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A walk on the wild side: a review of physiotherapy for exotics and zoo animals

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ABSTRACT: When considering physical rehabilitation (physiotherapy) for exotic and zoo animals, it is necessary to recognise painful behaviours in these patients prior to initiation of therapy. Once a creative treatment plan has been formulated, operant conditioning may be utilised in executing the various therapies. This article attempts to document therapies that have been used on various species that do not fall under the category of those normally receiving physiotherapy.

Keywords: physiotherapy; pain; distress; physical rehabilitation modalities; learning

Introduction

Physical Therapy is a protected term in many states in the USA. Only licensed physical therapy professionals may use this term. Success with human patients receiving post-operative physical therapy has galvanised the veterinary community into developing physical rehabilitation techniques that can be implemented for animal patients (Goldberg, 2018). Therefore, the term Veterinary Physical Rehabilitation is commonly utilised in the USA. This terminology may vary based on the country where you practice.

The use of physical rehabilitation for patients other than canine, feline and equine species is individualised. There are not huge amounts of evidence-based literature about exotics and zoo animals. Most literature is either anecdotal or case-based studies. One fact that is known is that the painful animal will be highly resistant to any manipulations that are attempted. With some of these animals, it is dangerous to try anything even when they are not in pain. Thus, recognition of painful patients is necessary (Goldberg, 2017).

Recognition of pain and distress in various species

There are numerous stereotypical responses to stress or pain stimuli in animals, particularly in mammals (Clark, Rager, & Calpin, 1997). Recognition of changes in behaviour and physical appearance in the species under study will allow early identification of an animal experiencing pain or distress. As caregivers, humans may know that an event or situation is no threat, but the animal usually does not function with the same information base as humans.

Personal observations of key signs for various species listed by the author (Table 1). Pain affects every single living creature from pomace flies *Drosophila melanogaster* (Tracey, Wilson, Laurent, & Benzer, 2003) to marine mammals (Haulena & Schmitt, 2018). The nociceptive process has been shown from invertebrates through mammals. The Veterinary Pain Short Course, 2018 (https://cme.ucsd.edu/vetpain/) meeting is unique in veterinary medicine for its emphasis

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Table 1. Recognition of pain and distress in various species.

Species	Key signs	References
Mice – see Figure 1	Withdrawal, biting response, piloerection, hunched back, sunken eyes and abdomen, dehydration, weight loss	Langford, 2010; Malik & Leach,2017
Rats – see Figure 2	Vocalisation, struggling, licking/guarding, weight loss, piloerection, hunched position, hypothermia	Carstens & Moberg,2000; Malik & Leach, 2017
Guinea pigs	Withdrawal, vocalisation, failure to resist restraint, staring coat, unresponsive	Carstens & Moberg,2000; Gaertner, Hallman, Hankenson, & Batchelder,2008
Mongolian gerbils	Hunched appearance, weight loss, shock syndrome (fear or surprise may cause convulsions)	Carstens & Moberg,2000; Gaertner et al.,2008
Syrian (golden) hamsters	Weight loss, hunched appearance, increased aggression or depression, extended sleep periods	Carstens & Moberg,2000; Gaertner et al.,2008
Rabbits – see Figure 3	Reduced eating and drinking; faces towards back of cage, limited movement, and apparent photosensitivity, tooth-grinding	Johnston, 2005; Carbone & Austin,2016
Ferrets – see Figure 4	Stiff posture, demented behaviour, lack of grooming, hunched head and neck, and inappetence	Johnston,2005; Ko & Marini,2014; Johnson-Delaney,2017
Birds	Escape reactions, atonic immobility, inappetence and avoidance of use of pain site	Murphy & Ludders,2001; Lichtenberger & Ko,2007; Petritz,2017
Reptiles	Flinching and muscle contractions, weight loss, anorexia	Mosley,2011; Malik,2018
Amphibians	Muscular movements, closed eyes, colour changes, rapid respirations, immobility and anorexia	Machin, 1999; Stevens,2011
Fish	Abnormal swimming behaviour, attempting to jump out of water, rapid opercular movements, clamped fins, pale or darkened colour, hiding. Anorexia is the first sign	Neiffer & Stamper,2009; Posner,2009; Sneddon,2012
Invertebrates	Rapid withdrawal	Mosley & Lewbart,2014; della Rocca, Di Salvo, Giannettoni, & Goldberg, 2015
Zoo animals – see Figure 5	Behavioural changes, appetite changes, animal isolation from their group or pack, aggression, lameness, unkempt appearance, or lowered head	Whiteside,2014; Boothe et al,2016
Non-human primates	Hunched position, failure to groom, refusal of food or water, dejected appearance	Wolfensohn & Honess,2005; Murphy, Baxter, & Flecknell,2012
Domesticated species		
Dog – see Figure 6	Whimpers, howls, growls, cowers, crouches, recumbent, reluctant to move; awkward, shuffles	Kata, Roland, & Goldberg,2015
Cat	Generally silent; may growl or hiss, stiff, hunched in sternal recumbency, limbs tucked under body, reluctant to move limb, carry limb	Kata et al.,2015
Horse	Grunting, nicker, rigid; head lowered, reluctant to move, walk in circles, "up and down" movement, restless, depressed	Kata et al.,2015
Cow	Dull, depressed, inappetence, grunting, grinding of the teeth, and rigid posture	Kata et al.,2015
Sheep	Rigid posture and reluctance to move, tooth-grinding	Kata et al.,2015
Goat	Rigid posture and reluctance to move, tooth-grinding, vocalisation	Kata et al.,2015
Pig	Vocalisation and the lack of normal social behaviour may be helpful indicators of a pig in pain	Kata et al.,2015

