Vet Clin Small Anim 35 (2005) 1411–1426

VETERINARY CLINICS
SMALL ANIMAL PRACTICE

Rehabilitation of Medical and Acute Care Patients

Dianne Dunning, MS, DVM[a,*], Krista B. Halling, DVM[b], Nicole Ehrhart, VMD, MS[c]

[a]College of Veterinary Medicine, University of Illinois at Urbana-Champaign, 1008 West Hazelwood Drive, Urbana, IL 61802, USA
[b]Department of Clinical Studies, Ontario Veterinary College, University of Guelph, Guelph, Ontario, Canada N1G 2W1
[c]Animal Cancer Center, Department of Clinical Sciences, Colorado State University, 300 West Drake Street, Fort Collins, CO 80523, USA

The primary goals of a clinical rehabilitation program in the intensive care or oncologic setting are to improve the animal's quality of life and reduce the complications associated with prolonged hospitalization or immunosuppressive therapy. Cancer and serious systemic illness result in several physiologic changes that involve multiple body systems. While the primary conditions are addressed with traditional modalities of medicine, the side effects, secondary changes, and complications can be ameliorated or even prevented with rehabilitation and supportive care. By applying the basic therapeutic modalities of massage, passive and active range of motion, postural drainage, low-intensity therapeutic exercise, electrical stimulation, and good general nursing care, one can improve the function of and decrease the animal's risk for complications associated with an intensive care admission or chemo- or radiotherapy. This article reviews problems facing the oncologic and critically ill animal, discusses basic techniques in the management of these animals, and highlights the essential role of rehabilitation in obtaining maximal functional capacity in the critically ill patient.

GENERAL APPLICATIONS OF REHABILITATION IN THE MEDICAL PATIENT

In the past, rehabilitation in companion animal medicine was limited to postoperative orthopedic and neurologic conditions. Although it is efficacious in both of these areas, the practice of rehabilitation can easily be modified and applied to many other animals, including those exhibiting clinical signs related to

*Corresponding author. North Carolina State University College of Veterinary Medicine, 4700 Hillsborough Street, Raleigh, NC 27606, USA. *E-mail address*: dianne_dunning@ncsu.edu (D. Dunning).

0195-5616/05/$ – see front matter
doi:10.1016/j.cvsm.2005.08.008

vetsmall.theclinics.com

cardiopulmonary dysfunction, systemic disease, neuromuscular weakness, generalized weakness, trauma, and cancer. In humans, the role of rehabilitation is well established for a variety of diseases, with inpatient and outpatient physical therapy being available and covered by medical insurance for a variety of conditions including (but not limited to) the following [1]:

- Orthopedic conditions of the back, neck, shoulder, hip, knee and ankle
- Postsurgical conditions
- Amputations
- Fractures
- Joints and soft-tissue injuries
- Neurologic conditions such as stroke, Parkinson's disease, and multiple sclerosis
- Arthritis
- Cardiopulmonary and circulatory conditions
- Systemic diseases such as cancer, AIDS/HIV, and fibromyalgia
- Connective tissue conditions
- Functional capacity evaluations and work conditioning
- Workplace injuries
- Sports injuries

All rehabilitation regimens should be authorized by the primary care clinician before their initiation. In addition, the rehabilitation practitioner or therapist should fully review the animal's medical history and perform and record independent physical and rehabilitation examinations. From this review and discussion of the case with the primary care clinician, a problem list should be completed to guide the therapy and provide a baseline assessment from which one can fully evaluate the success or failure of the therapy. Depending on the patient's status, periodic reassessment should be performed as often as daily to modify the regimen and identify additional problems. Components of the rehabilitation evaluation commonly include, but are not limited to, limb girth measurement for estimation of muscle mass, edema and bruising scoring, goniometry, disability assessment with timed standing or walking, subjective mentation scoring, and pain assessment scoring.

Flexibility in the therapy regimen is essential for the critical care patient and in particular the radiation patient owing to the necessity for sedation and even anesthesia on the days of treatment. The rehabilitation regimen should not disrupt chemotherapy, antimicrobial, or fluid administration. Planning of various treatment regimens must be clear and strategic between services and clinicians to avoid compromise of the patient and the therapy. Animals with invasive monitoring, diarrhea, or urinary tract infection are limited in their ability to participate in an intensive rehabilitation program (ie, swimming or exercising in an underwater treadmill) but may still benefit from the therapeutic modalities of massage, mobilization, and limited therapeutic exercise. In addition, intravenous, epidural, and urinary catheters, telemetry pads, rectal probes, thoracostomy and feeding tubes, and oxygen supplementation are issues that must be taken into account when creating a therapeutic plan.

METABOLIC AND TISSUE CHANGES ASSOCIATED WITH SYSTEMIC ILLNESS

Although the physiologic changes associated with inactivity have been observed in veterinary medicine, most research and clinical reports in this area have involved humans [2–21]. Reduced physical activity that accompanies an admission to an intensive care unit (ICU) or oncology ward represents a significant stress to the body. In humans, decreased physical activity results in significant losses in functional capacity of the musculoskeletal and cardiovascular systems [3,5,6,8,15,17,18].

