Hz) (Sluka and Walsh, 2003). Low frequency stimulates sensory nerves instead of motor nerves, which is thought to reduce pain perception through the gate control theory of pain inhibition (Melzack and Wall, 1965; Niebaum, 2013). The gate control theory is based on the idea that stimulation of large myelinated nerve fibers, which transmit signals rapidly into the dorsal horn of the spinal cord, can interfere with the slower transmission of pain nerve (nociceptors) to higher centers where pain is perceived. According to the theory, the impulses from TENS stimulate fast conducting mechanoreceptors (Cameron, 2003). Pain signals are transmitted by small cutaneous A-δ and C fibers. If a TENS current is applied, the large cutaneous (A-β) fibers are stimulated (Levine and Bockstahler, 2014). The signals from the A-β fibers activate inhibitory interneurons in the substantia gelatinosa of the spinal cord dorsal horn and block the transmission of pain impulses from the periphery to the brain (Melzack and Wall, 1965). Additional mechanisms involve the release of endogenous opiates (Levine and Bockstahler, 2014). Pain relief is provided only while the stimulation is being delivered. However, it may be beneficial for patients when pain is interfering with their abilities to perform therapeutic activities and functional movements (Niebaum, 2013) (see Chapter 3). Any deactivation of nociceptors can help to reduce the general state of wind up and so over time TENS can aid in reducing CNS sensitization. The presence of pain alone has been shown to cause changes in muscle activity and to subsequently decrease muscular forces throughout the whole body. A reduction in pain will result in an improvement in function. TENS is an excellent adjunctive pain therapy treatment that can be used in combination with pharmaceuticals in acute pain situations, such as following trauma or surgery, as well as in chronic pain situations associated with degenerative change (Box 16.8).

Box 16.8 Recommended parameters for TENS

- Amplitude high enough to elicit a comfortable sensory response
- Pulse duration between 50 and 100 ms
- Frequency between 30 and 150 Hz
- Duration of treatment varies according to the activity
- Placement of electrodes: over or around the area of pain, over the peripheral nerve or spinal nerve roots that innervate the painful region, or over acupuncture points

Source: Adapted from Nolan (2005).

Pulsed Electromagnetic Field Therapy

Pulsed electromagnetic field (PEMF) therapy signals are the most commonly used electromagnetic signals for therapeutic applications. This modality works through the creation of pulsed magnetic fields that have been found to have therapeutic benefit in the healing responses of various tissues. PEMF therapies provide therapeutic microcurrents using targeting signals to enhance the natural regenerative pathways used by the body (Seegers *et al*., 2001; Pilla, 2003). These signals come in the form of an electromagnetic field. A magnetic field is the region surrounding a magnet or an electric current. Electric current delivered through a wire to a magnet creates the pulsed magnetic field, which in turn induces an electric current that affects the targeted tissue to create a beneficial healing response (Pilla, 2003). This is termed inductive coupling. The ability to influence tissues remotely can enhance healing of the target tissue while penetrating through more superficial tissues (for example stimulating bone healing in closed fractures) and even penetrating bandages to stimulate repair in wound beds (Trock, 2000).

There is increasing use of PEMF as adjunctive therapy for a multitude of musculoskeletal injuries and problems. In current clinical veterinary practice, electromagnetic field (EMF) modalities have been shown to have therapeutic benefits for bone and wound repair and acute and chronic pain relief (Pilla, 2006). It is a safe, simple, and cost-effective modality with minimal to no side-effects, and is therefore becoming a popular modality choice in veterinary rehabilitation.

Pulsed Electromagnetic Field Therapy for Wound Healing

The treatment of wounds can be costly, require extensive care, and be time consuming. It may be challenging for owners to consistently bring their dogs to a veterinary practice regularly for wound care due to these factors. A modality applied at home that could assist in the healing wounds, especially in high-risk populations for delayed healing, would be advantageous to the pet owner, the veterinary staff, and the patient. Radiofrequency PEMF has been shown to enhance healing of skin wounds (Pilla, 2006). In a study done in 2007, the authors successfully demonstrated that treating wounds with PEMF with very specific settings accelerated early diabetic wound healing in rats. There was increased wound tensile strength at 21 days. The wounds were exposed to a 1.0 G PEMF signal for 30 minutes twice daily for 21 days (Strauch *et al.*, 2007). EMF strength is expressed in gauss units (symbol G). Wound healing in diabetic animal populations is enhanced in the early stages by PEMF. This is accomplished through an increase in myofibroblastic proliferation resulting in significantly enhanced wound closure and re-epithelialization 10 days after wound onset (Cheing *et al.*, 2014). The advantage of using PEMF over direct contact electrical stimulation to accelerate wound healing can be found in the production of an EMF created by this modality. This field allows the application of electric current to be somewhat remote from the wound bed, allowing the electromagnetic signals to penetrate bandaging and dressing material to affect the underlying tissues of the wound.

Pulsed Electromagnetic Field Therapy for Bone Healing

Understanding how PEMF contributes to bone healing requires some knowledge of the normal processes involved in bone growth. In response to stress, bone deforms slightly. Being a crystalline structure, compression in a long bone will be subject to the piezoelectric effect. The piezoelectric effect states that compressing a crystalline structure results in negatively charged electrons migrating to the side of concavity. It is thought that the electronegative potential creates an environment where osteoblasts can function normally but osteoclast activity is halted. Thus, the formation of bone tissue exceeds the normal physiologic breakdown of tissue for repair, which results in net bone growth. This is the reason why the trabeculae of the bone are organized in a manner consistent with the stress placed on the bone. This results in trabecular patterns that follow strain patterns in bone and causes greater bone mass to be present in areas of greater physical stress.

PEMF has been shown to increase healing time in non-union and delayed-union fractures. In these cases, it has been theorized that there is an absence of electrical charge to help stimulate osteoblastic activity. The application of an electrical charge applied to the bone using PEMF has been shown to assist in bone healing. A study in 2012 showed that PEMF stimulation is an effective non-invasive method for improving non-infected tibial union abnormalities. The time of treatment onset did not affect the incidence of fracture healing. Longer treatment duration showed a trend of increased probability of union (Assiotis *et al.*, 2012). In general, relevant clinical responses to PEMF are not immediate in delayed-healing bone, requiring daily treatment for sometimes several months in the case of non-union fractures (Pilla, 1993). A recent systematic review and meta-analysis found that PEMF may not be beneficial in decreasing the incidence of non-union fractures, however the authors did find a decreased healing time in acute fractures and diaphyseal fractures when PEMF was used (Hannemann *et al.*, 2014). PEMF is approved by the US Food and Drug Administration (FDA) for use as an adjunctive treatment to aid in fracture repair (Canapp, 2007; Galkowski, *et al.*, 2009).

Pulsed Electromagnetic Field Therapy for Osteoarthritis

Osteoarthritis has been estimated to affect 20% of the US canine population in middle age and 90% of older dogs have osteoarthritis in one or more joints; the percentages are even higher for the human population (Budsberg, 2010). This widely referenced estimate, in practical terms, translates to over 10 million dogs. In cats, a report indicated that a 26% radiographic prevalence of appendicular osteoarthritis and a 90% prevalence of all types of degenerative joint disease, but the study only included cats older than 12 years of age (Hardie *et al.*, 2002; Bennett *et al.*, 2012). Thus, the identification and management of the disease is of the utmost importance to the small animal clinician. Clinical signs may include stiffness, fatigue, lameness, pain, difficulty transferring from one position to another, and the inability to perform daily activities such as jumping on to the couch or climbing stairs. It can affect a dog's quality of life, and in severe cases may cause aggression, anorexia, and inability to ambulate.

Non-invasive therapies aimed at ameliorating symptoms of osteoarthritis typically include weight management/loss, physical rehabilitation, and the use of non-steroidal anti-inflammatory drugs (NSAIDs) along with other pharmaceuticals. Recent research into modalities and nutritional supplements aimed at modifying the disease are gaining acceptance as part of a multimodal approach. One such treatment for osteoarthritis is the application of PEMF therapy to the joint and periarticular tissues (O'Sullivan *et al.*, 2013).

In 2013, a randomized, controlled clinical trial was published that evaluated the efficacy of pulsed signal therapy (PST), which is the application of PEMF, in dogs with osteoarthritis, as measured by the Canine Brief Pain Inventory (CBPI) Severity and Interference scores (O'Sullivan *et al.*, 2013). The CBPI is a validated survey instrument to assess chronic pain in dogs (Brown *et al.*, 2008). The results showed the PST group performed significantly better than the control group, but the objective measures of range of motion and peak vertical force were not statistically significant between groups receiving and not receiving PEMF. It was speculated that the range of motion may have been limited more by mechanical means (i.e., osteophytes, periarticular fibrosis) than by pain (O'Sullivan *et al.*, 2013).

In 2009, a meta-analysis of randomized controlled trials was done to determine the effectiveness of PEMF in the management of osteoarthritis of the knee in humans. It concluded that PEMF improved function and clinical scores in patients with osteoarthritis of the knee and should be considered in conjunction with other treatments in the management of their disease process (Vavken *et al.*, 2009).

The theory behind the mechanisms of the effects of PEMF on osteoarthritic pain lies in the anabolic effects that PEMF has on osteoblast and chondrocyte proliferation, which produces healing effects at the cellular level (Diniz *et al.*, 2002) by enhancing regeneration of articular cartilage (Ciombor *et al.*, 2003). Pain in osteoarthritis is perceived by the patient from the stimulation of unmyelinated and small myelinated nerve fibers in the joint and the surrounding tissues of the joint (joint capsule, ligaments, synovium) (Felson, 2005). In addition, central sensitization, which is a hyperexcitability of neurons in the central nervous system associated with chronic pain conditions, results in changes within the brain responsible for pain perception, patient affect, cognition, and sensorimotor function (Felson, 2005; Imamura *et al.*, 2008). The literature provides mixed clinical evidence in the support of PEMF in pain reduction in human patients who suffer from osteoarthritis pain. A systematic review with meta-analysis was published in 2013 and showed PEMF improved physical function in people with osteoarthritis of the knee but did not result in significant improvement in pain levels (Negm *et al.*, 2013). Osteoarthritic pain originates from the joint capsule and subchondral bone, not cartilage.

There is currently a lack of quality studies in the literature investigating the effects of PEMF on osteoarthritis-related pain. It is difficult to adequately determine how well PEMF effectively works on osteoarthritic pain, although some evidence exists that supports an improvement in the function of patients with osteoarthritis if PEMF is used (Hunter, 2011).

Treatment Protocol for the Assisi Loop®

The Assisi Loop (www.assisianimalhealth.com/) offers targeted PEMF in a portable, easy-to-use device that can be used in clinic or in the home/stable (Figure 16.8). The Loop has been proven to reduce pain and inflammation and has been cleared by the FDA for palliative treatment of postoperative edema and pain in humans (Rohde *et al.*, 2015).

Therapy starts with a minimum of 3–4 15-minute treatments per day for acute and chronic or degenerative conditions. When treating acute conditions with an Assisi Loop-Automatic, it is recommended that treatments begin immediately and that the Loop is left on automatic mode for anywhere from 48 hours to two weeks. This depends on the animal's progress. When treating following surgery, treatment can begin immediately after the operation and should continue until the surgical site is healed.

Figure 16.8 Image of an Assisi Loop used for targeted PEMF.

For chronic or degenerative conditions, the company recommends that you continue with 3–4 treatments per day for 7–10 days and monitor the animal until you see improved mobility and less pain response. Taper down to 1–2 treatments per day or even 1–3 treatments per week. With some chronic and degenerative conditions, the patient may get to the point that they would only be treated as needed for pain, particularly if it is a condition that is prone to flare-ups.

There are no contraindications with other modalities, and the Loop is a take-home treatment for pet owners to continue healing between rehabilitation visits. However, given that the Loop and other treatment modalities, such as laser, have different mechanisms of action, the company recommends that you allow 2 hours between treatments to be certain that each treatment can operate at its fullest efficacy.

Using the Loop over a metal implant or brace will not cause any harm, but it may distract or weaken the signal. If possible, position the Loop so that it is at a 45° angle from the metallic implant. If you are not able to do this, then you may consider using the Loop more frequently. The FDA recommends against using the human version of the Loop over tissue known to contain implanted metallic leads such as pacemakers.

Targeted PEMF has no contraindication for the treatment of patients with cancer or for post-cancer surgical healing. Much of the human clinical trial work that has been done has been for patients following mastectomy reconstruction.

Pulsed Electromagnetic Field Therapy Bed or Blanket

PEMF uses pulsing magnetic fields developed by pulsing a small amount of battery current through coils of wire to initiate normal biological cellular reactions that result in improved circulation and provide pain relief. Respond Systems™ makes three products to provide pain relief for dogs and cats from common problems associated with hip dysplasia, arthritis, muscle, tendon or ligament injury, and old-age stiffness and soreness. For horses, they make this product as a blanket, wraps, and mat for the horse to stand upon (https://respondsystems.com/pemf/how-it-works/).

Conclusions

Selection of the appropriate modality depends largely on an understanding of the diagnosis, an accurate assessment of the stage of tissue healing and repair, an accurate clinical assessment of the functional limitations, the established treatment goals, and continued reevaluation of the patient (Pinna *et al.*, 2013). electrical stimulation is most commonly used to reduce pain and muscle spasm, in both acute and chronic circumstances, and to increase muscle strength. PEMF is used for healing of bone and tissues and pain management.

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17

Modalities Part 4: Therapeutic Ultrasound

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CHAPTER MENU

Introduction

Therapeutic ultrasound uses sound waves generated by piezoelectric effect at frequencies greater than 20 000 Hz to stimulate tissues and create physiologic effects. These effects include stimulation of fibroblast activity, improvement of blood flow, increase of protein synthesis, increase of tissue extensibility, decreased pain, and stimulation of soft tissue and bone healing (Steiss and McCauley, 2004; Baxter and McDonough, 2007; Niebaum, 2013). Therapeutic ultrasound devices may use short bursts of sound waves or a continuous stream to deliver ultrasonic energy to tissues. This modality has been used since the 1950s for indications such as tendon injuries and bursitis (Miller *et al.*, 2012). Based on a National Library of Medicine search, the first clinical report of its use in veterinary medicine was in 2009 (Mueller *et al.*, 2009).

Physical Principles

Sound Waves

Sound waves used for therapy consist of mechanical vibrations that are propagated longitudinally into the biologic tissues via a means of a transducer that is placed directly in contact with patient's skin. As sound moves through tissues, energy is absorbed and

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converted to kinetic energy (Niebaum, 2013). Sound waves create pressure and tensile forces on biologic tissues causing them to oscillate. The frequency of the sound waves determines the degree of sound wave oscillation.

Absorption of Ultrasound Waves

Factors that affect the travel and absorption of sound waves includes the substance traveled through to the target tissue, the components of the target tissue, the coupling media, and the treatment parameters. In general, sound is likely to move faster through solids, slowest through gases. Therefore, ultrasound transmission is impeded by air between transducer and skin. In order to reduce sound reflection at the skin resulting from air pockets, it is necessary to use a coupling medium. Liquids such as water and alcohol are suitable but evaporate quickly. A coupling gel is better for direct contact of probe on skin. Gels can be water or lipid based, but the latter are hard to remove after treatment, so water-based gels are more commonly used. Indirect coupling is when the probe does not contact the skin but moves through a medium, most commonly water. This can be useful for applying therapeutic ultrasound over irregularly shaped areas when complete contact with even the smallest treatment probe is not possible.

The patient's body consists of a variety of tissues with different acoustic impedances. Ultrasound is even reflected or absorbed differently by each structure within a tissue. Absorption of energy is greatest in tissues with high protein content (e.g., bone) and relatively low in adipose tissue (Steiss and McCauley, 2004). The prescribing veterinarian and the therapist must be familiar with the composition of the target tissue, and the tissues that the ultrasound waves have to travel through in order to reach the target tissue. Because hair has a high protein content it can diminish ultrasound penetration and therefore hair coat should be clipped very short, or even shaved prior to ultrasound therapy (Steiss and Adams, 1999).

Mechanical Effects of Ultrasound Waves

Cavitation is the most commonly cited mechanical effect of therapeutic ultrasound. It is the formation of small gas bubbles in tissues that occur when ultrasonic waves vibrate (Bockstahler *et al.*, 2004). Ultrasonic cavitation depends on the pressure amplitude of ultrasound waves; ultrasound transmitted into a tissue may cause pressure amplitudes of several megapascals. The resultant tensile stress is supported by the tissue and negative tension in the tissue can be several times atmospheric pressure; even diagnostic ultrasound can affect tissues this way (Miller *et al.*, 2012). Cavitation can affect tissue metabolism by causing temperature elevation, mechanical stress, or free radical production (O'Brien, 2007).

The different forms of cavitation are as follows:

- *Stable cavitation* is when the gas bubbles remain intact and move with the ultrasonic flux. This form of cavitation is desired to produce therapeutic effects.
- *Transient cavitation* is when the gas bubbles rapidly expand and collapse resulting in high pressure and increased temperature which can damage tissues. It primarily causes local tissue injury in the immediate vicinity of the cavitational activity, including cell death and hemorrhage. To prevent transient cavitation, avoid using a high-intensity setting especially with continuous wave ultrasound.

Cavitation is a secondary effect of transmission of ultrasound waves in tissues, another secondary effect is acoustic streaming, which is flow of currents in tissue fluid. The direct mechanical effects of ultrasound waves are compressional, tensile, and shear stresses; when an ultrasound wave moves through tissue, a mechanical stress is induced. We know from Wolff's law that bones remodel in response to stress, and we know that tendon cells produce collagen in response to high-frequency vibrations

(Thompson *et al*., 2015) but we do not know how sustained a mechanical stimulus must be in order to achieve a therapeutic response from ultrasound. The therapist aims to use the mechanical effects of ultrasound to stimulate breakdown of abnormal tissue (including scar tissue and mineralization) and to stimulate a tissue repair response. The therapist must also avoid adverse effects (too much tissue breakdown and disruption). Clinical research determining ideal settings (depth, intensity, time) for treatment of different pathologies is still lacking in both human and veterinary medicine. We do know that the mechanical effects of ultrasound act on the cell membrane, causing mild disruption and increased permeability. Ultrasound has been shown to result in a number of intracellular events that include triggering biochemical reactions and changes in gene expression. This can result in increased cell proliferation or turnover (Furusawa *et al*., 2014). Some examples of tissue responses are vasoconstriction, ischemia, extravasation, reperfusion injury, and immune reaction (Miller *et al*., 2012).

Thermal Effects of Ultrasound

Absorption of ultrasound waves by a tissue represents a portion of the wave energy that is converted into heat. If heat is produced by this process at a faster rate than can be removed/dissipated then a temperature increase will occur in the tissue. The use of unfocused heating can be moderated to produce enhanced healing without injury (Miller *et al*., 2012). Ideally, tissues should be heated by 4–5 °C for improving tissue flexibility (Levine *et al*., 2001). As therapists, we may want to increase local tissue temperature at our target in order to increased enzyme-based reactions, though there is a ceiling effect beyond which too much heat can denature enzymes (O'Brien, 2007). Heat can partially denature (unfold) collagen by breaking up hydrogen bonds in collagen crosslinks (Chen *et al*., 1998). This may be a mechanism by which ultrasound stimulates tissue remodeling and breakdown of scar tissue. Alternatively, the heat produced by therapeutic ultrasound can be deliberately concentrated by a focused beam until tissue is coagulated for the purpose of tissue ablation.

Chemical Effects of Ultrasound

The microbubbles of cavitation are under high pressure and temperature just before they collapse. These changes are very fast and so have minimal heating effect on surrounding tissues. However the high temperatures can lead to water breakdown and free radical formation (Furusawa *et al*., 2014). This "sonolysis" in the presence of oxygen leads to the formation of superoxide radicals, which can stimulate tissue remodeling. Ultrasound results in an immediate elevation of intracellular calcium ions that influx from the extracellular environment.

Treatment Parameters

Frequency

Frequency determines the depth of ultrasonic wave penetration and is measured in hertz (Hz). The frequency selected is based on the tissue to be treated and its depth from the skin surface.

The most common frequencies used in veterinary rehabilitation are 1 MHz and 3.3 MHz. Ultrasound of 1 MHz can effectively penetrate a depth of 2–5 cm, whereas 3.3 MHz can effectively treat tissues at a depth of 1–3 cm (Steiss and Adams, 1999; Levine *et al*., 2001; Bockstahler *et al*., 2004).

Intensity

Intensity is the rate of energy delivery per unit area and is measured in watts per centimeter squared (W/cm^2). Intensity is important because it describes the force at which the vibrations are applied (how fast the energy is delivered). Too much force could damage the tissue or, at the very least, result in pain. The higher the intensity, the higher the increase in tissue temperature. When treating an area with thick soft tissue (e.g., the deltoid muscle), a higher frequency should be selected to heat the tissue. In contrast, when treating an area with minimal soft tissue (e.g., the carpal joint), lower intensity and higher frequency are the parameters of choice as denser tissues heat faster. The most common intensities used in veterinary medicine are between 0.1 and 2 W/cm^2.

Duty Cycle

Duty cycle is the fraction of time that sound is emitted during one pulse period. It refers to whether the vibrations are applied continuously over the course of a treatment or whether they are pulsed on and off. The ratio of pulse on to pulse off during a treatment is referred to as the duty cycle. Most devices offer duty cycles in the range of 10%, 25%, 50%, 75%, and 100%. For example, a 10% duty cycle pulsed waveform would have the ultrasound on for a total of 10% of the treatment time and off for 90% of the treatment time. A 100% duty cycle is considered continuous waveform, in which the ultrasound is on 100% of the treatment time. Continuous waveform is used when thermal and non-thermal effects are desired (e.g., muscle spasms and chronic tendinopathies). Pulsed waveform is used when only non-thermal effects are desired (e.g., around bony prominences and in tissues with acute inflammation).

Transducer Heads

There are a variety of sizes of transducer heads available (Figure 17.1) and the size is selected based on the size of the treatment area. The treatment area should be no more than 2–3 times the size of the transducer head (Steiss and McCauley, 2004). Treating an area larger than these parameters decreases the dosage and thermal effects, therefore diminishing the therapeutic effects.

Figure 17.1 A 3 cm sized ultrasound transducer head.

An alternative is to divide a larger area into two smaller treatment areas. Common sizes of transducer heads include 1 cm^2, 3 cm^2, 5 cm^2, and 10 cm^2. The transducer head should be held directly over the treatment tissue and perpendicular to the skin. If it is held at an angle above 75 degrees, the ultrasound will travel along the skin instead of treatment tissue (Michlovitz, and Sparrow, 2012). The transducer head should be moved continuously over the skin at a speed of 4–8 cm/s to achieve uniform distribution of the ultrasound and prevent thermal burning and tissue damage (Michlovitz and Sparrow, 2012).

Coupling Techniques

Water-soluble coupling gel must be placed between the skin and transducer head; otherwise the ultrasound beam is reflected at air–tissue interfaces. Elimination of air as much as possible maximizes tissue penetration of the ultrasound energy (Figure 17.2).

Direct coupling is placement of the transducer head in direct contact with the skin. It is used when the treatment area is relatively flat and smooth and larger than the transducer head (e.g., gluteal muscles).

Indirect coupling is placement of the transducer head at a distance to the skin. It

Figure 17.2 Ultrasound gel used as a coupling agent.

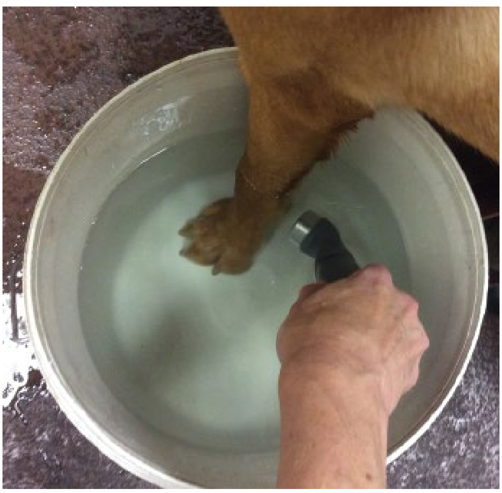

Figure 17.3 Treating a flexor tendon injury with indirect coupling. The patient's limb is immersed in warm water and the transducer head held 2 cm from the skin surface at the level of the lesion.

is used when the treatment area is irregularly shaped and smaller than the transducer head (e.g., digits). The most common form of indirect coupling is submersion, where the treatment area is submerged in a container of water and the transducer head is also submerged and held 1–3 cm from the skin's surface (Figure 17.3). Another type of indirect coupling is use of a coupling cushion, where a water balloon covered in coupling gel is placed between the skin and transducer head.

Role of the Veterinary Rehabilitation Technician

A technician that takes courses in veterinary rehabilitation will learn about therapeutic ultrasound and how and when to perform these treatments. If courses are not available to a technician, he or she can learn on the job from their veterinarian. The technician can perform these treatments without the supervision of the veterinarian in some states, however the treatment must always be prescribed by the veterinarian who employs the technician (legal supervisor). Prescription assigned to a technician by a non-supervising veterinarian is pushing the boundaries of state regulatory laws on the practice of veterinary medicine. After the treatment is completed, the technician should document that the treatment was performed and the treatment settings in the patient's medical records (Figure 17.4).

Figure 17.4 Maya, a 2-year-old Cockapoo having her Achilles tendon treated.

Clinical Applications

Conditions that benefit from non-thermal effects include acute soft tissue injuries, fractures, and wounds. Indications that benefit from thermal effects include osteoarthritis (except in acute exacerbation), muscle spasms, chronic soft tissue injuries, tendinopathies, muscle contracture, scar tissue and trigger points (Figure 17.5 and Box 17.1).

Dosage and Treatment Frequency

- Superficial conditions (target depth less than 2 cm) treated with pulsed ultrasound at 3.3 MHz should deliver between 0.25 and 0.9 W/cm^2 (Bockstahler *et al.*, 2004).
- Superficial conditions treated with continuous ultrasound at 3.3 MHz are recommended to be from 1 W/cm^2 to less than 1.5 W/cm^2. This is based on a research study by Levine and Millis in 2001, explained in the Relevant Scientific Research section (Levine *et al.*, 2001).
- Deep conditions are treated with either pulsed or continuous ultrasound at 1 MHz and 1–2 W/cm^2 (Steiss and Adams, 1999).
- Acute conditions are treated in short intervals (e.g., 3 times a week) for a short duration (e.g., 1–2 weeks) (Bockstahler *et al.*, 2004).
- Chronic conditions are treated in long intervals (e.g., 1–2 times a week) for a long duration (2–3 weeks or more if needed) (Bockstahler *et al.*, 2004).

Phonophoresis

Phonophoresis is the use of ultrasound to enhance the delivery and absorption of topically applied drugs such as analgesics

Figure 17.5 A feline patient undergoing ultrasound treatment of her neck muscles.

Box 17.1 Case study: Maya, 2-year-old spayed female Cockapoo

History

Maya was bitten on the right tarsus by her housemate during rough play.

Physical examination

On presentation, Maya was bright, alert and responsive. Her right tarsus was dropped and hyperextended, and there was a large swelling along distal calcaneal tendon, proximal to base of the gastrocnemius muscle.

Diagnosis

Partial right gastrocnemius and superficial digital flexor tendon avulsion

Treatment

Maya underwent reduction of the right gastrocnemius and superficial digital flexor tendon. A graft using a small portion of the tensor fascia lata was used to fill the 6 mm gap at the end of the gastrocnemius tendon. The deep digital flexor tendon was still intact therefore tension-relieving sutures were placed to decrease its length. Protein-enriched plasma was injected into the area of the tendons to help with healing. A bivalve cast was placed on the limb immediately postoperatively.

Two weeks postoperatively, a custom-made orthosis was used to provide stability in extension during the tendon healing phase, and a controlled and secure approach to tendon reloading. Adjustments were made to Maya's orthotic starting at 6 weeks postoperatively gradually allowing for 10 degrees increase in tarsal flexion up until 14 weeks postoperatively.

Maya received rehabilitation therapy consisting of therapeutic ultrasound to stimulate collagen formation with the results of allowing solid scar tissue formation and stability of the calcaneal tendon. The ultrasound settings used were 0.6 W/cm^2, 3 MHz, continuous wave, 7 minutes using a 5 cm^2 sound head. Low-level laser therapy was used to improve healing, decrease pain and inflammation, as well as alleviate muscle spasms of her paraspinals due to muscle compensation. Massage was performed to alleviate muscle compensation, and manual therapy was performed on all her limbs.

Therapeutic exercises were used to strengthen the muscles of the hamstring complex (semimembranosus, semitendinosus, and biceps femoris), quadriceps, and the gastrocnemius. Underwater treadmill was instituted to load the calcaneal tendon in a low-impact fashion using the buoyancy of the water.

Outcome

Maya completed 22 weeks of rehabilitation therapy starting 2 weeks postoperatively. Therapeutic ultrasound played an integral role in the healing of the gastrocnemius and superficial digital flexor tendon. At the end of the 22 weeks, she had functional mobility and was able to return to normal activities.

and anti-inflammatories. Conditions in which phonophoresis might be of benefit include tendinitis, osteoarthritis, bursitis, sprains, and neuromas (Kleinkort and Wood, 1975).

Byl (1995) conducted a review of human literature and determined that to maximize the clinical effectiveness of phonophoresis the topical drug (both the drug and the carrying agent) should transmit ultrasound; the skin should be pretreated with ultrasound, heating, moistening, or shaving; the patient needs to be positioned to maximize circulation during treatment; a dressing that seals the area and prevents the escape of moisture should be applied after treatment; an intensity of 1.5 W/cm^2 should be used to capture both the thermal and non-thermal effects; and low-intensity (0.5 W/cm^2) should be used when treating open wounds or acute injuries. A study of phonophoresis using hydrocortisone was performed on the knees of greyhounds. Joint hydrocortisone levels obtained with phonophoresis were extremely low in comparison with those obtained with direct joint injection and the levels were not different to topical application (Muir *et al.*, 1990).

Clinical Reports

Mueller *et al.* (2009) published a case report of two cases with partial gastrocnemius muscle avulsion treated with pulsed therapeutic ultrasound. The first dog received 13 therapeutic ultrasound treatments (1 MHz, 25% pulsed waveform, 0.7–1 W/cm^2, 10 min) for 5 weeks. During the first 2 weeks, therapeutic ultrasound was performed 3 times per week, then decreased to 2 times per week. The second dog received 12 therapeutic ultrasound treatments (1 MHz, 25% duty cycle, 0.8 W/cm^2, 10 min), 3 times per week for 4 weeks. The outcome in both dogs was evaluated using ultrasonographic imaging and the measurement of ground reaction forces with a force plate. Both dogs showed an amelioration of the clinical signs within 1 month after commencement of the ultrasound therapy. The follow-up time for these cases was 1 year and 6 months, respectively. Both dogs were free of lameness and returned to their normal amount of exercise. Palpation of the fabella associated with the muscle injury did not produce any signs of pain. Ultrasonographic imaging did not detect any signs of hemorrhage or edema, although scarring of muscle fibers was present. The force-plate analyses revealed an improvement in lameness. These results suggest that therapeutic ultrasound could be a beneficial treatment modality for this kind of muscle injury (Mueller *et al.*, 2009).

In a clinical study of 124 cases of muscle injury in dogs treated with therapeutic ultrasound, patients were treated with 5 or 6 twice-weekly therapeutic ultrasound treatments. Settings were continuous wave, at a frequency appropriate for the depth of target tissue (most cases 3.3 Hz, a few larger dogs with deeper muscle injury were treated at 1 MHz) and at a power setting of 1.1–1.3 W/cm^2, depending on patient tolerance. A stretching program was instituted at ultrasound treatment number 3–5, depending on when muscle extensibility improved. Following ultrasound therapy, isometric strengthening exercises were instituted for 2–3 weeks (standing with one or two legs lifted), followed by sprint practice and slow return to full activity/sport. Lameness resolved in 91.9% of cases, but a small number recurred, needing long-term management with ultrasound therapy every 4–6 weeks. Lameness improved 1–2 grades for the remaining cases in which lameness did not resolve. The overall percentage of cases treated for muscle injury with therapeutic ultrasound with resolution of lameness and no recurrence/repeat injury was 85.8%. Of the sporting or working dogs, 93.9% fully returned to sport/work (Tomlinson, 2015).

Cautions and Contraindications

Thermal burns are a major concern and can be avoided by constantly moving the transducer head over the skin, and by using lowest effective intensity. The transducer head can overheat if held in the air while the unit is emitting ultrasound. Exert caution when using ultrasound over bony prominences, fracture sites, metal implants, artificial joints, irradiated skin, areas of decreased circulation, and areas of decreased pain and/or temperature sensation. Your supervising veterinarian will guide you and should write a specific prescription with treatment parameters, although this may need to change depending on patient response during treatment sessions. If the patient shows any sign of discomfort, immediately stop treatment. Palpate the treatment area for sensitivity and resume the same treatment settings only if it is confirmed that the patient was not reacting in pain and was just restless. A good way to determine this is to move the probe head as if treating, but with the ultrasound off. This will help to discern discomfort from ultrasound from discomfort from probe head contact or from restraint. If in doubt, stop and find the supervising veterinarian. The veterinarian will advise you about altering treatment settings (turning down the intensity for example) and when to cease treatment completely.

Therapeutic ultrasound is contraindicated over the heart, pacemakers, lower abdomen in a pregnant animal, eyes, testes, open epiphyseal plates, spinal cord, infection, ischemic tissue, hemorrhage, thrombosis, or malignancy.

Maintenance of Equipment

Because ultrasound therapy commonly produces little, if any, sensation, you must depend on your equipment to assure appropriate parameters are being delivered. To ensure that your equipment is in proper working order, it should be inspected regularly (e.g., annually) to assure proper calibration. Often, a local medical company will inspect and calibrate the machine; it does not have to be the machine's manufacturer. Keep the probe heads clean. The technician should do periodic (i.e., once every 2–4 weeks) maintenance of the equipment by testing the transducer heads. In order to test the transducer heads, place them in a cup of water and turn the machine on. If the transducer heads are working, a ripple effect will occur in the water. If a probe head is dropped for any reason, it will need to be checked and calibrated.

Relevant Scientific Research

In a study of five dogs with induced Achilles injury, tendons were cut and then sutured. A transcalcaneal screw was used to immobilize the tendon. One group received therapeutic ultrasound from the third day after surgery at 0.5 W/cm^2 for 10 minutes daily for 10 days. It appears that the ultrasound was used on continuous setting but it is not directly referred to by the authors. The healing of the Achilles tendon was monitored using clinical observations, ultrasonography, and histology. By day 40, the ultrasound appearance started to improve in the ultrasound-treated group compared to the untreated group. Gross observations suggested that the Achilles tendon in group 2 (ultrasound treated) showed comparatively fewer adhesions than in group 1 (control) animals. Histologically, the treated group had better healing across the tendon fibers, by day 120, the tendon tissue was close to normal. The authors concluded that ultrasound therapy at 0.5 W/cm^2 enhanced the Achilles tendon healing (Saini *et al.*, 2002).

Ten small (7–8 kg) dogs underwent bilateral ulna ostectomies resulting in a fracture gap. One side was treated with pulsed therapeutic ultrasound. Settings were reported as 1 MHz, 20% duty cycle with resultant energy delivered being 50 mW/cm^2. Treatment was performed for 15 minutes once a day for 6 days a week for 5 months. The low-intensity pulsed ultrasound enhanced new bone formation and decreased the incidence of nonunion (Yang and Park, 2001).

A study of the heating effect of continuous ultrasound was performed on the thigh muscles of 10 dogs in 2001 (Levine *et al.*, 2001). Treatment intensity was either 1.0 W/cm^2 or 1.5 W/cm^2. Temperature of the muscle was measured using thermistors at three different depths (1 cm, 2 cm, and 3 cm). Treatment time was 10 minutes. At the end of treatment, the temperature rise at an intensity of 1.0 W/cm^2 was 3 °C at a depth of 1 cm, 2.3 °C at 2 cm depth, and 1.6 °C at 3 cm depth. At 1.5 W/cm^2, temperature rose by 4.6 °C at 1 cm depth, 3.6 °C at 2 cm depth, and 2.4 °C at 3 cm depth. Tissue temperatures returned to baseline within 10 minutes or sooner after treatment. The authors stated that research suggests that a 3–4 °C increase in tissue temperature is effective in improving flexibility in both animals and humans. Based on these findings of temperature increase, intensity settings below 1.5 W/cm^2 continuous wave are recommended when treating dogs.

A study of the use of 3.3 MHz continuous wave ultrasound in horses evaluated the effects on temperature of digital flexor tendons and the epaxial muscles. Ten horses were evaluated, thermistors measured tissue temperatures. One tendon was treated for 10 minutes at an intensity of 1.0 W/cm and the other at 1.5 W/cm^2. Temperatures rose by 3.5 °C in the superficial digital flexor tendon and 2.5 °C in the deep flexor tendon treated with 1 W/cm^2 and by 5.2 °C in the superficial and 3.0 °C in the deep digital flexor tendon after 1.5 W/cm^2. The epaxial muscles were treated for 20 minutes, still using 3.3 MHz (a setting usually used for superficial tissue depths) at an intensity of 1.5 W/cm^2. Muscle temperature was measured at 1, 4, and 8 cm depths. Temperature rise was 1.3 °C at a depth of 1.0 cm, 0.7 °C at 4.0 cm, and 0.7 °C at 8 cm depth. The authors concluded that the digital flexor tendons are heated to a therapeutic temperature using a frequency of 3.3 MHz and intensity of 1.0 W/cm^2. The epaxial muscles are not heated to a therapeutic temperature using a frequency of 3.3 MHz and an intensity of 1.5 W/cm^2 (Montgomery *et al*., 2013).

Freitas *et al*. (2010) evaluated the effects of therapeutic ultrasound on wound healing in rats. After 10 days of daily therapeutic ultrasound, results showed that therapeutic ultrasound improved wound healing, since the wound size had significantly reduced 5 and 10 days after starting treatment. Collagen levels were increased in the 0.6 W/cm^2 and 0.8 W/cm^2 treated groups. These authors concluded that therapeutic ultrasound has beneficial effects on the wound-healing process, probably by speeding up the inflammatory phase and inducing collagen synthesis (Freitas *et al*., 2010).

Conclusions

Therapeutic ultrasound is a useful modality in veterinary physical rehabilitation. There is research showing the thermal effects in dogs and horses (at certain tissue depths), and confirming stimulation of bone and tendon healing in dogs. There are also some canine clinical reports showing successful treatment of muscle injury with this modality. More research and clinical data will come.

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18

Modalities Part 5: Shockwave Therapy

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CHAPTER MENU

Introduction

Extracorporeal shockwave therapy (ESWT), commonly known as shockwave therapy, uses high-energy sound waves called "pulses" or "shock waves" to stimulate and speed the body's own healing process. Shockwave therapy has been used in human medicine since the 1980s to provide a non-invasive treatment for urolithiasis (Ogden *et al.*, 2001). This technology then emerged as a modality to help with difficult-to-treat orthopedic and soft tissue injuries, including skin wounds. In the late 1990s this modality became of use in veterinary medicine in the field of equine medicine (Biggs, 2011). The high-energy sound wave creates mechanical stress at a cellular level leading to a release of healing growth factors in the body that reduce inflammation and swelling, increase blood flow, help bones heal, and enhance wound healing. Shockwave therapy can be used to help with a wide variety of conditions including tendon and ligament injuries (Danova and Muir, 2003; Hsu *et al.*, 2004; Hunter *et al.*, 2004; Venzin *et al.*, 2004), osteoarthritis (McIlwraith *et al.*, 2004; Francis *et al.*, 2004; Dahlberg *et al.*, 2005), wounds (Morgan *et al.*, 2009; Silveira *et al.*, 2010), and non-union fractures (Chen *et al.*, 2004). Shock wave is non-invasive so it can be used in these conditions in conjunction with other modalities to help your patients feel better and recover. It is important to note that not

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all patients respond favorably to treatment with shockwave therapy. Although most studies show significant improvement after treatment, the results are not consistent (Brown *et al.*, 2005). Lack of response may be attributed to ineffective treatment protocol or technique or to the patient's individual response to shockwave therapy.

When all things are considered, this modality is rather new in the realm of treating small animals. With more widespread use and further studies it is hoped that how this therapy is best used will be revealed and the protocols will be refined to provide more consistent results.

What is a "Shock Wave"

Shock waves are transient, short-term acoustic pulses with high peak pressure and a very short rise to peak pressure time on the order of magnitude of nanoseconds (one billionth of a second) (Mittermayr *et al.*, 2012). To be considered a true "shock wave" the acoustic pulse must travel faster than 1500 m/s (the speed of sound).

There are three different ways to produce a true sound wave: electrohydraulic, electromagnetic, and piezoelectric. There are some therapy units that use radial pressure waves that travel at a much slower speed (~10 m/s) and therefore do not produce a true sound wave. The maximum energy is deposited on the skin and dissipates from there. Radial shockwave has been compared to a pneumatic "jack hammer" (Kirkby-Shaw, 2016). Research that shows positive effects of radial shockwave indicate that the dogs experienced a decrease in pain with a decrease in the degree of lameness (Mueller *et al.*, 2007; Souza *et al.*, 2016).

The electrohydraulic principle was used in the first generation of orthopedic shockwave machines. Electrohydraulic shock waves are high-energy acoustic waves generated by underwater explosion with high-voltage electrode spark discharge. The acoustic waves are then focused with an elliptical

Figure 18.1 An electrohydraulic shockwave machine.

reflector and targeted at the diseased area to produce the therapeutic effect. Electrohydraulic shock waves are characterized by large axial diameters of the focal volume and high total energy within that volume (Figures 18.1 and 18.2).

Shockwave generation through the electromagnetic technique involves the electric current passing through a coil to produce a strong magnetic field. A lens is used to focus the waves, with the focal therapeutic point being defined by the length of the focus lens. The amplitude of the focused waves increases by non-linearity when the acoustic wave propagates toward the focal point

The piezoelectric technique involves a large number (usually >1000) of piezo crystals mounted in a sphere, This receives a rapid electrical discharge that induces a pressure pulse in the surrounding water, steepening to a shock wave. The arrangements of the crystals cause self-focusing of the waves toward the target center, and lead to an extremely precise focusing and high energy within a defined focal volume.