upon fundamental (basic) principles and mechanisms of pain as they pertain to the veterinary patient. The 2018 meeting reviewed the evolution of pain behaviour and neuroanatomic substrates. Species discussed went from worms and flies (drosophila) to molluscs, cephalopods, reptiles, birds and mammals up to man. The literature clearly shows that while not every animal may have the cognitive abilities of man, they can all certainly respond to an aversive stimulus.

Physical rehabilitation common to canine, feline and equine patients

Physiotherapy is the treatment of injury or illness to decrease pain and restore function. Rehabilitation is used to address acute injuries and chronic injuries or diseases that have been affecting a patient for a long time (Goldberg, 2018). 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 (Goldberg, 2018).

Details about physiotherapy techniques for the veterinary nurse can be found in Goldberg (2018). The reader is referred to this textbook for details about each therapy mentioned.

Below are listed the various forms of Physiotherapy used with veterinary patients.

- **Therapeutic exercises** (Coates, Zink, & Van Dyke, 2013) – 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 (see Figure 6).
- **Manual techniques** (Millis & Levine, 2014; Saunders, Walker, & Levine,

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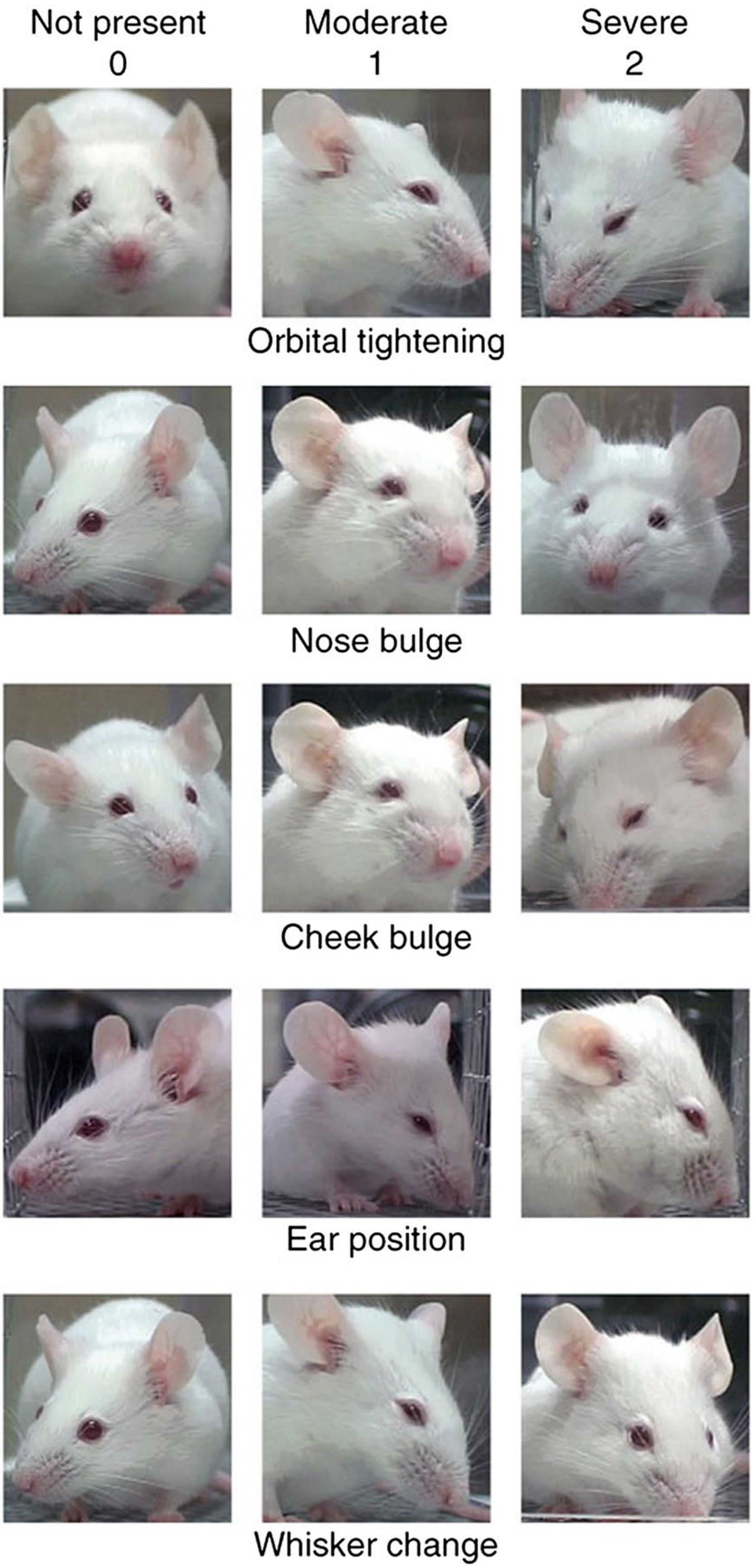

Figure 1. Mouse Grimace Scale progression of pain in mouse face. Langford,2010.

2014; Sutton & Whitlock, 2014) – techniques used can include joint mobilisations, massage, passive range of motion (PROM), active range of motion (AROM) and stretching. In the USA, veterinary technicians/ nurses are prohibited from performing joint mobilisations; therefore, they must be carried out by the rehabilitation veterinarian or the rehabilitation-certified physical therapist.