Patients in the ICU who are confined to bed rest for more than 1 week experience a rapid reduction of muscle mass and exercise intolerance [5]. Muscle atrophy caused by hospitalization and bed rest in humans is characterized by loss of myonuclei, decreased myocyte cytoplasm, myosin filament defects, and an increase in several proteolytic enzymes [2,10,21]. Some of these changes create inflammation within the inactive muscles, leading to production of reactive oxygen species (ROS) [20,21]. Molecular ROS factors, in turn, lead to contractile dysfunction, which is manifested as a reduced force of contraction without evidence of structural muscle damage or loss [20,21]. Inflammation contributes to acute and chronic myocyte damage and cell death through metabolic derangements in musculature, increased proteolysis, and disturbed regeneration of muscle fibers [13,22]. Elevated levels of proinflammatory factors have been implicated in reduced contractile force even in the absence of muscle damage [22]. In addition, inflammation is a normal consequence of injury or infection and a common phenomenon in the ICU. Cytokines initiate inflammation and contribute to muscle dysfunction [21]. Appendicular skeletal muscles are not alone in these changes. Similar alterations in muscle strength and endurance are seen in the diaphragm and intercostal muscles, which directly affect ventilation and decrease the cardiopulmonary response to exercise [5].

Inactivity in critically ill adults has been associated with an increased risk of decubital ulcers, pulmonary complications, deep vein thrombosis, and prolonged ICU and hospital stays [4,6,15,18,21]. Furthermore, cancer and systemic illness result in critical changes in metabolism and basal metabolic requirements and nutritional needs. The changes discussed herein most likely occur in dogs as well as humans and can be improved with a rehabilitation program. Any rehabilitation therapy regimen must be approached with caution and close monitoring. The heart rate and rhythm, the respiratory rate, and the animal's overall demeanor and response to therapy must be evaluated to detect stress or decompensation associated with the increased activity or intervention.

GENERAL NURSING CARE

Good general nursing care is an important component of any rehabilitation regimen. All therapies should take place in an area free from clutter and debris. Weak debilitated animals also benefit from textured flooring to provide firm footing during assisted standing or walking. Bedding should be checked and changed on a regular basis to prevent complications associated with decubital ulceration, urine scald, and soiling. Placing recumbent and nonambulatory animals on elevated racks facilitates air circulation and minimizes urine and fecal contamination. Disposable absorbable pads are also available to place under the animal's hind end.

The prevention of decubital ulceration and urine scald is significantly easier and more cost effective than the treatment of these complications [23]. Factors associated with pressure ulcers in humans in acute care hospitals include older age, male gender, sensory perception deficits, moisture, impaired mobility, nutrition, and friction or shear when transferring the patient from one surface to another with sheets or bedding [24]. Typical pressures over bony prominences when sitting or lying have been measured at 100 to 200 mm Hg [2,25,26]. Pressures greater than approximately 32 mm Hg exceed capillary filling pressure and result in potential tissue ischemia [2,25,26]. The standard recommendations of a 2-hour turning cycle for the immobile patient are based on animal models [2,25,26]. The location of pressure sores correlates well with pressure maps based on the anatomy of bony prominences and positioning.

Pressure sores are found in 3% to 10% of hospitalized human patients [2,25,26]. The prevalence correlates with advanced age and dependent mobility status [2,25,26]. More than 30% of hip fractures are complicated by pressure sores. Individuals with spinal cord injury have a lifetime risk ranging from 25% to 85% [2,25,26]. Specific risk factors for decubital ulcers in humans include the following [2,25,26]:

- Limitations in mobility (eg, paralysis, fracture, weakness, bed rest)
- Altered sensory feedback (sensory loss from spinal cord injury, peripheral neuropathy)
- Altered mental status (eg, pain medication, stupor, dementia, senility)
- Altered body mechanics (increased pressure over bony prominences secondary to spasticity, contractures, scoliosis, kyphosis)
- Malnutrition (weight loss, hypoalbuminemia)

Although individual risk factors in animals have not yet been identified, the skin of a recumbent animal should be inspected frequently to detect early signs of pressure sores [2,25,26]. Blanchable erythema is one of the first clinical signs of inflammation and pressure necrosis and is important in early detection of pressure-sensitive sites and the monitoring of current preventive strategies. Preventive strategies for patients at risk for decubital ulcers include turning the patient every 2 hours, soft bedding or an air mattress or water bed, and the use of doughnuts fashioned from cotton and tape and placed so that the open hole of the donut is over the pressure point to help minimize the pressure and distribute it over a greater surface area.