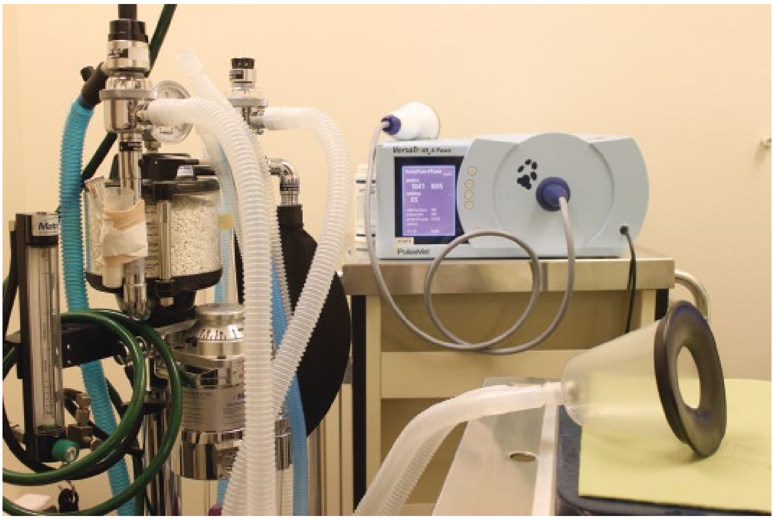

Figure 18.2 Versatron PulseVet™ next to anesthesia machine used for oxygen during sedation of patient.

When comparing different shockwave devices, the important parameters include pressure distribution, energy density, and the total energy at the second focal point in addition to the principle of shockwave generation of each device. For a complete therapy description, the energy flux density, in millijoules per millimeter squared (mJ/mm^2), the number of pulses, pulse repetition frequency, and the number and interval of retreatments are important parameters (Wang, 2012).

Mechanism of Action of Shock Waves

As the acoustic sound waves pass through tissue, energy is dissipated when it encounters denser tissue, such as bone, cartilage, tendon, and ligament. As energy is deposited in the tissues, the mechanical force translates to a biologic response that promotes healing. Currently the exact mechanism for the action for shockwave therapy in musculoskeletal disorders and the biologic effect on different anatomic structures (bone, cartilage, tendons, and ligaments) is not fully understood. It is believed that the mechanism of shock waves stimulates the early expression of angiogenesis-related growth factors including eNOS (endothelial nitric oxide synthase), VEGF (vessel endothelial growth factor), and PCNA (proliferating cell nuclear antigen) (Wang, 2012; Visco *et al.*, 2014). These factors then induce the ingrowth of neovascularization that improves blood supply and increases cell proliferation and eventual tissue regeneration to repair tendon or bone tissues. The rise of angiogenic markers was observed as early as 1 week after application and only lasted for approximately 8 weeks, whereas the neovascularization was first noted after 4 weeks and persisted for 12 weeks or longer, along with cell proliferation. These findings support the clinical observation that the effect of shockwave therapy appears to be dose-dependent and symptom improvement changes with time (Wang, 2012).

Other mechanisms might include: a release of cytokines, which can help a chronic condition revert to an acute state, thereby re-initiating the healing process with a reduction in inflammation and swelling; or release of BMP (bone morphogenic protein), which induces the formation of bone and cartilage.

Figure 18.3 An example of shockwave gel.

Patient Preparation

Acoustic sound wave energy dissipates as it passes from one medium to the next. Energy loss through attenuation is much larger through air than it is through water. Therefore, getting the probe head that delivers the sound wave as close to the skin as possible is recommended. The owner should be told that the area will need to have the hair short and a media gel applied to the skin (Figure 18.3). However, it is not necessary to shave the area.

Application of gel ensures good penetration of the sound waves as they pass from the probe head through the skin to the deeper tissues. It is along the boundaries between different media such as muscle and bone that the sound field experiences the biggest changes and emits the highest energy, and where the most biologic effects are expected.

After preparing the skin and applying an appropriate media gel, apply the probe head to the area being treated and use enough force to ensure good contact between the probe head and the skin (Table 18.1). Engage the shockwave generator and, as pulses are being formed, gently and slowly move the probe head over the area being treated, rotating and gliding the probe head as necessary to reach the intended target of treatment (Figure 18.4).

Table 18.1 Ranked couplant transmissivities relative to degassed water at 1.1 MHz and 3.4 MHz.

Couplant	Mean relative transmissivity at 1.1 MHz	Mean relative transmissivity at 3.4 MHz
KY	108%	99%
EMS	105%	99%
Aquasonic	104%	98%
JPM	100%	97%
Physiomed	98%	97%
SKF	95%	96%
Biofreeze	89%	88%

Source: Poltawski and Watson (2007). Reproduced with permission of Elsevier.

There is no consensus on how best to focus shock waves to manage a lesion. Some clinicians will use direct ultrasound guidance when treating a ligament or tendon injury and some will just estimate the area to be treated based on prior radiographic and sonographic diagnosis. Since focused shock waves are a locally concentrated therapy without regional or systemic effects, it is necessary to have a clear and concrete diagnosis to define the treatment area (McCarroll and McClure, 2002). A good working knowledge of the anatomical landmarks in the treatment area is essential to delivering the shock waves to the proper area and to avoid areas that the shock waves could damage or have less effect on. For arthritic joints, the best patient outcome seems to be obtained from concentrating on the attachments of the joint capsule surrounding the entire joint (Figures 18.5 and 18.6).

Typically, a loud “clicking” noise is created during the production of the shock wave and this noise may be startling to the patient. The intense stimulation from the energy produced

Figure 18.4 Treatment of canine elbow with probe head.

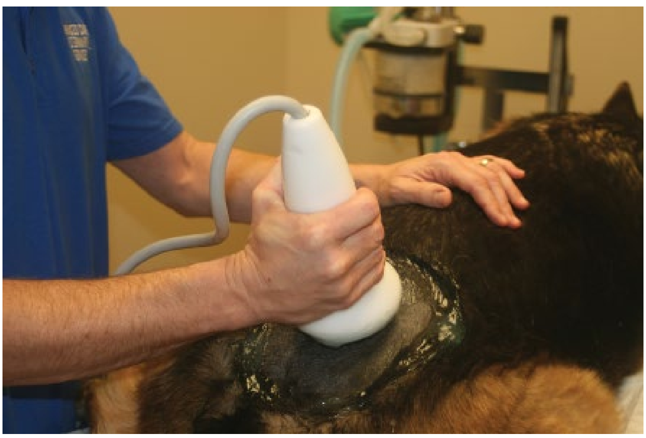

Figure 18.5 Treatment of canine pelvis with probe head.

by the shock wave may be perceived as uncomfortable to painful, depending on what condition is being treated and what shockwave generator is being employed. Therefore, mild to heavy sedation may often be used during the treatment sessions. Sedation can range from an alpha-2 (dexmedetomidine in small animals; detomidine or xylazine in equine) or a combination of an alpha-2 and opioid (butorphanol, hydromorphone, or morphine). This allows for comfort and stress relief to the patient and has the added benefit of safety for the veterinary staff.

What is the Common Treatment Protocol?

Treatment protocols have been established for many species, for a wide variety of indications and severity of disease. Because there are several different manufacturers and differences in the shockwave generators, it is imperative to follow the protocols set in place for each individual unit from the manufacturer. Most protocols call for two or three sessions of shockwave therapy at 2–3 week intervals. Be sure to enter the following information into

Figure 18.6 Treatment of feline elbow with probe head.

the patient's medical record for each session: type of shockwave generator used, energy flux density (mJ/mm^2), pulse repetition frequency, and the number of pulses.

The veterinary technician/nurse may be carrying out this treatment plan, but the rehabilitation veterinarian will be deciding upon the treatment range. The rehabilitation nurse will be instructed by the veterinarian on what and where to initiate shockwave therapy plus the settings used with the machine for each specific patient.

Pain Relief

Research in humans has shown that the analgesic effect of shockwave therapy appears to be more reliable in chronically affected patients rather than those acutely affected (Helbig *et al.*, 2001). Pain relief is quite common for 2–3 days after shockwave therapy (Buch *et al.*, 1998) and in an equine study analgesia was found to be similar to that induced by local or perineural analgesia, and the duration was 3 days (McClure *et al.*, 2004). However, the mechanism behind analgesia from shockwave therapy has not been elucidated. There has been some research in this area with no firm conclusions. Some research has even shown contradictory results: evidence that shows shockwave therapy has an influence on pain transmission by acting on substance P (Maier *et al.*, 2003; Hausdorf *et al.*, 2008) and calcitonin gene-related peptide (CGRP) (Takahashi *et al.*, 2003) expression in the dorsal root ganglion was refuted by the findings of Haake *et al.* (2002) who found no effect of shockwave therapy on substance P and CGRP. There is some evidence that shockwave therapy downregulates tumor necrosis factor-alpha (TNF-α) and interleukin-10 (IL-10) in osteoarthritic chondrocytes (Moretti *et al.*, 2008). The shock waves can create hyperstimulation of nociceptors resulting in intense stimulatory input into the periaqueductal gray area. This is the "gate control theory" whereby the nociceptive input is dampened before it reaches the brain; it has an abundance of supporting evidence (Rompe *et al.*, 1998; McClure and Weinberger, 2003; Bolt *et al.*, 2004; McClure *et al.*, 2005). Another theory is that cell damage is caused by the shock waves, thereby preventing normal membrane potentials required for the transmission of the nociceptive signals (Bolt *et al.*, 2004).

There are a wide variety of mechanisms that may allow for pain relief from shockwave therapy. Individual mechanisms may be affected by the type of shockwave generator used, the number of shock waves performed, energy level, frequency of application and the area being treated.

Adverse Events and Contraindications

When applied according to manufacturer specifications, the adverse events of shockwave therapy are minimal. The most commonly reported side-effect is bruising of the skin or soft tissue in the treatment area; small hematomas or swelling may also develop (Johannes *et al.*, 1994; Rompe *et al.*, 2001; McClure *et al.*, 2004; Dahlberg *et al.*, 2005; Speed, 2014). Shockwave therapy should never be directed over gas-filled cavities such as the lungs or the intestines (Ueberle, 1998). The acoustic impedance of air is distinctly lower than the acoustic impedance of soft tissue, thus virtually all the energy is reflected at the interface. The phase of the pressure is reversed and the maximum pressure at the interface may turn into rarefaction pressure, with up to twice the former maximal energy, which may result in considerable tissue damage at the interface. Intestinal perforation has been reported in a human after shockwave therapy where the colon was in the focal zone (Klug *et al.*, 2001). Large nerves and blood vessels also should not be within the focal zone. Arterial walls develop interstitial damage that can result in rupture, vasoconstriction, or increased permeability (Buch, 1998). Sites with neoplasia and infection have traditionally been avoided because of the potential to develop metastasis or septicemia from the primary site. The mechanical force of the shock wave can release the neoplastic cells and may cause an increase in the rate of metastasis (Oosterhof *et al.*, 1996; McClure *et al.*, 2004).

Indications

Osteoarthritis

Interest in the use of extracorporeal shock waves to treat orthopedic conditions was started by the observation that patients undergoing lithotripsy had an increase in pelvic bone density (Graff *et al.*, 1987). Shockwave therapy has been shown to modulate the osteoarthritic disease process in animal models by reducing eNOS, IL-10, and TNF-α levels and decreasing chondrocyte apoptosis, leading to a decrease in cartilage lesions (Moretti *et al.*, 2008; Zhao *et al.*, 2012; Kirkby, 2013). A significant improvement has been reported in ground reaction forces in dogs with elbow osteoarthritis after shockwave therapy as compared to the control group. These results suggest the effect of the therapy is what one would expect when treating this condition with a non-steroidal anti-inflammatory drug (Millis *et al.*, 2011). A study that included 14 dogs with stifle osteoarthritis showed an improvement in peak vertical force as well as range of motion that was not statistically different from the control group. However, in this study the dogs in the control group had a significant decrease in peak vertical force consistent with an increase in lameness (Dahlberg *et al.*, 2005). The evidence that shockwave therapy provides pain relief as part of a multimodal treatment plan is growing stronger each year and it can be a very valuable tool for managing arthritic pain (Mueller *et al.*, 2007; Souza *et al.*, 2016).

Tendon and Ligament Injuries

Tendinopathies typically result from overuse or repetitive activity and can cause significant pain and loss of partial or full function of a limb. These types of injuries are typically non-inflammatory in nature. The tendon's mechanical properties can break down due to an insufficient blood supply as well as degeneration of the tendon fibers. Learning from our equine colleagues, small animal practitioners have recently started to utilize shockwave therapy as part of the treatment strategy for their patients with tendon and ligament injuries. Evaluation of the bone–tendon interface in both the rabbit and dog model has demonstrated an increase in neovascularization, as confirmed by an increase in the angiogenic markers VEGF and eNOS and the formation of myofibroblasts that leads to healing after being treated with shockwave therapy (Wang CJ *et al.*, 2002, 2003). A study of 15 dogs that underwent shockwave therapy for issues of shoulder lameness after failure of conservative therapy found that 64% of the dogs remained improved or

Box 18.1 Indications for tendon and ligament healing

- Supraspinatus tendinopathy
- Biceps tendinopathy
- Medial shoulder instability
- Achilles tendinopathy (in addition to surgery if indicated)
- Patellar tendinopathy
- Iliopsoas strain

Source: Adapted from Kirkby (2013).

were without lameness at long-term follow-up, with a mean follow-up time of 844 days. These dogs presented with one of the following diagnosis: biceps tendinopathy; medial shoulder instability; supraspinatus tendinopathy; biceps and supraspinatus tendinopathy; medial shoulder instability and supraspinatus tendinopathy; or synovial osteochondroma (Becker *et al.*, 2015). Dogs that developed patellar desmitis after undergoing tibial plateau leveling osteotomy were evaluated after treatment with shockwave therapy. The thickness of the patellar ligament as measured at 6 and 8 weeks postoperatively was significantly different between treatment and control groups, demonstrating a positive effect of the shockwave treatment (Bosch *et al.*, 2007; Gallagher *et al.*, 2012) (Box 18.1).

Wound Healing

Large chronic wounds, especially those on lower limb extremities, can be quite challenging to treat. Research has demonstrated that the use of shockwave therapy may promote soft tissue healing because of neovascularization. Neovascularization will enhance the healing process and reduce pain associated with injury. One human study showed that 75% of patients had 100% epithelialization at a mean follow-up time of 44 days. The findings of this study suggest that unfocused low-energy shockwave therapy is a feasible modality for a variety of difficult-to-treat soft tissue wounds, particularly posttraumatic and postoperative wounds, decubitus ulcers, and burns (Schaden, 2007). Currently there are only experimental studies on equine wounds (Morgan *et al.*, 2009; Silveira *et al.*, 2010) and no published research in small animals. Further research is needed to determine the usefulness of this modality in veterinary medicine.

Bone Healing

Shockwave therapy is thought to increase bone healing through many different effects. Studies have implicated an induction of microfractures with the trabecular bone and the formation of medullary hematomas. The recruitment of bone marrow mesenchymal cells and the release of VEGF and transforming growth factor beta-1 (TGF-β1) may have a role in bone healing from shockwave therapy, and increases in BMP have been documented following shockwave therapy (Wang FS *et al.*, 2001, 2002, 2003). The growth factors in turn induce neovascularization and recruitment of osteogenic cells, leading to formation of bone (Chen *et al.*, 2004). In an equine study, no microfractures were induced and the mechanism was thought to be the result of bone marrow hypoxia, subperiosteal hemorrhage, increased regional blood flow, and activation of osteogenic factors such as BMP, direct cellular effects, and mechanical effects because of strain gradients (McClure *et al.*, 2004). In an experimental canine non-union radial fracture study, 4 out of 5 dogs had radiographic evidence of healing 6 weeks after a single shockwave session. At 9 weeks, there was narrowing of the fracture gap and increase in bridging callus. Complete radiographic confirmed union was present at 12 weeks. The one dog that had radiographic evidence of persistent non-union received a second shockwave session at 9 weeks after the first and had radiographic bony union in 12 weeks (Johannes *et al.*, 1994).

Wang (2012) demonstrated that shockwave therapy enhanced callus formation and induced cortical bone formation in acute fractures in dogs, and the effect of shockwave

Box 18.2 Indications for bone healing

- Delayed union and trophic non-union fractures
- In conjunction with surgical repair of highly comminuted fractures and/or anticipated slow fracture healing
- In conjunction with external coaptation for nonsurgical management of digital, metacarpal, or metatarsal fractures

Source: Adapted from Kirkby (2013).

therapy appeared to be time dependent. A study of electrohydraulic shock wave on the healing of stifle osteotomies (TPLO) showed that the radiographic healing score in the treated group of dogs was significantly better at 8 weeks than that in the untreated group (Kieves *et al.*, 2015). The current research is very supportive of the use shockwave therapy in treatment of delayed union and non-union fractures (Box 18.2).

Equine Use

Shockwave therapy entered veterinary medicine through its use in equine medicine, with the first recorded use in Germany in 1996 (McClure and Weinberger, 2003). The first use in the United States was in 1998 with horses with distal hock joint and navicular pain (McCarroll *et al.*, 1999; McCarroll and McClure, 2002). The research and use of shockwave therapy in equine medicine is vast when compared to that of small animal research. A number of studies have shown positive results in the treatment of: bone spavin, navicular syndrome, tendonitis, insertional desmopathy of the ligamentum nuchae, dorsal metacarpal disease, incomplete/stress fractures, proximal splint bone fractures, back pain due to "kissing spines" (Figure 18.7), and muscle pain.

In people and small animals skin petechiation at the treatment site has been reported, but it is not commonly seen in the horse (McClure and Weinberger, 2003). Despite the research not showing a clear mechanism, the analgesic effect is real and has caused some concern in the equine performance industry. According to the United States Equestrian Federation, most racing jurisdictions prohibit the use of shockwave therapy within 5–7 days preceding competition, and the Federation Equestre International prohibits shockwave therapy 5 days preceding competition (www.usef.org).

Clinical Applications

The following musculoskeletal conditions have been reported, either through clinical studies or anecdotally, to improve from the

Figure 18.7 Treating a horse for "kissing spine" disease.

Figure 18.8 Treatment of donkey lumbosacral disease.

use of shockwave therapy as the sole method of treatment or as an adjunctive treatment in a multimodal approach:

- chronic wounds
- lick granulomas
- delayed or non-union fractures
- non-surgical management of digital, metacarpal and metatarsal fractures
- osteoarthritis: hip, elbow, stifle, hock, shoulder
- supraspinatus tendinopathy
- glenohumeral ligament tears (medial shoulder instability)
- osteochondrosis of the shoulder
- triceps muscle tear
- fragmented coronoid process
- spinal column issues (intervertebral disc disease, lumbosacral disease, spondylosis deformans, cauda equine syndrome) (Figure 18.8)
- iliopsoas muscle injuries
- patellar tendonitis (especially following anterior cruciate ligament repair)
- Achilles tendinopathy
- calcaneal tendon tears.

Conclusion

Shockwave therapy is a unique modality that can be used to treat a wide range of conditions. Shock waves are high-energy acoustic waves generated under water from a wide variety of generators. The application of shockwave therapy for certain musculoskeletal disorders in veterinary medicine has been around since the late 1990s. This modality is non-invasive and has a low incident of adverse effects and complications. The current research demonstrates its effectiveness. However, further research is needed to understand the exact mechanism by which it works. Furthermore, due to a wide variety of soundwave generators, protocols need to be researched and developed for each condition treated, including energy level, number of shocks, frequency of pulses delivered, and number of sessions. Shockwave therapy should be considered as part of a multimodal approach to the conditions that have been discussed in this chapter.

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19

Therapeutic Exercises Part 1: Land Exercises

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CHAPTER MENU

Introduction

Therapeutic exercises are a crucial component of any patient's rehabilitation program regardless of problem or diagnosis. Exercises need to be tailored to the individual patient considering the clinical diagnosis (a requirement before any exercise prescription), the age of the patient, physical condition, and resources available. Exercises can be used to improve a patient's range of motion (ROM), strength, weight bearing and gait pattern, their flexibility, balance and proprioception, and to decrease pain and improve healing. Exercises also improve strength, aerobic capacity (endurance) and performance, and help with weight loss. Therapeutic exercises as part of a home exercise program allow the clients to become involved in their pet's recovery and often strengthen the human–animal bond.

History of Therapeutic Exercise

Physical therapists have been utilizing therapeutic exercises in human medicine since the beginning of physical therapy in the early twentieth century. The aim is to improve function, performance, and disability (Saunders, 2007). Interest in applying these techniques to dogs started in the mid-1970s with the first publication of a book on canine rehabilitation techniques by Ann Downer MPT (Downer, 1978). Shortly

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thereafter, national presentations about animal rehabilitation to such groups as the American College of Veterinary Surgeons (ACVS), American Physical Therapy Association (APTA), and the American Veterinary Medical Association (AVMA) led to more interest in canine rehabilitation. A growing interest in canine sports medicine resulted in the formation of the International Racing Greyhound Symposium in 1985. Rehabilitation was a frequent topic at this conference which later included all sporting dogs (McGonagle *et al.*, 2014). In the 1990s there was the long-awaited publication of two texts: *Care of the Racing Greyhound: A Guide for Trainers* (Craig *et al.*, 1994) and *Canine Sports Medicine and Surgery* (Bloomberg *et al.*, 1998). Today, physical rehabilitation is becoming common in small animal practices. Therapeutic exercises are used not only for recovery but also for wellness care and preventive medicine in the form of weight management and maintenance of muscle strength and conditioning, particularly for athletes and geriatric animals.

The Role of Exercise Physiology

Skeletal muscles perform motions guided by the nervous system. Skeletal muscle performance is dependent on muscle fiber type. Traditionally, muscles are classified as type I (oxidative or slow twitch) or type II (glycolytic or fast twitch) with subclassifications of these two types (Armstrong *et al.*, 1982). However, all muscles consist of a mix of different fiber types, in different ratios depending on the individual muscle and on training. Postural muscles (stabilizer muscles) such as the quadriceps femoris are capable of slow and sustained contraction and contain more type I fibers (about 50%) (Lieber *et al.*, 1989) than muscles like the gracilis, which contain more type II and are speed and power (mobilizing) muscles (Amann *et al.*, 1993). Type I muscle fibers have been thought of as the endurance muscle fibers (found to be more predominant in dogs which run long distances like sled dogs) and type II as the sprinting muscle fibers (for sprinting dogs such as Greyhounds) (Wakshlag *et al.*, 2004). However, when compared to humans, all dogs have a high oxidative capacity in all their muscles and are adapted for endurance activities (Wakshlag *et al.*, 2004). Certain breeds, for example Greyhounds, do have more fast twitch muscle fibers than others (Guy and Snow, 1981).

When muscles are immobilized, such as in casts or splints, muscle strength decreases rapidly, with as much as 50% of strength lost within the first week (Boyd *et al.*, 2009). With disuse, postural muscles that contain a predominance of type I fibers atrophy more than the mobilizing muscles containing type II fibers. With geriatric sarcopenia (the age-related change in muscles), it appears that in dogs the epaxial muscles atrophy early in the process. A study of live dogs compared epaxial, quadriceps, and temporalis muscle size in aged dogs, and in size and body condition score matched young dogs. The results showed that epaxial muscles were smaller in aged dogs but quadriceps and temporal muscles did not differ significantly (Hutchinson *et al.*, 2012). Fiber type lost, however, appears preferential for the large type II (power and strength) fibers (Deschenes *et al.*, 2013), as shown in analysis of cadaver canine biceps femoris muscles (Pagano *et al.*, 2015). This is an important consideration in designing an exercise program for an athlete with muscle loss due to injury, versus a geriatric patient with age-related sarcopenia (Appell, 1990).

Muscle contractions can be described as having two variables: force and length. The force is either tension or load. Load is the force exerted on the muscle by an object and muscle tension is the force the muscle exerts on an object. Isometric contractions occur when muscle tension changes with no change in muscle length. This is a static exercise, for example lifting a front leg so that more weight/load is on the muscles of the contralateral front limb and the rear limbs; these limb muscles are undergoing isometric contractions to support more body weight. Tension bands applied to the standing patient rely on the instinct to lean into pressure. As a patient maintains the same body position under an increased load (whether push or pull), the muscle work has increased without a change in muscle length.

Isotonic contractions occur when the muscle tension remains the same but the muscle length changes. Isotonic contractions occur as either concentric or eccentric contraction. Concentric contraction occurs when tensions in the muscle increases along with shortening. An example of this would be a human weight lifter performing a biceps curl. Eccentric contraction occurs when the muscle contracts but lengthens because the tension generated in the muscle is insufficient to overcome the load pulling down on the muscle. Think of the weight lifter slowly releasing the biceps curl and extending their elbow to put down the weight. The eccentric contraction is controlling the movement – it is the natural braking force that occurs during motion (Gillette and Duke, 2014). Eccentric contractions can predispose to injury in untrained individuals (Whitehead *et al*., 2003). Resistive exercise of all forms leads to the preferential hypertrophy of type II fibers and eccentric contractions render type II fibers more susceptible to damage when compared to type I fibers in humans, rabbits, and rodents (Quindry *et al*., 2011). In an exercise program, generally, concentric exercises are performed first to help accustom the muscle to movement. Eccentric exercises are added later as these have the potential to cause damage to the muscle and delayed-onset muscle soreness, but they help develop greater strength. A balanced program between concentric and eccentric muscle contractions is desired.

Principles of an Exercise Program

When designing an exercise program for a patient the therapist must consider any pathology affecting the cardiovascular, neuromuscular, skeletal, pulmonary, endocrine/metabolic, or integumentary system. These systems can affect muscular performance; for example a dog with laryngeal paralysis will have some respiratory compromise, and a patient with a repaired ligament will have some reduced joint stability early in the healing process. It is also important to evaluate the patient's psychological state and willingness to perform any exercise as well as the experience of the client or handler. A home exercise program may be very different for an agility dog with an experienced trainer versus a geriatric companion dog with an aging client.

After evaluating the patient, identifying problems and the amount of tissue healing that has already taken place (tissue integrity), the therapist must set both long- and short-term goals for the patient. It is important that the client's goals are in line with those of therapist. Each part of the program – proprioception, strength, endurance, and power (speed plus strength) – should have specific goals and these will vary with the patient and with the injury. Exercises should also include relaxation time between bouts, and flexibility exercises specifically tailored to the demands made on the body. It is important for therapists to know as much as we can about the effects of the exercises we use. Although not a lot of information is known about all the exercises we use, where information exists we should apply it. For example, cross walking (serpentine) on a hill results in a temporary increase in loading of the downside hindlimb, transferring forces off the upside hindlimb, but dogs adapt quickly and compensate – more weight is shifted to the downside forelimb and shorter steps are taken (Strasser *et al*., 2014). Using a serpentine pattern to start to introduce hills, or to start to increase the workload on a recovering hindlimb may not have the desired effect of significantly increasing the load on that limb beyond the first few steps therefore a different exercise may be more appropriate.

Once the goals are set and the program is designed, it is important for the therapist to evaluate the patient at each visit. Asking and documenting questions about soreness and level of home activity after the last session is crucial. The rehabilitation technician/nurse is instrumental in acquiring this information. This allows the therapist to adjust the program as needed so the patient continues to progress through the rehabilitation process. Therapists should ensure proper, efficient mechanics in motion for their patients. Faulty patient body mechanics must be corrected wherever possible and good fundamentals ingrained. Use a hand or an assistive device to guide as needed. Watch for decline of movement patterns (in gaiting and during transitions) as signs of fatigue. Do not continue an exercise once body mechanics degenerate from the best possible for that patient at that time (even if that best had initially required some assistance). Rest for a period (usually a few minutes), then attempt to resume the exercise. If the exercise cannot be performed to the level it was earlier in the session, then end the session. Ask for an easy motion to end on a good note.

At no time should the patient be harmed or uncomfortable. Chronic overexertion and fatigue can increase susceptibility to injury. According to the International Associations of Athletics Federations online medical manual (IAAF, 2016) muscular overexertion may present as muscle soreness, muscle stiffness, and muscle spasm. Adaptation to the demands of strengthening exercises occur gradually, over long periods of time. Efforts to accelerate the process may lead to injury. Conversely, an inadequate training load will not provide an adequate stimulus, and a strengthening of tissues will not occur.

Certain activity patterns are especially likely to cause overtraining (IAAF, 2016). These include a sudden increase in training volume and/or intensity without a gradual build-up and use of a single, monotonous training format which fatigues one muscle group or energy system. Early warning signs of overtraining include a longer recovery time needed between exercise bouts (patient is tired and stiff for longer than 2 hours after exercise). In this case the exercise may be too intense or the patient may need re-evaluation. Icing post exercise and prophylactic pain control will be needed, particularly for postoperative patients. In weak, ataxic or non-ambulatory patients, assistive devices must be used for exercise and this can include booties to protect feet from scuffing the floor or harnesses or slings to assist in ambulation.

According to McCauley and Van Dyke (2013), there are five variable parameters in any exercise program:

1) Frequency of work done (multiple times per day, daily or weekly)
2) Speed/intensity
3) Duration of work (time or number of reps)
4) Environment (terrain, footing, substrate)
5) Impact (low, high or no impact).

As the patient heals, the frequency, intensity, and duration of the exercise is increased to further challenge the patient and to strengthen the muscles. Remember that tendons, bones, and articular cartilage also remodel and "strengthen" with a correctly targeted exercise program. It is usually safe to increase the activity by 10–15% each week if the patient does not experience an increase in pain or a loss of function (Millis *et al.*, 2014).

Canine Rehabilitation Equipment

Physioballs/Peanuts/BOSU® Balls

Exercise balls come in many shapes and sizes and have many different uses. Peanut balls look exactly like a peanut shell, with an indent in the middle providing two separate points of ground contact for added stability over an oval ball. A physio roll is like a peanut ball but lacks the middle indent. Egg-shaped balls have less stability, which makes exercises on these more challenging. Round balls are the most challenging as they allow movement in all directions. A BOSU® ball is flat on one side and has a half ball attached, allowing the patient to balance on the half ball side or when flipped over to balance on the flat side (Figure 19.1).

In general, most ball work will start with an underinflated peanut for the most stability. The therapist should stabilize the peanut and allow for only small motions. Make sure the patient has good posture, avoid strengthening one muscle group predominantly over another (e.g., spinal flexors over extensors, resulting in kyphosis), always follow with a stretch to reverse the motion. As the patient progresses, more air is added for an additional challenge; later, more challenging ball shapes, along with more challenging postures, are used. When introducing a patient to the ball, make it a positive experience by using treats (see Chapter 9). When using balls for exercises, remember that time can be lengthened for sustained muscle contraction and transitions on the ball can be used for improving both strength and control further. Be cognizant of the type of muscle contraction you are asking for, and hence the muscle fiber type you are targeting. An old dog with weak spinal stabilizing muscles will benefit more from standing still in good posture on a challenging surface, rather than attempting transitions.

- Physioballs can help build strength while also increasing balance and proprioception.
- Peanut balls and BOSU balls are used for beginners as they allow more stability due to increased ground contact. BOSU balls are particularly good for core strengthening.

Cavalettis

Cavaletti poles or ground poles have been used extensively for training horses. In the small animal patient, these poles are used to train gait, improve proprioception, and strengthen the forelimb and hindlimb flexor muscles (Figure 19.2). They are also used to improve active ROM – specifically they increase flexion and extension of stifle and flexion of the carpus and elbow along with flexion of the tarsus (Holler *et al.*, 2010). Cavalettis are placed in a series, and are adjustable in height. They are placed

Figure 19.1 The patient has all four paws on the BOSU ball to work on balance. Posture is corrected as needed.

Figure 19.2 Cavalettis are great for strengthening the forelimbs and hindlimbs and as a proprioception exercise.

low or on the ground when the patient begins the exercise, or has significant muscle weakness. The height can be adjusted as the patient progresses through rehabilitation. They can also be placed in a circular pattern for jumping or as a series of "bounce" jumps for more advanced patients or athletes (Millis *et al.*, 2014). Spacing is patient-dependent; it depends roughly on height and body length, but most importantly on stride length.

Cavalettis are very easy to make using pylons (cones) with holes and PVC pipe or crushed aluminum cans and 2 × 4-inch planks. For home use clients can use anything from PVC pipe to broomsticks or even pool noodles, depending on the size of the dog. The cavalettis are spaced so that only one paw at a time is placed between the poles in gaiting over them, thus challenging proprioception as the dog avoids touching the pole. The height of the pole determines how much flexion occurs; more flexor strengthening occurs with higher poles.

- Cavalettis are used for improved proprioception and strengthening. They are a good exercise for dogs ranging from weak geriatric to athletes. They are easy for the client to make at home.

Weave Poles and Cones

These poles and cones are used for circling, walking in a figure eight, and weaving (in a serpentine). Weaving in and out of cones creates lateral flexion of the spine, aims to strengthen the adductor and abductor muscles and to improve balance and proprioception. Six to eight traffic cones can be used to make up an obstacle course for the dog to weave in and out of. Alternatively, multiple objects such as bowling pins, water bottles, or a line of trees can be used if they are lined up evenly spaced so the dog can weave in and out of the objects. Vertical weave pole agility sets can be used. An alternate is traffic cones with a pole at the top. The distance between the poles needs to be adjusted so that sufficient lateral bending occurs.

- Weaves can be used to visualize any discrepancy in the patient's gait. The objects can be anything that is lined up in a straight line. Weaves are used to help build core muscles and improve proprioception.

Planks/Blocks/Stairs

Planks are 2 × 8 inch (5 × 20 cm) or 2 × 10 inch (5 × 25 cm) pieces of wood that are 8–10 feet (2.5–3.0 m) in length. The planks are initially placed on the floor and the dog walks along it while maintaining balance. The plank is then raised up onto cinder blocks. The dog is further challenged by placing blocks as obstacles on the plank.

Blocks are smaller, thicker pieces of wood with a 4 × 6 inch (10 × 15 cm) non-slip area. Grip tape can be added (skateboard product). They are made in sets of 2, 4, and 6 inch (5, 10, and 15 cm) heights. The dog stands with one foot on each block or any combination of diagonals or front or back paws. Strengthening of the stabilizer muscles of the trunk is emphasized by this exercise.

Stairs can be made of any material and many different types of stairs exist in a home or clinical setting. Climbing stairs is good for proprioceptive training, core muscle strengthening, improved hindlimb weight bearing, and improving ROM of pelvic limb joints (improved extension of hip and hock and improved/increased flexion of stifle and hock) (Durant *et al.*, 2011). Descending stairs is also good for balance and proprioception and should increase forelimb weight bearing.

- Planks, blocks, and stairs strengthen and target proprioception.

Balance Discs or Boards

Balance discs are rounded on both sides, not as curved as a ball, with a side rim of about an inch (2.5 cm) high. Each surface has a different texture. One is smooth, the other is textured and can so provide more grip.

Figure 19.3 The rocker board pictured is placed against the wall. The dog is lured to place a foot on the board.

Balance discs create an uneven surface that helps to improve balance and strength, in both the digital flexors and in the stabilizer muscles that are activated by the uneven stance the balance disc creates (Figure 19.3). Balance discs are easier to stand on than are balls and can be used alongside other stabilization exercises.

Balance boards are created by laying a piece of plywood over a pillow, water bottle, or ball, thus creating an unstable surface. These can be made by gluing a half tennis ball to the bottom of a piece of plywood that has been covered in indoor/outdoor carpeting, making a non-slip surface.

Limb Weights

Limb weights are small weights that can easily be secured to the limbs. Normally they have a Velcro strap attached to them. With some creativity, limb weights can be manufactured for patients of different sizes. For some dogs, we have used stainless steel washers of various sizes that are readily available in the hardware store. These are wrapped in vet wrap and placed on the limb. Curtain weights also work. The advantage of these small structures is that you can use numerous ones of varying weights to slowly increase the weight on the limb. Limb weights are for more advanced rehabilitation and they promote natural weight shifting on the diagonal. Commercially available weights are available (e.g., from Canine Icer™).

Elastic Resistant Bands

These (e.g., TheraBands) are 6-inch-wide (15 cm) latex resistance bands that are color coded for different resistance levels, which are determined by the thickness of the material. They can be used in both beginner and advanced therapy and can also be used as a means of pulling a paralyzed leg forward, mimicking regular gait. They can also be used to increase tension and resistance to facilitate muscle development.

Trampoline (Mini)

This is a very useful tool for training proprioception and balance in small dogs and cats. The trampoline causes an uneven surface area that in turn causes multiple muscle firings. It is an excellent tool to increase core strength in small dogs recovering from back surgery and to build up core strength to help prevent back problems in this same group of dogs.

Land Treadmills

Land treadmills provide a great workout for dogs and cats, improving limb strength and increasing cardiovascular endurance. Neurological patients can benefit from treadmills for gait patterning during recovery from paralysis. A board placed across the front of the treadmill allows the front feet to be elevated off the belt while

Box 19.1 Treadmill safety

- Always use a leash and harness with the patient. Collars can be dangerous
- Never tie the patient to the treadmill or leave the patient unattended. Stand next to the dog throughout the entire workout
- Do not face the treadmill into a wall – the dog will resist walking "into" the wall
- Lead the patient onto the treadmill using an incentive such as a treat or toy, and then the treadmill can be slowly turned on
- If your treadmill does not have safety walls you may need assistance to keep the pet's attention looking and walking forward. Place one side against the wall so the patient does not fall off the side
- Short intervals are important until the patient gets accustom to the treadmill. Go slow and let the patient get acclimatized to the routine
- Always monitor the amount of panting, the pet's gait, body language, and signs of fatigue (excess or rapid panting, glazed eyes, change to gait (wobbling, staggering) and drooping tongue) the entire time
- Allow rest periods where stretching, massage, and ROM can be performed
- A water dish can be offered during intermission time as well
- Remember that each session should be positive and time on the treadmill should be dictated by the patient's condition and response

hindlimb gait retraining is concentrated on. Small patients can be placed in their cart on a treadmill. Most treadmills can be inclined (or in some cases down to a decline) to work on improving strength or reducing the force placed on front or hind legs. It has been reported that dogs walking on a treadmill with a 5% incline had increased hamstring activity, but that gluteals and quadriceps were not affected (Lauer *et al.*, 2009). So an incline should improve hamstring strength.

The speed and length of time can be varied to build up endurance and for conditioning. Canine athletes can be conditioned on treadmills with various inclines and various speeds for intervals of 20–30 minutes at a fast trot. Most medium to large dogs will comfortably walk at a rate of approximately 2 mph (3.2 km/h) whereas neurological patients must be started at 0.1–0.5 mph (0.2–0.8 km/h). It is important that the therapist evaluate each dog on the treadmill to determine optimal speed and effort while maintaining a normal gait (Box 19.1). What works for a Golden Retriever may not work for a Border Collie!

Dogs that are leash walked can be easily trained to walk on a treadmill (Box 19.2). A variety of treadmills can be used for exercising dogs. Specific dog treadmills such as Jog a Dog (inclined treadmills) or Dog Pacers can be purchased, or a human treadmill can be used (Figure 19.4). If a human treadmill is used, the belt length needs to be long enough to accommodate the dog's stride. Many medium and large dogs have too long a stride length for the traditional treadmill, especially at trot. Remember that during normal gaiting on land, speed varies. Also, a treadmill has the potential to gait retrain a patient into an undesirable pattern. Land treadmills can be used for feline patients if the cat is taught slowly (Figure 19.5).

Desirable features for a land treadmill include (McCauley and Van Dyke, 2013):

- belt length long enough to accommodate expected size of dog (minimum 6 feet/2 m)
- incline/decline capacity
- ability to go in reverse direction (hence decline?)
- one button push-start/stop or turn of a knob
- exact speed visible (this allows consistent exercise intervals)
- starting speed of 0.1–0.2 mph (0.2–0.3 km/h)
- side rails.

Box 19.2 Treadmill introduction

- Walk the dog into the room and around the treadmill while it is off
- Walk the dog up onto the treadmill while it is off, giving treats while on the treadmill. Practice walking on at the back and off at the front. You may want to start to introduce commands for getting on the treadmill and getting off so that the sessions are controlled
- Have the dog sit by the treadmill when it is on, giving cookies so that he or she remains calm and becomes accustomed to the noise
- Place whatever device you will be using while doing the treadmill on your dog (harness/ safety vest/leash) and have them get back onto the treadmill
- Never tie the dog to the treadmill. Always hold the leash and stand next to the treadmill in case of emergency
- Slowly turn the treadmill on while feeding cookies to make it a positive experience. Remember that in the beginning taking one step should be rewarded. As time passes, reward for longer sessions
- You may need to hold the harness so the dog feels comfortable or show a favorite toy to motivate him or her to walk forward
- Unless you know if your dog can chew and walk at the same time (which many cannot) you should reward with praise and pats until the treadmill stops
- Increasing speed and time is not crucial until the dog is comfortable with being on the treadmill. Increasing speed can cause the dog to misstep and cause injury. Increased time can cause fatigue and muscle soreness and therapy setback
- The whole point is to have the dog walking on the treadmill in order to strengthen muscles, increase endurance, as well as a multitude of other reasons. However, the most important thing to remember is – make it fun!

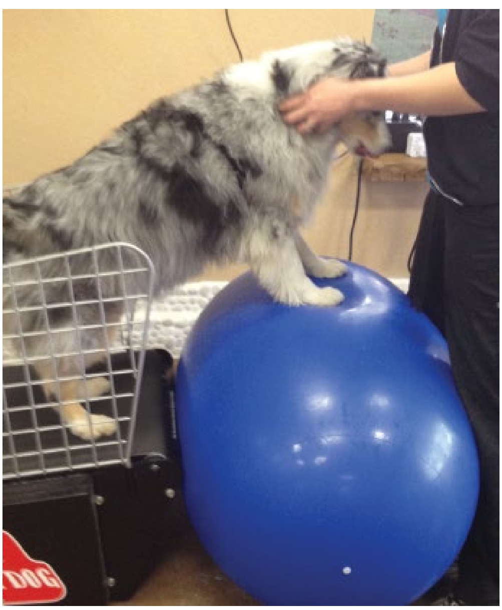

Figure 19.4 The land treadmill can also be used for advanced exercises as shown here. The dog has front feet on the ball and rear feet on the treadmill.

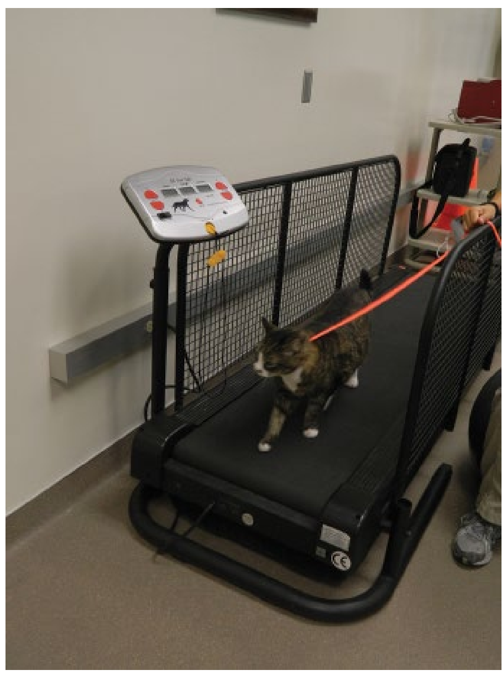

Figure 19.5 Land treadmills can be used with feline patients. Dr. Sheilah Robertson's cat, Calvin, is on the land treadmill.