SPECIFIC TREATMENT TECHNIQUES

Positioning

Positioning in this context describes the use of body position as a specific treatment technique (Fig. 1) [19,27,28]. Positioning for animals in the ICU can be

Fig. 1. Positioning of a dog in sternal recumbency with severe pulmonary contusions and pelvic fractures.

used to optimize oxygen transport through its effects of improving ventilation/perfusion, preventing atelectasis, increasing lung volumes by minimizing abdominal compression, reducing the work of breathing, and enhancing mucociliary clearance [19,27,28]. Positioning can also improve dependent limb edema, help prevent decubital ulcer formation, and improve patient comfort. The most common forms of positioning in recumbent animals are alternating between right and left lateral recumbency every 2 to 4 hours and positioning the animal in sternal recumbency with foam wedges, blankets, or pillows. For animals with unilateral lung disease, depending on its etiology, lying the animal with the affected side up or down can maximize remaining lung capacity and help resolve complicating atelectasis and edema from the dependent lung. In a patient with severe respiratory compromise, supplemental oxygen and close monitoring are necessary to ensure patient safety [27,28]. Attention should be paid to the animal's heart and respiratory rate, oxygen saturation, and demeanor, with periodic blood gas monitoring to detect respiratory decompensation [27,28].

Thoracic Postural Drainage Techniques

Thoracic postural drainage techniques use the position of the animal's body to promote removal of tracheobronchial secretions in animals with pulmonary disease (Fig. 2). Indications for thoracic postural drainage include pneumonia, lung lobe abscess, pulmonary contusions, and atelectasis from prolonged recumbency, mechanical ventilation, generalized weakness, or neurologic impairment. Thoracic radiographs or CT are imperative to guide postural drainage. The animal must be positioned so that the segmental bronchi are vertical to the affected lung to allow drainage of secretions into the larger airways [19,27,29]. By placing the animal's thoracic cavity in an inclined or declined position, the secretions can more easily reach the mainstem bronchi and trachea. Thoracic postural drainage sessions last 5 to 10 minutes performed two to four times

Fig. 2. Thoracic postural drainage. Note the elevated head position to improve left lung lobe drainage.

a day and are dictated by the comfort and tolerance level of the animal [27,28]. Coughing, percussion, and vibration may further enhance the flow up the mucociliary elevator [27,28]. A cough reflex may be elicited via digital pressure on the larynx and proximal portion of the trachea. All animals should be closely monitored for dyspnea and aspiration throughout the procedure, and supplemental oxygen should be available in case of hypoxemia.

Thoracic Percussion and Vibration

Thoracic percussion (coupage) and vibration are manual and mechanical techniques that are intended to promote clearance of airway secretions by the transmission of an energy wave through the chest wall [19,30]. Thoracic percussion is most commonly performed manually by clapping cupped hands on the chest wall over the affected area of the lung (Fig. 3) [19,27,29,31]. Correct technique and positioning over the affected lung segment are more important than the amount of force used, and only the affected lung lobe should be treated, because percussion causes atelectasis even when properly performed [27,29,31]. In an experimental study evaluating the effects of manual and mechanical thoracic percussion in a group of anesthetized, paralyzed, and ventilated dogs, both forms of percussion caused atelectasis based on postmortem and histopathologic evaluation. Despite the presence of atelectasis, gas exchange improved toward the end of percussion based on arterial blood gas analysis [31].

Vibration is also usually applied manually or mechanically by vibrating or pulsating the chest wall during expiration [19,30]. Manual expiratory vibration is performed with the animal in lateral recumbency and involves rapidly rattling the thoracic cavity with locked hands and arms [27]. Clinical studies in humans have shown manual percussion and vibration to be equal or superior to mechanical methods in the removal of proteinaceous material found in the alveoli of patients with pulmonary alveolar protein deposits while undergoing

Fig. 3. Coupage is being performed on a Golden Retriever recovering from aspiration pneumonia. The therapist is standing above the patient with her hands cupped. She is gently and rhythmically tapping the chest of the patient.

whole-lung bronchopulmonary lavage [32]. Each thoracic percussion is usually 3 to 4 minutes in duration followed by vibration on the four to six subsequent expirations [27]. Three to four thoracic percussion/vibration therapy cycles are recommended following each postural drainage session [27]. Contraindications to thoracic percussion and vibration include hemodynamic instability, traumatic myocarditis, a flail chest, rib fractures, pleural space disease (chylo-, pyo-, hemo-, and pneumothorax), thrombocytopenia (<30,000 platelets/μL), open wounds, pain, and pulmonary or thoracic tumors [27].

Suction

The decision to ventilate a patient via endotracheal intubation or a tracheostomy is usually made by the attending clinician [33,34]. Advantages of tracheostomy ventilation in humans are that general anesthesia or heavy sedation is usually not required and the patient can participate in a more active rehabilitation regimen. Suction via an endotracheal tube or tracheostomy is used with the aim of removing secretions from the central airways and stimulating a cough [19,33,34]. Tracheal irritation from protracted intubation, ventilation, and a lack of oronasal mucosa air conditioning leads to increased volume and viscosity of respiratory secretions that will obstruct the trachea and lead to difficult breathing. The full care of mechanically ventilated patients is outside of the scope of this article but should be considered as a part of good general nursing care to maintain pulmonary function.

Mobilization

In general, activity in the ICU and oncologic setting can be divided into therapeutic and nontherapeutic movement [21]. Nontherapeutic movement consists of agitated nonpurposeful behaviors that are random and that have the potential to harm the animal or create an unsafe environment [21]. In these situations, sedation and pain management may be indicated for clinician and animal safety. Therapeutic movement is purposeful and does not injure the animal or create an unsafe condition (such as catheter line dislodgement) [21]. Mobilization is a subset of therapeutic movement that promotes function, prevents disability, and slows the onset of degenerative processes [19,21, 28,35,36]. Mobilization includes range of motion (active and passive), assisted standing, and facilitated walking.

Range of motion

One of the most common low-intensity forms of movement employed in the ICU and oncologic veterinary patient is range of motion. Nevertheless, little is known about the physiologic effects of stretching or range of motion on the muscle in these animals [21]. Generally, range of motion consists of therapeutic movement about a joint to maintain the integrity of the tendon, ligament, articular cartilage, and muscle, and may be passive, active assistive, active restrictive, or active in nature [27,28]. Range of motion is often combined with stretching to lengthen shortened tissue and to decrease muscle stiffness. Chronic effects of stretching include adding sarcomeres to muscle mass in deconditioned muscles [8,9,21,28,37].

In the controlled experimental setting in humans, range of motion does not seem to affect adversely cardiopulmonary parameters. In patients who are critically and systemically ill, limb movements performed passively by a physiotherapist have been shown to result in statistically significant increases in oxygen consumption, heart rate, and blood pressure over baseline values [19,38,39]. Despite these elevated physical parameters, passive range of motion (PROM) activity has been used safely, even in persons with intracranial disease, as long as Valsalva-like maneuvers are avoided [40,41]. In two separate clinical studies evaluating the effects of PROM on human patients with increased or normal intracranial pressure in neurosurgical ICUs, limb movement and PROM did not increase intracranial or cerebral perfusion pressures and in some cases was associated with suppression of abnormal intracranial pressure waves and improved consciousness [40,41].

In recumbent or debilitated animals, PROM should ideally be initiated early in the course of hospitalization. All joints of the appendicular skeleton should be placed through a multiple series of gentle, slow, pain-free cycles of flexion and extension. The length of each session is variable depending on the size of the animal and the level of disability; however, a standard PROM session for the ICU patient usually consists of each joint being flexed and extended

10 to 15 times with the animal fully relaxed and laterally recumbent [28,42]. If a joint is found to be developing a contracture, PROM is performed more frequently on that joint. If the animal can ambulate normally and has a near-normal level of activity, range of motion may not necessary, because normal ambulation with weight bearing is a more intensive form of activity [43]. Because these exercises do not involve any contribution of effort from the animal, PROM will not prevent muscle atrophy or increase muscle strength or endurance, and it has limited effects on peripheral circulation [28,42].

Facilitated standing and assisted walking

Experimental investigations in humans indicate that activity can affect serum levels of selected pro- and anti-inflammatory cytokines [21,44]. Intense prolonged activity that causes epithelial and myocyte stretch and changes in myocyte conformation clearly stimulates cytokine synthesis of tumor necrosis factor alpha (TNF-α), interleukin-1 (IL-1), IL-6, and IL-10 in healthy human athletes [21,44]. Exhaustive or prolonged exercise in humans produces significant increases in levels of TNF-α, IL-6, and IL-10 [21,45,46]. Low-to-moderate levels of exercise have very different effects in the critically ill and can improve blood flow to muscles and joints, inhibiting changes seen with disuse atrophy without concomitant increases in proinflammatory or anti-inflammatory cytokines [11,21,47,48]. Mild therapeutic activity in people improves circulation to myocytes and prevents macrophage infiltration into inactive muscles, consequently reducing the local load of potentially destructive cytokines [7,21]. It has been hypothesized that low levels of activity in the critically ill may prevent ischemia/reperfusion injury with subsequent inflammation, minimizing the risk of multiple organ dysfunction and acute respiratory distress syndrome [21,49].

In the nonambulatory and recumbent animal, facilitated standing and walking with a sling, cart, or therapy ball are important components of rehabilitation. Both movements work to improve circulation and lymphatic drainage. The physical act of standing and ambulation improves and in some cases retains an animal's mobility, functional capacity, and postural balance. The simple act of standing is a complicated activity in compromised patients that involves neuromuscular coordination to maintain normal postural balance and limb position (Fig. 4). Initial exercises are restricted to multiple facilitated stands with a sling or ball for a 1- to 2-minute duration that may be extended to assisted walks with a cart or sling or sessions in an underwater treadmill, with the animal's weight supported by the buoyancy of water or floatation devices.