Control, Supportive, and Assistive Devices

Harnesses, safety vests, and leashes should be used to control the patient during exercise. Harnesses that do not restrict shoulder motion are used for rehabilitation. For patients that are not ambulatory or ataxic, front and rear end harnesses are used to assist both the patient and the therapist. Booties are used if the surfaces are slippery or if the dog is weak and dragging of the feet may be a problem. Doing exercises over balls, or foam rollers, over peanuts or while in a sling can be very useful for neurological patients (see Chapter 10 for more details about this topic).

Walking

Controlled leash walking is an excellent therapeutic exercise. It is easy to do and dogs usually enjoy it. Health benefits should include increased endurance, strength, cardiovascular fitness, and good mental stimulation. Unless the dog is confined for safety and only allowed outside for bathroom privileges, most dogs can start walking soon after surgery. Leash walks generally consist of 5 minutes of activity 2–3 times daily at first and progress each week by 1–5 minutes per walk depending on the patient. Be sure to specify the relative speed of the walk, and the need for continuous walking rather than the stop and sniff of a leisure walk. During inclement weather or cold winters, land treadmill walking may be preferable to walking outdoors. Treadmill walking, although it provides exercise, weight bearing, and strengthening, does not give the dog (or client) any mental stimulation (Saunders, 2007).

Exercise Categories

In the following sections various exercise categories are discussed:

- Balance and proprioceptive exercises
- Core strengthening
- Hindlimb exercises
- Forelimb exercises
- Neurological rehabilitation exercises
- Exercises for cats.

Balance and Proprioceptive Exercises

Cavaletti Course

This helps with proprioception, strengthening, and gait retraining. Pole heights can vary and the distance is case-dependent. The poles are evenly placed apart and the animal walks over the poles very slowly. The slow pace allows the animal to step over the poles one paw at a time and recognize their paw location. The goal is to walk over the poles without touching them. It is best to start with 5 minutes twice daily. The pace can be progressed to a trot as patient strength increases, and distance between poles can be lengthened to encourage more limb extension in protraction (longer stride length).

Balance Boards or Balance Discs

These are used for balance, proprioception, and strengthening legs. Place the targeted legs on the board, elevate the other limbs to the same height to equalize weight bearing, or elevate the other limbs above the board level to increase weight bearing through the affected limb(s). Control the patient with a harness. The board can initially be stabilized to allow only a small ROM in rocking as the patient learns to balance, then as the patient becomes more competent the board can be rocked back and forth. Balance discs or BOSU balls can also be used for this, and at home a firm cushion or air mattress. To increase the balance challenge, have the patient take treats from different locations on the board so they will have to shift position while maintaining balance. Start with a small amount of time twice daily and progress as the patient strengthens. Determine amount of time based on in-clinic observations. Watch out for fatigue and postural compensation as a guideline for when to stop, and give the client a time limit for home exercise, as well as red flags to look out for.

Weave Cones

Weave cones are generally used to improve proprioception and increase core strength. The exercise can also pattern-improved for weight bearing when a limb is being protected after long-term adaptations to pain. Objects, normally 6–8 of them, are lined up about 1–3 feet (30–90 cm) apart (depending on patient size) and the dog is weaved in and out of the objects. Work to have an even number of bends each direction. The dog needs to learn to pivot sharply at the end of the pattern, and the therapist or client can use their body as a guide to prevent excess lateral motion and to keep the turns tight. Normally, this exercise lasts about 5 minutes twice a day but base the amount of time on observations in-clinic, looking closely for signs of fatigue (reduced control in the tight turns, reluctance to bend, slowing down, etc.).

Figure Eights

This exercise is also performed using cones and is used to increase balance, coordination, spinal ROM, and for weight shifting from one limb to another. It is completed by walking the outline of the number "8" around two cones. The length of the figure eight normally is twice the height of the dog and the activity should be performed at a slow speed. The slow speed allows for an increase in spinal ROM. This should be done a few minutes at a time to avoid dizziness.

Blocks

These are used in developing proprioception and core muscles. The animal places one paw on each block in a standing position and holds the stance for increasing periods of time. The blocks can be moved closer to mid-line or both paws can be on one block.

Balance Beam

This is a length of plywood elevated as described above (in the section on Planks/Blocks/Stairs) that the dog walks along and sits on while maintaining their balance or posture. The goal is to have the dog walk along and not step off the beam.

Figure 19.6 Uneven cushions: This patient is a recovering neurological patient who is working on balance and proprioception with the uneven surface. Core strength is also challenged in this exercise.

Trampoline, Cushions, Air Mattress

These uneven surfaces help improve weight bearing as well as proprioception. The exercise can be done in many ways. Start with two paws on the uneven surface and move the patient around it, then have the patient walk across the surface (Figure 19.6). Progress to standing on the surface while the therapist applies gentle pressure to each hip or shoulder in a back and forth motion to challenge balance. Be sure to use a harness to control the patient so they do not lose balance and fall.

Rhythmic Stabilization and Weight Shifting

Weight shifting is used to increase weight bearing and balance. Weight shifting should be done while the dog is standing. Place your thumbs over the dog's pelvis bones and your hands down their sides. Slowly sway side-to-side or front-to-back, making sure both legs are weight bearing. Do not use enough force

Figure 19.7 Ball weight shift: This patient is recovering from a fibrocartilaginous embolism and is working on regaining strength in the rear legs. The therapist rolls the ball back and forth.

to cause the dog to lose their balance. This can also be performed in a supported stance, on a therapy roll, etc.

Ball Work

This targets proprioception, allows for advanced strengthening and balance, and increases core and trunk stability. Most exercises can be performed on a Theraball™ (Figure 19.7). Once the dog has mastered exercises on solid ground, balls can slowly be introduced. To work on balance and proprioception, a large, egg-shaped ball should be used. The goal is to have the dog balance on the unstable surface and eventually to perform transitions such as sit-to-stand exercises. More ball work is described in other sections.

Core Strengthening

Crawling

This exercise is great for core strengthening, improving spinal mobility, ROM, and limb strengthening. It can be done anywhere and with anything; dogs can crawl under chairs, beds, boxes, agility tunnels, or they can just learn to crawl along the floor. The higher the "crawling tunnel" that is created, the easier the exercise is for the patient. Begin with short distances and put treats along the tunnel to encourage the patient to move forward. Gradually increase the distance. Remember to add a command word and always reward while they are learning.

Sit Up and Beg

This helps core strengthening, and hind leg strength. Initially have the dog sit squarely and then get up onto their back legs as though they were begging. Treats will help make this easier to teach. The dog may be unstable and the therapist may need to hold one front leg until the dog is stronger (higher is easier for the dog). Once the dog can hold the beg position, asking the dog to stand on their hind legs will strengthen the pelvic limbs. This is done with holding a treat higher. The dog is then asked to get back into the beg position. The up and down from beg to stand is like performing squats for humans. Eventually work up to two sets of 8–10 twice daily. This exercise should not be done if the dog has significant spinal or hip issues.

Diagonal Leg Lifts

This exercise helps with core strengthening but also balance, weight shifting, and leg strengthening. The stance is achieved by lifting one leg off the ground along with the diagonal leg. Both legs are to be lifted at the same time and minimal support to the limbs should be provided so the dog must balance (Figure 19.8). Hold this pose for 10–30 seconds and repeat 8–10 times. When this exercise is easy for the dog, progress to having the dog stand on four blocks and then lift the diagonal legs. Finally add some weight shifting to cause the dog to balance further.

Diagonal leg lifts on a therapy ball are another possibility and these can be done as further challenge for the dog.

Planking on a Ball or BOSU

There are many ways this exercise can be done depending on the focus of the exercise. The

Figure 19.8 Diagonal leg lifts: This is a core strengthening exercise. As the patient's balance and core muscles improve the legs can be lifted higher.

dog may stand with their front legs on one peanut ball, their back legs on another ball, or front legs on a BOSU or ball and back legs on a balance disc or on the ground. The ball may also be moved while the dog is on it, rolled forward, or side to side while the dog balances. Alternatively the dog may be asked to keep front legs on the ball and walk around the ball.

Side Sit-Up

This exercise builds core strength but also increases spinal ROM. The dog should lie laterally. Using a treat, lure the dog up sideways, as if they were doing a sit-up sideways. Try to hold for 5 seconds then return to lateral. Do up to 10 reps per set. Dogs with spinal problems should be cleared before doing this exercise.

Hindlimb Exercises

Sit-to-Stand

This exercise aims to improve strength in the pelvic limbs. When performing this exercise, it is important to assure that the dog sits squarely and that on transition to stand, both pelvic limbs are used to propel the rear into extension. The patient should not pull themselves forward with the front limbs. A square sit occurs when the hips, stifles, and tarsi are in a straight line with the shoulders. The shoulders are perfectly aligned with the carpal joints. If the dog kicks one leg out to the side the therapist should have the dog stand again and sit while the therapist places their leg against the dog's paw, thus ensuring a square sit. Alternately, the dog could be asked to sit against the wall with the affected leg against the wall, thus preventing the leg from moving laterally. This exercise can be repeated over and over for increased strengthening.

Backward Walking

This exercise aims to strengthen the pelvic limbs and increase balance, coordination, and proprioception. We do not know the effects on specific muscles, only that the stance and swing phases of all four limbs are shorter with backward walking but that hip, stifle, shoulder, and elbow ROM are similar for forward and backward motion. There is some reduced ROM in carpus and tarsus, although this varied between the dogs studied (Vilensky and Cook, 2000). This exercise is easier to start with the dog parallel to a wall, a sofa, or anything straight. The therapist should hold a treat at their chest level and walk toward the dog saying "Back." Most dogs will try to turn while they are learning to walk backward, so it is important to give a reward when the dog takes a step backward. Another way of training this is to have a couch parallel to the wall just far enough from the wall that the dog cannot turn around. Lure the dog in forward with a treat, then say "Back" and encourage the dog to walk backward for another treat. This is an important exercise to teach all dogs and puppies as at some time in their lives. All dogs need good hindlimb awareness.

Side Stepping

This exercise aims to improve both forelimb and hindlimb strength as well as proprioception and balance. The therapist stands facing the side of the dog, grasps the dog's collar in one hand, and holds the other hand on the dog's opposite hip. The therapist then walks toward the dog, encouraging the dog to side step. An alternate method is to use a treat to keep the head focused forward, one hand on the hip and gently walk into the dog. If there is a problem controlling the back end of the dog during this exercise, a front and back end harness can be used for extra back end control. This exercise needs to be performed in both directions to target the muscles symmetrically.

Incline Walking

Incline walking helps build muscle in the rear legs due to the weight being shifted toward the back. On a treadmill, an incline has been shown to predominantly increase hamstring muscle activity versus gluteal and quadriceps activity (Lauer *et al.*, 2009). Incline walking increases stifle joint flexion (Holler *et al.*, 2010). This exercise should be started with shallow inclines and then steeper inclines can be added when the pet is comfortable and adjusting well. Serpentine or cross-hill walking can also be incorporated, where the patient walks in a zig-zag pattern across the hill up and down (see section on Principles of Exercise Program). Start with 5 minutes and gradually work up to 20 minutes twice daily, incorporating hills.

Stairs

Stair ascent increases extension of the hip (coxofemoral) and hock joints and results in reduced stifle extension when compared with level walking. The stairs also increase maximal flexion of the stifle and hock with each stride (Durant *et al.*, 2011). An example of therapeutic use would be for a patient with reduced flexion ROM in the hock (e.g., post-surgical osteochondritis dissecans) therapy would include stair ascent starting with low rise steps at the appropriate time in recovery. Descending stairs increases ROM in the hip, stifle and tarsal joints versus walking on a decline slope (Millard *et al.*, 2010).

Loving on Stairs/Couch

This exercise is used to improve rear leg weight bearing and strength, ROM, and hip extension. The client sits on the stairs/couch. With the dog's back legs firmly on the ground, lift up the front legs and place them one/two stairs up or on the couch cushion (height is dependent on dog's body length). This causes the dog's weight to be shifted to the pelvic limbs, and the weaker back legs must support most of the body's weight. While the pet is standing up on their back legs, praise them and give love or treats so that the time passes quickly.

Crawling or Tunnels

This exercise has been described in the section on Core Exercises.

Cavaletti

Cavaletti walking results in increasing flexion of the stifle and tarsal joints and increases extension of the stifle joint (Holler *et al.*, 2010). This exercise has been described in the section on Balance Exercises.

Zink-Zeus Get Up

This exercise was created by Dr. Christine Zink as an exercise she used with her patient Zeus. It is one of the most challenging hindlimb exercises and one that many dogs dislike performing. With the dog lying in lateral recumbency, the therapist holds the top paw. While holding the paw so it cannot be used to assist the movement, a treat is used to lure the dog into a standing position. If the dog will not lay laterally, the exercise can be started with the dog in sternal recumbency. Initially most dogs can only do 1 to 2 reps of this exercise (Zink, 2013).

Ladder Walking

This exercise aims to strengthen the legs and improve ROM, balance, coordination, and proprioception. The exercise is performed with a ladder placed flat on the ground. This exercise is like cavalettis but can change in difficulty. Initially the dog walks forward over the rungs but can be taught to walk backward and sidestep through the ladder. This exercise should start at 5 minutes twice daily and work up in frequency.

Front Limb Exercises

High Five Salute

High five salute helps with ROM and strengthening of front legs. To perform this exercise, the dog should be sitting. The dog then brings the paw up to their head and away as though saluting. This exercise does take some training for most dogs. When "giving a paw," dogs usually only move their forelimb distal to the elbow. In this exercise, they need to move their shoulder, which allows the paw to get up to their head. In this way, the extensors of the shoulder and limb protractor muscles are targeted, and if the paw is placed in various locations then abductors and adductors can also be strengthened. Start by holding a treat in the hand. When the dog paws at the treat, the reward is given. Move the hand higher and into the position you wish the dog to stretch.

Wheelbarrow

Wheelbarrow targets the front limbs and the core. This may seem like an easy exercise but it is quite challenging and needs to be done slowly and cautiously. First, never just pick the dog or cat up by their pelvic limbs as that is a great deal of load on them and you need to assess patient compliance. Start with lifting the patient by the caudal part of the abdomen or under the pelvis so that the rear legs are a few inches off the ground. Observe contractions of the core muscles. Keep the stationary position for a while until the dog is comfortable with being lifted. Second, slow movement forward and backward can be added, making sure that the animal's spinal alignment is monitored. Advancing the exercise, the rear legs can be lifted and the patient balances on the front limbs (Figure 19.9). Use treats to lure the patient. The spine should be perfectly straight to prevent injury. Do not push the patient too quickly; this can cause tripping, leading to the dog's head hitting the ground. Do not perform this exercise with a patient with significant spinal issues, shoulder pain, or carpal hyperextension.

Stairs

This exercise (as discussed earlier) is like walking on a decline and the stairs or decline should start out shallow and gradually become steeper as the patient progresses. Changes should only be added when the pet is comfortable and adjusting well. Time may be increased as the patient becomes stronger.

Crawling or Tunnels

This exercise has been described in the section on Core Exercises.

Figure 19.9 Wheelbarrow: Care should be taken when holding a dog for this exercise.

Cavaletti

Forelimbs show increased flexion of the carpus and elbow over cavalettis (Holler *et al.*, 2010). This exercise is described in the section on Balance Exercises.

Play Bow

This exercise aims to increase forelimb strength and flexibility and to promote core strengthening. The therapist holds a treat in one hand and the other hand is under the abdomen. The treat is moved to the floor and the dog's head and shoulders follow while the abdomen is being held up so back legs are standing and front legs are down.

Digging

This exercise aims to strengthen the front limbs, improve ROM in flexion, improve proprioception, and increase core strength. When performing this exercise, it is beneficial to have a command and a designated area where digging can occur. Sand, soft soil, or snow when in season are good substrates when they are not too packed down. Stones can hurt their paws and should not be used. A treat or favorite bone can be buried and dug up. Caution: some clients do not wish to encourage digging!

Ladder Walking

This has been described in the section on Hindlimb Exercise but also works well for forelimbs.

Neurological Rehabilitation Exercises

See also Chapter 11 for more information.

Assisted Standing

This exercise is important to build and maintain muscles needed for balance, proprioception, and locomotion. These muscles become atrophied if not used frequently, as for example, in a paretic patient. A therapy ball, rolled towel, cushion, foam roller, or other device (depending on the size of the dog) is placed under the dog's abdomen. While performing assisted standing, it is crucial to keep the pet's feet in normal anatomically correct standing position without knuckling. Larger dogs normally require additional abdominal support from a sling or back end harness. Frequently, the feet need to be positioned by two people. Smaller dogs and cats generally require only one person if their abdomen is supported by a Theraball™. Aim to keep the patient's spine as close to a normal standing posture as possible, not kyphotic. Assisted standing should only last until the first signs of fatigue. After a brief rest, it can be repeated, but do not exhaust the patient.

Physioball Work

Balls are particularly important for rehabilitation of neurological patients (Figure 19.10). They can be used for assisted standing as described earlier, as well as for assisted walking and to regain balance and coordination. Frequently, the front end of the patient is placed on the ball and the ball is rocked back and forth. Foot placing by a second therapist may be required.

Weight Shifting

Neurological patients need to practice balancing on three limbs to mimic the transient

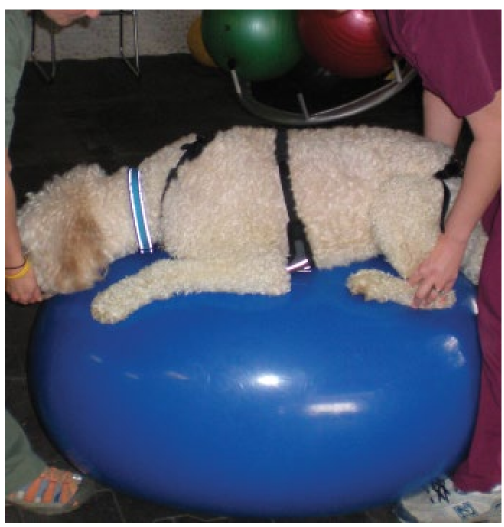

Figure 19.10 Sit-to-stand on the ball may need two people in the case of a large dog.

unloading of a limb during ambulation. To perform this exercise, the therapist places the dog or cat in standing position and lifts one limb. When they start to sway, the limb is replaced. All four paws are rotated through this exercise.

Treadmill Gait Training

Land treadmills are used for gait retraining for neurological patients. Many times, the patient must be supported with a sling. The therapist moves the dog's legs in walking gait pattern: RR to RF, LR to LF (Zink, 2013). Skin sensation stimulus (vibrations, scratching, or even e-stim) can be used to overcome spasticity. As the gait becomes more normal, incline can be added.

Proprioceptive Neuromuscular Facilitation Patterns

Proprioceptive neuromuscular facilitation (PNF) has been around since the 1930s when neurology physician Herman Kabat began to use the technique on his patients. He found that by stimulating the distal segments, the proprioceptive nerves in more proximal segments became stimulated. His purpose was to enhance and create movement in areas where the neurological system has been compromised. His techniques were based on the principles that describe the rhythmic and reflexive actions that lead to coordinated motion. PNF uses the body's proprioceptive system to facilitate or inhibit muscle contraction (Stillman, 1966). PNF patterns mimic the dog's running motions and other normal functions of daily living (scratching, digging). To perform a PNF pattern for running, lay the dog on their side and mimic the running pattern, then mimic in a supported stance if possible. The therapist should use one hand to mimic the ground contact at the appropriate part of the gait cycle (Edge-Hughes, 2012).

Tactile Stimulation

Tapping or using a vibrating massager over a muscle belly aims to elicit muscle contractions and stimulate the neural receptors (muscle spindle cells and Golgi tendon organs) in muscle and tendon. This should be done for 3–5 minutes a few times a day as part of the nursing care for animals recovering from paralysis. Brushing, scratching, pinching, or using a vibrating massager provides additional sensory stimulation to skin receptors to increase input into the nervous system.

Tensor Bandaging, Thundershirts™, or Snuglis™

The principle of using tensor bandages or Thundershirts for neurological dogs is to increase sensation in cutaneous and deeper tissues and so increase body awareness. The increased sensation input to higher centers can help with neurological coordination.

Exercises for Cats

Cats can be challenging when it comes to rehabilitation. The principles of exercise are the same for cats as for dogs but the personality of the cat may limit what the therapist can do. Cats are commonly presented for rehabilitation due to chronic pain from injuries or because of osteoarthritis, which is common in cats. Cats can require rehabilitation following surgery for such conditions as cruciate rupture or patellar luxation. A few examples are listed here.

Proprioceptive Exercises

These may include balance and rocker boards or standing on a therapy ball or using a rocking chair or glider as the uneven surface. Initially, some cats will only tolerate 30 seconds of exercise but may work up to 2 or 3 minutes as they become more comfortable. It is important that the therapist understand cat body language and discontinue the exercise as soon as the cat starts to become agitated.

Treadmill Training

Cats can be trained to walk on land or underwater treadmills. If the cat is amenable to wearing a harness, then leash walking and use of a land treadmill with assistance can be used to improve weight bearing and limb function (Millis *et al.*, 2014). Movement can be encouraged by attaching a feather or small toy to a string and pulling it in front of the cat.

Cavaletti Rails

Some cats can be trained to walk over cavaletti rails, particularly if they are food motivated. Some cats will respond to treats – others need to be encouraged by toys or by chasing a laser pointer over the rails.

Case Studies

Case Study 1: Iliopsoas Injury and Partial Cranial Cruciate Ligament Tear

Signalment/History

A 6-year-old male neutered Golden Retriever presented for rehabilitation 1 week after tentative diagnosis of a partial cranial cruciate tear and an iliopsoas muscle injury. Radiographs and musculoskeletal ultrasound were performed to confirm diagnosis. The dog had been injured by falling from an A-frame during an agility run 3 weeks prior to presentation.

Clinical Signs

Iliopsoas pain and spasm on right side. Slight drawer in flexion right stifle with very mild restricted ROM in flexion. Partial weight bearing and mild muscle atrophy right pelvic limb (1 cm discrepancy in circumference). Pain on ambulation, particularly extension of right pelvic limb and in left sacroiliac joint. Shoulder muscles high resting tone, myofascial trigger points in triceps.

Goals

Relieve pain, normalize ROM, improve ambulation, strengthen muscle, improve weight bearing.

Therapy

Therapeutic ultrasound, passive range of motion (PROM), and stretching helped relieve pain. Pain medication and herbals were also prescribed. Hydrotherapy was used to aid with strengthening. Therapeutic exercises in hospital and at home were used to aid recovery.

Exercise Plan

Warm-up right pelvic limb with hot packs applied for 10 minutes to iliopsoas and biceps femoris muscle. Massage and stretching was done before exercise to improve circulation and help with pain relief. Exercise sessions up to 20 minutes. Icing was done post exercise for 5–10 minutes. In hospital, exercises consisted of cavaletti course (cones with poles 4 inches (10 cm) high) for 5 minutes total with a few 10- to 30-second breaks. Weave poles 30 inches (76 cm) apart 6 cones in total; figure eights, slow circles, and turns for 5 minutes total with a few 10- to 30-second breaks; rhythmic stabilization on a rocker board 3 sets of 30 seconds each; side stepping initially 3 sets of 30 seconds each; 5 sit-to-stand exercises; backward walking 8–10 feet (2.4–3 m) 3 times; and treat stretches and twists. In hospital, exercises were to be done 2–3 times weekly.

Home Exercise Plan

Client was instructed to hot-pack the pelvic limbs for 10 minutes before exercising and ice for 10 minutes following exercise. After hot-packing the limbs, stretching was performed with the dog standing and one leg stabilized above the stifle, mimicking sitting position with a stretch and hold of 15 seconds. After that the leg was moved in a bicycling motion. Lastly, the limb was stretched gently in adduction and abduction. Stretches were performed 5 times before the exercise session.

Home Exercises

- Loving on the stairs with a twist – This patient had pressure added to each side of the body to sway him back and forth while he was standing on a cushion. This increased the firing of the muscle that allowed him to improve overall balance even more, since he was standing on an uneven surface. This was to be performed twice daily for 10 repetitions.

- Cavalettis, weave poles and figure eights were to be done twice daily and at a slow pace.
- Challenged standing – This exercise was performed at least twice daily with 10–15 repetitions per performance.
- Play bow – This exercise was done twice daily and worked up to 15 repetitions each session.
- Side stepping – This dog had a lot of obedience training and already knew how to walk sideways, so the duration was increased to 20–30 feet (6–9 m) 5 times twice daily.
- Sit-to-stands – This dog sat on their left hip and popped their right hip out. To correct this the client needed to position the dog against a fence/wall with their right leg touching the wall while he sat. This removed the ability for the hip to pop out and the patient sat. Repetition was set at 15 sit-to-stands 3 times a day every day and the emphasis was on square sitting.
- Treat stretches or treat twists – Twice daily for 5 minutes combined.
- Backward walking and backward walking upstairs/hill – In this case he was already able to walk backward, and was trained to do so previously, so the length was increased to 20 feet (6 m) 3 times a day with 5 repetitions each session.

Three weeks after the initial rehabilitation consult the client was having a few issues with the at-home exercises. The client was also finding it hard to keep the dog rested, as there was more than one dog in the house.

- Walking backward – There was a complication with the backward walking as the dog started to turn while walking backward since he was still favoring the right rear leg. It was recommended to walk along the fence line instead so that the dog was unable to turn.
- Walking backward up hills – The dog would only do two stairs backward then stop. The easiest solution would be to continue doing the two stairs multiple times per day if the dog was not willing to walk backward up more than those two steps.
- Leash walks were allowed for 10 minutes 2–3 times daily. The duration could be increased by 10 minutes each week but no off-leash running/play was allowed.

Five weeks after the rehabilitation consult the dog was doing much better. The iliopsoas muscle did not have any trigger points and muscle mass started to rebuild in hind right leg. The dog was sitting squarely almost every sit and the restriction of leashed bathroom break was removed.

Home exercises were continued with the addition of 30-minute walks and zigzag hill walking.

Outcome

By 10 weeks the dog had normal ROM and even muscle girth with no visible lameness and was discharged from rehabilitation.

Case Study 2: Intervertebral Disc Disease Conservative Management

Signalment/History

A 13-year-old F/S Bichon Frise presented 7 days after acute incident of paralysis. Radiographs were not presented. Lesion localized on examination to T3–L3. Normal urination and defecation. Previously treated with methylprednisilone and on oral prednisone at presentation.

Clinical Signs

Paresis of both pelvic limbs. Unable to walk or weight-bear on hindlimbs independently. Pain score 3/10. Panniculus reflex stopped at T11, localizing lesion to T12–T13 area. Superficial and deep pain sensations were present, tail wag present, withdraw present bilaterally. Left pelvic limb weaker than right, mild muscle atrophy of gluteals, hamstring group, and quadriceps. Shoulder muscles high tone with myofascial trigger points in triceps and trapezius muscles. Normal ROM all joints except stifles which had decreased ROM with bilateral medial patellar luxation (grade 1). Magnetic resonance imaging and surgery were not an option for this patient. Client elected for non-surgical therapy with rehabilitation.

Goals

Decrease pain, improve neurological function, strengthen muscle, and regain ability to ambulate properly.

Therapy

Two weeks of rest was instituted before any exercise therapy could start. During that time the client brought the dog to the rehabilitation center for laser, acupuncture, and electroacupuncture. At-home PROM exercises were performed twice daily and then home application of neuromuscular electrical stimulation (NMES) to hamstring and quadriceps muscles bilaterally once daily for 10 minutes, followed by massage. Prednisone was continued although dosage was decreased. Gabapentin and herbal medications were added for pain. Traction socks were placed on both back feet to prevent excoriations. After 2 weeks, the patient began exercise therapy including underwater treadmill therapy as well as continuing acupuncture for 3 more weeks.

Exercise Therapy

Initially, the dog needed assistance with ambulation as she was unable to sit or rise properly. The first exercises done (also taught to the client) were proper transition from sternal lying position to sit, and on to stand with tapping of the pelvic limb muscles to facilitate muscle firing during the transition. The left hind required more stimulation as it was weaker. PNF patterning for walking was taught to the client and was performed in-clinic. PNF patterning for scratching the ear was also demonstrated. Square sit-to-stands with assistance were performed along with assisted standing. Gait patterning was performed in the underwater treadmill.

Once the dog was stronger and more functional, unassisted sit-to-stands began, and assisted walking on land and rocker board work were introduced. Now the patient began to walk and had a “disconnected” gait. A Snugli was put on the dog to help coordinate the front and back end. NMES was discontinued when the dog started ambulating on her own. Cross-legged standing and weave poles were added to the exercises. The client elected to continue underwater treadmill therapy and to do home exercises.

Home Exercise Program

- Sit-to-stands 10 reps 3 times each.
- Loving on the couch – Hold for 30 seconds for 6–8 reps.
- Cavaletti course with pool noodles – 5 minutes twice daily.
- Treat stretches – 8–10 reps of each exercise.
- Walking up to 20 minutes 2–3 times daily and increased as dog became stronger.
- Hill walking 5 minutes as part of a 15- to 20-minute walk.
- Low steps were later added.

Outcome

Therapy goals were achieved within 4 months.

Conclusion

Land exercises are crucial to the physical rehabilitation program. The veterinary technician/nurse will be instrumental in carrying out the plans that their supervising veterinarian has designed. The rehabilitation nurse will be in communication with the client teaching many of the exercises discussed in this chapter. Most often, demonstrating the exercises to the client and asking them to demonstrate the exercises back to the nurse is the most effective way of teaching. In addition, written instructions and, if possible, images should be given to the client as aids. It could also be helpful to have the client video their pet while it is performing the exercises. This can be reviewed by the rehabilitation therapist and nurse. The exercise plan can be adjusted by the therapist as the patient progresses.

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Therapeutic Exercises Part 2: Hydrotherapy (Aquatic Therapy)

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CHAPTER MENU

Introduction

Principles of Hydrotherapy

The definitive goal of aquatic therapy is ultimately to make the patient more functional on land in a faster time frame in comparison to land-based therapy alone. Swimming and underwater treadmill (UWTM) walking remain the most commonly encountered aquatic therapies in veterinary medicine.

Physics of Hydrotherapy

To gain an understanding of how aquatic therapy differs from land-based therapy you must understand the properties of water and how those properties act on the patient during hydrotherapy.

Density and Buoyancy

The density of an object determines whether it will sink or float when placed in water. In hydrotherapy, we look at the relative density of an object, which is described as a ratio between the object's weight and the weight of an equal volume of water. If an object's density is less than that of water it tends to float and if an object's density is greater than that of water the object tends to sink. The relative density of an object, or in our case a patient, is dependent on the patient's body composition and it is related to the patient's skeletal mass, muscle mass, and body fat percentage (Prydie and Hewitt, 2015). When a patient is immersed in water there are two main forces acting them – gravity and buoyancy. Gravity is attempting to submerge the patient, while buoyancy provides upwards thrust, which

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counteracts gravity. A patient's center of buoyancy depends on their body conformation, and on the volume of fat and muscle that makes up their body. The water level of an UWTM can be changed as required, and the percentage bodyweight carried by a dog's limbs while using the treadmill can be changed by varying depth. Basically, the deeper the water, the less bodyweight is loaded onto the limbs (Tomlinson, 2013).

Hydrostatic Pressure

Hydrostatic pressure is the sum of pressure on a body surface exerted by the fluid that it is immersed in (Connell and Monk, 2010). The hydrostatic pressure exerted on the patient is directly proportional to the depth and density of the water that they are standing in. Hydrostatic pressure increases with increased depth and density of water. Density of water is temperature-dependent. Increased hydrostatic pressures during hydrotherapy can reduce edema by moving tissue fluid from the extravascular space to the intravascular space. Increased hydrostatic pressure also has a direct effect on cardiac function; peripheral blood flow venous return has been shown to increase as hydrostatic pressure increases, and this can lead to a 10–15% drop in heart rate (Levine *et al.*, 2014). It has also been established that increased hydrostatic pressures during aquatic therapy can reduce pain during exercise. The elevated hydrostatic pressure of water blocks the pain response by acting on mechanoreceptors in the skin, which send signals to the cerebral cortex, downregulating pain pathways (Prydie and Hewitt, 2015).

Viscosity and Resistance

Water molecules are attracted to each other and to objects moving through them. This attraction generates frictional resistance to movement of an object through water. Marine animals are adapted to have streamlined bodies that enable lower friction (drag) when moving through water. Our canine patients lack these adaptations and we can use this to our advantage; the drag of movement through water provides more resistance to muscles than walking through air (Prydie and Hewitt, 2015). Viscosity is a measure of fluid friction, with more viscous substances generating more resistance to movement. We can alter the viscosity of the water in a pool or UWTM by altering the temperature of the water. Cold water is denser than warm water and is therefore more viscous and vice versa. The friction created by moving through water helps provide sensory feedback to patients via their skin. This may help, particularly in the rehabilitation of neurological patients who have damaged sensory positional awareness. Gait is exaggerated and gait speed is slowed by water viscosity. This is of benefit in patients recovering from neurological injury and is also useful as it allows more accurate assessment of a patient's gait, especially when walking on a UWTM.

Surface Tension

The attractive force exerted between water molecules on the surface of a body of water is described as surface tension. Water molecules stick to each other with more force at the surface of a body of water than underneath the surface. This means that there is higher resistance to movement at the surface of a body of water in comparison to below the surface. For patients, this means that it requires more effort to move a limb in and out of water ("break the surface of the water") than if the limb remains submerged 100% of the time. As therapists, we can use this to increase force of motion on a joint (or limb segment) by adjusting where the surface of the water lies.

Refraction

The path of light is altered as it passes across the boundary between two substances of differing density (e.g., air to water). This is known as refraction. It alters the patient's depth perception, which can make animals misjudge their foot placement on steps and ramps during water entry and exit. Care must be taken when transferring patients into and out of water. The refraction of light may also alter the therapist's perception of a patient's limb movement under water.

Evidence

There is a paucity of evidenced-based literature within the field of veterinary aquatic rehabilitation in comparison to human rehabilitation. There is currently a need for well-constructed research projects to evaluate the benefits of aquatic therapy across an array of orthopedic and neurological conditions. The main areas of research so far have revolved around using aquatic therapy to rehabilitate patients after cruciate ligament surgery and have largely been driven by the economic importance of cruciate disease (Wilke *et al.*, 2005).

In humans, underwater exercise has been shown to generate less cardiovascular and respiratory demand than equivalent land-based activities (Yoo *et al.*, 2014). This is of use in patients with coexisting disease or in obese patients who have low levels of athletic capability. Water temperature plays an important role in human aquatic therapy. Cold water temperatures have been shown to increase the energy expenditure of patients during aquatic therapy (Versey *et al.*, 2013), but the same evidence cannot be assumed to be directly transferable to veterinary aquatic therapy.

Which Patients will Benefit?

There is substantial research available which indicates that muscle atrophy begins within 24–48 hours following immobilization. The muscles first affected are the postural muscles, which contain a large proportion of type I muscle fibers (Randall, 2010) (Box 20.1).

The Orthopedic Patient

The most common orthopedic conditions treated with aquatic therapy are cranial cruciate disease, hip dysplasia, and osteoarthritis (Goldberg, 2015). Patients visiting your clinic for aquatic therapy will either present for non-surgical management of their orthopedic disease or for post-surgical rehabilitation.

Box 20.1 Aims of hydrotherapy

- Enhance preoperative fitness and conditioning (e.g., before a hip replacement)
- Complete resolution of clinical signs (e.g., after cruciate surgery)
- Postoperative restoration of some function (e.g., in cases of intervertebral disc disease)
- Merely palliative (including analgesia)
- Increase cardiovascular fitness
- As an adjunct to obesity management
- As a "fun" form of exercise

Source: Prankel (2008).

Non-surgical management of veterinary orthopedic disease compromises pharmaceutical management of pain, weight management, and rehabilitation therapy (Waining *et al.*, 2011). Patients with degenerative joint disease suffer from loss of muscle mass, reduced joint range of motion, and joint pain. These are all problems which can be effectively managed with aquatic therapy. Orthopedic disease of the canine coxofemoral joint is often managed with rehabilitation. Research has highlighted that between 70% and 90% of patients with hip dysplasia will have clinical signs attributed to the disease process and therefore most patients with hip dysplasia could benefit from aquatic therapy (Farrell *et al.*, 2007). Research has confirmed patients with degenerative joint disease benefit from hydrotherapy. Twice weekly hydrotherapy over an 8 week period has been proven to improve the function of joints affected by degenerative joint disease (Nganvongpanit *et al.*, 2014b).

Aquatic therapy is an integral component of the post-surgical rehabilitation of patients undergoing surgery for orthopedic disease. Research has shown that over US$1.32 billion dollars a year are spent on the treatment of cranial cruciate disease in canines (Wilke *et al.*, 2005). Results of a study suggested that following surgical management of cruciate disease in dogs, swimming resulted in greater extension and flexion of the stifle and tarsal joints than walking alone, which helps accelerate a return to normal function (Marsolais *et al.*, 2003).

Neurological Patients

Intervertebral disc disease and degenerative myelopathy are the two most common neurological diseases treated using aquatic therapy in our practice. Aquatic therapy should be the cornerstone of rehabilitation in neurological patients. It can be tailored to accommodate patients with varying degrees of neurological disease from quadriplegia to mild muscular weakness. Standing in water is assisted by buoyancy, which provides a simple and comfortable means to maintain a standing position in non-ambulatory patients (Prydie and Hewitt, 2015). Standing can benefit lung inflation and cardiovascular fitness in a patient who has been non-ambulatory for some time. Pool- or UWTM-based aquatic therapy is also more likely to encourage limb movement earlier in the recovery period than similar therapeutic exercises carried out on dry land. The resistance provided by the water helps to strengthen muscles while the buoyancy of the water assists patients in reaching and maintaining a standing position with less exertion (Prydie and Hewitt, 2015).

Therapy in the UWTM may be more appropriate than a pool for neurological patients once they begin to develop a partially coordinated gait pattern, as the treadmill will provide a more controlled movement during which the gait pattern can be assisted to correct motion. The controlled motion provided by UWTM-based exercise places less strain and torque on the spine and encourages normal gait (the action of the treadmill belt drawing the limb caudally in stance phase along with the exaggerated flexion needed to bring the limb through swing phase in the water). Patients with neuromuscular disease are also likely to benefit more from UWTM-based therapy in comparison to free swimming, as the UWTM will help to reinforce a proper gait pattern and provide vital tactile feedback during footfall onto the treadmill belt. Water level and treadmill speed can be adjusted to achieve an optimal gait pattern along with the ability to provide assisted active range of motion as needed. The UWTM can also allow the impaired patient to perform movement against gravity earlier during therapy then they would be able to during assisted exercise on a land treadmill.

Aquatic therapy also has several ancillary benefits for the immobile and weak neurological patient. Hydrostatic pressure and elevated water temperatures can help to ease muscle pain, reduce edema and promote lymphatic drainage (Prydie and Hewitt, 2015). When carrying out aquatic therapy on patients with neuromuscular disease it is important to bear in mind that these patients fatigue very rapidly and they should have their head and neck fully supported to prevent aspiration of water during therapy (you can use a pool float or an inflatable neck pillow). Swimming in a pool is often limited to very short periods of time (60–120 seconds) in these patients every 2–3 days, as this is the best way to avoid fatigue and exacerbation of weakness at home from this fatigue. It is best to have the patient wear a life vest (buoyancy aid) for their own safety. Hands-on support to the chest or abdominal areas can bring about a more comfortable swimming position, putting less strain on the spine.

Athletes

There are a wide variety of sports in which canine athletes currently compete; a few examples include obedience, agility, herding, dock-diving, disc-dog and flyball, coursing, hunting and field trial, sledding, and skijoring. Working dogs such as those in police protection and detection work and search and rescue dogs also fall within the category of athletes. These sports (and jobs) require strength and aerobic fitness. Some activities require endurance. Aquatic therapy can provide vital post-injury strengthening and conditioning in rehabilitation of the canine athlete. Aquatic therapy can also play an integral role in training of canine athletes (strength and endurance). It can be used in the off-season to maintain condition. Maintaining a level of fitness during the off-season helps to prevent injury when the patient returns to competition, though it should be emphasized that sports-specific training (for example jumping) is still needed.

Aquatic therapy engages and trains muscle groups that are difficult to recruit during land-based exercises, and therefore helps add to the overall fitness of the patient. Water-based therapy is less strenuous on the patient as it does not cause the same repetitive concussive forces on a patient that training on dry land does. An increase in joint flexion during aquatic therapy helps to increase a patient's active range of motion during land-based activities (Marsolais et al., 2003).

Figure 20.1 Pool entry. *Source:* Courtesy of Wendy Davies.

Equipment

Pool Design

Prefabricated pools offer an "off-the-shelf" option to centers wishing to introduce pool-based aquatic therapy. Prefabricated pools are manufactured in a variety of sizes and tend to command less space than a custom-built pool. They can be surface mounted or sunken to meet the design constraints of the facility. One key advantage over a custom-built pool is that prefabricated pools can be moved if the facility decides to move and they tend to have water management plant systems incorporated into the product (or plant systems that can be easily moved). Decking can be built around an above ground pool to provide ramp access from ground to pool level.

Custom pools provide a permanent solution to introducing aquatic therapy to a facility. The financial commitment associated with installing a custom-built pool means the facility must not be planning on moving in the medium- to long-term future. Custom pools give design flexibility in comparison to prefabricated pools, and they can be designed to fit into the available space. A custom pool also allows for the internal design of the pool to be tailored to the needs of rehabilitation unit. Different methods of entry and exit (i.e., ramp and steps) down into the water can be added (Figures 20.1 and 20.2). Working platforms of varying depths can also be added to provide areas on which to rest animals and provide static water-based therapy. Custom pools also add flexibility when it comes to water management plant design. If a custom-built pool becomes so busy the water management system is unable to maintain water quality, the systems can usually be easily upgraded.

Pool jets are an option that can be added at the time of pool installation. Underwater jets generate turbulence in the water that increases the amount of drag and consequently increases the amount of work being done by a patient (Box 20.2).