Hydrotherapy in combination with massage is an excellent method to remove lymphedema and swelling from the distal extremities while relaxing and cleansing the patient. Postoperatively, hydrotherapy may be employed as soon as the surgical incision has established a fibrin seal, generally within 48 to 72 hours from surgery. Whirlpools, swimming pools, or underwater treadmill systems provide a reduced gravity environment that is ideal for performing nonconcussive active assisted exercise. The natural properties of water provide buoyancy and resistance to improve limb mobility and joint range of

Fig. 4. Assisted standing for a dog with a femoral fracture. Note that the animal is supported at either end to prevent falling, and the limb position is adjusted to a normal weight-bearing position.

motion [50]. Caution should be used with any water exercise, particularly with the critically ill, because some dogs dislike water or resist swimming and may become distressed unless acclimatized to the regimen [28,51]. The authors recommend that the therapist accompany the pet in midchest deep water to provide assistance and assurance to the animal until it is accustomed to the activity. At no time should an animal be left unattended during a hydrotherapy regimen, because water aspiration and drowning are real risks.

Massage

Busy effective ICUs can be highly stressful environments. Sick animals in the ICU are often further stressed by prolonged separation from their owners and are subject to continuous high-intensity noise and bright light. In addition to disrupted sleep cycles, the constant and necessary nature of monitoring is often invasive and uncomfortable. Reducing stress for an animal is important to improve patient comfort. One of the most effective means of relaxing an animal and providing a positive stimulus is massage (Fig. 5). In humans, massage seems to decrease stress and provide tactile stimulation. It has been recommended as an intervention to promote growth and the development of preterm and low birth weight infants [52]. In another study in hospice patients, slow-stroke back massage was associated with modest clinical but statistically significant decreases in systolic blood pressure, diastolic blood pressure, and heart rate with an increase in skin temperature [53]. In animals, the effects of massage are undocumented to date, but massage still has a role as a clinical treatment tool because it is benign, noninvasive, and inexpensive to employ [51,54].

In general, massage is the therapeutic manipulation of soft tissues and muscle by rubbing, kneading, or tapping. Benefits of massage include increased local circulation, nerve sedation, reduced muscle spasm, attenuation of edema,

Fig. 5. Massage therapy provides relaxation and socialization for the critically ill and recumbent animal in a hectic and stressful ICU environment.

and break down of irregular scar tissue formation. The physiologic properties of massage stem from reflex and mechanical effects. Reflex effects are based on peripheral receptor stimulation producing central effects of relaxation while peripherally producing muscle relaxation and arteriolar dilation. Mechanical effects include increased lymphatic and venous drainage, removal of edema and metabolic waste, increased arterial circulation enhancing tissue oxygenation and wound healing, and manipulation of restrictive connective tissue, enhancing range of motion and limb mobility.

The most common techniques of massage used in veterinary medicine are effleurage, pétrissage, cross fiber, and tapotement. Effleurage (from the Latin *effluere* meaning to flow out) is a form of superficial or light stroking massage and is generally used in the beginning of all massage sessions to relax and acclimatize the animal. Pétrissage (from the French *pétrir* meaning to knead) is characterized by deep kneading and squeezing of muscle and surrounding soft tissues. Cross-fiber massage is also a deep massage that is concentrated along lines of restrictive scar tissue and is designed to promote normal range of motion [51,55] Tapotement involves percussive manipulation of the soft tissues with a cupped hand or instrument and is often used to enhance postural drainage for respiratory conditions. Contraindications to massage are unstable or infected fractures and the presence of a malignancy; however, in most patients, massage is an indispensable alternate for mobility in the critically ill animal with restricted mobility [56].

Electrical Stimulation

Electrical stimulation is a commonly used modality in rehabilitation and physical therapy. The two most common forms used in the critically ill animal are neuromuscular stimulation for improving range of motion activity, increasing muscle strength, and muscle re-education, and transcutaneous electrical nerve stimulation for modifying pain. Neuromuscular stimulation is indicated in any animal that is exposed to prolonged recumbency owing to systemic illness or neurologic impairment. Neuromuscular stimulation helps prevent disuse atrophy and improves limb performance by recruiting contracting fibers and increasing maximum contractible force of affected muscles (Fig. 6) [51,57]. The electrical stimulation device consists of a pulse generator and electrodes that are placed over selected weakened or paralyzed muscle groups to create an artificial contraction [51,57]. The pulse amplitude, rate, and cycle length may be varied to suit the comfort of the patient [51,57]. Reduction of muscle pain and edema owing to improved blood flow also occurs [51,57]. Combining neuromuscular stimulation with PROM exercises improves joint range of motion and prevents muscle contracture and is particularly indicated when dealing with muscle contracture and limb dysfunction originating from loss of range of motion [51,57]. Furthermore, neuromuscular stimulation is effective in promoting muscle re-education after prolonged disuse. A full discussion of electrical stimulation is outside the scope of this article, and the reader is referred to other texts for a more complete discussion of this modality in veterinary medicine [57].

Adjunct Pain Management

Assessing pain in the veterinary patient is challenging, especially when dealing with the critically ill animal that may be physically unable to display the common behavioral signs indicative of pain (vocalization, postural changes, trembling, restlessness, depression, disrupted sleep cycles, inappetence, aggression, and agitation) [58–61]. Furthermore, the physiologic parameters associated with pain (tachypnea, tachycardia, hypertension, dilated pupils, and ptyalism) may be masked or conversely exacerbated by the primary disease or its therapy [58–61]. Most systemic diseases and oncologic conditions present

Fig. 6. Neuromuscular stimulation in a dog with muscular atrophy owing to a fibrocartilaginous embolus. Note that the electrode has been placed on the rehabilitationist's hand to facilitate pad positioning and to direct the electrical impulse.

Fig. 7. Multimodal pain management in a postoperative hind limb amputee owing to osteosarcoma. Massage, icepacks, assisted standing, facilitated walking, and pharmaceutical intervention were employed in this patient to reduce postoperative pain, manage depression, and regain ambulatory function.

with a series of clinical signs that are arguably related to pain or at least malaise, and such patients would benefit from carefully planned multimodal pain management, in which rehabilitation has a supportive but important role (Fig. 7). Effective multimodal pain management reduces anxiety, decreases stress and its associated hormonal and metabolic derangements, and allows the animal to rest more comfortably.

In human patients, chronic noncancer pain is a common problem that is often accompanied by serious psychiatric comorbidity and disability [62]. Clinical studies in a variety of conditions of chronic pain have highlighted the effectiveness of physical therapy in a multidisciplinary pain management program to improve pain, depression, and disability scores [62,63]. Similarly, veterinary and human oncologists believe that the relief of cancer-related symptoms is essential in the supportive and palliative care of patients [64]. Complementary therapies such as acupuncture, mind-body techniques, and massage therapy can help when conventional treatment does not bring satisfactory relief or causes undesirable side effects [64]. Massage is increasingly applied to relieve pain and nausea symptoms in patients with cancer [65]. This practice is supported by evidence from several small randomized trials and a recent large study performed at Sloan-Kettering. The latter study involved 1290 patients and evaluated the effects of pre- and post-massage therapy on pain, fatigue, stress/anxiety, nausea, and depression using a 0 to 10 rating scale [65]. Symptom scores were dramatically reduced by approximately 50% even for patients reporting high baseline scores [65]. Outpatients improved about 10% more than inpatients. Furthermore, the benefits of massage therapy persisted, with outpatients experiencing no return toward baseline scores throughout the duration of a 48-hour follow-up period [65]. These data indicate that rehabilitation, even in its simplest form of massage therapy, is associated with substantial improvement in the symptom scores of cancer patients [65].

SUMMARY

Rehabilitation should begin as soon as the critically ill animal is stable, before the onset of complications associated with prolonged hospitalization. A proactive approach to rehabilitation in the medical, oncologic, and acute care animal will require less effort and reap greater rewards than one that is in response to a developing crisis. The nature of the treatment is influenced by factors such as the status of the animal, the etiology and extent of the disease, and the facilities, equipment, and trained personnel [66]. Most patients will experience improved recoveries with even simple fundamental techniques such as massage, cold-packing, PROM, and controlled exercise regimens that involve primarily an investment of time and training on the therapist's part.

References

[1] American Physical Therapy Association. Physical therapy and your insurance: a patient's guide to getting the best coverage. Available at: http://www.apta.org. Accessed October 2005.

[2] Allen C, Glasziou P, Del Mar C. Bed rest: a potentially harmful treatment needing more careful evaluation. Lancet 1999;354:1229–33.

[3] Anzueto A. Muscle dysfunction in the intensive care unit. Clin Chest Med 1999;20:1–25.

[4] Chulay M. Should we get patients out of bed who have a pulmonary artery catheter and introducer in place? Crit Care Nurse 1995;15:93–4.

[5] Cirio S, Piaggi G, De Mattia E, et al. Muscle retraining in ICU patients. Monaldi Arch Chest Dis 2003;59:300–3.

[6] Cook D, Attia J, Weaver B, et al. Venous thromboembolic disease: an observational study in medical-surgical intensive care unit patients. J Crit Care 2000;15:127–32.

[7] DeLetter M. Critical illness polyneuropathy and myopathy (CIPNM): evidence for local immune activation by cytokine-expression in the muscle tissue. J Neuroimmunol 2000;106: 202–13.

[8] Gamrin L, Essen P, Forsberg A, et al. A descriptive study of skeletal muscle metabolism in critically ill patients: free amino acids, energy-rich phosphates, protein, nucleic acids, fats, and electrolytes. Crit Care Med 1996;24:575–83.

[9] Griffiths R, Palmer T, Helliwell T, et al. Effect of passive stretching on the wasting muscle in the critically ill. Nutrition 1995;11:428–32.