As pool size increases it should be kept in mind that specialist air-handling equipment may be required to manage the air quality in the therapy suite. Humidity levels and

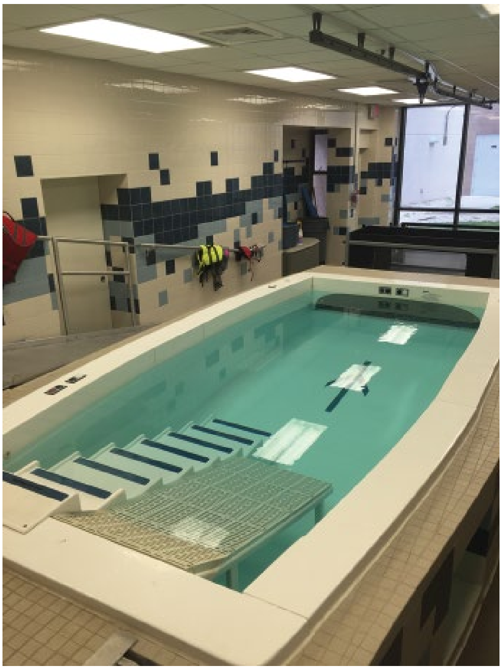

Figure 20.2 Pool entry side view. *Source:* Courtesy of Wendy Davies.

Box 20.2 Benefits of swimming

- Totally non-weight-bearing
- Maximum active range of motion of joints
- Non-ambulatory patients with paraparesis/paralysis
- Improved core and trunk strength
- Cardiopulmonary conditioning
- Endurance for cross-training
- Fun for patient
- Facilitates passive range of motion/all body work

Source: Chiquoine *et al*. (2013). Reproduced with permission of John Wiley & Sons.

temperature must be controlled to maintain patient and therapist comfort as well as prevent damage to the fabric of the building due to excessively high humidity levels.

There are large costs associated with heating a pool/UWTM every day. To conserve energy and control heating bills careful consideration should be made when planning how to retain and maintain the temperature of the water in the pool/UWTM. Pools tend to circulate water 24 hours a day to maintain water quality, so ensuring all pipework is lagged with proprietary heat-retention products can help retain a lot of heat in the pool. In addition, it is recommended to use a pool cover to maintain the heat in the pool while it is not in use. The pool cover should be insulated with foam or a similar material to ensure as much heat as possible is retained. UWTM differ from pools in that the water used in the treadmill tends to be stored in a tank. Non-insulated tanks expend a lot of energy keeping the water to temperature even when the treadmill is not in use, so it is recommended to insulate the water storage tank to save energy.

Underwater Treadmill

There are several companies manufacturing UWTMs across the globe. When looking to invest in an UWTM first explore all the options available to you in your geographical location. Second, aim to visit rehabilitation centers that are using the treadmills you are considering and ask the therapists using the machines to give you all the positives and negatives regarding that unit (Box 20.3).

When investing in a UWTM one should examine the minimum and maximum speed of the unit and what is the smallest incremental speed change that can be made on the unit during a therapy session. To effectively rehabilitate small patients after neurological injury you need to be able to alter belt speeds by small increments (0.1 mph) so small changes in belt speed can be made to tailor therapy to the exact needs of the patient. It should be noted that treadmill speeds are usually not calibrated to actual speed so if the facility has two UWTM, they may differ in actual speed. Before committing to a unit ensure you check whether speed can be altered during the therapy session. Does the machine need to be stopped, the belt speed adjusted, and then the belt restarted? The ability to add an incline during therapy is an

Box 20.3 Benefits of the underwater treadmill

- Improved active range of motion compared to land
- Permits partial weight bearing
- Proprioceptive gait training
- Improved balance while walking
- Cautious fracture loading
- Builds lean muscle in limbs
- Helps timid/new swimmers get started
- Speeds gait retraining

Source: Chiquoine *et al.* (2013). Reproduced with permission of John Wiley & Sons.

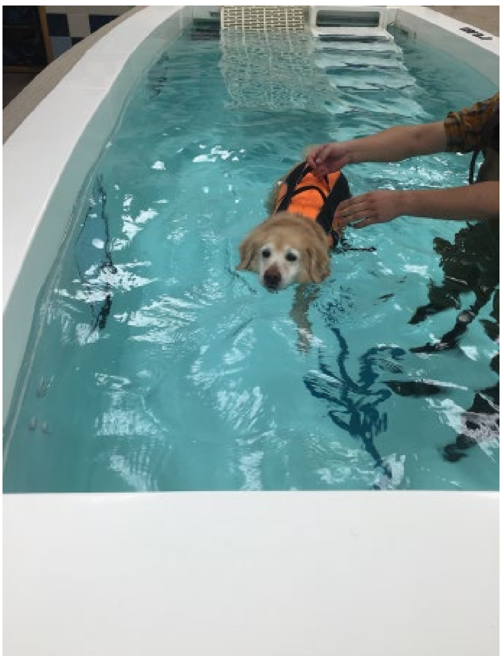

Figure 20.3 Dog swimming in pool. *Source:* Courtesy of Wendy Davies.

important addition that many treadmills offer. Some units automate adding inclination to the belt via the control unit, allowing you to change the angle of inclination during a therapy session (Figure 20.3 and 20.4). Most units available on the market require the inclination of the belt to be set manually prior to commencing the therapy session and do not allow the inclination to be altered once the UWTM has had water added.

Figure 20.4 Weight bearing is reduced by 15% if the water is filled to the level of a patient's stifle in an underwater treadmill. *Source:* Courtesy of Wendy Davies.

UWTMs are complicated mechanical machines that require daily maintenance in the clinic and regular maintenance from the manufacturer. Cleanliness is incredibly important to keep an UWTM running effectively and daily maintenance protocols should be established to maintain the machine.

Ancillary Equipment

A buoyancy jacket, or life vest, helps a patient to float in the pool or in the UWTM if the treadmill is filled to the patient's shoulder blades. Buoyancy jackets allow the therapist to remain in control of patients via handles and straps. A jacket also helps the patient maintain a level stance in the water. An exception to the use of a buoyancy jacket to keep a patient level is the amputee. The rotational instability which is already a problem for the amputee in the water can be made worse by increasing buoyancy (Box 20.4). Buoyancy jackets are very useful in patients who are fearful or lack confidence in the pool as they help the patient maintain their head well out of the water (Figure 20.5). The jackets must be carefully sized for the patient to ensure they do not restrict limb or neck movement.

Once a patient no longer requires a buoyancy jacket during therapy, use a non-flotation jacket or a robust harness during their therapy session. Harnesses or jackets provide the same patient control benefits as buoyancy jackets without providing flotation.

Box 20.4 Equipment used with therapeutic swimming

- Life vest
- Harnesses
- Slings
- Head wraps
- Balance equipment
- Leg weights
- Resistance swim mitts
- Pool noodles
- Toys
- Food

Source: Chiquoine *et al.* (2013). Reproduced with permission of John Wiley & Sons.

Patients with neurological conditions affecting limb strength may require additional flotation for therapy to be beneficial. Long foam cylinders, commonly called pool noodles, are useful for both pool and UWTM therapy and can be placed under the thorax or abdomen to provide additional flotation during treatment sessions. These foam cylinders make excellent bumpers for use in the UWTM to prevent patients from placing their limbs on the static side panels either side of the treadmill belt. An alternate bumper for this latter use is a fender float (Figure 20.6).

Motivation is key to ensuring a patient remains focused and attentive during therapy. Owners should be encouraged to bring along toys that the patient enjoys playing with. Toys can be used to encourage a patient to swim laps or lengths of a pool and can be used to promote consistent gaiting during UWTM therapy. Toys should be cleaned prior to use to minimize pool contamination and should be in good repair to prevent the patient possibly swallowing broken pieces. Toys should also easily fit in a patient's mouth; excessively large toys that require the patient to open their jaws to the maximal extent may put the patient at risk of aspiration of water into the respiratory tract.

There are various therapeutic aids that can be used to make aquatic therapy more

Figure 20.5 Harness for controlling patient in underwater treadmill and keeping head above water.
Source: Courtesy of Wendy Davies.

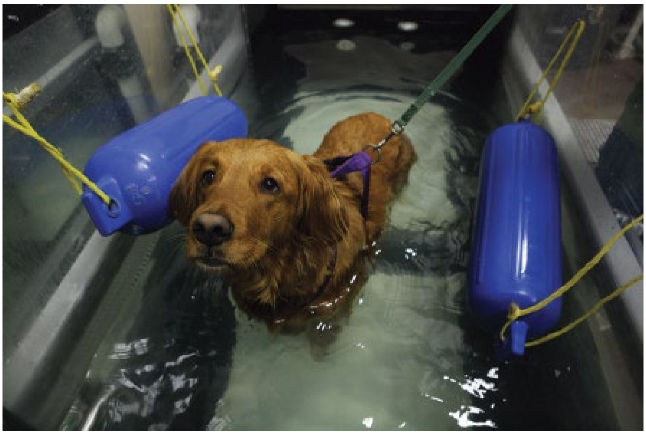

Figure 20.6 Fender floats prevent patients from placing their limbs on the static side panels either side of the treadmill belt.

challenging for the patient. Velcro weights can be placed around the carpus and tarsus to increase the work a patient must carry out to move their limbs during therapy. A source for pre-made leg weights is Canine Icer (www.canineicer.com/), or use curtain weights to make your own weighted wraps. Weights must be used with caution to prevent patient fatigue. Additional flotation can also be added to a patient's lower limbs using either children's air-filled water wings, modeling balloons, or foam piping insulation cut into short strips. The added flotation means the patient must use more effort to bring their paw down to the treadmill belt during movement as the added buoyancy draws the limb upwards.

Safety and Maintenance

Microbiological contamination of UWTM and pool water can result in pathological organisms causing infections in both patients and therapists. Contamination is introduced into the water largely by our canine patients, with skin and fecal bacteria causing most bacterial contaminations. Pathogens can also be introduced into the water from poorly maintained water filters and occasionally from defects in the pool design. The regional legislation regarding water quality in UWTM and pools should be consulted to ensure local health and safety legislation is being adhered to. Microbiological assessment of UWTM and pool water is largely directed at identifying markers of fecal contamination and assessing the levels of *Pseudomonas aeruginosa*, as these bacteria have been associated with ear and skin infections in both dogs and therapists. The presence of significant colony numbers of *Ps. aeruginosa* during microbiological testing or the presence of *Escherichia coli* indicates poor water management and remedial action must be taken.

Water management is an integral part of running a safe aquatic therapy unit. Poor water quality or inappropriate use of water management chemicals can have a major impact of the health and safety of therapists and patients. Poor water quality can also lead to staff sickness, staff injuries, and staff absences. From the patient's point of view, poor water quality can also lead to sickness and injury which will lead to client dissatisfaction and have a detrimental effect on your business success. The complexity of the water management protocol will be dictated by the size of the UWTM or pool and the number of patients using the pool daily. Protocols for water management should be tailored to meet the exact needs of the unit and there must be records outlining when, and by whom, water management tasks are carried out.

All owners should be instructed to bring their pet to an area to encourage defecation and urination prior to commencing an aquatic therapy session. Despite the best efforts of owners and therapists our canine patients will challenge the therapist from time to time by defecating during an aquatic therapy session. Fecal contamination of the pool water must be dealt with swiftly and safely. Nets and sieves can assist in removing formed fecal matter and, if carried out in a timely fashion, the UWTM or pool can likely be kept open. If loose feces are passed in the UWTM or pool, it is likely the unit must be shut down for 3–4 hours and a decontamination cycle run to maintain water safety. This highlights the importance of the owner answering pre-hydro questions regarding the recent toilet habits of their pets. In the case of patients who have fecal incontinence or who are "repeat offenders" contaminating the water, manual evacuation of the rectum and a bath before hydrotherapy is recommended.

Protecting Staff and Clients

When working in and around pools and UWTM all staff and clients must be made aware of the risks of being in an aquatic therapy unit. Local legislation regarding health and safety around a pool or UWTM should be carefully researched, including the appropriate guidelines regarding safe working practices and rules within the unit to ensure the safety of client, patient, and therapists. There should be clear protocols to deal with emergencies such as clients becoming unwell and it is advisable that staff members are trained in first aid techniques to assist both their colleagues and clients in the event of an injury on the premises.

Pre-Hydro Patient Assessment

Initial Patient Assessment

Initial patient assessment should occur prior to the patient arriving for hydrotherapy. Paper or email referral forms should be sent to both the client and the primary care veterinarian. Question the client to ascertain a patient's prior experience with water. Patient and therapist safety is paramount and dogs that have a serious fear of water or are reluctant to swim may pose a danger to themselves and to therapists. When a patient panics, the natural reaction of a therapist is to try to restrain the patient and remove them from the water. This can lead to injury and, in extreme cases, the loss of bite inhibition caused by panic may lead to the therapist receiving serious bite injuries. Low-stress handling should be used and slow introduction to the environment performed. Client questionnaires should also ask about the best way to motivate a patient (e.g., food or toys) and establish whether the patient is safe to be around other canines. The questionnaire should be accompanied with a set of therapy guidelines, health and safety guidelines, and terms and conditions. The veterinary referral form should focus on why the patient is being sent for aquatic therapy and what the supervising rehabilitation veterinarian is hoping to achieve from therapy. There should be declarations regarding coexisting diseases that may interfere with aquatic therapy and the patient's vaccination status should be confirmed on the referral form.

Client Questionnaires

Upon arrival at the therapy unit the client should be asked a standard set of questions which are designed to assess the patient's immediate suitability for aquatic therapy. The pre-session questions should ascertain if the patient has emptied their bladder and bowels prior to the session. The therapist should also focus on identifying how the patient was in the hours after the last aquatic therapy session. This information should be used to form a basis for whether the therapy session needs to be made more challenging.

Coexisting Disease

Understanding why a patient is presenting for aquatic therapy and how pre-existing medical conditions affect their ability to safely engage in aquatic therapy is vital. Preexisting medical conditions such as heart, respiratory, kidney, or liver disease do not preclude a patient from engaging in aquatic therapy. Each patient should be evaluated as an individual and a tailored plan created. It is unsuitable for a patient with concurrent clinical cardiac disease to engage in strenuous swimming or treadmill activity, but they may benefit greatly from water-based massage therapy and water-based range of motion exercises. The key to creating tailored aquatic therapy plans for patients with multiple disease processes is gaining a complete understanding of the patient's limitations and understanding the risks that water-based therapy may present to that individual. The rehabilitation veterinarian will perform a thorough examination determining the patient's abilities to carry out aquatic therapy. Gaining a complete medical and orthopedic history for every patient is key; a close working relationship with referring veterinarians is also vital for creating patient-centric treatment plans.

Surgical Wounds

Although historically, patients with surgical (sutured) wounds were excluded from aquatic therapy, new advances in surgical wound management are challenging this concept. There are a variety of wound sealant products that can be applied in theatre to theoretically completely seal a surgical wound to allow early aquatic rehabilitation (Baranoski and Ayello, 2012). The performance of such products has been evaluated in human medicine and studies will continue in animals to validate the use of these products in animals receiving aquatic therapy in the early postoperative period. Patients with open wounds or infected surgical wounds should not receive aquatic therapy until the wound is fully healed.

Contraindications for Hydrotherapy

Although every effort should be made to create a treatment plan that accommodates a patient's coexisting disease, there are several presentations that exclude a patient from aquatic therapy either temporarily or permanently. For the protection of staff members, and in the interest of water hygiene, dogs with acute or chronic gastrointestinal disease that leads to either vomiting or diarrhea should be excluded from aquatic therapy and should see the veterinarian. Patients who are obviously unwell with evidence of an elevated body temperature or signs of malaise should not receive therapy and instead should be directed to their supervising veterinarian for assessment. The chemicals used in water management have been shown to irritate damaged skin and therefore patients with acute dermatological problems (e.g., acute moist dermatitis) should not swim (Nganvongpanit and Yano, 2012). Patients with chronic dermatological conditions should only swim under the clearance of the supervising veterinarian and attention should be paid to post-therapy management (Box 20.5). Patients with signs of infectious diseases, such as kennel cough, should be excluded from the clinic until the infectious period has passed. Lastly, patients with a history of uncontrolled epileptic activity should not engage in aquatic therapy until their condition is medically controlled.

There are patients that you will encounter who are simply not suitable to engage in aquatic therapy. Although it is recommended

Box 20.5 Contraindications to hydrotherapy/aquatic therapy

- Unhealed surgical incisions
- Skin irritation or infection
- Emesis
- Diarrhea
- Untreated cardiac, liver, or kidney disease
- Incontinence
- Uncontrolled epilepsy
- If the dog has an external fixator, as there is a risk of infection associated with open wounds

Source: Adapted from Tomlinson (2013) and Connell and Monk (2010).

to try at least 2–3 sessions to acclimate and get a patient used to either pool-based or UWTM activity, some patients find the experience too stressful or use their limbs in a counterproductive fashion and are at risk of making their particular condition worse.

Managing the Incontinent Patient

Opinions will remain divided on whether the urinary incontinent patient should receive aquatic therapy due to the risk of pool contamination and ascending urinary tract infection. The most commonly encountered urinary incontinent patient is the neurological patient suffering from intervertebral disc disease. Aquatic therapy plays a key role in the rehabilitation of these patients and withholding such therapy could prolong the patient's recovery time. Several strategies can be applied for managing the urinary incontinent patient. The first involves pre-therapy bladder emptying to ensure the patient has an empty bladder prior to starting aquatic therapy. Technicians/nurses who have received veterinary training in bladder expression can empty the bladder using manual expression. This should provide a 30- to 60-minute window where the patient will produce a negligible volume of urine and should be able to receive UWTM or pool-based rehabilitation without urine contamination. Specially designed canine incontinence pants can also be used to minimize leaking urine. Infant swimming diapers can also be used in small dogs.

Patients with urinary incontinence can also be managed with a Foley catheter *in situ*. This remains a controversial strategy, with some believing it predisposes the patient to ascending urinary tract infection. If the catheter is meticulously managed during aquatic therapy, there should be no reason why its presence should prevent a patient receiving therapy. The bladder should be actively emptied via the Foley catheter prior to therapy. The catheter should then be sealed using an appropriate bung to prevent water entering. At this point the patient can begin therapy. On completion of therapy, the external portion of the Foley catheter and the prepuce should be flushed and cleaned with dilute chlorhexidine solution. The bung should be disposed of and the patient reconnected to a closed collection system.

Patients with fecal incontinence may be presented for aquatic therapy. It is the author's opinion that these cases should not receive aquatic therapy unless an appropriate swim diaper is placed after evacuation of the rectum. Many times, patients can have a bowel movement stimulated by using a "Q-tip" around the anal sphincter. This helps to stimulate evacuation. If a patient has persistent liquid feces or cannot be managed using a swim diaper the patient must not swim because of the risk to the health and safety of the therapist.

Patient Conformation

Although almost any size and shape of dog or cat can be taught to swim in a pool or use an UWTM there are some considerations that should be made for individual breeds, and the challenges that their specific conformation and breed personality present to the therapist. The conformation, or size and shape of a patient, affects a patient's ability to swim. Brachycephalic breeds, such as Bulldogs and Pugs, with shortened faces, have narrowed nasal passages. This conformational change is often accompanied by an excessively long soft palate and a small trachea in comparison to overall body size. These changes restrict these patient's athletic capability as they simply cannot effectively move enough air in and out of their lungs to maintain strenuous athletic exertion. These dogs may also struggle to carry toys in their mouth during therapy and protect their airway at the same time. With these breeds, careful attention should be paid to providing enough flotation in the form of jackets and ancillary flotation devices to maintain the patient's head above the surface of the water always. The therapist must also pay careful attention for the early signs of fatigue.

Pool Versus Underwater Treadmill

There are distinct differences in the therapeutic benefits of pool-based aquatic therapy and those of UWTM rehabilitation. The choice of pool-based therapy or UWTM therapy is tailored to the problem that is being treated. Many patients can benefit from a combination of pool-based therapy and UWTM therapy. It should be remembered that many small and medium patients can swim in the UWTM.

Pool-based therapy allows the patient to be rehabilitated without bearing any weight; this is ideal for patients who are painful when weight bearing, or are unable to weight-bear due to neurological disease or an unstable limb (Figure 20.7). Rehabilitating patients in a non-weight-bearing environment can be continued until these patients start to show improvement; they can then be transitioned to UWTM therapy to help retrain the patient to gait normally and to slowly return to weight bearing. Patients who lack flexion when gaiting on land can benefit from swimming versus UWTM activity as the limbs are in flexion during swimming (Marsolais *et al.*, 2003).

Figure 20.7 Toys make excellent motivational tools in the pool. Care should be taken to avoid airway impedance.

The water height in a UWTM can be adjusted to tailor the amount of weight a patient is bearing during therapy (Levine et al., 2002, 2010). As a patient improves during therapy the water level can be lowered to allow more weight bearing, and then upon completion of the therapy program the water can once again be deepened to allow the patient's athletic capabilities to be challenged (Box 20.6).

The UWTM provides some distinct advantages over pool-based therapy in certain scenarios and vice versa. Most UWTMs have clear plastic sides which allow the patient's gait (and joint extension and flexion) to be assessed during motion. This can be very difficult to assess when using pool-based therapy. UWTMs provide a more controlled environment in which to introduce animals that have never encountered water to paddling and even swimming. Patients bear weight during training on an UWTM, which

Box 20.6 Assessment of anxiety and fatigue when swimming

Anxiety

- Anxious facial expression (lips pulled back)
- Rapid breathing/pulse
- Thrashing forelimbs
- Inability to rest
- Attempting to exit the pool

Fatigue

- Tired body posture
- Deep or irregular breathing
- Slowed swim pace
- Reluctance to swim
- Change in tongue color/shape

Source: Chiquoine *et al.* (2013). Reproduced with permission of John Wiley & Sons.

may benefit patients that are recovering from fracture repair, tendinopathies, and other conditions in which weight bearing can stimulate healing. The controlled weight bearing offered by a UWTM can be advantageous during rehabilitation of fracture patients or those recovering from joint instabilities. Pool-based therapy is more suited for strengthening a patient's core and trunk muscles as the rotational forces encountered during swimming help build these muscle groups. A pool allows the patient's whole body to be treated and enables massage and manual therapy to take place in the water environment; this is very difficult to do in a UWTM because of space limitations.

Pool-Based Exercises

Static Therapy

Static therapy ideally takes place on a platform within the pool, allowing as much of the patient's body to be submerged with the patient's paws on a solid surface. Static therapy is used to help treat specific areas of muscle pain, improve patient comfort, and increase the range of motion of a joint. In addition, static pool-based therapy helps reeducate patients in maintaining a normal standing posture. It should be noted that although patients are often referred to treat a specific joint or problem, it is imperative to take a holistic approach to aquatic therapy (the meaning of holistic being to look at the patient's whole body). For example, a patient recovering from cruciate ligament surgery may have muscle fatigue and pain in the contralateral non-operated limb due to transitioning weight in adapting to operative limb pain and weakness. Water-based massage therapy can help to reduce muscle pain, reduce postoperative edema, improve flexibility, and can greatly improve a patient's comfort and wellbeing.

The pre-therapy examination should focus on identifying areas of pain, discomfort, and tightness in major muscle groups. Therapy should then focus on massage of these muscle groups by a qualified individual along with gentle stretches aimed at improving flexibility (see Chapter 5). Joint mobilization aims to improve joint motion and reduce joint pain, thus improving joint function. Carrying out joint mobilizations underwater adds the warming and hydrostatic benefits of the aquatic therapy to this modality. It should be noted that joint mobilizations should only be carried out by suitably qualified rehabilitation veterinarians or physical therapists. Postural exercises such as three-legged standing can be used in the pool to encourage a patient to actively load a specific limb.

Active Therapy

Pool-based active aquatic therapy aims to improve muscle strength, improve aerobic fitness, increase flexibility, and improve range of motion. It tends to involve either swimming lengths or laps of the pool depending on the size of the pool. In an endless pool the patient will swim against the water flow, which provides resistance. In the early stages of therapy, the patient must be supported and guided by a technician/nurse. Active therapy does not mean simply allowing a patient to swim uncontrolled. An active role is taken by the handler during the session and ensures the patient is using their limbs as normally as possible during therapy. Patients who have limb paresis and paralysis have their affected limbs cycled through a swimming motion (active assisted range of motion) during therapy to stimulate neural pathways and encourage volitional limb movement. In large patients two handlers may be required – one to guide and support the patient and a second to carry out the therapeutic exercises. Toys make excellent motivational aids for patients engaging in pool-based aquatic therapy and are often a necessity to ensure patients engage with therapy and get the most out of a session.

During assisted swimming the technician/nurse can challenge the patient by gently rolling the patient from side to side while swimming. This rolling movement, described as a perturbation, stimulates the patient's righting reflex. Stimulating this postural reaction evokes limb extension mediated through neural feedback pathways with stepping responses in the patient, which, when translated onto land, helps patients with balance, bending, and turning. These perturbations also help build and strengthen a patient's core stabilizing muscles. A point may be reached with some patients where little support or guidance is required during swimming due to the patient having a high level of proficiency. A technician/nurse should remain in the pool with these patients, however little input is required.

The patient that becomes adept at swimming can be transitioned to a lake and swimming with companions (Figures 20.8 and 20.9). This technique can be used for maintaining cardiovascular fitness.

Treadmill-Based Exercises

Speed

There is a lack of research to determine exactly what belt speed is most appropriate for patients with specific conditions and for specific breeds. However, there are a wealth of experienced aquatic therapists that have established the most useful treadmill belt speeds for a variety of breeds and conditions. Leg length and stride length must be taken into account when deciding upon a belt speed. It should be noted that smaller dogs often walk relatively faster than larger dogs (Voss *et al.*, 2010). It was stated earlier than treadmill belt speed is not calibrated to miles per hour (or km/h) by most UWTM manufacturers, therefore advice regarding speed is not given in this chapter. It is best to say the speed should be adjusted to the most comfortable-looking gait in each patient, whether that gait is walk, trot, or, in some cases, faster. Pacing should be avoided unless the dog has always paced naturally. Doubling belt speed from the walk should in most patients initiate a trotting gait. If a patient fights the transition into a trot it may start to use a pacing

Figure 20.8 Swimming in open water – in this case, a lake.

Figure 20.9 If multiple dogs are entering the pool/lake at the same time during a fun swim session it is important that all the dogs are confident in the water, and are wearing appropriate jackets or other flotation aids.

gait. Patients can be moved out of a pace into a trot by encouraging them forward on the belt, using a leash or toy.

Patients with neurologic issues may have a dissociative gait where the forelimbs move at faster tempo with shorter strides than the rear limbs (Gordon-Evans *et al.*, 2009). A platform can be added over the front of the treadmill belt so that the patient can stand with the forelimbs and gait with the rear limbs. This has been successful in practice for gait retraining these types of patients (Tomlinson JE, personal communication).

Water Depth

The depth/height of the water has a great impact on the amount of work being carried out by the patient during UWTM aquatic therapy. Studies have examined how water depth affects the amount of weight a patient is supporting during therapy. Filling the UWTM to the level of a patient's tarsus reduces the weight bearing of the patient by 9% (Levine *et al.*, 2010). Weight bearing is reduced by 15% if the water is filled to the level of a patient's stifle. If the treadmill is filled to the level of a patient's great trochanter (hip joint) we see the greatest reduction in weight bearing, with a maximal reduction in total weight bearing in the region of 62% (Levine *et al.*, 2010).

Filling the UWTM to different levels on a patient's body does not only affect the total weight bearing, it also influences the ratio of weight being supported by the forelimbs in comparison to the hindlimbs. Unaided by the buoyancy of water, dogs support approximately 60% of their weight through their forelimbs. This is largely unchanged as water is brought up to their hock and stifle joints (Levine *et al.*, 2014), but as water is filled up to a patient's great trochanter we see the forelimbs supporting up to 71% of the patient's weight (Levine *et al.*, 2010). Remember that overall weight bearing is reduced by 62% when the water is this high, but this weight redistribution may still be of significance in patients who have forelimb disease as UWTM therapy with deep water levels may in some patients exacerbate forelimb weight load. Patients who have an adaptive weight shift to the forelimbs due to hindlimb insufficiency may be better served by being exercised in the UWTM at a maximum water height of the stifle to avoid exacerbating the forward postural shift.

Water Temperature

Pool and UWTM water temperature is an important variable to control during aquatic therapy. Studies have investigated the ideal water temperature for patients undergoing therapy. Water temperatures between 30 and 34 °C were examined and the effects of different temperatures on heart rate, respiratory rates, rectal temperature, and patient exertion were measured. Research showed that all patients undergoing therapy showed increased vital parameters during therapy, but there were no significant differences in parameters between different water temperatures. This research demonstrates that water temperatures between 30 and 34 °C (86–93.2 °F) are considered safe for canines (Nganvongpanit *et al.*, 2014a).

Maintaining the water temperature of a pool or UWTM represents one of the largest expenses for an aquatic therapy business and water temperature should be thermostatically controlled to control energy expenditure.

Inclination

Exercising on an incline on land changes joint kinematics in dogs (Bockstahler *et al.*, 2012). Increasing the incline of the UWTM belt during therapy likely increases the work for the patient but the effects on joint motion are unknown. Most neurological and orthopedic patients will not require the addition of an incline to the UWTM belt during therapy, but those patients who have recovered fully from their injury and canine athletes may benefit from the additional of an incline to the belt during therapy to challenge their fitness during therapy.

Session Duration

It is imperative to build the duration of activity in a patient's aquatic therapy slowly.

A patient's first few UWTM sessions may not progress beyond 2–3 intervals of walking for 45–60 seconds. Patients should be given 90–120 seconds to recover by standing still in the water between training intervals. This recovery time frame may need to be shortened in animals with a high level of fitness or lengthened in very unfit animals. As a patient becomes more confident on the UWTM the interval length should be increased session by session. At the end of a session a patient should be evaluated to determine how difficult they found a session. If they are excessively exhausted by the session it should be made less intense at the next appointment. If the patient obviously coped with the session well it should be made tougher at the next appointment.

Developing Patient Programs

The patient's first session in the pool or on the UWTM is often more of an acclimatization session rather than a true therapeutic session. It is important to get the patient as comfortable as possible and get them used to the sensation of water moving up their body as well as to the movement of the treadmill belt prior to engaging in useful therapy sessions. Engaging in static therapy in the pool or UWTM during the first session is a very useful acclimatization tool (Figure 20.10). A whirlpool bath can be used for the neurological patient at the beginning of rehabilitation therapy.

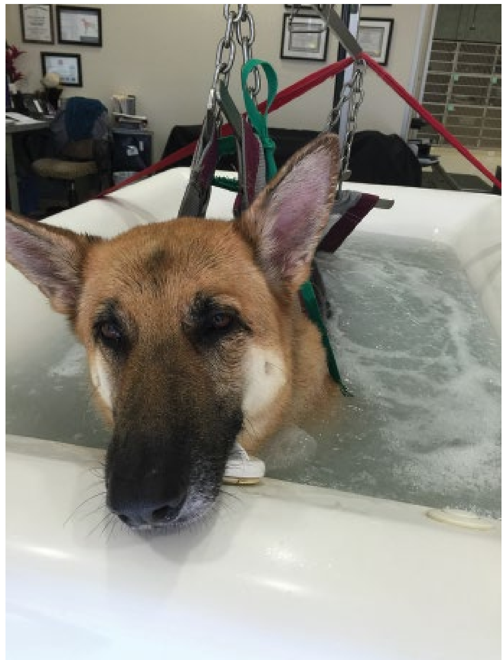

Figure 20.10 Whirlpool bath for a neurologically impaired dog.

A patient's treatment program must have specific goals. The goals of a program dictate the ideal number of sessions a patient should engage in on a weekly basis. Patients early in their recovery from a neurological or orthopedic injury benefit from more frequent sessions. Both UWTM and pool-based therapy revolve around repetition of training intervals. In the pool an interval may be a single length or lap of the pool. As a patient progresses through an aquatic therapy program, the number of repetitions will be slowly increased during the session, while at the same time the rest period between intervals is slowly decreased. In the UWTM, the number of intervals for a given time is increased, as is the length of the training interval as the patient progresses in an aquatic rehabilitation program.

There are some parameters that can be examined to determine if a program is meeting the goals for a patient. The recovery of a patient in the hours after a pool or UWTM session is one of the best guides of whether a program is suitable or requires adjustment. If a patient recovers rapidly and does not appear tired after a rehabilitation session, it is possible that the session was not demanding enough and at the next session the duration or speed should be increased. When a patient appears tired for 4–6 hours after a session one must consider that the session was too demanding for the patient and the next therapy session should be adjusted so that the session is less demanding on the patient. This advice is all subjective and you should be guided by your supervising veterinarian as fatigue needs to be carefully avoided in some patients.

Once rehabilitation has been completed the patient should ideally be transitioned to a maintenance program that focuses on maintaining the improvements that have been achieved. This maintenance program may include hydrotherapy. Maintenance therapy should consistently bring a patient to the edge of their ability to maintain cardiovascular fitness, preserve muscle mass, and, most importantly, retain the improvements gained during an aquatic therapy program.

Canine athletes are common visitors to aquatic therapy centers, not only to treat specific orthopedic problems but also to maintain and improve cardiovascular fitness during the off-season to maintain fitness and improve athletic prowess. Once a patient can easily achieve a level of continuous exercise in a pool, it can be difficult to apply further challenges to patients in the pool apart from increasing the length of the session. The UWTM may be a more versatile tool for canine athletes aiming to maintain fitness, as it allows an array of parameters to be adjusted to challenge the patient during their session. Resistance jets (may also be available in some pools), incline, water height, and speed can be adjusted. The aim for canine athletes who are engaging in UWTM should be to reach a point where they can maintain a single interval on the UWTM of between 20 and 30 minutes at a brisk walk without a break. Once a patient can maintain a brisk walk for 20–30 minutes the session should be interspersed with a small number of brief 20- to 30-second intervals at the fastest pace the canine can maintain.

Business Diversification

There are significant costs associated with running a UWTM or swimming pool. To maximize income, any rehabilitation center offering these therapeutic options should examine how they can make these assets pay for themselves. Adapting opening hours to suit client needs is a basic strategy that can help increase bookings; evening and weekend openings offer appointments outside of the usual daily working hours and are very popular. In addition to flexible opening hours, diversifying away from pure aquatic rehabilitation and exercise therapy can assist in increasing UWTM/pool revenue and ensure maximal use of the facilities.

Obesity Clinics

While aquatic therapy is unlikely to be successful in achieving weight loss in the obese canine/feline if used alone, if combined with dietary restriction and lifestyle modifications it can be a very effective means of achieving weight loss. The veterinary technician or nurse should remain in the UWTM or pool with the patient (Figure 20.11). Accelerated weight loss has been reported in patients that have hydrotherapy incorporated into a weight loss program. Weight loss of up to 1.5% body weight per week was reported in a study that saw patients exercising on an UWTM for up to 30 minutes once a week

Figure 20.11 Technician Jenn Panko in the underwater treadmill with a feline patient. Even when little support or guidance is required due to the patient having a high level of proficiency, a technician/nurse should remain in the underwater treadmill/pool with these patients.

(Chauvet *et al.*, 2011). This is compared to reported weekly weight losses of 0.75% per week with dietary modification alone.

If you are going to promote UWTM or pool swimming as a weight loss tool, it is important that you involve the supervising veterinarian in the development of the exercise program as well as details of dietary management. Client education, dietary management, and additional home-based exercises are key to successful weight loss and one cannot rely on aquatic therapy alone. Owner compliance will be better if results are seen early and these results can only be achieved if a holistic approach to weight management is taken. Once a target weight has been achieved, owners can be encouraged to continue aquatic therapy on a maintenance basis to help the patient maintain their target weight.

Developing the "Fun" Swim

The non-therapeutic aquatic session or "fun swim" can prove an important revenue stream for rehabilitation centers with a pool. Fun swims need to be supervised to ensure dog and client safety, but they are less labor intensive than therapeutic sessions. If multiple dogs are entering the pool at the same time during a fun swim session it is important that all the dogs are confident in the water, they are wearing appropriate jackets or other flotation aids, and that there are sufficient staff members to evacuate the animals from the pool in a timely fashion. Legal disclaimers need to be incorporated in the United States.

Puppy Water Introduction Classes

As previously discussed, there are a subset of dogs that have not experienced swimming or being partially submerged in water. This can lead to fear and aversion to water in dogs. Puppy water introduction classes are aimed at exposing young dogs to water in a controlled and safe fashion in either a UWTM or a pool. Buoyancy aids should be worn in the early sessions. Some dogs can be safely introduced to water over a single session, but some may require multiple sessions to become confident in water. One should first introduce a puppy to water of a depth level to the patient's carpus and use positive reinforcement, either verbal or treat based, to put the dog at ease. The water should be gradually deepened over the session while ensuring the dog feels comfortable and reassured. This is where working "pods" in a pool come into their own, as you have a static platform on which to work with the dog. Over the water introduction session in a pool with a platform, the dog should be encouraged to lift its feet off the platform and begin to swim. If the dog becomes distressed, return to a solid surface and work on building the dog's confidence prior to attempting swimming again.

Water Safety Courses

Older dogs can be safely introduced to water in a similar fashion to puppies. Water safety classes are something that can also be utilized in working dogs, such as army and police dogs, who currently rarely receive water safety lessons during their training. Police and army dogs, as well as other working dogs such as gun and trial dogs, may unexpectedly enter water of varying depths in their working life and should be trained to cope with this. Handler involvement is paramount to success in effectively training working dogs and if insurance permits, the handler should be directly involved, ideally being in the pool with their working dog. One particular area of training that can assist working dogs is training dogs to exit water unassisted, which could prove a life-saving skill if a working dog enters water without supervision.

Promoting Your Business

Successful promotion of an aquatic rehabilitation business can be the key to accelerating a rehabilitation clinic's growth and the onus for this frequently falls on the veterinary nurse/technician rather than the supervising veterinarian. All investments in advertising should focus on reaching clients and referring veterinary surgeons within a sensible geographical radius. Investing in a quality waterproof camera will help you generate engaging and interesting images and videos to use in promotion of the business. Underwater videos can also be used to document a patient's session-by-session progress.

Building relationships with referring veterinarians is key to maintaining a steady flow of rehabilitation cases and a lot can be said for visiting possible referring clinics to discuss what you can offer. Face-to-face communication can build business relations that can support the growth of a rehabilitation center in its early years and builds security by providing a steady stream of referrals. Having a physical presence at local community events and sponsoring local community teams and events all helps to build community bridges that builds the clinic's profile. Your veterinarian should join you.

Social media provides a cost-effective platform through which you can engage with clients, potential clients, and referring veterinary surgeons. A Facebook business page can provide a fledgling aquatic therapy unit with an excellent platform on which to advertise the business prior to making the investment in a webpage and domain. Publishing regular, interesting, and succinct articles about the conditions that aquatic therapy can assist with is an excellent starting point to gain confidence in writing and publishing social media content. Twitter can be used in a similar way to Facebook to generate client interest and promote aquatic therapy. Encouraging current clients to engage with your social media platforms is paramount if a venture into social media is going to work. Publishing daily updates about the patients you are treating is an excellent way of growing interest in an aquatic therapy business. When venturing into social media it is vital that client confidentiality is protected always and permission needs to be gained from all clients prior to publishing pictures of their pet, or any images of the actual client.

Conclusion

Aquatic therapy remains a cornerstone of rehabilitation for many orthopedic and neurological conditions. When the approach taken to therapy is regimented, individualized, and responsive to a patient's progress and when it considers the holistic needs of the patient, the impact on a patient's life can be hugely positive. This sphere of therapy will continue to mature as research helps us to define specific benefits that aquatic therapy has for a spectrum of specific conditions.

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21

Troubleshooting as a Team

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CHAPTER MENU

Introduction

The veterinary rehabilitation team works towards a common goal: improving quality of life, relieving pain, and maximizing function for a patient, even in the light of physical impairments. The veterinary rehabilitation team can consist of a rehabilitation veterinarian, a rehabilitation veterinary technician, and a physical therapist trained in animal rehabilitation. Adjunct team members can include veterinarians trained in acupuncture and manipulative therapies, chiropractors with further training in therapy on animals, massage therapists, veterinary assistants, and physical therapist assistants. Collaboration with primary care veterinarians, veterinary specialists (neurologists, surgeons, oncologists, etc.), other veterinary clinic staff, and the owner/handler/caregiver is integral to the success of rehabilitation. This collaboration is especially vital when troubleshooting patient problems or lack of progress.

The Rehabilitation Veterinarian

The rehabilitation-trained veterinarian will examine the patient and make a diagnosis including assessment of pain level, injured tissues, concurrent disease and functional limitations including strength, range of motion, balance and proprioception, and gait impairment. If further diagnostics are needed, they will be performed. The rehabilitation veterinarian will develop a treatment plan including at-home and in-clinic therapies,

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medications, and recommended nursing care. The veterinarian may perform manual therapies. Other professionals, if present, will contribute to this plan. The rehabilitation veterinarian may be a specialist in rehabilitation and sports medicine (DACVSMR) or certified in rehabilitation.

The Rehabilitation Veterinary Technician

The rehabilitation technician will assist the rehabilitation veterinarian, physical therapist, and any other adjunct professional with the examination. The technician will assist in handling the patient, taking and recording measurements and observations, such as vital signs and pain scoring. The rehabilitation technician will take part in educating the client and explaining the home care and in-clinic therapy plans. The rehabilitation technician will also take part with in-clinic therapies under the supervision of the rehabilitation veterinarian. The rehabilitation technician should have received specific training in (if not certification in) veterinary rehabilitation.

The Physical Therapist

The physical therapist, trained in animal rehabilitation, will evaluate the patient with the rehabilitation veterinarian and document impairments in range of motion (including accessory joint motions), flexibility, strength, functional mobility, gait, and neurological function. Together with the rehabilitation veterinarian, the physical therapist will develop and institute the treatment plan and will perform treatments including manual therapy, facilitation techniques, therapeutic exercises, and physical modalities. Physical therapists who work in animal rehabilitation need to be certified in such, or hold a master's degree in animal rehabilitation depending on state legislation. A physical therapist trained in animal rehabilitation may work with and supervise a physical therapist assistant. This is an individual who has an associate's or bachelor's degree and can provide some therapies under supervision of a physical therapist. As with all team members, the physical therapist assistant should have received training in animal anatomy, biomechanics, handling, and rehabilitation.

Other Team Members

Other team members can include veterinarians who are trained in acupuncture or spinal manipulative therapy (veterinary term for chiropractic) and other veterinarians including specialists (surgeon, oncologist, neurologist, primary care veterinarian). Chiropractors who have received additional training and certification in animal chiropractic along with massage therapists may be involved in the care of the rehabilitation patient.

Case Management

Each case will be very different; two dogs with the same problem that have undergone the same surgical procedure at the same facility will have differing levels of function, pain, and recovery rates, even when everything goes per plan. This rather obvious statement highlights the need to avoid applying a set protocol to groups of patients. The foundation of the therapeutic plan is the patient evaluation. Patient evaluation should continue throughout the rehabilitation process; evaluation of patient function, pain score, and examination for concurrent disease should occur at every rehabilitation visit. The veterinary technician should immediately report to the supervising rehabilitation veterinarian any changes that have occurred from one visit to another so that appropriate measures may be taken. The therapeutic plan is altered accordingly and might include changes in medications, progression of home exercises, and relaxation of restrictions when a patient is progressing (or healing has been confirmed). Daily rounds (Figure 21.1) in which patients are discussed (both inpatients and outpatients), and the

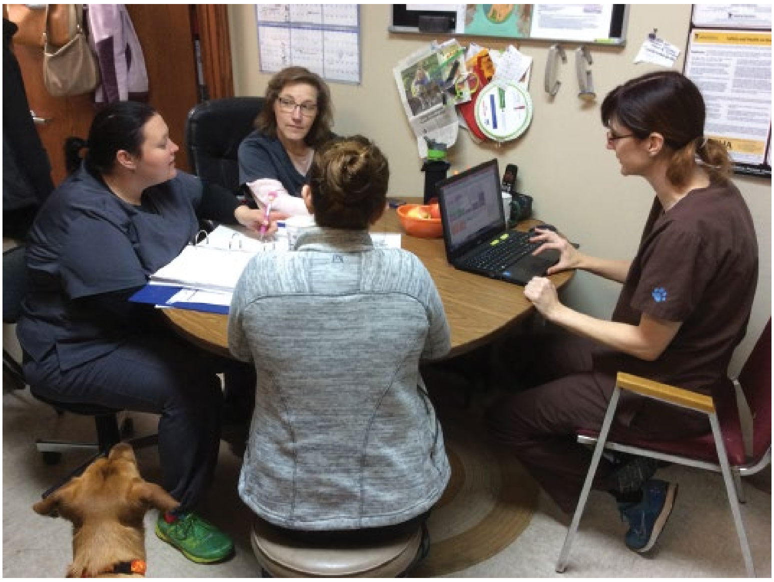

Figure 21.1 Patient rounds in the clinic of one of the authors (Tomlinson) are 1 hour a day. Round sheets hold written descriptions of daily therapy plan, and digital records are accessed for last therapeutic notes as each case is discussed between doctors and technicians.

therapy plan adjusted accordingly, are strongly recommended. Alerting the supervising veterinarian regarding patient concerns in the clinic may take a few moments as they may be overseeing several patients at one time. Owners should be counseled of the need to wait for veterinary intervention before progressing with therapy for that day. Troubleshooting should always involve the supervising veterinarian as the veterinarian technician is not the case manager and should not be determining the therapy plan.

Communicating with Specialists and the Primary Care Veterinarian

It is essential that communication with the primary care veterinarian be on a frequent basis, and in the case that there is a sudden change in patient status, the communication should be immediate. The rehabilitation veterinary technician may be facilitating this communication via phone, fax, or email. Whenever a client self-refers their own pet, the rehabilitation facility staff must inform the client that communication and collaboration with the primary care veterinarian is required.

If the patient develops a new issue that requires further diagnostics or treatment, it is the responsibility of the rehabilitation veterinarian to refer the patient back to the primary care veterinarian or on to a different specialist. In the latter case, the primary care veterinarian needs to be involved in that referral. The American Animal Hospital Association Referral Guidelines (www.aaha.org) state that, "A referral should be considered when there is a need for additional expertise/advanced training, additional services to provide further diagnostic testing or an unresolved or worsening medical condition." All veterinarians involved in the care of the patient need to be apprised of the change in condition and of any subsequent referral. Communications between veterinarians and veterinary clinics involved in patient care should include updated medication lists and care notes from the rehabilitation facility.

The rehabilitation veterinary technician is a patient advocate and should note the importance in taking a role in recognizing changes in patient status. The ultimate advice is, "when in doubt, ask your supervising veterinarian."

Communicating with Adjunct Team Members

When many team members are involved in patient care, many points of view about such care can come into play. The team leader and case manager is the rehabilitation veterinarian, who will consider team member input on the case with respect and professional courtesy. Collaboration is a simple process when all team members are at the same facility and have direct access to the patient. Such collaboration leads to excellent patient care. Problems can arise when members of the care team are seeing the patient at different times or in different facilities; patient status can differ day to day and recommendations may be made that disagree with those made by other team members. Team members should avoid making recommendations to the owner that contradict previous recommendations made by another team member; the case should first be discussed with the team leader. This includes recommendations about nutrition, supplements, medications, home care, and rehabilitation therapy. Team members that are not qualified to make a diagnosis or recommend a treatment should avoid doing so. For example, even though a pet store employee can make recommendations on diet and supplements without legal consequences to themselves, but which may have consequences for the animal, rehabilitation team members who are not veterinarians should not do so. Supplements and food are not tightly regulated and the wrong recommendations can do harm. The team should strive to avoid the effect of "too many cooks spoiling the broth" and refrain from making unilateral decisions.

Examples of Case Management

Case 1: Surgical Implant Failure

Daisy, a 1-year-old Golden Retriever, was referred to Moving Paws Rehabilitation Center by her orthopedic surgeon following failure of left triple pelvic osteotomy (TPO) which had been addressed with implant retrieval and a left femoral head and neck ostectomy. Daisy had been hit by a car prior to TPO surgery and had a history of hip dysplasia. The initial TPO had been performed 8 weeks prior to initial consultation with the rehabilitation team. Due to unknown causes the TPO failed and implants were removed 4 weeks following the initial surgery.

At the rehabilitation consult, Daisy presented with a grade 5/5 (non-weight-bearing) lameness of her left hindlimb. The rehabilitation team noted severe atrophy of the left quadriceps, hamstrings, and gluteals. She had severe contracture of her left semitendinosus and moderate iliopsoas and sartorius spasms while standing (Box 21.1, red flag box 1). The soft tissue contracture severely restricted her stifle range of motion in extension. No neurologic deficits were noted. The rehabilitation veterinarian recommended that Daisy come for therapy twice a week for 4 weeks with the physical therapist and certified rehabilitation technician, after which a full repeat assessment would be made. The owners were advised to restrict all activity at home until beginning therapy. A non-steroidal anti-inflammatory,

Box 21.1 Red flag boxes for Case 1

1) Contracture can be permanent and must be addressed effectively in a timely manner
2) Sedation requires the presence of a veterinarian and whole veterinary team. Without this ability, assessment would be impaired and treatment could have been delayed
3) Quick action needed and even then the issue may not be resolved

along with tramadol and methocarbamol, were prescribed for pain relief and to reduce muscle spasm.

The following week, Daisy began therapy. Upon examination, the physical therapist agreed with the rehabilitation veterinarian's findings and instituted a therapy plan that included low-level laser therapy (LLLT) to her coxofemoral joint, therapeutic ultrasound to her hamstrings, passive range of motion of each joint, and cross friction massage to her hamstrings. The home exercise plan included passive range of motion of the left rear limb following application of heat therapy to her hamstrings for 10 minutes twice a day. Daisy's restrictions included no off-leash activity, 5-minute leash walks 3–4 times a day, and no running, jumping, or rough play.

Following the second week of therapy, the physical therapist spoke with the rehabilitation veterinarian about sedating Daisy to assess her hamstring contracture; this was to remove any conscious protecting of the area and to provide maximal pain relief during assessment of muscle limitations (Box 21.1, red flag box 2). Upon sedation, it was determined that hip range of motion was limited to 90 degrees of flexion, 110 degrees of extension, and stifle range of motion to 90 degrees of extension due to the severity of the hamstring contracture and that surgical intervention may be required. Daisy was then referred back to her surgeon for evaluation. At 8 weeks following the TPO implant retrieval, a semitendinosus myotomy was performed. The surgeon contacted the rehabilitation veterinarian and explained that, although the surgery has increased Daisy's stifle extension, he was concerned that the muscle would quickly become fibrotic and adhere down, so he recommended she return to rehabilitation.

After Daisy's suture removal, she met with the physical therapist, and goniometric measurements were taken. Left hip flexion measured 60 degrees, extension 110 degrees, stifle flexion 36 degrees, extension 104 degrees, and tarsal flexion 88 degrees. Her initial in-hospital and at-home therapy continued as originally directed. During the following week, the rehabilitation technician noted that Daisy's left hind paw began to knuckle onto the dorsum of her foot during her walks and informed the physical therapist. Upon examination, the physical therapist found that Daisy's digital flexors were beginning to contract (Box 21.1, red flag box 3). She called the owner and recommended that Daisy be fitted with an assistive device to help to hold her toes in an extended position for weight bearing. Upon examination, the rehabilitation veterinarian determined that as the flexion of the toes could still be manually corrected and she agreed with the decision to prescribe the device. The owner was advised to continue therapy as directed until the assistive device arrived. During this time, the rehabilitation team could advance Daisy's in-hospital exercises with weight shifting that included picking up her opposite front paw, while holding the left rear paw in a normal position to promote weight bearing.

The device was delivered and applied to Daisy's paw (Figure 21.2). The therapist

Figure 21.2 Assistive device to prevent flexion of the rear toes in stance (Therapaw).

Figure 21.3 An example of an orthosis which would hold the foot in adequate extension for weight bearing and, in addition, allow for some stifle and tarsal motion. *Source:* Photo courtesy of Orthopets.

found that although it helped keep her digits in a normal position, Daisy was having trouble advancing her leg. The rehabilitation technician suggested that an elastic "resistance" band be connected from the bottom of the brace up to Daisy's harness ring over her back, to help with her limb advancement using elastic recoil. The physical therapist and technician applied the band, which aided Daisy's limb advancement. The owner was advised to increase leash walks to 10 minutes twice a day using the band. Daisy continued therapy for the next 2 weeks.

Two weeks into the new therapy, Daisy had a recheck examination with the rehabilitation veterinarian. Her examination findings included an improvement in range of motion of hip extension, stifle extension, and tarsal flexion. However, the digital flexor tendons were contracting further. Daisy was referred back to the surgeon to discuss a possible release of the left rear digital flexor tendons. The surgeon spoke with the rehabilitation veterinarian and recommended that her left flexor tendons be released due to the contracture and possible neurologic insufficiency. The surgery was performed the following day.

The digital flexor release was successful and Daisy was no longer knuckling, but would need a long-term orthosis due to her limb abnormalities. The physical therapist consulted with a certified orthotist (CO or CPO) and the rehabilitation veterinarian and technician took several videos, pictures, and casted Daisy's left rear limb for an orthosis which would hold the foot in adequate extension for weight bearing, and in addition, allow for some stifle and tarsal motion (Figure 21.3). Daisy adapted to her device successfully and, although her stifle and hip extension did not completely improve to the level of her right rear limb, she had enough range of motion to be highly functional. Daisy visits the rehabilitation veterinarian every 6 months for orthosis and a general mobility check.

Case 2: Post-Surgical Rehabilitation

Chipper, a 6-year-old, intact Pit-Bull mix, was brought into Animal Friends Animal Hospital for his annual examination and the owner mentioned an acute onset of right rear limb lameness. The owner expressed no previous issues of lameness other than a mass removal from the same leg a few years prior. The mass was not further identified via pathology and the owner felt that there was no relation between the mass removal and current lameness. Upon examination and radiographs by the veterinarian, Chipper was diagnosed with cranial cruciate disease of the

Box 21.2 Red flag boxes for Case 2

1) Menisci should be examined at surgery and any tears addressed, it may have been examined but was not noted in the records received by the rehabilitation technician. Postoperatively, meniscal problems can cause ongoing, chronic lameness and should be on the list of rule-outs
2) Who is supervising the case? Is the technician prescribing therapy and therefore acting out of the bounds of the Veterinary Practice Act? Does the veterinarian have rehabilitation experience?
3) Laser therapy can reduce symptoms of pain but we need to know the source of the pain. Why is Chipper not progressing well? Prescribing a new therapy needs veterinarian input
4) Owner concerns about symptoms should always be referred to the supervising veterinarian

right stifle with subsequent instability. A standard tibial plateau leveling osteotomy (TPLO) was performed. Medical notes did not state the meniscal condition (nor any treatment of the meniscus) (Box 21.2, red flag box 1). The owner was advised to restrict Chipper's activity to leash walks to the bathroom and to ice his stifle three times daily until his suture removal.

At the time of suture removal, the owner was concerned about continued lameness. The veterinarian noted that he had a grade 4/5 right hindlimb lameness and atrophy of right gluteal, quadriceps, and hamstring muscles. The veterinarian advised the owner to meet with one of his certified technicians who was also a certified canine rehabilitation assistant. During that appointment, the rehabilitation technician met with the owners and examined Chipper. She noted that there was still inflammation of the distal incision with mild restriction in right stifle flexion.

After speaking with the veterinarian, the technician recommended that Chipper come in for twice weekly in-clinic therapy. Therapy included LLLT of the right stifle joint and quadriceps and hamstring muscles; neuromuscular electrical stimulation (NMES) of right quadriceps and hamstrings (to promote co-contraction); range of motion exercises of the right rear limb (flexion and extension of hip, stifle, tarsal, and toe joints); and introduction weight shifting and rhythmic stabilization exercises (Box 21.2, red flag box 2).

The following week, the rehabilitation technician noted that Chipper's lameness had improved and advised the owner to begin 5-minute slow leash walks 3–4 times daily along with passive range of motion of the right stifle in flexion and extension followed by icing twice daily. Chipper had nearly completed the prescribed postoperative course of anti-inflammatories and cefpodoxime proxetil. Cefpodoxime proxetil is an oral cephalosporin antibiotic used to treat bacterial infections of the skin, such as wounds and abscesses as well as bladder and respiratory infections in dogs and skin and soft tissue infections in cats.

After 3 weeks of therapy, the owner met with the rehabilitation technician and expressed concern that Chipper was not progressing well at home, although they had noticed him feeling better the day following laser therapy. The rehabilitation technician recommended that the owner bring Chipper in for laser therapy an additional day during the week (Box 21.2, red flag box 3) As Chipper continued to come in for therapy, the rehabilitation technician continued NMES along with weight-bearing exercises, but noted that Chipper's progress was slower than expected.

Another 2 weeks of therapy had passed and the owner was very concerned (Box 21.2, red flag box 4) that Chipper was still toe touching and "not really wanting to use his leg." The rehabilitation technician recommended that the owner meet with the veterinarian. Upon examination, the veterinarian noted severe atrophy of right gluteal, quadriceps, and hamstring muscles with a grade 3/5 lameness. Since Chipper was 8 weeks post-op, the veterinarian took radiographs to ensure that the surgical plate was stable.

The radiographs showed that the plate was in the proper position, but unusual, reactive bone remodeling was seen distal to the plate. The veterinarian recommended and performed a bone biopsy. Chipper was referred back to continue therapy until the results came in. The next morning, however, the owner called and reported that Chipper's leg had become swollen and they had to take him to the emergency room. The emergency room doctor repeated radiographs, and saw a pathologic fracture secondary to cancerous remodeling. Chipper was referred to an oncologist. His diagnosis was osteosarcoma and his prognosis poor as it had already metastasized to his lungs.

What are some of the things that could have been done differently with this case? Be sure to note that osteosarcoma can cause lameness that starts mild and progresses, and is also associated with previous surgery sites (Holmberg *et al.*, 2004; Selmic *et al.*, 2014).

Case 3: Activity Restrictions

Luke, a 4-year-old, neutered, Belgian Malinois was referred to Fit Furry Friends Animal Rehabilitation Center, 6 weeks after surgery to repair an Achilles tendon rupture. Initially, Luke had presented to the orthopedic surgeon following 4 weeks of non-weight-bearing lameness after a laceration to his left tarsus. The laceration had been repaired by his primary care veterinarian, but a week after surgery he began walking with an almost fully plantigrade stance (Figure 21.4). Surgery was performed and the identified tendon tear was apposed with sutures. The surgeon noted that there was an increased amount of tension on the repair since the tendon had retracted proximally. A calcaneotibial screw was placed to lock the tarsus in hyperextension during healing. A full bivalved cast was also placed over a bandage to restrict movement of the stifle and distal limb. Luke returned for weekly bandage changes until 4 weeks after surgery, when removal of the calcaneotibial screw was performed and his cast was changed to a soft padded bandage with a lateral splint. Bandage changes continued weekly for 2 weeks, at which time he was referred to the rehabilitation team for orthosis prescription and rehabilitation consultation (6 weeks after surgery).

During Luke's initial consultation with the physical therapist, he was non-weight bearing on his left hindlimb. He had moderate atrophy of his left gluteals, quadriceps, and hamstrings with severe restriction of left tarsal flexion range of motion. After taking measurements and a fiberglass impression for an articulating tarsal and foot orthosis (Figure 21.5), the physical therapist consulted

Figure 21.4 A dog with an almost plantigrade stance of the left rear due to Achilles tear.

Figure 21.5 An articulating tarsal and foot orthosis (Orthopets) placed on the patient in Figure 21.4.

with the surgeon regarding the implementation of other modalities that would help facilitate Luke's healing. The surgeon was not a "fan of rehab" and elected to keep Luke in a soft padded cast and declined any further therapies at present (Box 21.3, red flag box 1).

Two weeks later, Luke returned for his orthosis fitting and adaptation exercises. Upon consultation with the surgeon again, the physical therapist was advised not to begin additional therapies. The rehabilitation technician reviewed orthosis care instructions and recommendations with the client, who was advised to return to the surgeon for a recheck (Box 21.3, red flag box 2). The following week, the surgeon contacted the physical therapist and reported that a skin sore had formed, so the surgical staff replaced the orthosis with a soft padded lateral splint. The owner was frustrated with this "step back" in healing and wanted more assistance with orthosis use once the wound had healed. The surgeon then contacted the physical therapist and advised that it would be acceptable to initiate rehabilitation modalities and take over care of the orthosis after a week in the bandage splint to allow sores to heal.

At the next rehabilitation visit, the bandage splint was removed, the orthosis was reapplied (Box 21.3, red flag box 3) and LLLT of the left Achilles tendon, quadriceps, and hamstrings was initiated. NMES was applied to the quadriceps and hamstrings (for a co-contraction). The orthosis was to be worn always. The client was given specific instructions regarding permissible activity and exercise in the orthosis to reduce the risk of skin sore development. Luke was to continue outpatient therapy once weekly and the client to follow a specific home exercise plan. An

Box 21.3 Red flag boxes for Case 3

1) Would a rehabilitation veterinarian as team leader have made it easier to use other prescribed therapies? Once a veterinarian refers to another, treatment choice is at the discretion of the receiving veterinarian. The surgeon was team leader but had no rehabilitation training
2) The individual prescribing and fitting the orthosis is the person to monitor and evaluate orthosis use and complications. This is the person with the most suitable skill set. Some orthotics companies will only work directly with a veterinarian so that follow-up is complete
3) The orthosis was reapplied but why had the sores occurred in the first place? Did the orthosis need refitting or changing?
4) An orthosis is a medical device; it needs to be fitted correctly and any issues troubleshooted by a therapist with specific training in orthosis fit and application. Regardless, an owner may be non-compliant. Careful, repeated counseling about the risks and importance of proper device use is needed

orthosis recheck evaluation at the rehabilitation facility was set up for 2 weeks later.

Ten days later, 21 weeks following the repair and a few days before the scheduled orthosis recheck and weekly therapy visit, the surgeon called and reported that Luke had jumped off the bed, and was not wearing his orthosis at the time of the incident. Upon examination, it was determined that Luke's Achilles repair had failed. The owner stated that Luke could not wear the orthosis for more than 20 minutes without his skin reddening and due to concerns about a sore, she had been removing it at home. She always took Luke to therapy in the device however (Box 21.3, red flag box 4).

Several options were discussed with the owner: first, repair of the tendon, with the risk of it being a weaker repair and, therefore, more prone to re-injury; second, a pan-tarsal arthrodesis; and third, amputation. The owners elected to perform the arthrodesis.

Case 4: Spinal Surgery

A 10-year-old, 45-pound (20 kg), spayed female Dalmatian called Marty presented to the veterinary neurologist for acute-onset, rear limb ambulatory paresis. She was observed to have difficulty getting up from sitting and from lying. Also, when ambulating, she placed the dorsum of her right hind paw on the ground or knuckled over on the right hind foot. Marty was taking a non-steroidal anti-inflammatory and a glucosamine chondroitin sulfate supplement for a presumptive diagnosis of osteoarthritis (location unspecified). Physical examination findings included normal pain score, intact segmental spinal reflexes, the presence of deep and superficial sensation, but conscious proprioceptive deficits in the rear limbs (when her paw was placed knuckled over, she did not replace it). Her bladder was "easily expressed."

Further diagnostics were performed. Radiographs showed a T13–L1 and L1–L2 spondylosis, while the myelogram showed extradural compression left T13–L1 and right L1–L2. Intervertebral disc protrusion was suspected as the cause for the compression and so surgical decompression was recommended. Marty underwent a T13–L2 hemilaminectomy. Her 3-day hospitalization period was without incident and she was discharged on postoperative day 4. On the day of discharge, veterinary examination findings included: absent deep pain sensation in the left hindlimb, hypertonic left hindlimb myotactic (stretch) reflexes, and urinary incontinence with fecal continence. She was discharged with prescriptions for prednisone, phenoxybenzamine to aid urination, and cephalexin (Box 21.4, red flag box 1). The rehabilitation team was consulted at the time of her discharge. The rehabilitation-certified veterinary technician instructed the clients in the proper administration of the discharge medications, bladder management (including demonstration of techniques for expression), home nursing care (including bedding and preventing sores), making the home safe for Marty, limiting the area she could move in, and dietary changes considering her reduced activity. The physical therapist instructed the clients in basic home rehabilitation techniques including sensory stimulation, passive range of motion (PROM), and patterning of Marty's hindlimbs. The clients were also advised of proper and safe sling-walking techniques, considering the clients' safety with body mechanics. The physical therapist also discussed the potential for use of a cart by Marty as her prognosis for recovery of normal gait was guarded.

Marty returned on postoperative day 13. After recheck and staple removal, she was referred directly for her rehabilitation evaluation. The clients reported that Marty could support weight through her back legs when her bladder was expressed and that they had, since discharge from surgery, restricted her to a small pen. They were using a sling for limited ambulation (outdoors for elimination only). The clients expressed their hope to return Marty to as high a level of function as possible and that they would pursue a cart for ambulation assistance, if necessary.

The physical therapist's evaluation revealed no pain response when palpated. Marty could stand for 30–60 seconds after being placed in that position. She then would slowly "sink down" with her rear limbs into a sit. She had significant postural compensation in standing, including cranial weight shifting onto her forelimbs with her head lowered towards the floor (Box 21.4, red flag box 2).

When walking with assistance, Marty knuckled over onto the dorsum of her rear paws and adducted her rear limbs with crossing over (Figure 21.6). Her flexor withdrawal response was intact. Deep pain perception was present in the right hind, questionable in the left. Extensor tone was present in both hindlimbs. Conscious proprioception appeared absent in both hindlimbs.

Box 21.4 Red flag boxes for Case 4

1) Marty was not discharged on any analgesics; it is important for the rehabilitation team to assess pain before commencing with the rehabilitation plan
2) Marty's weight shift forward caused neck and shoulder soreness. Though focused on her return to function, the rehabilitation team could have performed acupuncture and manual therapy techniques earlier in her rehabilitation as a preventative measure. Additionally, the clients should have been instructed not to lift Marty's pelvic girdle too high off the ground as this might have further stressed her
3) All neurologic patients should be screened for possible urinary tract infections as bladder emptying can be incomplete due to postural difficulties or neurologic dysfunction of the bladder itself

The rehabilitation team, in consultation with the neurologist and clients, set short-term and long-term functional goals. A plan was also outlined and discussed for in-clinic and home therapy. Following this discussion, the clients were given a home program, including sensory stimulation techniques, postural transitions, assisted standing and sling-walking. The clients were instructed in techniques to care for their own backs as well, given Marty's size and dependence upon them for care and mobility.

Marty's rehabilitation progressed as she was seen initially twice weekly for physical rehabilitation. Treatment included: neuromuscular facilitation techniques with functional mobility training and manual therapy (including traction techniques) by the physical therapist, therapeutic exercise (on land and in an aquatic environment), NMES, and LLLT. The home program was progressed to encourage motor learning and carryover from each therapy session. The physical therapist performed all manual therapy and facilitated exercises and performed the initial NMES session while instructing the rehabilitation technician in altering the settings and treatment locations

Figure 21.6 Rear limbs crossed over. Natural stance of a neurologic Dachshund.

for NMES in subsequent sessions. The rehabilitation technician performed therapeutic exercises, NMES, and LLLT.

Marty was rechecked by the neurologist 4 weeks later. Her prednisone dose was tapered and phenoxybenzamine discontinued as bladder control normalized. Progress included walking with less assistance, needing only support at her left hindlimb. Sit-to-stands now needed only moderate assistance. A new sling and boots to protect the rear feet were provided so that Marty could walk more safely and regularly outdoors (see Chapter 10 for examples).

Full functional re-evaluation was performed 6 weeks after surgery. Marty was occasionally able to be independent during recumbent-to-stand transitions and was independent with recumbent-to-sit transitions. She could walk a few steps independently prior to losing her balance. With harness assistance, she could go further but would adduct her rear limbs or knuckle on the left hind 25–50% of the time. Marty demonstrated good motor control for stand-to-sit transitions >75% of the time. Marty continued to compensate in both sit and standing posture by lowering her head and weight shifting cranially to her forelimbs (Box 21.4, red flag box 2).

Marty continued to progress in her therapy and was seen once weekly for sessions with the physical therapist and rehabilitation veterinary technician. Sessions included facilitation techniques, therapeutic exercise, and LLLT.

At 8 weeks after surgery, Marty could stand for up to 4 minutes independently and recover her standing balance when minimally perturbed. She could walk up to ¼ mile (0.4 km) with her assistive harness. Marty regained control of her bladder but full emptying was still ensured with manual expression to prevent infection. The rehabilitation technician reviewed bladder palpation techniques with the clients.

At her 12-week re-evaluation appointment, the clients reported to the veterinary technician that Marty appeared to have some shoulder and neck soreness (Box 21.4, red flag box 2). They were also concerned that she might have a urinary tract infection, as she was dribbling urine and it was stronger smelling and more concentrated than it was previously (Box 21.4, red flag box 3). The clients had been counseled about signs of infection and so were aware of what to look for. This report was relayed to the physical therapist, as well as to the rehabilitation veterinarian, who recommended a urinalysis and culture. Urine was sampled by cystocentesis aided by the technician and initial analysis by the technician revealed white blood cells and bacteria in the urine. The sample was sent for culture and a broad-spectrum antibiotic prescribed. A non-steroidal anti-inflammatory and acupuncture treatment were both prescribed and administered for the bladder and neck pain. Following veterinary evaluation, the physical therapist applied manual therapy techniques to the neck and shoulder area, localizing and releasing trigger points in muscles surrounding the pectoral girdle. Therapeutic exercises were modified so to decrease stress upon the forelimbs and increase load on the hindlimbs. In addition, fewer repetitions of each exercise (both in clinic and at home) were performed, as it was assumed that multiple repetitions might be causing fatigue of the hindlimb muscles and further stress (through compensation) of the forelimb muscles. The justification for modification of the home program was discussed with the clients by the physical therapist. The veterinary technician instructed them in administration of medications and possible side-effects.

Marty recovered quickly from her urinary tract infection as the correct antibiotic was prescribed for the bacteria cultured. The exercise modifications were found to have reduced neck and shoulder pain. Marty continued to progress in function with periodic re-evaluations by the physical therapist at lengthening intervals. Manual therapies were continued as needed. Marty now walks mostly unassisted but will knuckle over onto the dorsum of her left rear paw periodically and so wears a protective boot. She continues to be prone to urinary tract infections but her owners are quick to recognize them and seek appropriate treatment.

This case highlights the need for a team approach to all aspects of care, including counseling the owners about potential complications. Luckily, Marty's owners were instructed in signs suspicious for urinary tract infection, including more frequent urination, more concentrated urine, blood in the urine, and/or foul-smelling urine.

Case 5: Needing a Team

Sam, a 10-year-old male neutered Labrador, presented to Jane Doe who was a certified veterinary technician and had completed a certification course in canine rehabilitation. Sam had just had a TPLO on the right stifle. The rehabilitation facility was housed next to a primary care veterinary clinic. State law read that a technician could work under indirect supervision by a veterinarian, which was interpreted by Jane as meaning a veterinarian could refer directly to her for rehabilitation care and that she would manage the case. Jane owned her own business and was paid by clients directly (Box 21.5, red flag box 1).

Sam was sent to Jane by a local surgeon for routine postoperative rehabilitation. Sam was otherwise healthy. He was started on a program of twice weekly hydrotherapy in an underwater treadmill followed by balance and proprioceptive work. Home exercises recommended by Jane were flexion and extension range of motion of both stifles and rhythmic stabilization (Box 21.5, red flag box 2).

Sam progressed well until week 6 after surgery, when he developed a grade 4/5 lameness while exercising in the water treadmill. Jane immediately terminated therapy, drained the tank and brought Sam out. After quickly drying him, she examined him closely for signs of heat, swelling, and pain. Jane noted pain on palpation over Sam's cranial thigh muscles on the right. Sam was not painful when his right stifle was extended, but he was painful at end range flexion. He was not painful on pressure medially over the surgical implants.

Jane iced Sam's cranial thigh muscles and his stifle and advised his owner to do the same that evening. Jane's business was not connected to the adjacent primary care clinic, nor was Sam a patient of that clinic. Jane called Sam's surgeon and his primary care veterinarian to facilitate an examination at either the primary care or surgical clinic (Box 21.5, red flag box 3). The primary care veterinarian saw Sam the next day, prescribed a non-steroidal anti-inflammatory (the same one that Sam was previously on for 2 weeks immediately after surgery), and took radiographs of the stifle. The radiographs

Box 21.5 Red flag boxes for Case 5

1) The term "indirect supervision" is interpreted in the relevant State (province or country) Veterinary Practice Act. In the case of a veterinary technician working in the veterinary medical field under the indirect supervision of a veterinarian, that technician needs to be under the employ of the supervising veterinarian. Liability insurance would be carried by the supervising veterinarian
2) Recommending a treatment plan is the same as prescribing a treatment, this can be interpreted as the practice of veterinary medicine
3) It is not clear whether the primary care veterinarian or the surgeon is Jane's supervising veterinarian. Jane was right to contact them both, but what if recommendations from each were different?
4) Sam's veterinarian(s) who were supervising Jane should have informed her of the plan and outlined their instructions for her in management of the case
5) Jane cannot legally make a diagnosis or prescribe a treatment for that diagnosis

were checked by the surgeon and no new pathology was noted. Sam's owners were instructed by the surgeon to confine him to a crate and to rest him for 2 weeks with leash walks to the bathroom only. Jane was informed of the plan for Sam by his owners (Box 21.5, red flag box 4) and despite her concerns, she had no legal power to modify the veterinarian's recommendations. Following the 2 weeks of rest, Sam presented back to Jane's rehabilitation facility. He was no longer on the anti-inflammatories, but exercise was still being restricted to leash walks. On examination, Sam had a grade 3/5 lameness on the right rear which was an improvement since the most recent onset of acute lameness, but prior to that time, Sam's postoperative lameness had been only a grade 2/5. Jane had concerns about persistence of pain. On further examination, Jane found that Sam was painful on direct palpation over his quadriceps muscles on the right and slow stretch of these muscles produced resistance and pain, the left quadriceps had normal stretch with no pain (Figure 21.7).

Figure 21.7 Quadriceps stretch.

Jane was concerned about a quadriceps strain but had not examined the quadriceps specifically before the acute onset of lameness (Box 21.5, red flag box 5) Jane applied LLLT to the quadriceps and then gently massaged the muscle group. Sam's owners were instructed to massage at home twice daily. Sam visited for laser therapy five times over 2 weeks with improved muscle tone and pain relief noted following each session, but on each return visit the muscle spasm, shortening, and pain had returned. Sam's grade 3/5 lameness persisted.

Jane encouraged Sam's owners to make a recheck appointment with the surgeon so that she could re-evaluate Sam. Sam's treatment notes were sent with the owners so that the surgeon could understand Jane's examination findings. Jane could not write a diagnosis of a quadriceps muscle strain anywhere in the medical record as diagnosis or prescription of a treatment was outside of her scope of practice. Jane was aware that even changing to a therapeutic modality for a new problem was technically illegal without a veterinarian prescribing this therapy. The medical record was carefully worded "pain on palpation over muscles of right cranial thigh, mostly limited to the quadriceps muscle group. Quadriceps stretch shortened compared to the left side. Applied LLLT for symptomatic relief. On return to the rehab center, Sam still had the same pain and shortening of his right quadriceps. It was recommended to have an evaluation by a surgical specialist."

Sam was brought to the surgeon for examination. She confirmed muscle pain but said that it was likely secondary to relative overload from too much activity and recommended a further 2 weeks' rest with leash restriction. A follow-up visit was booked for then. The anti-inflammatory medication prescribed by the primary care veterinarian was resumed for another 2 weeks. Sam's lameness persisted and on repeat examination and radiographs, the surgeon recommended implant removal as his osteotomy was healed but there was a small amount of bony reaction around the distal screw. The medical notes also indicated some progression of Sam's stifle arthritis.

Following implant removal, Sam was rested for 2 weeks. His lameness appeared to have resolved and so exercise restrictions were lifted by the surgeon. The surgeon recommended returning to Jane for therapy as Sam's right rear leg had "lost muscle." The anti-inflammatory was continued to help manage pain from arthritis. It would be "reduced to lowest effective dose once Sam was back to full fitness."

Sam returned to the rehabilitation center and resumed therapeutic exercises including hydrotherapy, balance work, and cavalettis. Jane measured Sam's thigh circumference and the right was 2 cm less than the left. The home exercise plan was altered by Jane, adding isometric strengthening of the rear limb muscles using front leg lifts (three-legged stands) in addition to his range of motion and rhythmic stabilization exercises.

Sam's first two therapy sessions went well. Jane palpated his quadriceps before and after each therapy session and there was no pain response, although she did not evaluate his response to stretch. Sam returned for the third session with a grade 3/5 right hindlimb lameness. On examination, Jane found pain over the right quadriceps muscle group and shortened stretch, which was painful. Jane treated the muscle spasm and pain with laser therapy and massage and recommended a home heat and stretch exercise. She informed Sam's primary care veterinarian, who recommended leash restriction along with continuing Jane's plan for laser therapy. After six more laser and massage treatments Sam was feeling better and stretch of the right quadriceps had improved. Jane decided that hydrotherapy might be "too much" for Sam and so continued the home exercise plan of front leg lifts progressing to diagonal leg lifts. She added sit-to-stand exercises. Leash walks twice daily were started on the second week of the exercise plan and increased incrementally by 5 minutes each week.

Sam's owners followed the plan and returned for a recheck 4 weeks after the home-only plan was started. Sam appeared comfortable and his thigh circumference measurements were 1 cm different now – an improvement of 1 cm. Jane removed Sam's leash restriction, allowing short periods of time in the back yard.

Sam's owners called to cancel his recheck appointment which had been scheduled for 2 weeks after removal of restrictions. Sam was lame again. He was going to see the orthopedic surgeon. Sam also went to a sports medicine and rehabilitation clinic where he saw a rehabilitation veterinarian and a physical therapist. A grade II quadriceps strain was diagnosed and was treated by the team with therapeutic ultrasound, myofascial trigger point therapy (dry needling), and manual therapies including cross friction massage and mobilization of the coxofemoral and stifle joints. Sam's lameness resolved and he was slowly returned to full activity. His nonsteroidal anti-inflammatory medication was discontinued.

Case 6: Working with Adjunct Professionals

Sophie, a 7-month-old female Irish Wolfhound presented to the Piney Animal Rehabilitation Clinic for an intermittent rear lameness that had suddenly progressed to ambulatory paraparesis in the rear. It was winter and the puppy had been outside on snow and ice with other dogs when the lameness had first been seen.

The owner had initially consulted her chiropractor who was trained in animal chiropractic. The chiropractor had examined the patient and had concerns about working with a neurologic patient with no veterinary diagnosis. A recommendation was made to seek veterinary advice, particularly from a specialist rehabilitation veterinarian (DACVSMR). Following the chiropractor's advice, the owner self-referred her dog to Piney Animal Rehabilitation for initial examination. After the client made the appointment, a technician at the rehabilitation clinic contacted the primary care veterinarian to inform them of the self-referral and to ask for patient records (pending owner release).

A review was made of the medical notes from both the primary care veterinarian and the chiropractor. It was apparent that the patient had not been seen by the primary care veterinarian since she had developed neurologic signs. The patient had been clinically normal at last veterinary examination. The chiropractor's records noted a mentally alert but ataxic patient, palpation of the spine revealed atlanto-occipital joint restriction in motion. No spinal adjustments were performed, but manual therapy techniques were applied to the muscles of the neck (Box 21.6, red flag box 1). After two visits and no improvement in gait or comfort, the recommendation for veterinary examination was made. It was noted in the chiropractor's medical record for the dog that it is "customary for chiropractors to advise clients that three chiropractic visits should take place before drawing conclusions about how much change we will be able to make through adjusting however concerns about patient status raised a concern before this. It was becoming clear that imaging should be performed. An evaluation from a rehabilitation veterinarian will help to narrow the specific area to be imaged" (Box 21.6, red flag box 2).

The review of the notes produced a tentative differential diagnosis list. Top of the list was spinal cord compression. It was the rehabilitation veterinarian's opinion that cervical vertebral malformation was the primary differential diagnosis, but that other forms of spinal compression, congenital issues with central nervous system development, or infectious/inflammatory disease of the nervous system were possible.

Box 21.6 Red flag boxes for Case 6

1) The animal chiropractor stressed the point that she had not manipulated the patient's joints in the areas of concern. Although manipulations have been found to be safe and effective in the management of discomfort due to nerve compression (Lisi and Bhardwaj, 2004) and have been shown to safely provide symptomatic relief in the case of cervical disc herniation (Peterson *et al*., 2013), it was clinically advisable to use caution in a case where hypomobility may be a protective response to hypermobility from instability, and/or to impingement on the spinal cord
2) The history of acute progression from lameness to paresis indicates spinal cord compression. A patient with these signs should be fully evaluated by a veterinarian as soon as possible. Advanced imaging of the spinal cord is advised. A young, large-breed dog with neurologic signs may have cervical vertebral spondylomyelopathy/instability (wobblers syndrome) or other congenital abnormality
3) A patient who has a (tentative) diagnosis of instability in the vertebral column may have intermittent exacerbation of spinal cord compression on making certain movements – in this case, full range neck movements should be avoided, especially rapid motions as they involve more force in muscle activation which in turn results in more compressive forces on the vertebral joints. Traction on walking surfaces needs to be adequate and the patient needs to be supported as needed
4) A patient may improve in strength and coordination after rehabilitation therapy but this does not mean the underlying disease is completely managed or at all resolved. Age-related progression of signs in patients with vertebral instability are due to degenerative changes, disc degeneration, and hypertrophy of ligaments and other soft tissues. These changes can increase compression of the spinal cord. Owners should be cautioned about progression of signs and regular monitoring of these cases is needed

As the patient's condition was stable, an examination at the rehabilitation clinic was performed as requested. Referral to a neurologist would then be discussed with the owner after the physical and functional examination findings were explained.

Rehabilitation veterinarian examination findings included grade 2/4 ataxia of the rear limbs with low ground clearance in swing phase and wide-based stance which became wider on turning. On turning, the patient swayed in a frontal plane but did not fall. Transitions between postures (sit, down, stand) revealed reduced eccentric control of motion with some tendency to fall into a sit or a down after initiation of movement. Sit position was with the forelimbs placed in abduction and the rear limbs extended to one side. Head position was forward with the neck in slight flexion. Stance posture was head-low and wide-based rear limbs. The patient could rise from a down or sitting position without assistance but relied on forward motion of the head, neck, and front limbs. Rear extension was partial until the patient moved forward several steps after a stand was achieved. Voluntary motion of the cervical spine using treat motivation revealed normal range of motion in lateral and ventral flexion of the neck but reluctance to extend the neck beyond the neutral (in line with thoracic spine) position. Palpation of the spine revealed restriction in motion of the C4–C5 intervertebral joints and the atlanto-occipital joints. Neck musculature was noted to be high in tone but no specific areas of pain were identified. Segmental spinal reflexes were within normal limits, and there was minor weakness in the withdrawal reflexes of the rear limbs. Tail motion was normal.

Radiographic findings (tipping at vertebral end plates, narrowing of spinal canal) were consistent with signs of cervical spondylomyelopathy, and advanced imaging (MRI) along with consultation with a neurologist was recommended by the rehabilitation veterinarian. The owner declined as she was not prepared to "put her animal through subsequent surgery" based on previous experiences she had undergone with a dog who had had the same disorder.

A therapeutic/management plan was developed. The patient would undergo in-clinic and home exercises aimed at working on strength and coordination while preventing overload and excess motion in the cervical spinal cord as much as possible. A cervical collar (neck brace) was custom ordered from a veterinary supply company (Figure 21.8) and was used to prevent large motions of the cervical spine. The patient was changed to a diet with relatively low energy intake, correct calcium:phosphorus balance and adequate protein in order to prevent developmental orthopedic disease. Daily caloric intake was calculated by the rehabilitation technician who was responsible for nutritional counseling as well as home care advice and teaching home therapeutic exercises. The rehabilitation veterinarian explained the disorder to the owner at length and advised about the potential for progression and management of that progression. Every team member was also educated about progression, precautions, and activity contraindications (Box 21.6, red flag box 3).

The rehabilitation technician carried out in-clinic exercises under the supervision of the rehabilitation veterinarian. Clinical signs indicating fatigue or relative overload of the cervical spine were discussed as signals to stop or change therapy, and daily rounds assured that the case was discussed with the team each time the patient visited for therapy. The animal chiropractor used manual therapies to maintain normal joint motion in the thoracolumbar spine and took time to counsel the owner about the condition. Communication with the primary care veterinarian was through biweekly updates. Communications also occurred after any significant re-evaluation and/or status change. Sophie did have intermittent episodes of pain on arising from a prone (down) position. These episodes were associated with higher levels of activity the previous day. Pain was managed with a non-steroidal anti-inflammatory and gabapentin. The owner was counseled about consistency of activity level. However, this was difficult in a

Figure 21.8 Custom cervical brace (Therapaw).

multi-dog household. Sophie improved in coordination slightly, and her strength improved markedly. She could turn more easily and had improved control of transitions. Sophie was transferred to a home exercise plan and coped well with no decline in clinical signs (Box 21.6, red flag box 4). She continued to see her chiropractor monthly and had rechecks at the rehabilitation clinic every 4–6 months.

Conclusions

Through a collaborative team approach, incorporating the strengths of each of the team members, best practices and best patient outcomes are achieved in the rehabilitation setting. Regular communication, re-evaluation including measurement of objective outcomes, and respect for the rehabilitation chain of command and legal scope of practice of each team member is essential, especially when an unexpected problem or set-back is encountered. The overlap of the skill set provided by individual team members can be a bonus by allowing comprehensive patient care even when one team member is unavailable; or it can be a limitation resulting in competition, thus risking the integrity of the team. Focus on provision of the best possible rehabilitation practice/services while maintaining open communication will preclude these limitations.