[10] Helliwell T, Wilkinson A, Griffiths R, et al. Muscle atrophy in critically ill patients is associated with the loss of myosin filaments and the presence of lysosomal enzymes and ubiquitin. Neuropathol Appl Neurobiol 1998;24:507–17.

[11] Hund E. Myopathy in critically ill patients. Crit Care Med 1999;27:2544–7.

[12] Lacomis D, Guiliani M, Cott A. Acute myopathy of intensive care: clinical electromyographic and pathologic aspects. Ann Neurol 1996;40:645–54.

[13] Marinelli W, Leatherman J. Neuromuscular disorders in the intensive care unit. Crit Care Clin 2002;18:915–29.

[14] Nevins M, Epstein S. Prolonged critical illness management of long term acute care. Clin Chest Med 2001;22:1–28.

[15] Nickerson N, Murphy S, Davila-Roman V, et al. Obstacles to early discharge after cardiac surgery. Am J Manage Care 1999;5:29–34.

[16] Norton L, Conforti C. The effects of body position on oxygenation. Heart Lung 1985;14: 45–52.
[17] Polkey M, Moxham J. Clinical aspects of respiratory muscle dysfunction in the critically ill. Chest 2001;119:1–23.
[18] Roebuck A, Jessop S, Turner R, et al. The safety of two-hour versus four-hour bed rest after elective 6-French femoral cardiac catheterization. Coron Health Care 2000;4:169–73.
[19] Stiller K. Physiotherapy in intensive care: toward an evidence-based practice. Chest 2000;118:1801–13.
[20] Tisdale M. Loss of skeletal muscle in cancer: biochemical mechanisms. Front Biosci 2001;6: D164–74.
[21] Winkelman C. Inactivity and inflammation: selected cytokines as biologic mediators in muscle dysfunction during critical illness. AACN Clinical Issues. Advanced Practice in Acute Critical Care 2004;15:74–82.
[22] Lundberg I, Dastmalchi M. Possible pathogenic mechanisms in inflammatory myopathies. Rheum Dis Clin North Am 2002;28:799–822.
[23] Maugham L, Cox R, Amsters D, et al. Reducing inpatient hospital usage for management of pressure sores after spinal cord lesions. Int J Rehabil Res 2004;27:311–5.
[24] Fisher A, Wells G, Harrison M. Factors associated with pressure ulcers in adults in acute care hospitals. Holist Nurs Pract 2004;18:242–53.
[25] Allman R. Pressure ulcers among hospitalized patients. Ann Intern Med 1986;105: 337–42.
[26] Barbenel J, Jordan M, Nicol S. Incidence of pressure-sores in the Greater Glasgow Health Board area. Lancet 1977;ii:548–50.
[27] Manning AM. Physical rehabilitation for the critically injured veterinary patient. In: Millis D, Levine D, Taylor R, editors. Canine rehabilitation and physical therapy. Philadelphia: Saunders; 2004. p. 404–10.
[28] Manning AM, Ellis DR, Rush J. Physical therapy for the critically ill veterinary patient. Part II. The musculoskeletal system. Comp Cont Educ Pract Vet 1997;19:803–7.
[29] Manning AM, Ellis DR, Rush J. Physical therapy for critically ill veterinary patients. Part I. Chest physical therapy. Comp Cont Educ Pract Vet19 1997;675–89.
[30] Pryor J. Mucociliary clearance. In: Ellis E, Alison J, editors. Key issues in cardiorespiratory physiotherapy. Oxford (UK): Butterworth-Heinemann; 1992. p. 105–30.
[31] Zidulka A, Chrome J, Wight D, et al. Clapping or percussion causes atelectasis in dogs and influences gas exchange. J Appl Physiol 1989;66:2833–8.
[32] Hammon W, McCaffree D, Cucchiara A. A comparison of manual to mechanical chest percussion for clearance of alveolar material in patients with pulmonary alveolar proteinosis (phospholipidosis). Chest 1993;103:1409–12.
[33] King LG, Hendricks JC. Use of positive-pressure ventilation in dogs and cats: 41 cases (1990–1992). J Am Vet Med Assoc 1994;204:1045–52.
[34] Campbell V, King LG. Pulmonary function, ventilator management, and outcome of dogs with thoracic trauma and pulmonary contusions: 10 cases (1994–1998). J Am Vet Med Assoc 2000;217:1505–9.
[35] Szaflarski N. Immobility phenomena in critically ill adults. In: Clochesy J, Breu C, Cardin S, et al, editors. Critical care nursing. 2nd edition. Philadelphia: Saunders; 1996. p. 1313–34.
[36] Hoffman K, Shanley JM, Oakley DA, et al. Care and management of the critically ill recumbent animal. Comp Cont Educ Pract Vet 1986;7:110–4.
[37] Hall C, Body L. Therapeutic exercise: moving toward function. Philadelphia: Lippincott; 1999.
[38] Norrenberg M, De Backer D, Moraine J, et al. Oxygen consumption can increase during passive leg mobilization. [abstract]. Intensive Care Med 1995;21:S177.
[39] Weissman C, Kemper M, Damask M, et al. Effect of routine intensive care interactions on metabolic rate. Chest 1984;86:815–8.
[40] Brimioulle S, Moraine J, Norrenberg D, et al. Effects of positioning and exercise on intracranial pressure in a neurosurgical intensive care unit. Phys Ther 1997;77:1682–9.