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22

Equine Rehabilitation

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CHAPTER MENU

Introduction

The process of rehabilitating a horse after an injury or surgery is neither cookbook nor inflexible. Horses must be treated as individuals. The goal of a rehabilitation program is to achieve as close to the level of pre-injury physiologic and psychological fitness as is possible in the shortest amount of time.

Physiotherapy is common to human medicine. In the human field, there are many studies that have been performed on the different modalities that have demonstrated efficacy for specific conditions. An example would be the use of cryotherapy to decrease postoperative pain and swelling. However, there are some modalities that have limited or no proven efficacy.

In the horse, there is even less information available in the form of evidence-based medicine. However, research into the tissue effects and efficacy of therapeutic modalities has been increasing. The quality of the research that has been performed recently is improving though most are dealing with effects and not efficacy for a condition. Just because there is an effect does not mean a particular therapy is efficacious.

There is minimal work that has been done in the horse to validate the efficacy of different therapeutic modalities. Many of the treatment protocols have been adapted from human medicine for which there is better evidence of efficacy. There are clinical technique reports that address specific conditions or modalities, but these reports utilize techniques

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that have been adapted from human medicine or personal experience. There is no reason not to use modalities that have been proved to be efficacious in the human, but efficacy determination needs to be performed in the equine.

Therapeutic Plan Development

A "shotgun" approach to developing and implementing a treatment plan should be avoided. It is important to realize that this is a team approach. The team consists of the veterinarian, veterinary technician/nurse, therapist, owner, as well as other professionals (trainers, farriers, etc.). All members of the team should be involved in all aspects of the treatment to ensure the best possible outcome.

There are several things one must look at while developing a rehabilitation program for an individual horse. The first is to have an understanding of success with patients that your team treated for a similar condition. How have they progressed during the treatment period? The second is to establish some outcome goals. Where should this patient be during a certain time in the rehabilitation process? Third, the team should determine therapist capabilities and the resources/facilities available. If a specific modality is indicated and you do not have it, then the patient should be referred to a clinic that has, or alternatively a different plan should be developed. Fourth, there should be a full assessment of the patient. What is the nature of the injury? What type of therapy or surgery has been done? How amenable is the patient to therapy? What are the owners' expectations? These questions should be answered prior to initiating therapy. The team should develop a plan specifically for the patient based on the answers to the above questions.

Any plan will depend on the stage of the injury. The initial stage after injury is from the time of injury or surgery until all acute inflammation has resolved (Prentice, 2014). This may be as short as a few days to as long as or longer than 3–4 weeks. The goal during this initial stage is to decrease pain and inflammation, preserve range of motion, and prevent muscle atrophy. Typically, cold therapy, supportive wraps, and passive motion are all utilized in this period.

The second stage after injury begins as the acute inflammation is resolving (Prentice, 2014). The goal of this stage is to gradually increase the stress being placed on the healing tissues. This aids in structural healing and preventing or revising scar tissue. Therapies that could be considered include therapeutic exercise, aquatic therapy, and modalities such as therapeutic ultrasound, shockwave therapy, as well as others.

The choice of which modality to use in which stage is dependent upon the veterinarian, the therapists' experience, and the exact goal for the modality. For instance, laser therapy may be used in stage 1 to help relieve tissue edema or inflammation and in stage 2 to help in epithelial migration during wound healing.

Therapeutic Monitoring

It is extremely important to develop methods for evaluating the effects of therapy and the response of the disease or injury to therapy – the distinction should be made between these two things. In addition, one must be able to document these changes. Ideally one should use quantifiable methods (Figure 22.1). There are fairly simple methods available. A tape measure may be used to measure limb circumference. Goniometers can be used to measure joint angles. Pressure algometry may be used to evaluate for lessening pain in an area. More sophisticated methods can also be used, including but not limited to radiographs, diagnostic ultrasound, thermography, or lameness evaluation (Paulekas and Haussler, 2009).

It is important that measurements be taken at the onset of therapy and frequent re-evaluations be performed. Early in the therapy period re-evaluations may need to be

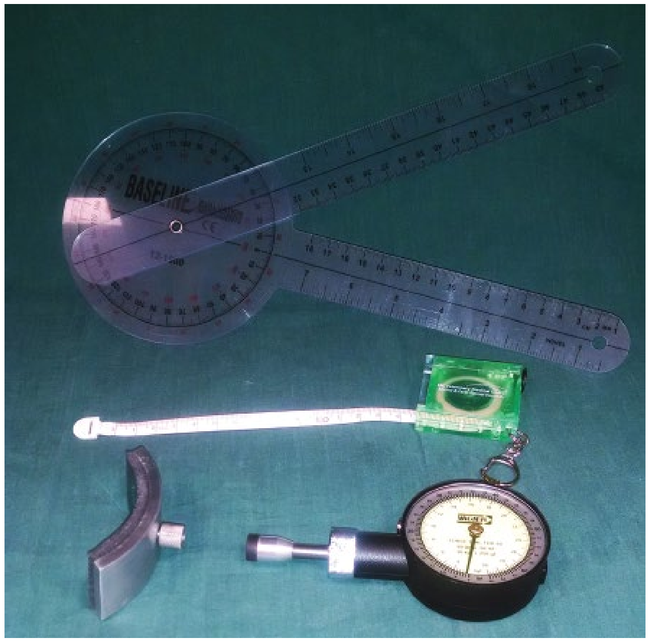

Figure 22.1 Therapeutic monitoring equipment. From top to bottom: goniometer, tape measure, and pressure algometer.

performed daily or weekly, while later they may need to be done at monthly or longer intervals. If worsening or no improvement of the condition is noted the therapeutic plan must be modified.

Facilities, Equipment, and Personnel

Prior to the development of a rehabilitation practice it is important to read the State Veterinary Practice Act. In most states performing animal rehabilitation is considered the practice of veterinary medicine. As such, if a person is not a veterinarian then they will need to be a full-time employee of a veterinarian. If a person is a full-time employee of a veterinarian, then the level of supervision required will need to be determined. In most states a licensed veterinary technician/nurse can work under indirect supervision, meaning that the licensed veterinarian need not be on the premises, has given either written or oral instructions for treatment of the patient, is readily available by telephone or other forms of immediate communication, and has assumed responsibility for the veterinary care given to the patient by a person working under his or her direction. However, laws vary from state to state and need to be reviewed for each state (province or country) in which a person is working.

It is important that the individuals developing rehabilitation plans, performing therapies, and monitoring progression should be thoroughly trained. This should be more in depth than the technical service training provided by equipment manufacturers. Individuals should seek out advanced training in the form of certification courses or by spending time training at a veterinary equine rehabilitation center. One of the major problems in the field of equine rehabilitation today is lack of formal training and education. Often therapies are provided that are of no benefit to the patient or in some cases are detrimental. Depending on what services are going to be provided, advanced training is available for equine rehabilitation, hyperbaric oxygen therapy, therapeutic taping, and massage, to name a few.

When planning a rehabilitation service, the demographics of the area needs to be evaluated.

Types of horses and their concentration in the area need to be determined. In addition, the equine disciplines (dressage, cross country, hunter/jumpers, reining, barrel racing, etc.), the types of clients, and the location of other rehabilitation facilities are a few other items that should be determined.

One also needs to decide whether the rehabilitation service is going to be ambulatory or haul-in to a clinic. If it is an ambulatory service, then this will limit the type of equipment and service you can provide. An ambulatory service will be limited to those modalities that can be easily transported in a vehicle and to prescribed therapeutic exercises, but is more economically feasible than a haul-in service. A haul-in service will be able to provide a much wider range of modalities but will also be a more significant expense.

Equipment needs will depend on all the factors presented above. For an ambulatory service, equipment that should be considered includes therapeutic ultrasound, therapeutic laser, thermal therapies, shockwave therapy, and equipment to perform therapeutic monitoring. For a haul-in facility, equipment in addition to that mentioned above includes underwater treadmill, swimming pool, a cold salt therapy unit, whole-body vibration, and pulsed electromagnetic therapy to name a few.

The above equipment need not be all obtained initially, but future needs should be anticipated. If funds are not available to purchase an underwater treadmill, for example, one should still plan for one in the future. Location and housing of the equipment need to be planned for. Most equipment is expensive, ranging from several hundred dollars to several thousand dollars. In addition to the purchase price of the equipment one must account for maintenance cost. In determining the charge for a service, you must take this into account in addition to the time it takes to perform the therapy. A fee must be charged that makes the service profitable. If you have a low number of cases, then you may have to charge a significant amount in order to recoup the expenses. That is why it is extremely important to determine if the service area can support the equipment prior to purchase.

Nutrition

Nutrition is very important in the rehabilitation of the horse. Most horses that are painful and in the process of healing have specific nutritional requirements (Fleeman and Owens, 2007; Secombe and Lester, 2012). For example, horses are prone to the development of gastric ulcers. Practices that may be needed to reduce the incidence of ulceration is the feeding of a non-grain-based diet and alfalfa hay. An overly obese horse may only need grass hay fed at 2% of their body weight and a ration balancer. Horses that have laminitis or are prone to laminitis should be fed a low-starch feed and may need to have their hay soaked in water for 30–60 minutes to leach out the fructose (Longland *et al.*, 2011). Horses that are in a catabolic state will require additional calories. This can often be met by increasing the fat content of the diet instead of increasing the concentration portion of the diet. Lastly, all horse should have access to clean, fresh water and a white salt block or red mineral block.

Patient Environment and Mental Status

Many times, we focus on the injury and neglect the rest of the patient. We often have success in treating the injury, but lose use of the horse to contralateral limb problems such as laminitis, breakdown of supporting structures, and angular limb problems (in the case of foals and weanlings). Providing a high plane of nutrition, a good environment, and support to the other limbs is as important as the treatment of the injury. One should also not neglect the mental status of the horse. Having a companion in the barn (pony, another horse or goat), as well as play toys (environmental enrichment) will go a long way in keeping the patient happy. Mental stimulation is important as many of the problems we are treating require long confinement of some type. Bedding type may need to be changed from straw to shavings or sand in the case of laminitic problems.

Therapeutic Modalities

Physiotherapy interventions that are commonly used in the horse include, but are not limited to, manual therapy, thermal agents, electrotherapeutic techniques, mechanical agents, therapeutic exercise, aquatic therapy, and hyperbaric oxygen therapy.

Manual Therapies

Manual therapies include massage, stretches, joint and soft tissue mobilization, and/or chiropractic (manipulation). These are used to restore optimum joint movement by reducing adhesions, mobilizing tight joint structures, and providing enhanced joint lubrication and joint nutrition.

Stretching and Massage

Stretching and massage can promote circulation, decrease muscle spasm, mobilize adhesions and scar tissue, and aid lymphatic drainage. They can also provide pain relief from tight muscles and connective tissue that are responsible for pressure or tension on nerve pathways, restore normal muscle length after injury and maintain normal muscle length (prevent shortening), avoid stiffness related to age or inactivity, and protect from stresses and strains.

Static or passive stretching consists of stretching a muscle (or group of muscles) to its farthest point and then maintaining or holding that position (Frick, 2010). This type of stretching is the most common type used in horses as the desired motion and positioning are controlled. It requires a human assistant to perform and is not under control of the horse. It is unclear how effective stretching is in horses. No improvement in stride length was found after 8 weeks of stretching in a group of normal horses (Rose *et al.*, 2009), but they found several significant differences in joint range of motion between treatments in the shoulder, stifle, and hock. They concluded that the frequency with which passive stretches are applied to the horse appears to have some influence on horse movement. Their research did not demonstrate consistent improvement in equine movement because of passive stretching and highlighted the possibility that stretching on a daily basis may not be appropriate and may cause delayed onset muscle soreness. They suggested that the application of stretching on a three-times-per-week basis may be safer.

The basic science rationale for massage is supported by human research, indicating that massage may affect a number of physiologic systems as well as cellular and fascial components of the muscular system (Scott and Swenson, 2009; Hill and Crook, 2010). Equine therapeutic massage employs a number of techniques first developed in humans and has been reported to increase range of motion and stride length, reduce activity of nociceptive pain receptors, and reduce physiologic stress responses (Scott and Swenson, 2009). There is minimal evidence in the horses that suggest that massage is of any benefit other than for promoting lymphatic drainage (Buchner and Schildboeck, 2006). One study found that massage to the caudal limb muscles significantly increased passive and active limb protraction (Hill and Crook, 2010).

Myofascial Release

Myofascial release (MFR) is the use of the hands and fingers to apply pressure to cause a release of tension in muscle or fascia. It is a form of manual therapy that involves the application of a low load, long duration stretch to the myofascial complex, intended to restore optimal length, decrease pain, and improve function (Ajimsha *et al.*, 2015). MFR generally involves slow, sustained pressure applied to restricted fascial layers either directly or indirectly (Ajimsha *et al.*, 2015). Direct MFR technique is thought to work directly over the restricted fascia: practitioners use knuckles or elbow or other tools to slowly sink into the fascia, and the pressure applied is a few kilograms of force to contact the restricted fascia, apply tension, or stretch the fascia (Ajimsha *et al.*, 2015). Indirect MFR involves a gentle stretch guided along the path of least resistance until free movement is achieved. The pressure applied is a few grams of force, and the hands tend to follow the direction of fascial restrictions, hold the stretch, and allow the fascia to loosen itself (Ajimsha *et al.*, 2015). The rationale for these techniques can be traced to various studies that investigated plastic, viscoelastic, and piezoelectric properties of connective tissue (Ajimsha *et al.*, 2015).

Mobilizations and Manipulations

These are aimed at pain relief, restoration of normal joint biomechanics and nerve function, improved muscle function, and promotion of healing. They are used to treat joint dysfunctions that limit range of motion by specifically addressing altered joint mechanics (Haussler, 2016). Factors that may alter joint mechanics include pain and muscle guarding, joint hypomobility (fixation), joint effusion, contractures, fibrosis or adhesions in joint capsules or supporting ligaments and degenerative joint disease.

Passive mobilization is a passive joint movement for increasing range of motion or decreasing pain (Goff, 2009). It is applied to joints and related soft tissues at varying speeds, amplitudes, or rhythm. The force is light enough that patient can stop the movement (Goff, 2009). Dynamic or active mobilization is a dynamic or active joint movement that is carried out and controlled by the patient (Goff, 2009).

Joint mobilizations and chiropractic manipulation are only to be performed by the rehabilitation veterinarian or animal physical therapist. Veterinary technicians/nurses can perform massage, passive range of motion exercises, and stretching techniques.

Manipulation is characterized by manual thrust delivered at high velocity in a specific direction. It incorporates a sudden, forceful thrust that is beyond the patient's control (Haussler, 2000). It is performed at the physiologic joint motion limit (elastic barrier) and into paraphysiologic space (Leach, 1994). It should only be done after receiving appropriate training.

Mobilizations have been evaluated in the horse. Most the studies have been directed toward the axial skeleton. Clayton *et al.* (2010a) found that the amount of bending in different parts of the cervical vertebral column differed among the dynamic mobilization exercises. As the horse's chin moved further caudally, bending in the caudal cervical and thoracolumbar regions increased, suggesting that the more caudal positions may be particularly effective for activating and strengthening the core musculature that is used to bend and stabilize the horse's back (Clayton *et al.*, 2010a). These researchers also determined that dynamic mobilization exercises performed in cervical flexion have applications in mobilizing the cervical and thoracic intervertebral joints (Clayton *et al.*, 2010a). Haussler *et al.* (2007) found that the passive vertical mobility of the trunk varied from cranial to caudal. At most sites, spinal manipulative therapy increased the amplitudes of dorsoventral displacement and applied force, indicative of increased vertebral flexibility and increased tolerance to pressure in the thoracolumbar portion of the vertebral column (Haussler *et al.*, 2007). In another study spinal manipulative therapy increased dorsoventral displacement of the trunk, which is indicative of producing increased passive spinal flexibility in actively ridden horses (Haussler *et al.*, 2010). Stubbs *et al.* (2011) found that dynamic mobilization exercise can cause enlargement of the multifidus muscle in as little as 3 weeks.

Based on the human literature, it has been recommended that mobilization for most injuries and post surgery can begin within 3 days if careful protocols are followed

(Schills and Turner, 2010). For severe ligament and tendon injuries, mobilization can begin at 3 weeks (Schills and Turner, 2010).

Thermal Agents

These include hot and cold applications. Heat or cold may be administered to horses using many modalities and can range from simply applying water from a hose to deep-heating ultrasound technologies.

Cold Therapy

The major physiologic benefits of cold therapy are decreases in circulation, cell metabolism, secondary tissue damage, edema, muscle spasm and pain (Belanger, 2010a). The benefits are most effective early in the period following injury or surgery. The primary effect of cold application is to constrict blood vessels. The reduced blood flow to tissues reduces edema, hemorrhage, and extravasation of inflammatory cells. Reduced tissue metabolism inhibits the effect of inflammatory mediators and slows enzyme systems. Analgesia follows cold therapy. The viscoelasticity of soft tissues is reduced with cold therapy.

Cold therapy is indicated in acute musculoskeletal injuries or inflammation and following surgical procedures to reduce edema, slow inflammation, and reduce pain. Cold is particularly effective during the first 24–48 hours after injury.

Cold may be applied by ice water immersion, application of ice packs, cold packs, salt water hydrotherapy units (Figure 22.2) and ice water-charged circulating boots.

Figure 22.2 Cold salt water spa.

Several studies have documented tissue effects or efficacy of cryotherapy in horses. The influence of hypertonic cold-water (5–9 °C) spa bath hydrotherapy on the response of 27 horses with various lower leg injuries has been reported (Hunt, 2001). Fifteen horses with grade 2 or 3 superficial digital flexor tendon (SDFT) damage and four with suspensory ligament injury treated for 10 minutes three times a week responded with markedly improved ultrasonographic echogenicity and fiber realignment of injured tissues. All but two of these horses, when placed back into training returned to compete successfully within 6 months without re-injury. Petrov *et al.* (2003) were able to reduce the core temperature of the SDFT to a minimum of 10 °C after 1 hour using a commercial compression splint with circulating coolant. These results indicated that topical application of cryotherapy can significantly reduce core SDFT temperature in standing horses and that the temperatures achieved *in vivo* during cold treatment were not detrimental to the *in vitro* viability of tendon cells. Cold immersion of the distal limbs is effective in reducing the severity of laminitis by decreasing the activity of laminar matrix metalloproteinases (MMP) and causing laminar vasoconstriction (van Eps and Pollitt, 2009; van Eps *et al.*, 2014).

Heat Therapy

The major benefits of heat therapy are increased local circulation, muscle relaxation, and increased tissue extensibility (Kaneps, 2000). By increasing blood flow tissue metabolites are mobilized, tissue oxygen levels are increased, and the metabolic rate of cells and enzyme systems are increased. Metabolic rate increases 2–3 times for a tissue temperature increase of 10 °C. Increased blood flow and vascular permeability promotes resorption of edema. Heat application also decreases pain via the mechanisms cited earlier for cold therapy. Soft tissues may be stretched more effectively after warming. Heat is applied after acute inflammation has subsided. It is useful for reducing muscle spasms and pain because of musculoskeletal injuries. Heat therapy can be used to increase joint and tendon mobility. Heat may benefit recovery of localized soft tissue injuries by accelerating the healing response.

Superficial heat is most commonly applied using hot packs and hydrotherapy. Deep heat may be applied using therapeutic ultrasound. The most profound physiologic effects of heat occur when tissue temperatures are raised to 40–45 °C (Kaneps, 2000). However, tissue temperatures above 45 °C may result in pain and irreversible tissue damage (Kaneps, 2000). Heating for 15–30 minutes is required to elevate deep tissue temperature to the therapeutic range. Kaneps (2000) found that tissue temperature changes due to warm-water hose therapy ranged from 3.7 to 10.8 °C. In addition, temperature elevation was short-lasting and dependent on the distance to the surface, with only limited effect on deep tissues more than 1.5–2 cm under the skin (Kaneps, 2000).

Using therapeutic ultrasound, Montgomery *et al.* (2013) found that the SDFT and deep digital flexor tendon (DDFT) are heated to a therapeutic temperature using a frequency of 3.3 MHz and intensity of 1.0 W/cm^2. The epaxial muscles are not heated to a therapeutic temperature using a frequency of 3.3 MHz and an intensity of 1.5 W/cm^2 (Montgomery *et al.*, 2013).

Electrical Techniques

These techniques include electrical muscle and nerve stimulation, pulsed electromagnetic field therapy, and low-level laser therapy (Schlachter and Lewis, 2016),

Neuromuscular Electrical Stimulation

Neuromuscular electrical stimulation (NMES) works by making the muscle contract through motor nerve stimulation using an interrupted direct current. Of all the electrotherapy techniques this is the most appropriate as it produces a controlled motor and sensory responses both superficial and deep, while maintaining a high level of compliance by the horse (Schills, 2009). Electrical muscle stimulation improves venous and lymphatic drainage, prevents muscle atrophy, prevents the formation of unwanted adhesions, reduces scar tissue formation, builds and re-educates damaged or weakened muscle, and encourages nutrition into the affected area.

Limited research is available on its use in the horse and it is conflicting. Bergh *et al.* (2010) used NMES on the m. gluteus medius and m. longissimus dorsi. They concluded that NMES treatment was well tolerated by the horse, but their protocol did not induce significant muscle adaptations. Ravara *et al.* (2015) concluded that functional electrical stimulation is a safe rehabilitation strategy in the management of equine epaxial muscle spasms and provides clinical improvements and some structural changes of the muscle tissue at the histological level (Box 22.1).

Transcutaneous Electrical Nerve Stimulation

Transcutaneous electrical nerve stimulation (TENS) is primarily used for pain modulation (Belanger, 2010b). It is the application of a pulsed electrical current over the skin surface for the purpose of pain modulation (Belanger, 2010b). There are no scientific studies in the current literature that document effect or efficacy in the horse. In the authors' experience it has not been found to decrease the need for analgesics in horses suffering from acute laminitis.

Box 22.1 University of Tennessee Equine Rehabilitation Department's protocol for neuromuscular electrical stimulation

Neuromuscular electrical stimulation is used primarily to treat or prevent muscle atrophy (Figure 22.3). The following is an example protocol for treatment of muscle atrophy:

1) Clip hair using a #40 blade where the electrodes are to be placed
2) Clean skin with alcohol
3) Apply electrodes to the area to be treated. Most commonly this will be at the origin and insertion of the affected muscle
4) Settings:
   - Waveform: Modified square wave with zero net direct current component
   - Contraction time: 10 s
   - Relaxation time: 30 s
   - Frequency: 30
   - Ramp: 3
5) Treatment protocol:
   - Once to twice daily
   - Start with 5 minutes, and then work up to 20 minutes (i.e., increase treatment time by 2–3 minutes per day until 20–30 minutes is reached)
   - It may take a few sessions to get a good contraction
6) Suggestions:
   - Start first session with 5 minutes, and then build up successive sessions, daily, by several minutes (2–3) to get to a 20- to 30-minute treatment session. It may help to allow the horse to eat hay during treatment for distraction
   - You should be able to see a good contraction while it is "on," then a 10-second rest, then contraction again
   - Only adjust intensity up when "on"
   - You can assist with "active muscle" recruitment by imposing weight shifting onto the horse's involved side when the unit is "on"
   - Economical, battery-operated units may be purchased and loaned to owners to provide treatment at home if needed

Pulsed Electromagnetic Field

Pulsed electromagnetic field (PEMF) therapy has been used to increase circulation, improve fracture healing, reduce pain and edema, and promote healing of wounds in humans and animals (Inoue *et al.*, 2002; Cinar *et al.*, 2008; Matic *et al.*, 2009; Strauch *et al.*, 2009; Rohde *et al.*, 2010; Nelson *et al.*, 2013). However, limited evidence is available in the horse that demonstrate effect or efficacy. It should be remembered that PEMF can have different intensities and frequencies depending on the unit. Biermann *et al.* (2014) evaluated the use of PEMF on back pain in polo ponies. They could not document an effect on either back pain or induced back movement. Rindler *et al.* (2014) also evaluated the effects of PEMF on the backs of actively working polo ponies. They found there was no measurable effect of PEMF on the surface temperature of horses' backs. Auer *et al.* (1983) reported beneficial effects for the repair of cortical stress fractures of metacarpal III (MC III) bones using PEMF, whereas Sanders-Shamis *et al.* (1989) did not find any significant differences in bone healing of surgically induced cortical lesions of MC III/metatarsal III between a PEMF and control group. Watkins *et al.* (1985) found that PEMF significantly delayed maturation of the tissue formed within the defect at weeks 8 and 12, as determined by histological examination. The collagen-type transformation was also delayed by PEMF, but not significantly. Collier *et al.* (1985) found that topical treatment with PEMF had no effect on the uptake of technetium in normal equine bone. The strongest evidence for efficacy with PEMF lies with non-union or slow-to-heal fractures (Schlachter and Lewis, 2016).

Figure 22.3 Neuromuscular electrical stimulation application for muscle strengthening.

Figure 22.4 Low-level laser therapy application.

Low-Level Laser Therapy

Low-level laser therapy (LLLT) (Figure 22.4), which uses an intense beam of light of a single wavelength, stimulates the body's processes, activates waste removal, increases repair activity, relieves swelling, heals surface wounds, and stimulates blood and lymphatic systems (Hamblin and Demidova, 2006). It also increases serotonin, thereby achieving a calming response (Hamblin and Demidova, 2006; Kazem Shakouri *et al.*, 2009; Silver, 2009). It has been reported that laser stimulation has certain biostimulating effects, such as accelerating cell division, increasing leukocytic phagocytosis; stimulating fibroblastic activity, and enhancing regeneration of lymph and blood vessels (Hamblin and Demidova, 2006; Kazem Shakouri *et al.*, 2009; Silver, 2009). Studies have shown that it also can cause vasodilatation (Hamblin and Demidova, 2006; Kazem Shakouri *et al.*, 2009; Silver, 2009). These effects can assist wound healing and relieve chronic pain when properly applied (Hamblin and Demidova, 2006; Kazem Shakouri *et al.*, 2009; Silver, 2009).

Lasers are divided into safety classifications in the United States by the American National Standard Institute (ANSI). Classes 1, 2, and 3a have low power output and are not used for therapeutic purposes.

- *Class 1 lasers* or systems cannot emit accessible laser radiation more than the applicable class 1 accessible emission limit (AEL) for any exposure times within the maximum duration inherent in the design or intended use of the laser. Class 1 lasers are exempt from all beam-hazard control measures.
- *Class 2 lasers* are continuous wave (CW) and repetitively pulsed lasers with wavelengths between 0.4 and 0.7 μm that can

emit energy more than the class 1 AEL, but do not exceed the class 1 AEL for an emission duration less than 0.25 seconds and have an average radiant power of 1 mW or less.

- *Class 3a lasers* have an accessible output between 1 and 5 times the class 1 AEL for wavelengths shorter than 0.4 µm or longer than 0.7 µm, or less than 5 times the Class 2 AEL for wavelengths between 0.4 and 0.7 µm.
- *Class 3b lasers* cannot emit an average radiant power greater than 0.5 W for an exposure time equal to or greater than 0.25 seconds or 0.125 J for an exposure time less than 0.25 seconds for wavelengths between 0.18 µm and 0.4 µm, or between 1.4 µm and 1 mm. In addition, lasers between 0.4 µm and 1.4 µm exceeding the class 3a AEL cannot emit an average radiant power greater than 0.5 W for exposures equal to or greater than 0.25 seconds, or a radiant energy greater than 0.03 J per pulse.
- *Class 4 lasers* and laser systems exceed the class 3b AEL.

Research on the use of LLLT in the equine is limited. Bergh *et al.* (2007) found that minor superficial morphological changes occurred in equine epidermis after treatment with 91 J/cm^2 doses of defocused CO_2 laser and severe changes with a homogeneous eosinophilic acellular zone of underlying dermis and a significantly thinner epidermis, when irradiation doses of 450 J/cm^2 were applied. They also found that irradiation with defocused CO_2 laser causes a moderate to vigorous heating effect in superficial tissue, and a marked increase in blood flow (Bergh, 2006). The increase in temperature was of such intensity that there is a potential risk of thermal injuries to the skin (Bergh, 2006). The results also suggest that treatment with defocused CO_2 laser is not statistically better than placebo at reducing the grade of lameness in horse with traumatic arthritis of the fetlock joint (Bergh, 2006). Ryan and Smith (2007) found that light transmission was not affected by individual horse, coat color, or leg. However, it was associated with leg condition. They found that tendons clipped dry and clipped and cleaned with alcohol were both associated with greater transmission of light than the unprepared state. Also, the use of alcohol without clipping was not associated with an increase in light transmission. Their results suggested that when applying laser to a subcutaneous structure in the horse the area should be clipped and cleaned beforehand.

The most prevalent method of indicating laser therapy dosage is to measure the density of energy applied to the tissue surface. This is typically expressed in joules per square centimeter (J/cm^2). Some variation in clinical effects can be observed; particularly at very high (>50 W) or very low (<1 W) power settings using the same J/cm^2 dose. The dose required for a particular condition is dependent on the equipment used and what its wavelength is. In general, the more superficial a tissue the less energy required. In other words, the density of energy required for a wound will be less than that required for a tendon.

At the University of Tennessee's equine rehabilitation practice, the most common use of LLLT is to decrease pain and inflammation associated with musculoskeletal injuries and for wound healing.

Mechanical Agents

These agents include therapeutic ultrasound, shockwave therapy, and devices such as whole-body vibration units (Schlachter and Lewis, 2016).

Therapeutic Ultrasound

Therapeutic ultrasound is a form of acoustic energy used to treat musculoskeletal injuries, including inflammation and wounds. It offers deep heating without excessive heating of the skin. Ultrasound can also be used to decrease pain and muscle spasm, promote wound healing, aid reabsorption of hematoma, reduce swelling, and reduce scar tissue. It increases blood flow in the area treated. It increases cell membrane permeability to ions and other substances. It blocks signal transmission in nerves. It decreases muscle spasms. It has been shown in clinical and scientific trials to increase collagen extensibility, enhance collagen remodeling, enhance collagen production, increase heat in deep tissues, increase blood flow, increase range of motion, reduce pain and muscle spasm, and accelerate wound healing.

The benefits of therapeutic ultrasound have been established in human and veterinary medicine (Dyson, 1990; Heckman *et al.*, 1994; Singh *et al.*, 1997; Doan *et al.*, 1999; Saini *et al.*, 2002; Fernandes *et al.*, 2003; Maiti *et al.*, 2006; Noble *et al.*, 2007). Therapeutic effects of ultrasound are both thermal and non-thermal (biologic). Thermal (tissue heating) effects are achieved by heating tissue using non-interrupted sound waves, or continuous ultrasound (Porter, 2005). Thermal effects result from energy carried by ultrasonic waves being attenuated and absorbed by tissue as the waves pass through it (ter Haar, 1999). Some of the positive effects of heat produced by therapeutic ultrasound include improved extensibility of collagen, decreased pain, decreased muscle spasms, and increased blood flow (ter Haar, 1999; Levine *et al.*, 2001; Noble *et al.*, 2007). Non-thermal (biologic) effects result from mechanical alteration of the local, cellular environment induced by the ultrasound waves (ter Haar, 1999; Siska *et al.*, 2008). To avoid heating the treated tissue and achieve non-thermal effects, pulsed ultrasound is used where pulse rates interrupt the sound waves at rates of 50%, 80%, or 90% (Porter, 2005). Changes in cellular environment may lead to modifications in cellular function resulting in a shorter inflammatory phase of healing, increased vascularity at the treatment site, and enhanced proliferation of fibroblasts (ter Haar, 1999; Levine *et al.*, 2001; Pounder and Harrison, 2008; Siska *et al.*, 2008). Non-thermal ultrasound has been used as an adjunctive therapy for patients with a fracture or a tendinopathy (Saini *et al.*, 2002; Fu *et al.*, 2008; Siska *et al.*, 2008).

The increase in temperature needed to achieve the desired therapeutic effect for thermal ultrasound has been established in people (Draper *et al.*, 1995; Levine *et al.*, 2001; Demmink *et al.*, 2003). An increase in tissue temperature of 1 °C is required to increase the metabolic rate of tissue, an increase of 2–4 °C is required to lessen pain, muscle spasms, and chronic inflammation, and improve blood flow, and an increase >3 °C is required to decrease the viscoelastic properties of collagen (Draper *et al.*, 1995; Levine *et al.*, 2001; Demmink *et al.*, 2003). For people, 1 MHz ultrasound is most effective at increasing temperature at a tissue depth of 2.5–5 cm, and 3.3 MHz ultrasound is most effective at increasing temperature at a tissue depth of 1.0–2.5 cm (Draper *et al.*, 1995). Results of a study performed to evaluate the effects of 3.3 MHz ultrasound on the temperature of the thigh musculature of dogs show that a 10-minute treatment at an intensity of 1.0 W/cm^2 increases the temperature of tissue by 2–4 °C at depths of 1.0 cm and 2.0 cm. At an intensity of 1.5 W/cm^2, the temperature of tissue increases by at least 2–4 °C at depths of 1.0 cm, 2.0 cm, and 3.0 cm (Levine *et al.*, 2001).

Research into the use of therapeutic ultrasound is lacking. Montgomery *et al.* (2013) found that the SDFT and DDFT are heated to a therapeutic temperature using a frequency of 3.3 MHz and intensity of 1.0 W/cm^2. However, the epaxial muscles are not heated to a therapeutic temperature using a frequency of 3.3 MHz and an intensity of 1.5 W/cm^2. Reis (2009), using a frequency of 1 MHz on pulsed mode, an intensity of 0.5 W/cm^2 for 5 minutes, treated collagenase-induced superficial flexor tendon lesions for 60 days. They found no significant difference clinically between treated and untreated limbs at either 15 or 60 days. However, there was a significant improvement in ultrasonographic evaluation at 60 days in treated limbs versus untreated. Singh *et al.* (1997) evaluated the use of ultrasound for 10 minutes per day at 1 W/cm^2 for 6 days after induction of arthritis in donkeys. They found that gross changes in the joint capsule, synovial membrane, and articular cartilage were mild in ultrasound-treated donkeys as compared to untreated controls.

At the University of Tennessee Equine Rehabilitation facility, therapeutic ultrasound is most commonly used for its heating effect on tendons and ligaments prior to exercise or mobilizations. The protocol used is 3.3 MHz and intensity of 1.0 W/cm^2

Extracorporeal Shockwave Therapy

Extracorporeal shockwave therapy (EWST) is a non-invasive treatment that involves the delivery of high-energy sound waves, or acoustic energy, to an affected area. Shock waves are characterized by high pressure bars of up to 100 bar and negative pressures of 5–10 bar (McClure *et al.*, 2003). They have a rapid rise time of 30–120 ns and a short (5 μs) pulse duration (McClure *et al.*, 2003). The mechanism of action seen in tissue and its relation to the clinical effect of treatment are not fully understood. Current theories include cytokine induction, increased osteoblast activity, stimulation of nociceptors, which in turn inhibits afferent pain signals, stimulation of neovascularization, induction of nitric oxide synthase and thus bone healing/remodeling, and induction of heat shock proteins (McClure *et al.*, 2000).

There are four methods for generation of sound waves: (i) piezoelectric; (ii) electromagnetic; (iii) electrohydraulic; and (iv) pneumatic-ballistic. Each has its own positive and negative traits. The first three are commonly referred to as focused extracorporeal shockwave units while the fourth is referred to as a radial extracorporeal shockwave unit. This is because of how the shockwave itself is generated.

EWST is generally considered safe (McClure *et al.*, 2003). No untoward effects have been noted on skin, tendons, ligaments, nerves, or bone (Boening *et al.*, 2000; McClure *et al.*, 2000, 2003). Mild skin irritation that resolved after 24 hours has been noted with radial ESWT (Boening *et al.*, 2000). Local analgesia lasting up to 3 days has been reported, resulting in the recommendation that horses should not undergo strenuous activity for a minimum of 4 days after treatment (McClure *et al.*, 2003). EWST is not recommended for acute injuries. Sufficient time must be allowed for inflammation to subside and, in the case of tendons and ligaments, the lesion to organize.

Indications claimed to be effectively treated by EWST are insertion desmopathies, navicular syndrome, dorsal spinous process impingement, arthropathies (fetlock, pastern, and hock), exostosis, constriction of the annular ligament, tendinopathies with or without calcifications, calcification of the nuchal ligament, splint bone fractures, and dorsal metacarpal disease (Boening *et al.*, 2000; Crowe *et al.*, 2002; Palmer, 2002; McClure and Weinberger, 2003; Revenaugh, 2005; Waguespack *et al.*, 2011).

Treatment protocols are going to vary depending on whether focused or radial EWST is used and the particular manufacturer of the unit (McClure and Weinberger, 2003). As a rule, 1500–2000 pulses delivered to the affected site at 10- to 14-day intervals for 1–4 treatments are used. Horses are rested during the treatment period and, depending on the condition being treated, may require an extended rest period of up to 6 months.

Whole-Body Vibration Therapy

In whole-body vibration therapy (Figure 22.5), vibrating plates are used to induce oscillating vibrations throughout the body. It is most commonly used in human medicine to improve bone density and to improve neuromuscular function and muscle strength (Rehn *et al.*, 2006; Rauch, 2009; Slatkovska *et al.*, 2010; Von Stengel *et al.*, 2011; Chanou *et al.*, 2012; Pozo-Cruz *et al.*, 2012). However the literature is conflicting, with some reviews reporting benefit and others reporting none (Bautmans *et al.*, 2005; Cardinale, 2005; Nordlund and Thorstensson, 2006; Rehn *et al.*, 2006; Rauch, 2009; Feland *et al.*, 2010; Slatkovska *et al.*, 2010, 2011; Verschueren *et al.*, 2011; Von Stengel *et al.*, 2011; Wysocki *et al.*, 2011; Chanou *et al.*, 2012; Pozo-Cruz *et al.*, 2012; Costantino *et al.*, 2014). What is evident is that in those studies that do report benefits treatments

Figure 22.5 Whole-body vibration.

must be performed 2–3 times daily, 5–7 days per week for several months. In addition, to see improvement in neuromuscular function or muscle strength exercises must be performed while on the plate.

There are no scientific studies of whole-body vibration therapy in the horse. Thus, proof of effect and efficacy is based on antidotal evidence. Claims include improved circulation, increased bone density and muscle mass, reduction in injuries, and reduced stress. At the University of Tennessee Equine Rehabilitation Facility, whole-body vibration is used for those horses that are confined to a stall and cannot be adequately exercised or have a limb immobilized. It is known that immobilization for several weeks causes a decrease in bone density (van Harreveld, *et al.*, 2002a, 2002b). Each case is placed on the plate for 20 minutes twice daily, 5 days per week.

Hyperbaric Oxygen Therapy

Hyperbaric oxygen therapy is the delivery of oxygen to the tissues by increasing environmental oxygen levels and pressure. Very little work has been done to evaluate hyperbaric oxygen therapy in horses and the work that has been done is conflicting. Dhar *et al.* (2012) found that hyperbaric oxygen treatment resulted in a significant increase in CD90-positive cells. Horses that did not yield any cells before treatment did so only after three hyperbaric oxygen treatments (Dhar *et al.*, 2012). However, Holder *et al.* (2008) found that the use of hyperbaric oxygen therapy after full-thickness skin grafting of uncompromised fresh and granulating wounds of horses is not indicated. Baumwart *et al.* (2011) found that pretreatment with hyperbaric oxygen prior to the administration of endotoxin did not offer any protection against endotoxemia.

Most indications and treatment protocols have been adapted from humans and research animals. More hyperbaric oxygen therapy units are now being placed in clinical practices and more information should be forthcoming. However, current clinical impressions are promising for certain conditions. The University of Tennessee Equine Rehabilitation Department is currently using hyperbaric oxygen therapy for treatment of wounds, osteomyelitis, acute laminitis, and postoperative colics, and has observed a more rapid improvement in these conditions versus those treated without hyperbaric oxygen therapy. Box 22.2 provides a list of indications for hyperbaric oxygen therapy.

Hyperbaric oxygen therapy works by increasing the amount of oxygen delivered to the tissues. This is accomplished by placing the horse in an enclosed chamber and increasing both the percentage of oxygen and

Box 22.2 Conditions that may benefit from hyperbaric oxygen therapy

- Thermal burns
- Smoke inhalation
- Cerebral edema
- Exceptional blood loss anemia
- Ileus
- Hypoxic encephalopathy
- Peripheral neuropathy
- Crush injuries
- Cellulitis
- Fracture healing – non-unions
- Delayed wound healing
- Compromised skin flaps and grafts
- Meningitis
- Refractory mycoses
- Carbon monoxide poisoning
- Cyanide poisoning
- Traumatic brain injury
- Gas gangrene – clostridial myonecrosis
- Cranial nerve paralysis
- Soft tissue swelling
- Compartment syndrome
- Acute and chronic osteomyelitis
- Tendon and ligament injuries
- Deep vein thrombosis
- Intra-abdominal abscess
- Neonatal maladjustment syndrome
- Tooth root abscess
- Myositis
- Neonatal septicemia
- Chronic sinusitis
- Laminitis

pressure within the chamber. Normal atmospheric pressure is 1 atmosphere absolute (ATA), which is equal to 14.7 pounds per square inch (PSI). Normal room air is approximately 21% oxygen. Most hyperbaric oxygen therapy treatments are carried out under 2–3 ATAs in the presence of 70–90% oxygen (Tibbles and Edelsberg, 1996; Gill and Bell, 2004; Slovis, 2008).

The amount of oxygen delivered to the tissues is dependent on the amount of oxygen in the air that is breathed, lung function, the amount of hemoglobin in the blood, and blood pressure (Slovis, 2008). Increasing the amount of air that is breathed does not improve the amount of oxygen delivery by hemoglobin, and breathing 100% oxygen at normal atmospheric pressure only increases the amount of oxygen in the blood by a small amount (Slovis, 2008). However, the partial pressure of oxygen in the blood is dramatically increased when breathing oxygen at two or more atmospheres of pressure. Increasing the atmospheric pressure during a treatment increases the solubility of oxygen into the body, allowing for an increased amount of oxygen to enter plasma and tissues (Slovis, 2008).

Oxygen can be considered a drug, in that not enough and too much can be detrimental to the patient. Clinical use of oxygen under pressure should not exceed 3 ATA. No benefits are derived from further increases in pressure and the risk of toxicity increases (Gill and Bell, 2004; Slovis, 2008).

Hyperbaric oxygen can increase healing of hypoxic wounds (Slovis, 2008). Fibroblasts cannot synthesize collagen without adequate oxygenation (Slovis, 2008). More rapid wound healing occurs because of accelerated angiogenesis and prevention of excessive healing (granulation tissue formation). It can improve resistance to infection and accentuates the action of some antimicrobial agents (Tibbles and Edelsberg, 1996; Leach *et al.*, 1998; Slovis, 2008).

Hyperbaric oxygen can inhibit some clostridial toxins and increases the ability of polymorphonuclear leukocytes to kill *Clostridium perfringens* organisms (Slovis, 2008). It also has a direct killing effect on anaerobic organisms (Tibbles and Edelsberg, 1996).

Hyperbaric oxygen can lessen carbon monoxide toxicity and may be beneficial in animals suffering from smoke inhalation. It can increase osteoclastic activity and may reduce hematocrit and platelet aggregation, improving red blood cell stability. It also improves the killing ability of neutrophils (Gill and Bell, 2004). Hyperbaric oxygen can decrease edema formation as evidenced by less edema following thermal injuries and ischemia (Tibbles and Edelsberg, 1996; Leach *et al.*, 1998; Slovis, 2008).

Hyperbaric oxygen therapy has complex effects on immunity, oxygen transport, and hemodynamics. The positive therapeutic effects come from a reduction in hypoxia and edema, enabling normal host responses to infection and ischemia (Gill and Bell, 2004).

Under normal circumstances, oxygen delivery in the body is dependent on the proportion of oxygen in the air that we breathe, lung function, the amount of hemoglobin in our blood, and the body's blood pressure. Increasing the amount of air that you breathe cannot improve the amount of oxygen delivery by hemoglobin, and breathing 100% oxygen at normal atmospheric pressure will only increase the amount of oxygen dissolved in blood plasma by a small amount. The partial pressure of oxygen in the blood is dramatically increased when breathing oxygen at 2 or more atmospheres of pressure. Increasing the atmospheric pressure in the chamber during a treatment increases the solubility of oxygen into the body. This process allows oxygen to enter plasma and tissues more readily and promotes the formation of new cells, thus further enhancing oxygen availability. Ischemic wounds and areas of infection now have new cells to increase circulation and supply life-saving oxygen and antibiotics.

Overall, hyperbaric oxygen therapy is safe. The Equine Rehabilitation Department has performed hundreds of sessions with minimal issues. Box 22.3 provides a list of contraindications. A strict protocol that includes "go or no go" evaluations is mandated. A checklist is utilized prior to and after therapy that includes animal evaluation as well as full assessment of the chamber function. All treatments are performed by individuals who have had advanced off-site training in hyperbaric oxygen therapy. It is critical that protocols be established and personnel are adequately trained. Depending on the specific disease or injury, hyperbaric oxygen therapy can be the factor that pushes the patient toward a positive outcome when standard therapeutic measures are ineffective (Geiser, 2016).

Box 22.3 Contraindications for hyperbaric oxygen therapy

Absolute contraindications

- Untreated pneumothorax
- Tension pneumothorax
- Concurrent treatment with cis-platinum, disulfiram, or doxorubicin

Relative contraindications

- Chronic emphysema with CO_2 retention
- Optic neuritis
- History of spontaneous pneumothroax, thoracic surgery
- Seizure disorders
- High fevers
- Viral infections of the respiratory tract

Therapeutic Exercise

Therapeutic exercise is often used during the rehabilitation program. The amount and intensity is dependent upon the condition being treated, the extent of the damage, the time of healing and facilities available. Types of exercise include hand walking, riding, ponying (leading a horse while riding another), mechanical walker, underwater treadmill, swimming pool, and turnout to paddock or pasture. Each exercise program is tailored to the individual and may need to be adapted several times during the rehabilitation program. The basic principle is to reduce the force and strain on injured tissue while the normal reparative process proceeds (Davidson, 2016). Ground obstacles (ground poles, cavalettis) may also be incorporated to increase coordination and agility. In addition, change in terrain may be included to target specific areas (i.e., inclines to strengthen rear limbs). The goal of therapeutic exercise to provide a gradual return to function, improve strength and coordination, and provide mental stimulation.

Equine Aquatic Therapy

Equine aquatic therapy primarily encompasses swimming and use of an underwater treadmill. Whirlpools and recovery pools are also examples but will not be addressed in this chapter. Equine swimming pools have been available for 25–30 years, but prior to that often ponds, lakes, or the ocean have been used. Many of the pools are located at tracks or barns. A few veterinary hospitals and equine rehab centers also have these pools. The main drawback of pools is the expense of construction and the costs of maintenance.

A cold salt water (hypertonic) spa has been reported to have anti-inflammatory, osmotic, and analgesic effects (Bender *et al.*, 2005). In horses, tendonitis and desmitis monitored ultrasonographically demonstrated reduced peritendinous and preligamentous edema, decreased inflammatory infiltration, and improved collagen fiber alignment after the 4 weeks of hypertonic cold-water therapy (Hunt, 2001). The added mineral components in water provide an increased osmotic effect, which reduces soft tissue inflammation and swelling, decreases pain, and ultimately improves joint range of motion. These osmotic effects can play an important role in managing soft tissue changes associated with musculoskeletal injury in horses (King, 2016).

More recently, equine underwater treadmills (Figure 22.6) have been developed to overcome the expense of construction and maintenance of in-ground pools. These units also provide a more controlled environment than do pools, with a decreased possibility of injury.

Swimming and underwater treadmill therapy may provide several benefits. They primarily provide cardiovascular conditioning without the stresses on the musculoskeletal system (Buchner and Schildboeck, 2006). In addition, they provide a different type of muscle exercise and also work different groups of muscles than when working on land. Resistance to joint movement is also a benefit that contributes to rehabilitation.

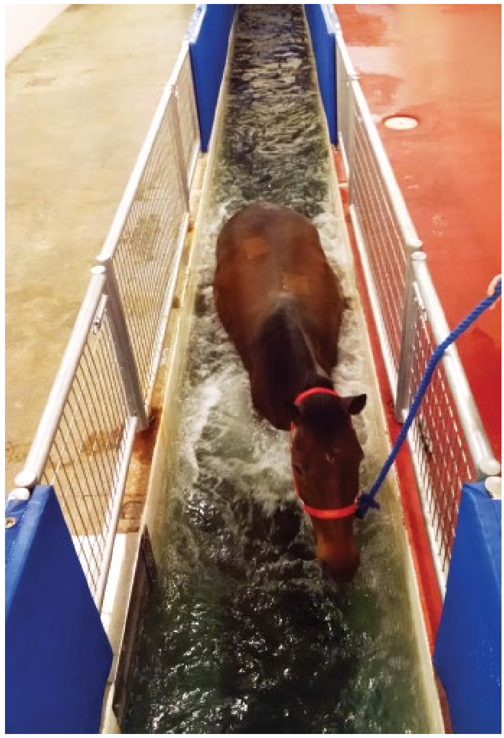

Figure 22.6 In-ground underwater treadmill.

The use of swimming and underwater treadmill therapy in the rehabilitation of musculoskeletal injuries is becoming more common. Their use allows maintenance of cardiovascular fitness, muscle tone, and improved joint movement without undue stresses occurring on the injured limb. The reason for the decreased stresses placed on the limb is the buoyancy that the water provides, which depends on the depth of water and on the amount of water in relation to the body mass of the horse. Thus, if a horse is placed in a small area, less water will be required to get the water level to the point of the shoulder. Because of the reduced amount of water there is less buoyancy, thus more weight is borne by the horse.

Buoyancy is the force experienced as an upthrust, which acts in the opposite direction to the force of gravity (Monk, 2007). A body immersed in water appears to lose weight, and the weight loss is equal to the weight of water displaced (Monk, 2007). Immersion in water allows for unweighting of tendons, ligaments, bones, and joints within the distal limb (McClintock *et al.*, 1987). There is a reduction ground reaction forces, leading to reduced concussive stresses on joints and tendons, allowing for exercise without further trauma induced by weight bearing or concussive forces (Misumi *et al.*, 1994). Reduced body weight decreases postoperative and convalescent complications. McClintock *et al.* (1987) determined the weight reduction for a horse in a flotation tank filled with saline. They found approximately a 10% reduction in the weight borne by the limbs when the saline was at the level of the olecranon. When the saline was raised to the level of the tuber coxae there was approximately a 75% reduction in weight.

Immersion causes water displacement and increased hydrostatic pressure. Hydrostatic pressure is the sum pressure exerted on all surfaces of a body immersed in water, for any given depth (Monk, 2007). In humans this can cause redistribution of blood flow from the peripheral limbs due to an isotonic fluid shift from extravascular space (Yamazaki *et al.*, 2000). It can also lead to a decrease in hemoglobin and hematocrit level within 25–60 minutes of water immersion (Yamazaki *et al.*, 2000). Hydrostatic pressure will affect lung volumes, hence care needs to be taken with patients with respiratory distress or compromise (Monk, 2007).

Viscosity is the resistance of a fluid to motion (Monk, 2007). The viscosity of water increases as the speed of the horse increases. This is due to increased turbulence and drag, which in turn increases the amount and intensity of work being performed. The addition of hydrojets to the pool or treadmill can increase the drag on limb movement. Viscosity decreases as water temperature increases (Monk, 2007). This means weaker and smaller muscles move more easily in warmer water (Monk, 2007).

The relative density and specific gravity of an object will depend on the composition of the object and determine whether an object will float or sink (Monk, 2007). Lean animals and heavily muscled animals, for example, have a tendency to sink and animals with a greater amount of body fat will float more easily (Monk, 2007).

Both swimming and underwater treadmill exercise are forms of aerobic exercise and help develop cardiovascular fitness. With water immersion there is a decrease in systemic vascular resistance and the changes in total peripheral resistance are dependent on water temperature (Yamazaki *et al.*, 2000).

Following underwater treadmill exercise there is a moderate but non-significant increase in blood lactate and plasma creatine phosphokinase levels (Lindner *et al.*, 2003). Hemoglobin concentration is significantly increased as a result of the physical exercise (Voss *et al.*, 2002). Voss *et al.* concluded that underwater treadmill training, following their training protocol, represents a medium-sized aerobic work load for horses.

Swimming causes a significant increase in blood pressure (Thomas *et al.*, 1980). However the maximum heart rate obtained while swimming is less than that obtained during ground exercise (Thomas *et al.*, 1980; Galloux *et al.*, 1994). There appears to be no relationship between heart rate and duration of swimming (Galloux *et al.*, 1994). There also appear to be increased cardiovascular benefits while working at slower speeds (Galloux *et al.*, 1994; Hobo *et al.*, 1998).

Water pressure on the horse's body during swimming prevents adequate ventilation (McClintock *et al.*, 1986a, 1986b; Hobo *et al.*, 1998). Hobo *et al.* (1998) found an increase in respiratory rate, an increase in both inspiratory and expiratory pressure, and that the expiratory time was roughly doubled the inspiratory time (Hobo *et al.*, 1998). This suggested that a longer expiratory time may limit sudden collapse of airways by water pressure during swimming and prevent a marked decrease in air space volume, thus maintaining buoyancy (Hobo *et al.*, 1998). There are no studies available on the effects of underwater treadmill exercise on the respiratory function in horses.

Walking in water at the level of the carpus or ulna resulted in a lower stride frequency and greater stride length compared to walking in water at hoof height (Scott *et al.*, 2010). Water provides a resistance to movement of the limb in the sagittal plane, so an increase in height of the flight arc may also minimize the resistance experienced in swinging the limb back and forth (Scott *et al.*, 2010). When moving in water between carpal and ulna height, the horse may find it easier to adopt a rounder flight arc by increasing flexion of the hip, stifle, and hock joints. Water treadmill exercise may increase activity of muscles which flex the hip, flex the stifle, and protract the hindlimb (Scott *et al.*, 2010). Borgia *et al.* (2010) found no effect of water treadmill training on the properties of the gluteal and superficial digital flexor muscles and on cardiocirculatory response to a standardized exercise test. However the authors state that a more strenuous water treadmill conditioning protocol may be needed to induce a training effect in gluteal and superficial digital flexor muscle and heart rate response Borgia *et al.*, 2010).

Evaluating the effects of swimming on 2-year-old thoroughbreds in race training, Misumi *et al.* (1995) found that fast twitch, high oxidative fibers increased. There was an increase in aerobic capacity of muscles and a decrease in fast twitch, low oxidative fibers. There was no change in slow twitch fibers. They suggested that a training program including swimming training is seen as being useful for improvement in performance capacity, since it can reduce locomotor diseases in young horses and allow for smooth progress in future training (Misumi *et al.*, 1994, 1995).

Horses use their forelimbs to regulate their lateral balance and their rear limbs function in propulsion (Galloux *et al.*, 1994). The propulsive action of the rear limbs is much exaggerated. During swimming, the equine spine is lordotic. Because of the exaggerated rear limb action and lordotic back, horses with rear limb injuries or back pain should not swim.

There is an increased range of joint motion in both fore- and hindlimbs depending on water height. Joint angle in horses decreases as water approaches the carpus or hock. Once the level of the carpus or hock is reached, joint flexion and limb height will vary little. This may be used to target specific joints and aid in re-establishment of joint range of motion after joint surgery. In dogs, there is increased flexion and range of motion during swimming compared to walking in both normal and operated stifle joints post-cranial cruciate ligament surgery (Marsolais *et al.*, 2003). The increased range of motion was due to increased joint flexion. Ground treadmill walking produces greater stifle extension than swimming (Marsolais *et al.*, 2003).

Water density is 12 times greater than that of air (Monk, 2007). During aquatic therapy there is increased resistance to limb or body movement and increased energy costs compared to walking at similar speeds on land due to this increased density. This provides better muscle development and muscle tone due to working against resistance and provides better balance of muscle groups working against increased resistance while maintaining a symmetrical gait (Bromiley, 2000). In addition, underwater treadmill exercise significantly improves the horse's postural stability (King *et al.*, 2013).

Safety is a paramount importance when using swimming or an underwater treadmill. It is very important that the handlers are thoroughly familiar with the equipment and able to read the horse's temperament. The handler should be able to anticipate and correct problems with the horse or equipment before they develop.

Swimming pools should be constructed so that two handlers can easily walk 360 degrees around. Depth should be adequate so that the horse cannot touch the bottom. Most are 12–15 feet (3.5–4.5 m) deep. The sides should be sloped to prevent injury. Some type of ramp system should be employed that allows easy entry and exit from the pool. The filtration system is very important. The water becomes quickly contaminated with dirt and feces so a good filtration system is a necessity. Most horses are good swimmers but do require training. Usually an introductory period is required with increasing time intervals in the pool. The time is slowly increased to a period of approximately 15 minutes. Little research has been done on proper protocols. There has been a protocol described using a swimming test to determine the level of fitness a horse has achieved following conventional training. However, it is not very applicable for determining swimming protocols.

There are two types of underwater treadmills: in-ground and above-ground. The in-ground type allows for a larger volume of water to be used and so there is greater buoyancy. Both have variable speeds that range up to 15 mph (24 km/h). This is much lower than the high-speed treadmill, which can achieve speeds of 45–50 mph (72–80 km/h). Some may require sedation until they are familiar with the routine. Both units require filtration and most can provide both heated and unheated water. These units are expensive but the prices are becoming more reasonable.

Acclimation to water treadmill exercise requires a minimum of two 15-minute non-sedated acclimating runs (Nankervis and Williams, 2006). Sedation can be used to prevent horses panicking during the first exposure but, thereafter, does not affect the time taken to acclimate.

Water temperature should be adjusted to provide maximize comfort. For active exercise and swimming use 18–27 °C (65–82 °F). For less vigorous exercise 35–40 °C (96–104 °F) is acceptable. The least adverse physiologic effects occur at 36 °C (97 °F).

Unfortunately, most of the facilities do not monitor any parameters either during or after a session. Because of this, recommended protocols are empirical. Two easy parameters that can be measured include heart rate and blood lactate levels. Heart rate can be used to monitor the level of stresses that are being placed on the cardiovascular system. Maximum heart rate in the horse is approximately 200 bpm. By using a heart rate monitor you can set a target rate and then set a time to stay in the target range. Blood lactate is used to determine if the horse has progressed into the aerobic metabolism stage. This is a desired state to achieve adequate conditioning. Respiratory rate can also be used but is not as reliable as heart rate. In addition, lameness evaluation should be performed at weekly intervals to determine if any musculoskeletal problem has arisen.

Indications for aquatic therapy include rehabilitation after injury or surgery, tendon injuries, post-arthroscopic surgery, replacement for hand walking, joint stiffness, osteoarthritis, increase in muscle development, encourage symmetric gait and back development, cardiovascular conditioning, and reconditioning after a lay-up.

Contraindications for aquatic therapy include acute joint inflammation, skin infections, open wounds, upper limb lameness (swimming), back pain (swimming), acute myositis, cardiovascular compromise, and respiratory disease.

The following are variables that must be considered when developing a protocol for an individual patient. Of utmost importance is the disposition of the horse. There are going to be some horses that never get used to aquatic therapy. In these individuals, another therapeutic plan will need to be developed.

- Injury and condition of patient
- Water level (if possible)
  - Amount of buoyancy and limb weight bearing
  - Degree of joint flexion desired
- Water temperature: warm versus cold
- Treadmill speed
- Hydrojets – on or off (if equipped)
- Warm-up period
- Duration of exercise: 5–30 minutes
- Exertion during exercise
- Frequency of exercise
- Cool-down period.

Box 22.4 Sample underwater treadmill program

Acclimation period (days 1 and 2)

- Walk in and walk out of underwater treadmill
- Walk in unit and add 6 inches (15 cm) of water, drain, and walk out to acclimate to sounds of unit filling
- Walk in, add water, turn on treadmill, stop treadmill, drain unit, and walk out
- May use sedation during acclimation if needed. It also helps to have a trained horse at the facility to act as a lead horse

Rehabilitation program days 3–7

- Water level at olecranon
- Speed – walk at 2 mph (3 km/h)
- Warm-up – 5 min at 2 mph (3 km/h)
- Duration of active walk – 5 min at 2 mph (3 km/h)
- Cool-down – 5 min at 2 mph (3 km/h)
- Frequency – Once per day; 5 days per week
- Outcome measures:
  - Walking comfortably for 5 min at 2 mph (3 km/h)
  - If successful proceed to next level

Rehabilitation program week 2

- Warm-up – 5 min at 2 mph (3 km/h)
- Duration of active walk – 10 min at 3 mph (5 km/h)
- Cool-down – 5 min at 2 mph (3 km/h)
- May begin lowering or raising water level
- May increase speed to 2–3 mph (3–5 km/h)
- Frequency – Once per day; 5 days per week
- Outcome measures:
  - Walking comfortably for 10 min at 3 mph (5 km/h)
  - If successful proceed to next level

Rehabilitation program week 3

- Warm-up – 5 min at 2 mph (3 km/h)
- Duration of active walk – 15 min at 4 mph (6.5 km/h)
- Cool-down – 5 min at 2 mph (3 km/h)
- Adjust water level to best address specific injury and goals
- Frequency – Once per day; 5 days per week
- Outcome measures:
  - Walking comfortably for 15 min at 4 mph (6.5 km/h)
  - If successful proceed to next level

Rehabilitation program week 4

- Warm-up – 5 min at 2 mph (3 km/h)
- Duration of active walk – 20 min at 5 mph (8 km/h)
- Cool-down – 5 min at 2 mph (3 km/h)
- Frequency – Once per day; 5 days per week
- Outcome measures:
  - Walking comfortably for 20 min at 5 mph (8 km/h)
  - If successful proceed to next level

Rehabilitation program week 5

- Warm-up – 5 min at 2 mph (3 km/h)
- Maximum exercise intensity of 5 mph (8 km/h) for 20–30 min
- Cool-down – 5 min at 2 mph (3 km/h)
- May introduce cross-training activities
- Frequency – Once per day; 3–5 days per week;
- Outcome measures:
  - Walking comfortably for at least 20 min at 4–5 mph (6.5–8 km/h)

Sample Underwater Treadmill Protocol Box 22.4 gives an example of an underwater treadmill program for a mild to moderate tendon injury. It is only begun after an ultrasound evaluation has shown significant healing has occurred and that the horse can have a significant amount of hand walking. It is important that the horse be evaluated prior to each treadmill session for any increased heat or swelling of the affected tendon or ligament. It also should be evaluated weekly for change in the degree of lameness. Ultrasonography should be repeated at monthly intervals so that the rehabilitation program can be adjusted or terminated if necessary. Note that the ability to vary water height to any appreciable amount only applies to above-ground units. If an in-ground treadmill is used, then disregard the water height recommendation. All sessions should have a 2- to 5-minute warm-up and 2- to 5-minute cool-down periods.

Ground Exercises

Ground exercises are exercises that are performed at hand or while being ridden. They are usually targeted at a specific area, such as improvement in proprioception and coordination, strengthening of specific muscles, improving joint mobility, and improving overall body condition. There are many types of exercises that may be used. It is often based on the imagination of the rehabilitation veterinarian, rehabilitation physical therapist and rehabilitation veterinary technician/nurse to develop specific exercises. One must consider the nature of the patient and injury, the equipment and facilities available, and the personnel. Many of the therapeutic exercises are inexpensive and just require time and personnel.

Proprioception and coordination may be improved by walking over ground poles placed randomly (Figure 22.7). Other configurations and different obstacles can be used (Paulekas and Haussler, 2009). Different surface transitions may also be tried, such as going from grass, to sand, to gravel, to water, and then to asphalt. Joint mobility can be worked on by having cavalettis arranged like spokes on a wagon wheel and having the horse step over them, going in both directions (Figure 22.8).

Bracelets or weights can be placed around the pasterns (Clayton *et al.*, 2010b, 2011a, 2011b). However, horses will become habituated to the devices (Clayton *et al.*, 2008). Core muscle stability can be improved utilizing therapeutic bands placed around the caudal limbs or abdomen (Paulekas and Haussler, 2009). These may be used at hand, lunging, or while being ridden (Figure 22.9).

Strengthening of rear limb musculature may be accomplished by riding up and down gradual inclines or pulling a cart. This most commonly has been used as a therapy for intermittent upward fixation of the patella.

Kinesiology Taping

Kinesiology taping is an elastic therapeutic tape method used for treating sports injuries and a variety of other disorders. A chiropractor, Dr. Kenso Kase, developed these taping techniques in the 1970s (Williams *et al.*, 2012). It is claimed that it supports injured muscles and joints and helps relieve pain by lifting the skin and allowing improved blood and lymph flow (Williams *et al.*, 2012) (Figure 22.10).

There is conflicting evidence in humans as to whether kinesiology taping is effective or not (Williams *et al.*, 2012; Montalvo *et al.*, 2014; Parreira *et al.*, 2014). There is no scientific

Figure 22.7 Ground cavaletti poles laid in random fashion to improve proprioception.

Figure 22.8 Ground cavaletti poles laid in a radius to encourage joint motion and improve coordination.

Figure 22.9 Therapeutic band application to improve core muscle strength.

Figure 22.10 Equine kinesiology taping.

evidence to support its use in the equine. The effect and efficacy of kinesiotaping is anecdotal or based on human literature. Courses are available in the proper technique of equine kinesiology taping.

Return to Work

At some point the rehabilitation program will end and the horse must be returned to work if possible. It is important that return to work is done gradually. Although the particular injury may have healed, the rest of the body may not be in condition. Table 22.1 gives an example of a conservative back-to-work plan. We always recommend at least a 10-minute warm-up and cool-down period.

Conclusion

The equine rehabilitation veterinary technician or nurse plays an important role in carrying out the rehabilitation equine veterinarian's treatment plan and communicating that plan to the owner on a routine basis. Monitoring the patient's progress and maintaining the records will be important to track trends for the patient. Monitoring pain and advancement in achieving the therapeutic goals will be necessary to aid the rehabilitation veterinarian and physical therapist in developing plans. By understanding all aspects of equine physical rehabilitation, the equine physical rehabilitation veterinary technician or nurse will contribute to the success of bringing an injured patient back to the goals set forth by the team.

Table 22.1 Example back-to-work plan following resolution of injury.

Initially start with 3 days of riding. After 2nd week can be increased to 5 days per week if desired

Week	Walk	Trot	Walk	Trot	Walk
	20 min walking under saddle				
2	30 min walking under saddle				
3	40 min walking under saddle				
4	10 min	2 min	6 min	2 min	10 min
5	10 min	3 min	4 min	3 min	10 min
6	10 min	4 min	2 min	4 min	10 min
7	10 min	6 min	2 min	6 min	10 min

Starting week 8 add canter

Week	Walk	Trot	Canter	Walk	Trot	Walk
8	10 min	2 min	2 min	5 min	2 min	10 min
9	10 min	3 min	2 min	4 min	3 min	10 min
10	10 min	2 min	3 min	4 min	2 min	10 min
11	10 min	4 min	4 min	4 min	4 min	10 min

Weeks 1–6

Start turning out into a paddock/round pen. Start with 2 hours per day and build up to approximately 8 hours by week 4. Can also be hand walked 20–30 minutes, 2–3 times per day during this time if desired (in addition to walking under saddle).

Weeks 7–11

Turn out to pasture; start with 2 hours per day of pasture and 6 hours of paddock/round pen. Increase pasture time by 2 hours weekly so that by week 11 he or she is on pasture at least 8 hours per day.

Starting week 12

No restrictions in work or turn out; resume normal work over a 2- to 3-week period. Recommend re-evaluation prior to canter work and again prior to resuming regular work.

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23

Adjunctive Therapies Part 1: Acupuncture and Traditional Chinese Medicine

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CHAPTER MENU

Traditional Chinese Veterinary Medicine Basics

Brief History

Traditional Chinese Veterinary Medicine (TCVM) is a medical system that has been used in China to treat animals for about 2000 years. TCVM emerged from its parent system, Traditional Chinese Medicine (TCM) that is used to treat people. Over the years, TCVM has become widely accepted in the United States and in Europe. Many of the original theories are still used today; however, with advances in modern medicine new treatment techniques have been employed. TCM is categorized into five branches: acupuncture, Chinese herbal medicine, tui-na massage, food therapy, and qi gong. Due to the difference in veterinary patients, the only branch that is vastly different in TCVM is the fifth branch. This branch has been termed "exercise," which can be considered as physical rehabilitation.

Physical Rehabilitation for Veterinary Technicians and Nurses, First Edition.
Edited by Mary Ellen Goldberg and Julia E. Tomlinson.

Figure 23.1 Dr. Carolina Medina places acupuncture needles in JimmyCat (Mary Ellen Goldberg's cat).

Five Branches of Traditional Chinese Veterinary Medicine

Acupuncture

Acupuncture is defined as the stimulation of a specific point (acupuncture point) on the body with a specific method, resulting in a physiologic effect. These physiologic effects include both systemic and local effects as acupuncture stimulates both the central and peripheral nervous systems. Some of the systemic effects include release of endogenous substances such as beta-endorphins (Han *et al.*, 1984; Wu *et al.*, 1995; Skarda *et al.*, 2002), dynorphins, enkephalins, serotonin (Costa *et al.*, 1982; Scherder and Bouma, 1993), epinephrine, gamma-aminobutyric acid (GABA), cortisol, and various hormones. Acupuncture can also improve blood flow to the pituitary axis and capillary wall enzyme concentration; release somatotropin in chronic pain; induce luteinizing hormone release which triggers ovulation; stimulate prolactin release to promote lactation; stimulate oxytocin release to induce uterine contraction; and modulate thyroid function. The local effects of acupuncture include muscle relaxation and spasm relief; release of Hageman's factor XII, which activates the clotting cascade, complement cascade, plasminogen, and kinins; degranulation of mast cells, which releases histamine, heparin, and kinin protease; release of bradykinin, which leads to vasodilation; and production of local prostaglandins, which leads to smooth muscle relaxation (Smith, 1994) (Figure 23.1).

Chinese Herbal Medicine

Pioneer TCVM practitioners used individual (single) Chinese herbs to treat diseases. Over time they found that combining several Chinese herbs into a formula was more effective than single herbs alone. A Chinese herbal formula contains different quantities of several herbs. A typical Chinese herbal formula contains anywhere between 4 and 15 herbs, each of which has an assigned a role and mechanism of action within the formula. Formulas consist primarily of plant particles including bark, stems, roots, flowers, and/or seeds. There are a few formulas that contain minerals and animal-origin products.

Tui-na Massage

Tui-na is a form of Chinese manual therapy used for prevention and treatment of disease. It incorporates massage, acupressure, and physiotherapy techniques. It can be applied directly to acupuncture points, trigger points, and meridians. In Chinese, Tui-na means "push-pull and lift," which is the basis of most of the techniques. Tui-na can be very useful as it is practical to apply to many cases. It can be performed by the veterinarian and/or technician and certain simple techniques can be taught to owners to perform at home. Like massage, Tui-na increases local circulation and leads to vasodilatation, which warms the soft tissues and provides pain relief.

Food Therapy

Food therapy is the use of the healing power of food and is often utilized alone or more frequently used in conjunction with other TCVM therapies to treat disease. Western medicine has lately begun to understand the effect of food on healing the body; the interaction between genes and nutrients is termed "nutrigenomics" (Sales *et al*., 2014). TCVM food therapy is the art and science of tailoring diet plans to individual patients and food ingredients are chosen based on TCVM principles. Like other TCVM modalities, the ultimate goal of food therapy is to restore and maintain balance in the body. However, given its very nature, the effects of food therapy are slower acting than modalities such as acupuncture and herbal medicine. On the other hand, there are virtually no side-effects when food ingredients are chosen correctly, and food therapy is a mode of treatment that can be used safely throughout a patient's lifetime.

Exercise/Qi Gong

Qi gong is the practice of aligning body, breath, and mind for health. It is traditionally viewed as a practice to cultivate and balance Qi ("life energy"). Qi gong typically involves meditation, coordinating slow flowing movement, deep rhythmic breathing, and a calm, meditative state of mind. Since veterinary patients are incapable of practicing qi gong, exercise in the form of physical rehabilitation is considered a suitable substitute.

Yin Yang Theory

The yin yang theory depicts everything as being composed of two opposing yet complementary pairs of opposites. The simplest example is the sun and the moon, in which the sun is considered yang while the moon is considered yin. Anything that relates to activity, brightness, or function is considered yang, while anything that relates to inactivity, darkness or structure is considered yin. In regards to medicine, physiological activities belong to yang while nutrient substances correspond to yin.

The yin yang theory is incorporated into TCVM to assist in the diagnosis and treatment of disease. According to TCVM, disease does not occur if yin and yang are in balance. There are four possible states of imbalance: excess yin, excess yang, yin deficiency, and yang deficiency. Excess yin typically has an acute onset of clinical signs with a short course of disease and can present with edema, pain, and/or loose feces. Excess yang also has an acute onset of clinical signs with a short course of disease but presents with a high fever and/or hyperactivity. Common signs of yin deficiency include general weakness, polydipsia, low grade fever, and the disease state is generally chronic in nature. Yang deficiency is seen in patients with a chronic history of urinary incontinence, low back pain, limb edema, and cold extremities (Xie, 2005).

Five Element Theory

The five elements refer to five categories of nature: wood, fire, earth, metal, and water. There is an enhancing, inhibiting, and restraining relationship between them to maintain a balance. Like the yin yang theory, the five element theory is embodied into TCVM to assist in the diagnosis and treatment of disease. The five element theory is used to describe the nature of the anatomical structures and their relationships with each other, in addition to the relationship between the patient and their environment. The liver, gallbladder, eyes (vision), tendons, ligaments, and nails belong to the wood element. Therefore, a patient with a cranial cruciate ligament tear is considered to have a disharmony with the wood element. The cardiovascular system, including the heart and pericardium, and the small intestines and tongue (voice) correspond to the fire element. A patient with congestive heart failure would have a disharmony with the fire element. The spleen, stomach, muscles, and mouth (taste) are related to the earth element, causing a patient with gastrointestinal disease to suffer from an earth element imbalance. The lungs, large intestines, skin, hair coat, pores, and nose (smell) are associated with the metal element. An atopic dermatitis case would be classified as a metal element disharmony. The kidneys, bladder, bones, reproductive system, and ears (hearing) belong to the water element. A patient with osteoarthritis would be categorized as having a water element disharmony (Xie, 2005).

Acupuncture Points

Research shows that most acupuncture points are in areas on the skin of decreased electrical resistance or increased electrical conductivity (Urano and Ogasawara, 1978). This can be measured by using a point finder, acupoint detector, or AC dermometer. In addition, it has been found that acupuncture points are closely associated with free nerve endings, veins, lymphatics, and an aggregation of mast cells (Jaggar and Robinson, 2001). There are 173 major acupuncture points in horses and 361 points in people. Acupuncture points correspond to four known neural structures. Type I acupuncture points, which make up 67% of all points, are considered motor points. The motor point is the point in a muscle which, when electrical stimulation is applied, will produce a maximal contraction with minimal intensity of stimulation. Motor points are in areas where nerves enter muscles. For instance, SI-9 is located at the junction of the deltoid muscle and triceps brachii and is supplied by axillary and radial nerves. Type II points are located on the superficial nerves in the sagittal plane on the dorsal and ventral midlines. For instance, *Bai hui* lies in the depression between the spinous processes of the seventh lumbar and the first sacral vertebrae on dorsal midline and is supplied by the dorsal branch of the last lumbar nerve. Type III points are located at high-density loci of superficial nerves and nerve plexuses. For example, GB-34 is located at the point where the common peroneal nerve divides into the deep and superficial branches cranial and distal to the head of the fibula. Type IV points are located at the muscle–tendon junctions where the Golgi tendon organs are located. For example, BL-57 is located at the junction between the gastrocnemius muscle and the calcanean tendon (Gunn, 1997; Hwang and Egerbacher, 2001).

Meridians

Most commonly, acupuncture points are located on meridians. Meridians are channels or conduits of energy that connect the acupuncture points throughout the body. There are 14 major meridians, named Lung (LU) Meridian, Large Intestine (LI) Meridian, Stomach (ST) Meridian, Spleen (SP) Meridian, Heart (HT) Meridian, Small Intestine (SI) Meridian, Bladder (BL) Meridian, Kidney (KID) Meridian, Pericardium (PC) Meridian, Triple Heater (TH) Meridian, Gallbladder (GB) Meridian, Liver (LIV) Meridian, Governing Vessel (GV) Meridian, and Conception Vessel (CV) Meridian. A close correlation exists between meridians and peripheral nerve pathways. Meridians possess bioelectric functions like peripheral nerves and they follow along peripheral nerves. For example, the Lung Meridian follows the musculocutaneous nerve and the Pericardium Meridian follows the median nerve. In a study to investigate the locations of meridians, researchers injected a radio-isotope into one acupuncture point and visualized it gradually accumulate at another acupuncture point on the same meridian. Radio signals over one acupuncture point can be picked up at another acupuncture point on the same meridian. Meridians conduct current, with flow toward the central nervous system (Smith, 1994).

Methods of Stimulation

Acupuncture can be stimulated by various means, including acupressure, dry needle, electro-acupuncture, aqua-acupuncture, moxibustion, gold implantation, pneumo-acupuncture, hemo-acupuncture, and laser acupuncture (Altman, 1994; Ferguson, 2007).

- In acupressure, firm digital pressure is applied to an acupuncture point for a specific length of time (e.g., 5 minutes). This is the least invasive type of stimulation.
- Dry needle is the insertion of a sterile filiform needle into an acupuncture point to elicit a response. These needles are typically left in place for 15–30 minutes. Dry needle is the most commonly used technique in veterinary medicine (Figure 23.2).
- In electro-acupuncture, electrical currents are applied to the dry needles to increase the therapeutic response (Figure 23.3). This modality is desirable because you can adjust the frequency and amplitude and induce a stronger stimulation than dry needle alone. Low-frequency (1–40 Hz) electro-acupuncture predominantly stimulates A-delta fibers and releases beta-endorphins and met-enkephalins (Figure 23.4). High-frequency (80–120 Hz) electro-acupuncture predominantly stimulates C fibers and releases dynorphins. Very high-frequency (200 Hz) electro-acupuncture predominantly stimulates serotonergic fibers and releases serotonin and epinephrine (Smith, 1994).
- Aqua-acupuncture is the injection of a sterile liquid (i.e., saline, vitamin B12, lidocaine, Adequan®, etc.) into an acupuncture point. This causes constant stimulation of the acupuncture point for an extended period (until the liquid is absorbed) and it has the added benefit of the medicinal properties of the liquid used.
- Moxibustion is the use of a Chinese herb called *Artemesia vulgaris* that is rolled into a cigar shape and burned just above the acupuncture point without touching the skin. This is a warming technique that is therapeutic for older patients with chronic pain.
- Gold implantation is the injection of sterile pieces of gold, whether in a bead or wire form, into acupuncture points for permanent

Figure 23.2 Calming point needle placed on JimmyCat's head.

Figure 23.3 JimmyCat models electroacupuncture needles and machine.

Figure 23.4 JimmyCat shows acupuncture needles attached to the electrostimulator machine.

implantation. It provides long-term stimulation for chronic conditions.

- Pneumo-acupuncture is the injection of air under the skin in the subcutaneous space to produce pressure by the air and stimulate the acupuncture points, nerves and muscles. It is used solely for muscle atrophy.
- Hemo-acupuncture is the insertion of a hypodermic needle into an acupuncture point that is located on a blood vessel to draw blood. It releases heat, toxins, and fever and can be applied like leech therapy.
- Laser acupuncture is the use of laser therapy to emit light to penetrate the tissues

and stimulate acupuncture points. It stimulates ATP production, cellular proliferation, collagen synthesis, fibroblast activity; decreases pain; and improves circulation and wound healing.

Clinical Applications Associated with Rehabilitation – Dog and Cat

Pain

Because it causes the release of endogenous opioids, acupuncture is used extensively for pain management. Acupuncture can be used as a sole agent but is more commonly practiced in conjunction with other modes of pain control as part of a multimodal protocol. In rehabilitation cases, acupuncture is commonly used after therapeutic exercises or hydrotherapy. For example, a patient that is undergoing rehabilitation for a femoral head ostectomy might start with laser therapy along the hips and lumbosacral junction, then exercises to encourage weight bearing and improve hip extension, followed by underwater treadmill, and finally acupuncture to alleviate pain. Acupuncture is reportedly effective for the treatment of various painful conditions including cervical, thoracolumbar and lumbosacral hyperpathia, chronic lameness, and degenerative joint disease (Xie and Ortiz-Umpierre (Medina), 2006).

Musculoskeletal Disorders

The most common musculoskeletal disorders treated with acupuncture are osteoarthritis, cranial cruciate ligament rupture, hip and elbow dysplasia, tendinopathies, and fractures. Therapy can be instituted before or after surgery and in many cases is used as part of the medical management protocol.

Neurologic Disorders

Acupuncture is used frequently for neurologic conditions, especially electro-acupuncture to stimulate nerve function. Common applications include intervertebral disc disease, degenerative myelopathy, fibrocartilagenous embolism, polyneuropathy, cervical spondylomyelopathy, and degenerative lumbosacral stenosis.

Clinical Applications Associated with Rehabilitation – Equine

Pain

In horses, acupuncture is commonly used for painful conditions such as osteoarthritis, laminitis, back pain, tendinopathies, and colic. Performance horses commonly experience soft tissue pain due to exertion and/or overuse which can be successfully treated with 1–2 acupuncture treatments.

Musculoskeletal Disorders

Acupuncture is commonly sought out by performance horse owners and trainers as its provides pain relief without using pharmaceuticals. Musculoskeletal conditions that are effectively treated with acupuncture include osteoarthritis, laminitis, navicular syndrome, tendinopathies, and back pain. A study showed that electro-acupuncture was effective in alleviating chronic thoracolumbar pain in horses (Xie *et al.*, 2005).

Neurologic Disorders

Acupuncture can be used to treat neurologic conditions such as cervical spondylomyelopathy, laryngeal hemiplegia, and suprascapular neuropathy.

Safety

Although acupuncture is typically considered to be a safe and minimally invasive modality, there are some conditions that warrant caution or contraindication. For example, caution must be used when treating a weak, debilitated, or obtunded patient. Generally, fewer needles and less stimulation are used. It is contraindicated to needle directly into skin lesions, ulcers, scar tissue, umbilicus, tumors, or masses. Specific acupuncture points around the abdomen and lumbar area are contraindicated in pregnancy. Length of needles needs to be considered, particularly in very small patients. Electro-acupuncture wire leads should not be connected through or across a known or suspected tumor or mass. Electro-acupuncture wire leads should not be connected around or across the chest of animals with pacemakers. Electro-acupuncture should not be used in patients with a history of seizures (Xie, 2007).

Role of the Veterinary Rehabilitation Technician

The role of the veterinary rehabilitation technician in TCVM includes:

- client education
- tui-na massage
- acupuncture
- patient prep
- needle prep
- needle insertion – veterinarian only
- needle manipulation/electro-acupuncture
- withdrawal of needles.

Research

The earliest scientific studies done on acupuncture focused on its analgesic effects. In the late 1970s researchers discovered that acupuncture stimulation led to an increased concentration of endogenous opioids in the serum and cerebral spinal fluid (Pan *et al.*, 1984; He, 1987). Other studies showed that naloxone, an opioid antagonist, blocked the effects of acupuncture and decreased the pain threshold in acupuncture subjects (Mayer *et al.*, 1977). These were the first studies showing that endogenous opioids played a role in the mechanism of action of acupuncture analgesia.

Groppetti *et al.* (2011) studied the efficacy of electro-acupuncture compared with butorphanol for postoperative pain management in dogs undergoing elective ovariohysterectomy. Twelve dogs were randomly allocated into two groups. Dogs received either electro-acupuncture (16 and 43 Hz) at BL-23, BL-25, ST-36, GB-34, LI-4, LU-9, and GV-20; or butorphanol. Intra-operative cardiovascular and respiratory parameters were recorded for both groups. Plasma β-endorphin concentrations were evaluated before surgery (baseline) and up to 24 hours later. For each dog, pain was measured on a subjective pain scoring system. Plasma β-endorphin levels in dogs receiving electro-acupuncture increased significantly against baseline values after 1 and 3 hours after surgery. Moreover, the end-tidal isoflurane concentration needed for second ovary traction was significantly lower in electro-acupuncture dogs than control dogs. The dogs in the electro-acupuncture group experienced prolonged analgesia, over 24 hours at least, while 4 out of 6 dogs treated with butorphanol needed post-surgical ketorolac and tramadol supplementation for pain management (rescue analgesia). Their results showed supportive evidence for electro-acupuncture as an alternative technique to provide postoperative analgesia in dogs.