[41] Koch S, Fogarty S, Signorino C. Effect of passive range of motion on intracranial pressure in neurosurgical patients. J Crit Care 1996;11:176–9.
[42] Coby LA. Range of motion. In: Kisner C, Colby LA, editors. Therapeutic exercise: foundations and techniques. 4th edition. Philadelphia: FA Davis; 2002. p. 24–55.
[43] Bruce W, Frame K, Burbidge H, et al. A comparison of the effects of joint immobilization, twice-daily passive motion, and voluntary motion on articular cartilage healing in sheep. Vet Comp Orthop Trauma 2002;15:23–9.
[44] Pedersen B, Steensberg A, Fischer C, et al. Exercise and cytokines with particular focus on muscle-derived IL-6. Exerc Immunol Rev 2001;7:18–31.
[45] Nieman D. Exercise effects on systemic immunity. Immunol Cell Biol 2000;78:496–501.
[46] Pedersen B. Exercise and cytokines. Immunol Cell Biol 2000;78:532–5.
[47] Sargeant A, Davies C, Edwards R. Functional and structural changes after disuse of human muscle. Clin Sci (Colch) 1977;52:337–42.
[48] Neviere R, Mathiew D, Chagnon J. Skeletal muscle microvascular blood flow and oxygen transport in patients with severe sepsis. Am J Respir Crit Care Med 1996;153:191–5.
[49] Payen D, Faivre V, Lkaszewicz C, et al. Assessment of immunological status in the critically ill. Minerva Anesthesiol 2000;66:757–63.
[50] Payne J. General management considerations for the trauma patient. Vet Clin North Am Sm Anim Pract 1995;25:1015–29.
[51] Taylor R. Postsurgical physical therapy: the missing link. Comp Cont Educ Pract Vet 1992;12:1583–94.
[52] Vickers A, Ohlsson A, Lacy J, et al. Massage for promoting growth and development of preterm and/or low birth-weight infants. Cochrane Database Syst Rev 2004;(2). CD000390.
[53] Meek S. Effects of slow stroke back massage on relaxation in hospice clients. Image J Nurs Sch 1993;25:17–21.
[54] Ogilvie G, Robinson N. Complementary/alternative cancer therapy—fact or fiction? In: Ettinger S, Feldman E, editors. Textbook of veterinary internal medicine: diseases of the dog and cat. 5th edition. Philadelphia: Saunders; 2000. p. 374–9.
[55] Taylor R, Lester M. Physical therapy in canine sporting breeds. In: Bloomberg M, editor. Canine sports medicine and surgery. Philadelphia: WB Saunders; 1998. p. 265–75.
[56] Langer G. Physical therapy in small animal patients: basic principles and application. Comp Contin Educ Pract Vet 1984;6:933–6.
[57] Johnson J, Levine D. Electrical stimulation. In: Millis D, Levine D, Taylor R, editors. Canine rehabilitation and physical therapy. Philadelphia: Saunders; 2004. p. 289–302.
[58] Paddleford R. Analgesia and pain management. In: Manual of small animal anesthesia. 2nd edition. Philadelphia: WB Saunders; 1999. p. 227–46.
[59] Hendrix P, Hansen B, Bonagura J. Acute pain management. In: Kirk's current veterinary therapy XIII: small animal practice. Philadelphia: WB Saunders; 2000. p. 57–61.
[60] Hansen B, Mathews KA. Management of pain. Vet Clin North Am Sm Anim Pract 2000;30: 899–916.
[61] Lamont L. Feline perioperative pain management. Vet Clin North Am Sm Anim Pract 2002;32:747–63.
[62] Chelminski P, Ives T, Felix K, et al. A primary care, multi-disciplinary disease management program for opioid-treated patients with chronic non-cancer pain and a high burden of psychiatric comorbidity. BMC Health Serv Res 2005;13:3.
[63] Goldenberg D, Burckhardt C, Crofford L. Management of fibromyalgia syndrome. JAMA 2004;295:2388–95.
[64] Deng G, Cassileth B, Yeung K. Complementary therapies for cancer-related symptoms. J Support Oncol 2004;2:419–26.
[65] Cassileth B, Vickers A. Massage therapy for symptom control: outcome study at a major cancer center. J Pain Symptom Manage 2004;28:244–9.
[66] Downer A, Spear V. Physical therapy in the management of long bone fractures in small animals. Vet Clin North Am Sm Anim Pract 1975;5:157–64.