La *et al.* (2005) investigated the effects of electro-acupuncture on nerve regeneration. The sciatic nerves (specifically at a location 5 mm above the stifle joint) of 15 rabbits were crushed by a Halsted straight mosquito hemostat with 8–11 newton force for 60 seconds, and then the rabbits were divided equally into three groups. Group 1 was treated with electro-acupuncture at GB-30 and BL-40 for 25 minutes daily for 7 days. Group 2 was treated with intramuscular administration of diclofenac 15 mg daily for 7 days. Group 3 was the control group and therefore was not treated. After treatment, the distal parts of crushed nerve were examined under light microscope, the densities of normal myelinated fibers in 0.126 mm^2 were counted, and the diameters of 20 normal myelinated fibers were measured for each rabbit. The results showed that the mean densities were 176.2 ± 5.953 in the electro-acupuncture group, 118.2 ± 10.878 in the diclofenac group, and 101.4 ± 8.548 in the control group. The mean values were significantly different between the electro-acupuncture and diclofenac groups; highly significant different between the electro-acupuncture and control groups; and there was no significant difference between the diclofenac and control groups. There were more small myelinated fibers (0–9 μm) in the electro-acupuncture group than in the diclofenac and control groups. These results confirmed that electro-acupuncture promotes nerve regeneration whereas diclofenac does not have such an effect (La *et al*., 2005).

Two case studies representing the use of acupuncture therapy in physical rehabilitation are described in Boxes 23.1 and 23.2.

Box 23.1 Canine case study

Jake is a 14-year-old neutered male mixed breed dog (Figure 23.5).

History

Jake was diagnosed with hip dysplasia and osteoarthritis at 6 years of age. At that time, he was started on Rimadyl® and Cosequin®. A year later, he started rehabilitation therapy and acupuncture. He also started Adequan® injections and Duralactin® 4 years ago, as well as amantadine and Chinese herbs 1 year ago.

Figure 23.5 Jake from the canine case study undergoes acupuncture and electroacupuncture treatment.

Physical examination

On presentation Jake was bright, alert and responsive. He was lame on the right pelvic limb, and had decreased range of motion of both hips, and pain (4/10) on extension of both hips.

Treatment plan

Recommendations consisted of acupuncture, laser therapy, manual therapy, exercises and hydrotherapy. Initially therapy was performed twice a week and currently his maintenance schedule is once a week.

Treatment

- Acupuncture (points varied at each visit but commonly used points are listed below)
  - Dry needle: Bai hui, Shen peng, Shen jiao, ST36, GB34, LIV3, LI10, GB29, BL40
  - Electro-acupuncture: BL11, BL18, BL23, GB21, Shen shu, Jian jiao + GB30, BL54 + KID1, @ 20 Hz × 20 minutes
- Laser therapy:
  - 292 Hz, 4 J/cm^2, continuous wave, 7 minutes 12 seconds, 229.624 J total
  - Back, hips, stifles, shoulders and carpi

- Manual therapy
  - Passive range of motion, full body massage, circles to hips, joint compressions to joints of pelvic limbs, standing compression of pelvic limb joints, and scapular glides
- Exercises
  - Rhythmic stabilization, cookie stretches, three-leg standing, sit to stands, backward walking, and side stepping
- Hydrotherapy
  - Underwater treadmill at 0.8–1 mph (1.3–1.6 km/h) in 18 inches (46 cm) of water (level with the distal aspect of the greater trochanter) for 10–15 minutes or to tolerance

Outcome

Jake has been receiving multimodal therapy for his osteoarthritis for the past few years. This therapy has allowed him to have his pain level well-controlled and enjoy a good quality of life despite his debilitating osteoarthritis.

Box 23.2 Feline case study

Cricket is a 13-year-old spayed female domestic shorthair (Figures 23.6–23.8).

History

Cricket has been overweight most of her life and has been eating Hills W/D for the past 10 years. Over the past 6 months she has had decreased mobility and has been unwilling to get on furniture, play with other cats, and go up stairs. Also she growls at her owners when they try petting her back and hips. She had been taking Cosequin® for the past 3 months.

Physical examination

On presentation, Cricket was bright, alert and responsive. She had a body condition score of 9/9 and weighed 22 pounds (10 kg). She exhibited pain (5/10) on range of motion of her elbows, hips, thoracolumbar spine, and lumbosacral junction.

Figure 23.6 Cricket from the feline case study receives acupuncture treatment for obesity and pain from osteoarthritis.

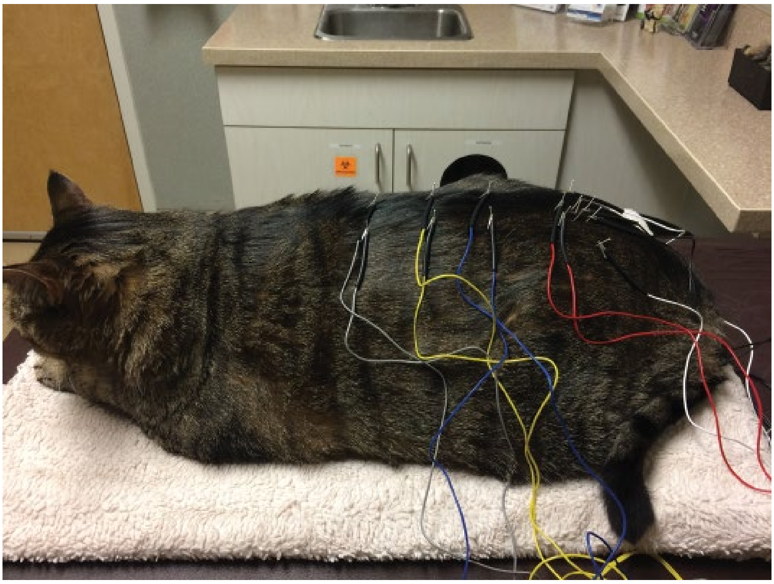

Figure 23.7 Cricket receives electroacupuncture treatment.

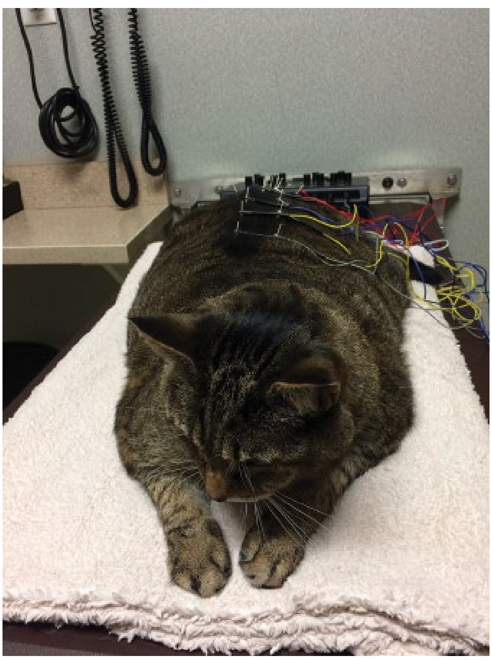

Figure 23.8 Cricket resting and dozing during acupuncture treatment.

Treatment plan

Recommendations consisted of continuing Cosequin®, starting gabapentin at 10 mg/kg orally every 8 hours, weekly acupuncture for 4 weeks, and switching to Hills Metabolic to promote a 10 pound (4.5 kg) weight loss.

- Initial acupuncture treatment:
  - Dry needle: Bai hui
  - Electro-acupuncture: BL18, BL20, BL23, Shen jiao, BL54 + Jian jiao @ 20 Hz × 20 minutes
- Follow-up acupuncture treatment (1 week after initial presentation):
  - Dry needle: Bai hui, Shen shu, Shen peng, Shen jiao
  - Electro-acupuncture: BL54 + GB30, BL18, BL20, BL23, BL25 @ 20 Hz × 20 minutes
- Update: Cricket is allowing her owners to pet her and jumped on their bed a few times in the past week. She is also engaging more and playing with toys
- Follow-up acupuncture treatment (2 weeks after initial presentation):

  - Dry needle: Bai hui
  - Electro-acupuncture: BL18, BL20, BL21, BL23, BL25, Shen shu @ 20 Hz × 20 minutes
- Update: Cricket is engaging more with the other cats and is also jumping up on the furniture more so than the previous week
- Follow-up acupuncture treatment: (3 weeks after initial presentation):
  - Dry needle: Bai hui, Shen shu
  - Electro-acupuncture: Jian jiao, Shen peng, Shen jiao, BL18, BL20, BL23, BL24 @ 20 Hz × 20 minutes
- Update: Cricket is much more active than the past 3 weeks and is comfortable on palpation

Outcome

Cricket has returned to doing the activities she used to enjoy doing and allows her owners to pet her without showing signs of pain. Her owners are continuing to work on weight loss and take her for acupuncture on an as-needed basis.

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Adjunctive Therapies Part 2: Veterinary Chiropractic

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CHAPTER MENU

Introduction

Lower back pain is the leading cause of disability among American workers (Meeker and Micozzi, 2001). A study published in the *British Medical Journal* concluded that chiropractic adjustment outperformed hospital outpatient management for lower back pain (Meade *et al.*, 1995). Pain is the leading reason human patients seek care from chiropractic practitioners (Leach, 1994a). Pain and pain relief are central to the discipline of chiropractic (Bove and Swenson, 2001).

It makes sense to consider applying chiropractic techniques for the relief of pain in animals within the context of physical rehabilitation. Chiropractic also aims to restore normal joint range of motion. Adding incentive to the exploration and application of chiropractic care to animals are the challenges associated with assessing pain in non-verbal species, and the limited pharmacologic options available for managing pain. In order to better appreciate the role of the veterinary technician in the discipline of veterinary chiropractic care, it is important to have an overview understanding of chiropractic principles and practices. Although chiropractic adjustments may only be performed by a veterinarian or a chiropractor trained in animal chiropractic, the veterinary technician plays a critical role in restraint and positioning of the animal patient receiving chiropractic care.

Physical Rehabilitation for Veterinary Technicians and Nurses, First Edition.
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A Brief History of Chiropractic Medicine

Chiropractic is a medical discipline based on spinal manipulation. The term chiropractic is derived from the Greek words *cheir* ("hand") and *praxis* ("practice"). Manipulation of the body and its tissues is ancient and universal. The traditional paradigm of chiropractic reflects the following core beliefs:

- The body is self-regulating and self-healing.
- The nervous system is the master system of the body.
- Alterations in spinal movement adversely affect the nervous system's ability to regulate function.
- Correcting, managing, or minimizing the vertebral subluxation complex via chiropractic adjustment optimizes patient health (Cleveland *et al.*, 2001).

The adaptation of chiropractic techniques for use in veterinary medicine is relatively recent (Pascoe, 2002). The American Veterinary Medical Association has published Guidelines for Complementary and Alternative Veterinary Medicine, which contains the following terminology/description about chiropractic care: "veterinary manual or manipulative therapy (similar to osteopathy, chiropractic, or physical medicine and therapy)" (AVMA, 2001).

This places chiropractic into the category of complementary care, to be used (literally) to "complement" traditional allopathic veterinary medicine and patient care. Because of its designation as a complementary medical technique, it is best to acquire informed consent from the client before beginning chiropractic treatment of an animal.

The Role of Chiropractic in Physical Rehabilitation

Chiropractic can serve as a valuable "tool in the toolchest" of the rehabilitation therapist working with animal patients. Chiropractic provides a means to maintain spinal mobility, mobility in joints of the extremities, and function in healthy athletic and working animals. In animals experiencing clinical problems such as pain and lameness, chiropractic addresses spinal dysfunction, whether that dysfunction is the result of a primary pathology such as intervertebral disc disease (IVDD), or secondary to a lameness that leads to disrupted spinal biomechanics. The positive outcomes of chiropractic adjustment in animals undergoing physical rehabilitation include:

- restoration of proper spinal segmental function,
- restoration of proper bony relationships,
- resetting neural receptors back to healthy firing frequency,
- improving overall mobility,
- assisting neurologic healing,
- rebalancing proper muscle tone and function, and
- reducing pain (Jurek, 2013).

The Vertebral Subluxation Complex

Pathology of the spine leading to nervous system dysfunction is described as a vertebral subluxation complex (VSC). Unlike an orthopedic luxation, where bones normally engaged in a structural relationship become disrupted or distracted (e.g., coxofemoral luxation), the VSC is a term that describes a *functional* rather than a *structural* abnormality. The VSC describes a spinal segment that is restricted from moving throughout its normal range of motion. The complex describes this loss of movement within the context of one vertebra in relation to neighboring vertebrae. Gatterman (1995) specifically defines spinal subluxation as "a motion segment in which alignment, movement integrity, and/or physical function are altered though contact between the joint surfaces remains intact". This is a reflection of neuromuscular dysfunction. Vertebrae that do not function properly within the spinal framework generate mechanical stress, thus accelerating the wear and tear on the surrounding spinal muscles, ligaments, discs, joints, and other spinal tissues. If left untreated, pain, inflammation, tenderness to palpation, decreased mobility, and muscle spasm/tension eventually occur. After just 2 weeks of immobilization in rats, degeneration of facet joint cartilage occurred in the lumbosacral joints (Yoshida, 1989).

Detailed information about chiropractic care can be found in: Bergmann TF and Peterson DH (2011) *Chiropractic Technique: Principles and Procedures*, 3rd edn. Mosby, St. Louis, MO.

The key to appreciating the concept of the VSC and its relationship to pain is to understand the intimate relationship between structure and function. Various models of the VSC have been developed in human patients. Biped spinal biomechanics are quite different from those of quadrupeds, but some structural and functional analogies exist between biped and quadruped skeletons, allowing for the application of chiropractic principles to four-legged patients once anatomical and motion differences are accounted for.

In order to know what to treat, the practitioner must determine which spinal segment(s) are dysfunctional and in which direction(s) motion is restricted. The chiropractic examination will always include a motion palpation as a critical component in order to evaluate the relationships among spinal segments (or limb joints) as well as to identify those segments between which motion is compromised. The description of the VSC and its treatment is referred to as a "listing." The listing vernacular provides information about the place on the animal's body that will be contacted by the practitioner, the direction of reduced motion, as well as the direction in which the VSC will be adjusted or corrected. The listing vocabulary is taken from human chiropractic, specifically the Palmer Gonstead system (Scaringe and Cooperstein, 2001) and, in acknowledgement of its origin, maintains use of human chiropractic terminology in spite of the differences in describing analogous locations on an animal's body. One example is the use of "anterior" for "ventral" and "posterior" for "dorsal." A complete explanation of the VSC listing nomenclature is beyond the scope of this chapter.

The Chiropractic Adjustment

The fundamental chiropractic interaction between the practitioner and the patient is the adjustment. The chiropractic adjustment involves a specific, small-amplitude, high-velocity, controlled thrust to restore motion through a specific vector by moving the joint surfaces to the anatomical limit of joint play (Leach, 1994b). It is the specificity of the adjustment, in both location and direction, which differentiates the chiropractic adjustment from other less-specific tissue manipulation. Sometimes during an adjustment there will be a sound, called an "audible," caused by pressure changes in the joint (Leach, 1994b).

The chiropractic adjustment is focused on the functional spinal unit comprising two adjacent vertebrae, the joints that link them, the skeletal muscles that move the joints, and the supportive structures that span the distance between them. Between the elastic barrier and the anatomical barrier is a virtual/theoretical space referred to as the "physiological space," and it is within this space that the chiropractic adjustment occurs. This is an extremely small space, which means the adjusting thrust is a very low-amplitude movement (Scaringe and Cooperstein, 2001).

The adjustment thrust is a fast, specific, and small movement applied to the affected spinal segment in the direction required to overcome the restricted motion, as diagnosed, and restore normal motion to the segment. The thrust motion stimulates mechanoreceptors and acts on the small muscles of the spinal segment (rotatory muscles), causing them to relax or reduce spasm (Sung *et al.*, 2005). Predicting or feeling for the moment of greatest relaxation takes practice and involves palpating many, many patients to train the practitioner to most effectively diagnose and adjust VSCs (Options, 2008).

Evaluation of the Animal Chiropractic Patient

The chiropractic examination should occur prior to any adjustments. An evaluation of posture and gait, vertebral and extremity palpation, motion palpation, as well as an orthopedic and neurological evaluation are part of the examination. No matter the size of the animal chiropractic patient, the principles of evaluation, diagnosis, and adjustment are the same. The cornerstone of the chiropractic examination is the motion palpation. A systematic approach to palpation will reveal areas of discomfort or altered sensation along the spine and over the pelvis. A detailed description of a pain palpation in a dog is published elsewhere (Downing, 2011), but the key component for any species includes a systematic approach using pressure applied with the fleshy tissue over P3 of the first and second fingers of the palpator. If back pain is identified, or if areas along the back feel tense (or less pliant) than surrounding areas, the patient may be a good candidate for chiropractic evaluation and adjustment.

As the veterinarian locates the segments that need adjustment, the animal may move away from being palpated or react negatively in some way. The soft tissues in the surrounding area may spasm under the veterinarian's fingers. The veterinarian needs to begin with light pressure and slowly increase to motion palpate as needed. The veterinary technician needs to anticipate potential discomfort while restraining the patient appropriately.

The chiropractic examination should be systematic and consistent. A habitually systematic evaluation also reduces interpatient variability for the practitioner, as there is subjectivity involved in any physical medicine technique. Evaluation and adjustments should take place in an area large enough to accommodate the patient. A non-skid surface is necessary in order for the patient to be comfortable standing. It is also important to evaluate and adjust the patient in an area free of noise or distractions. Be aware of behavioral cues that can be interpreted by the animal as signals of aggression. In keeping with the AVMA's current recommendations, clients should not restrain their animals for the chiropractic practitioner. It is the practitioner's responsibility to keep the client safe during the chiropractic diagnosis and treatment. The animal should be monitored carefully for signs of anxiety, agitation, or aggression. It will primarily be the technician's job to keep the practitioner and client safe. If the animal cannot be reassured, the chiropractic session should be stopped until it can be resumed safely and comfortably for all.

A painful dog or cat should only be adjusted after breaking the pain cycle pharmacologically. If the patient is painful, the motion palpation prior to the adjustment will be uncomfortable for the patient, and it may be challenging to determine specifically the location and nature of the VSC, and any adjustment risks exacerbating the patient's pain. In equine patients, there are fewer pain management options, and chiropractic adjustment itself can play an important role in pain relief.

The Chiropractic Adjustment and the Veterinary Technician

Companion animals are adjusted using a one-handed technique, allowing the practitioner to use the opposite hand and arm to help stabilize the patient. Appropriate stabilization allows the practitioner to isolate the affected spinal segment for adjustment, as well as to more easily take the segment to tension. In addition, appropriate stabilization of the patient ensures that most of the force of the thrust employed during the adjustment will reach the intended tissues in the VSC (Options, 2008). Appropriate stabilization without excessive restraint seems to reassure the patient, allowing them to relax into the adjustment, making the chiropractic treatment as effective as possible. Limb adjustments are accomplished by stabilizing the patient on three legs so that the chiropractor can isolate one joint at a time for adjustment. Many animal chiropractic providers report anecdotally that canine patients who are treated successfully with chiropractic adjustment appear to "enjoy" their subsequent experiences. It is a common occurrence to witness dogs straining at the leash in order to enter the facility for their chiropractic care.

Equine chiropractic adjustment technique varies depending upon the location of the adjustment. The cervical spinal segments are adjusted using a technique in which the horse's head is positioned with one hand and the adjustment is performed with the other hand.

The thoracic and lumbar spinal segments and the pelvis are adjusted using a two-handed technique, and depending upon the location and direction of the adjustment, the technician may be asked to provide stabilization on the opposite side of the horse from the practitioner.

Horse limb adjustments are performed by lifting the leg, and isolating and adjusting one joint at a time.

Common sense will dictate which patients or locations on the body should not be treated with chiropractic adjustment. Examples of conditions that should not be treated with chiropractic include (but are not limited to):

- Areas with active infection
- Fractures
- Acute prolapsed or ruptured intervertebral disc
- Significant pain
- Joint luxation (e.g., traumatic coxofemoral luxation)
- Acute painful joint sprain or strain
- Meningitis/encephalitis.

The veterinary technician's involvement with animal chiropractic cases will depend upon the practice, the practitioner's preferences, and the specific case. In those practices where the technician has first contact with the client and patient, it will be the technician who takes the preliminary history and conducts the initial pain assessment, reporting the findings to the chiropractor before the adjustment begins. During the adjustment, the technician provides restraint of the chiropractic patient as needed, as well as stabilization for specific adjustments.

For equine chiropractic patients, the technician will typically be positioned at the head on the same side of the horse as the chiropractor when the adjustment is along the spine or over the pelvis (Figure 24.1).

For adjustments in the thoracic spine of the horse, the technician will provide stabilization against the dorsal spinous processes on the side opposite to the chiropractor. The precise positioning of the technician's hands, posture, and body will vary by practitioner. It is always appropriate to ask for guidance about body position when assisting with an equine chiropractic adjustment.

Figure 24.1 Dr. Downing adjusting an equine pelvis.

Figure 24.2 Dr. Downing performing adjustment with minimal restraint.

For canine chiropractic patients, the veterinary technician's role will vary depending upon the size of the patient (Figure 24.2).

For larger dogs, the technician will provide appropriate restraint to allow the chiropractor to isolate the segment being adjusting. During thoracic adjustments, in addition to restraining the patient, the technician will stabilize the appropriate ribs by placing the flat of the hand on the side of the ribcage opposite to the adjustment (Figure 24.3).

For limb adjustments, the technician will help to balance the dog while the chiropractor isolates and adjusts each joint. Finally, the technician will typically stabilize C1 during an occiput–C1 adjustment.

Because each practitioner has his or her own subtle variations of hand, body, and patient position during chiropractic adjustment, it is always best to seek direction in order to provide optimal assistance.

Chiropractic and Cats

Although current training of veterinarians and chiropractors in animal chiropractic principles and techniques focuses on horses and dogs, all quadrupeds share many structural, functional, and biomechanical commonalities. Cats should therefore benefit from the application of chiropractic adjustments within the context of physical rehabilitation when they experience VSCs. Feline patients are notorious for "masking" painful conditions, making pain recognition and subsequent treatment quite challenging.

Figure 24.3 Hand position for stabilizing the thoracics during an adjustment.

The same principles apply to diagnosing and adjusting cats using chiropractic as apply to dogs, including decreasing significant pain before adjusting in order to provide the best outcome and experience for the patient. It also means appropriate gentle handling and minimal restraint to keep the patient, assistants, and the practitioner safe. Cats may object more vigorously to restraint than the typical dog. Likewise, cats tend not to stand still for their assessments and adjustments. Cats generally require flexibility on the part of the practitioner in order to accomplish appropriate chiropractic diagnosis and treatment (Figure 24.4).

Figure 24.4 Adjusting the patient when the table can be used to stabilize the patient.

Because of their small size, the veterinary technician's role during feline chiropractic adjustment may consist primarily of distracting the patient to minimize any objections it may have to being handled and manipulated.

Conclusion

The need for animal patient chiropractic studies is clear. Chiropractic care provides a reasonable strategy for complementing and enhancing the effects of pharmacological (and other) pain management strategies, and restoring biomechanically sound movement and function. Physical rehabilitation is all about restoring movement, function, strength, and ability. The future position of chiropractic among accepted treatment modalities for animals undergoing physical rehabilitation will depend upon the results of rigorous clinical studies. Attention must be paid to the neurologic implications of chiropractic adjustment as well as sustaining the effects of adjustment.

Although it is important for veterinary technicians to understand the principles and practices of veterinary chiropractic as it can be applied within physical rehabilitation, it is not appropriate for technicians to perform animal chiropractic adjustments. The veterinary technician is positioned to play a vital role in providing chiropractic care to companion animals both large and small by working hand-in-hand with those practitioners who bring the benefits of chiropractic adjustment to their patients.

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Adjunctive Therapies Part 3: Myofascial Trigger Point Therapy

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CHAPTER MENU

Introduction

Myofascial pain syndrome, described in humans as a chronic painful condition of muscle, has started to become acknowledged in the field of veterinary medicine. Muscle is the largest organ in a mammal's body (ranging from 40% in a human to 57% in a greyhound) and can be thought of as the "orphan organ," as no traditional medical specialty is designated to treating it. Until recently, it was rare to provide veterinary education on muscle dysfunction, concentrating more on muscle tears and on the bones, joints, and ligaments of the musculoskeletal system. Although currently there is limited research on the development, diagnosis, and treatment of myofascial trigger points (MTrPs) in the non-human animal species, great strides are being undertaken to transpose the human techniques initially developed by doctors into the realm of veterinary patients. With the development of the American College of Veterinary Sports Medicine and Rehabilitation and their mission "advances the art and science of veterinary medicine by promoting expertise in the structural, physiological, medical and surgical needs of athletic animals and the restoration of normal form and function after injury or illness" (ACVMSR, 2015), anticipation of advancements in the study of muscle pain and dysfunction exists.

Myofascial pain syndrome (MPS), is typically thought to arise from MTrPs. The pioneers recognizing MPS were Janet Travell MD and David Simons MD, and their textbook defines an MTrP as a hyper-irritable spot in skeletal muscle that is associated with

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a hypersensitive palpable nodule in a taut band. The spot is tender when pressed, and gives rise to characteristic referred pain, motor dysfunction, and autonomic phenomena (Simons and Travell, 1998). The three components that make up an MTrP are the sensory, motor, and autonomic components.

Sensory Component

MTrPs can be very painful. The pain begins as nociception in the peripheral tissues from all the normal chemical activators, including serotonin, prostaglandins, bradykinin, and substance P. It is not within the scope of this chapter to go into details about all the pain-generating substances. These substances can decrease the activation threshold of a neuron, so that the nociceptor fires more easily with less of a stimulus, potentially leading to peripheral sensitization. Sampling of tissue fluid from active MTrPs in the upper trapezius of human patients was performed. Elevated levels of protons, bradykinin, serotonin, substance P, norepinephrine, calcitonin gene-related peptide, tumor necrosis factor alpha, and interleukin-1b were detected and were significantly different compared to samples taken from areas without MTrPs (Shah *et al.*, 2005). A persistent barrage of nociceptive signals from MTrPs may eventually lead to central sensitization, a form of neural plasticity involving functional, and/or structural change within the dorsal horn of the spinal cord. Central sensitization can be clinically expressed as allodynia (pain associated with a typically non-painful stimuli) or hyperalgesia (when an actual painful stimulus is perceived as more painful than it should).

Motor Component

MTrPs are also known as "contracture knots" due to the severe focal muscle contracture in the region of the MTrP. Contracture of the muscle fibers can compress local sensory neurons as well as compressing local blood vessels, leading to a reduced supply of oxygen. MTrPs may inhibit normal motor activity in their muscle of origin or in functionally related muscles. Motor inhibition is often identified as muscle weakness and can lead to poor coordination and muscles imbalances (McPartland and Simons, 2011). Clinically this can appear as muscle weakness without atrophy and unrelated to neurologic causes (Simons and Travell, 1998).

Autonomic Component

The autonomic nervous system (ANS) primarily exerts control over cardiac tissue, blood vessels, visceral organs, and glands of the body. Typically, ANS responses seen in human patients with MTrPs include localized sweating, vasoconstriction or vasodilatation, and pilomotor activity (goose bumps) (McPartland and Simons, 2011). Although these responses are seen frequently and are easily detectable in humans, the detection of any ANS response is rare in the veterinary patient – with pilomotor activity (piloerection) being the most likely event noted.

How Do Myofascial Trigger Points Develop

Several possible mechanisms can lead to the development of MTrPs, including low-level muscle contractions, uneven intramuscular pressure distribution, direct trauma, eccentric contraction in unconditioned muscle, and maximal or submaximal concentric contractions. The exact reason as to why these mechanisms lead to the formation of MTrPs remains unclear. The original hypothesis introduced in 1981 as the integrated trigger point hypothesis was dependent on an energy crisis that would result in excessive acetylcholine at the motor endplate. The excess of acetylcholine would then cause contraction of the sarcomere leading to the development

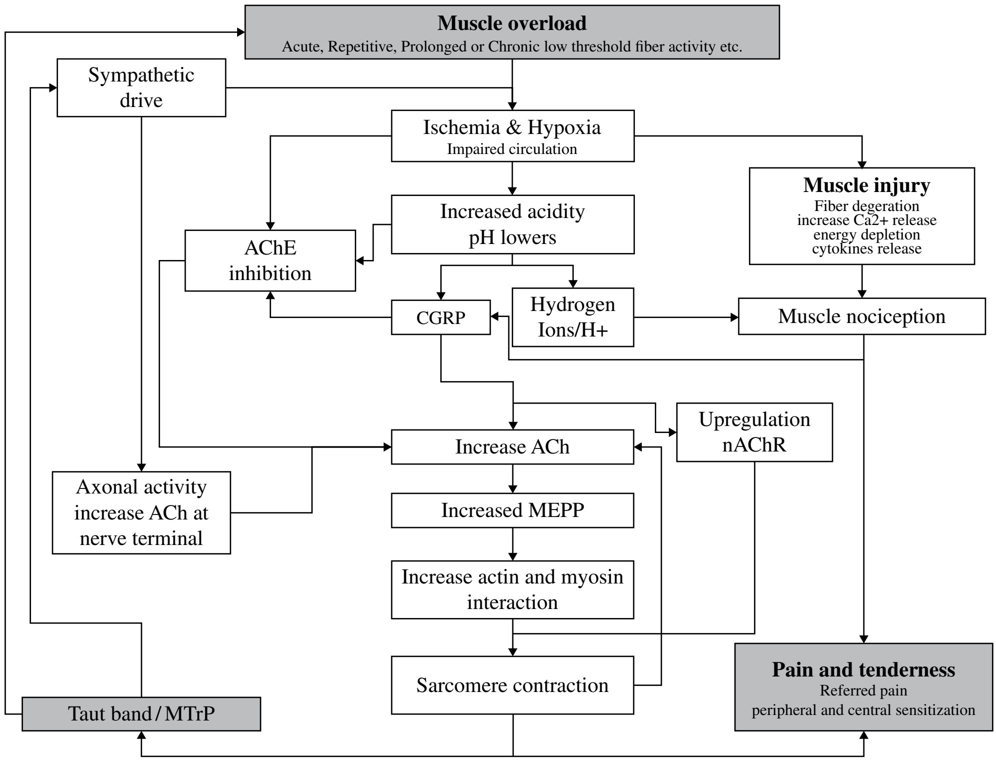

Figure 25.1 Schematic showing the expanded integrated trigger point hypothesis. *Source:* Courtesy of Dr. Jan Dommerholt.

of MTrPs. With advances in research, this hypothesis became the expanded integrated trigger point hypothesis in 2004 (Gerwin *et al.*, 2004) (Figure 25.1).

Low-level muscle contractions can result in degeneration of muscle fibers. This can lead to an increase in calcium release, energy depletion, and structural damage especially to the mitochondria. During low-level muscle contractions, intramuscular pressure can lead to excessive capillary pressure causing localized hypoxia and ischemia. Direct trauma may create a vicious cycle of events wherein damage to the sarcoplasmic reticulum or the muscle cell membrane may lead to an increase of calcium concentration, a subsequent activation of actin and myosin, a relative shortage of adenosine triphosphate (ATP), and an impaired calcium pump, which in turn will increase the intracellular calcium concentration even more, completing the cycle. Eccentric and concentric exercises have been associated with hypoxia and ischemia (see Figure 25.1). However, there is currently inadequate evidence to demonstrate that these exercises are absolute precursors to the development of MTrPs (Dommerholt *et al.*, 2011; Bron and Dommerholt, 2012).

Perpetuating Factors

Perpetuation of MTrP formation in dogs appears to be most often related to mechanical stresses resulting in chronic muscle overload. Postural changes in dogs resulting from orthopedic injury, postoperative surgical trauma and pain, neuropathy, joint dysfunction, and pain related to osteoarthritis create muscle overload. Many of the same muscle-related mechanisms that lead to the development of MTrPs are also perpetuating factors.

An example to illustrate this point is the canine patient with chronic osteoarthritis of the coxofemoral joints. The pain caused by the joints will cause the patient to invoke compensatory postural changes to relieve pressure on the joints, thereby activating and perpetuating MTrPs. MTrPs will readily be found in the hip flexors (e.g., iliopsoas, tensor fasciae latae, sartorius, and rectus femoris), extensors (gluteals, piriformis, semimembranosus, and semitendinosus) and adductors (gracilis, pectineus, and adductor). As the patient shifts weight cranially, thereby changing the typical 60/40 weight distribution pattern, compensatory changes will be found in the muscles of the forelimbs. The overload placed on the forelimbs can lead to the formation and presence of MTrPs; primarily in infraspinatus, triceps, teres major, and deltoids. As the patient ambulates, there will be considerable lateral flexion of the spinal muscles to avoid extensive coxofemoral flexion and extension. This can be described as a "hula type motion" when viewed from the caudal aspect of the patient. This overuse of the iliocostalis lumborum can result in the formation of MTrPs. This example of formation of trigger points secondary to joint pain not only illustrates the perpetuation that can be involved with MTrPs, but it also demonstrates the need to treat any underlying pain. If the MTrPs are cleared with treatment and any known underlying source of pain is not addressed, then the MTrPs will return and the patient will continue to suffer from myalgia as well as the underlying pain. This is just one illustration of a condition that can perpetuate MTrPs; similar findings can be found with patients suffering from shoulder injuries, antebrachial injuries, chronic medial luxating patella, and cruciate injuries among others.

In humans, MTrPs have been found from nutritional, metabolic, or systemic perpetuating factors, including the use of statin-class drugs, iron insufficiency, vitamin D insufficiency, vitamin B12 (cobalamin) insufficiency, and hormonal imbalances, such as is seen with hypothyroidism (Dommerholt and Gerwin, 2011). Hypothyroidism is the most common endocrine disorder in dogs and is associated with a variety of clinical signs; however, the veterinary literature does not mention pain resulting from hypothyroidism (Wall, 2014). However, one might pause to consider those hypothyroid dogs that suffer from myopathy and muscle weakness and closely evaluate the patient for MTrPs.

Evaluation of the Patient

Close observation of the patient prior to placing your hands on them can provide you with a lot of information and knowledge. Observing the patient at various gaits (walk, trot, jog) or the unwillingness to move; observing position changes such as stand to sit or laying down to stand can provide the astute observer with considerable information as to which muscle or muscle groups may be involved. Video-taping the patient to analyze in slow motion can also be very beneficial. In dogs, a simple test can be performed to evaluate muscle weakness. With a dog in standing position, slowly slide the limb backward until non-weight bearing. A slight to profound drop of the contralateral side can be indicative of muscle weakness or altered muscle firing patterns associated with MTrPs within the antigravity muscles of that limb (Wall, 2014).

MTrPs are classified as active or latent. Active MTrPs cause local or referred pain patterns while at rest, with muscle movement or upon direct stimulation. Latent MTrPs do not trigger pain without direct stimulation (Dommerholt *et al.*, 2011). Both active and latent MTrPs are painful on compression, thereby making it virtually impossible for the veterinary examiner to know if a patient is suffering from active or latent MTrPs, so all MTrPs that are found should be addressed as a possible cause of pain and muscle dysfunction (Figure 25.2). Identification of taut bands and hypersensitive MTrPs within muscle is an acquired skill set that requires an understanding of these

Figure 25.2 Example of flat palpation in a dog for the presence of myofascial trigger points.

Figure 25.4 Pincer palpation on a dog.

Figure 25.3 Example of flat palpation on a horse for the presence of myofascial trigger points.

changes, skilled instruction, and repeated practice (Wall, 2014).

Without a "gold standard" of laboratory testing or diagnostic imaging to diagnose MTrPs we are heavily reliant on palpation skills. Palpation for MTrPs can be accomplished by two simple techniques. Flat palpation is the gentle but firm movement of the finger tips perpendicular to the muscle fibers being examined as they are pushed against the underlying bone (Figure 25.3). This technique lends itself to examination of muscles such as the iliopsoas, infraspinatus, and supraspinatus.

Pincer palpation is performed by rolling the muscle perpendicular to the muscle fibers between the finger tips and thumb. This technique lends itself to the examination of muscles such as the sartorius, tensor fasciae latae, and triceps (Figure 25.4). Once a taut band is detected, the taut band is evaluated for an area of hardness and discrete pain.

As the stimulation of an active or latent MTrP can lead to a "jump sign," a pain response leading to vocalization or the patient trying to move away, palpation is best done with an assistant providing gentle restraint. Although palpation can be performed on a standing patient, many people find it is much easier to palpate the taut bands in a relaxed muscle in a non-weight bearing lateral recumbent position.

A "local twitch response" (LTR) may be induced during the palpation over an MTrP. The LTR is a unique spinal cord reflex resulting in a rapid contraction of the taut band following manual stimulation of the MTrP. Manual stimulation can be accomplished by direct palpation or introduction of a needle. The LTR in dogs can also serve as verification of the presence of an MTrP (Wall, 2014).

The criteria for identification of MTrPs can be best summed up by: a palpable taut band, exquisite spot tenderness of a nodule in the taut band, and patient recognition of pain upon palpation of the nodule (jump sign in the veterinary patient). Confirmatory observations in the veterinary patient would be a visual or tactile identification of an LTR (Simons and Travell, 1998).

Treatment of Myofascial Trigger Points

Therapies fall into two categories: invasive and non-invasive. At this time, no clinical studies have been done to evaluate the outcome or validate the effectiveness of any treatment for MTrPs in the veterinary patient. All reports are considered anecdotal and symptomatic and clinical improvement or failure of treatment is based strictly on "observation" by the clinician and the owner.

Non-Invasive Therapies

Electrotherapy

Anecdotal reports from several veterinary clinicians report successful treatment of MTrPs with the Pointer Excel II™, a handheld transcutaneous electrical nerve stimulation device. The Pointer Excel II™ is placed on the skin over the MTrP and electrical intensity is increased until rhythmic muscle contraction is produced. Response to therapy is likely related to rapid muscle stretch that occurs with induced contraction rather than the introduction of electrotherapy (Wall, 2014).

Low-Level Laser Therapy

This chapter will only discuss the use of class IIIa and IIIb lasers. As the class IV laser (output power of greater than 500 mW) must continually be moved over the surface of the skin to prevent thermal damage, it is difficult to determine the exact J/cm^2 that would be delivered to the underlying MTrP. Class IIIa lasers produce an output power of up to 5 mW; whereas Class IIIb lasers produce an output power up to 500 mW. During laser therapy the energy delivered is reported in joules (J), where 1 J = 1 W/s and the treatment area is described in centimeters squared, therefore the therapeutic laser dose is described as J/cm^2. Although many research studies have investigated low-level laser therapy for the treatment of MTrPs, there is no conclusive evidence to support or deny its effectiveness (Ilbuldu *et al.*, 2004; Altan *et al.*, 2005; Dundar *et al.*, 2007; Manca *et al.*, 2014). Inadequate dosages may be the principal factor involved in the inconsistency among reports of LLLT efficacy. Until there is further research to demonstrate an effective therapeutic laser dose for the treatment of MTrPs, this modality should not be a standalone treatment procedure.

Ultrasound

Current research demonstrates that the use of conventional therapeutic ultrasound is no more effective than placebo or no treatment for MTrP pain in the neck and upper back (Lee *et al.*, 1997; Gam *et al.*, 1998; Esenyel *et al.*, 2000; Manca *et al.*, 2014).

Shockwave Therapy

Current research, although limited in number of studies, is demonstrating some effectiveness for the treatment of MTrPs and this modality will need further research to fully elucidate its role as a therapy (Jeon *et al.*, 2012; Ji *et al.*, 2012; Moghtaderi *et al.*, 2014). It is the clinical observation of the authors that after shockwave therapy is performed on a patient with osteoarthritis of the coxofemoral joint, the number of palpable MTrPs in the tensor fasciae latae, proximal sartorius, and gluteals muscles is less than that before the therapy is done.

Manual Therapies

In humans, the evidence for manual therapies is once again not clear, as the data regarding most manual therapies is inadequate and conflicting. Most trials do not limit the number of modalities per treatment, so positive outcomes cannot be exclusively claimed by a certain therapy. Several studies reported that exercise and stretching appeared to be the effective therapy when included in treatment groups comparing active and placebo modalities (Mense and Gerwin, 2010; Rickards, 2011). Research on trigger point pressure release has shown positive outcomes as a treatment in human subjects. This technique is one of the more commonly described manual techniques to address MTrPs (Bodes-Pardo *et al*, 2013; Cagnie *et al.*, 2013; Llamas-Ramos *et al.*, 2014). Trigger point release consists of pressure progressively applied and increased over the MTrP until the fingers encounter an increase in tissue resistance (tissue barrier). This pressure is maintained until the clinician senses a relief of the taut band. At that moment, the pressure is increased again until the next increase in tissue resistance is felt.

Figure 25.5 Dry needling of a horse for treatment of myofascial trigger points by Mrs. Angela Stramel.

Figure 25.6 Dry needling of a dog for treatment of myofascial trigger points by Dr. Douglas Stramel.

The process is repeated 3 times during each session (Lewit, 1991).

Invasive Therapies

Although veterinary technicians are not allowed to perform these procedures, a knowledge of the procedure and proper restraint or sedation for the procedure is important for technicians in their role as part of the animal healthcare team. Invasive procedures consist of dry needling (DN) or trigger point injections (TPI). TPI involves the use of a hypodermic needle attached to a syringe to inject a substance directly into the MTrP. Commonly used substances in the human world include lidocaine and botulinum toxin. Due to the discomfort from these injections, this procedure is not well tolerated in the veterinary patient. DN consists of the use of a filiform needle inserted into the skin and then into the deeper underlying muscle (Figure 25.5).

The MTrP within the taut band is targeted and eliciting LTRs is essential. Once an LTR is evoked, the needle is slightly withdrawn from the muscle, but not the skin, and can be redirected to the same MTrP until no further LTRs are evoked (Figure 25.6). Additional MTrPs in the area can also be treated prior to the needle being completely removed from the patient. The human literature covers in depth the advantages of DN (Dommerholt and Gerwin, 2010). Treatment outcome goals would include a decrease in peripheral and central sensitization as well as improved motor function as seen with increase in muscle strength and range of motion leading to a better quality of life for the veterinary patient. A successful outcome of DN for the treatment of MTrPs is heavily reliant on the knowledge and skills of the veterinary clinician. One must have an in-depth knowledge of anatomy and develop keen tactile awareness and visualization of the needle pathway as it travels through the soft tissue of the patient's body (Dommerholt and Gerwin, 2010).

Conclusions

If you have an awareness of MTrPs affecting the veterinary patient, you can better assess those patients suffering from myalgia and having a decline in athletic performance. Knowledge that MTrPs can complicate, prolong, or delay the pain management and healing process in the chronic or acute orthopedic and neurologic patient can vastly change the way patients are treated. These patients have a better outcome than those left untreated. The skill set to be able to understand, palpate, and treat MTrPs is essential for each member of the veterinary healthcare team that is interested in pain management, rehabilitation, and sports medicine.

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