- **Physical modalities** (Niebaum, 2013; Goldberg, 2018) – can be used as tools to manage pain, weak muscles,

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Figure 2. Rat Grimace Scale progression of pain in a rat face. Sotocinal et al.,2011.

inflexibility, limited joint ROM and to aid in tissue healing. Physical modalities include the following:

- superficial thermal agents – hot (thermotherapy) and cold (cryotherapy) (Tomlinson & Goldberg, 2018)
- neuromuscular electrical stimulation (NMES) – usually used to address muscular weakness (Sprague & Goldberg, 2018)
- transcutaneous electrical nerve stimulation (TENS) – used for pain relief (Sprague & Goldberg, 2018)
- therapeutic ultrasound – a deep heating technique used for rehabilitating musculoskeletal conditions (Medina & Davies, 2018)
- low-level laser therapy (LLLT) or therapeutic laser – using (non-surgical) lasers to accelerate wound healing, promote muscle regeneration, treat acute and chronic pain, chronic and acute oedema and neurologic conditions (Shaw & Brown, 2018)
- extracorporeal shockwave therapy (ESWT) – to increase bone, tendon and ligament healing, accelerate wound healing and provide antibacterial properties and pain relief (Stramel & Stramel, 2018)
- 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, Bonasia, & Marmotti, 2015). The main therapeutic purpose is for enhancement of bone or tissue healing and pain control (Sprague & Goldberg, 2018).

Learning (Cheng, 2016)

Associative learning is so called because in this type of learning, the animal connects (associates) two types of events. The prevailing view is that one event predicts another event for the animal. In classical conditioning, the animal connects two events in the world, using one event to predict another event. In operant conditioning, the animal learns to connect its own behaviour to consequences. In addition, it needs to learn the circumstances under which a behaviour brings a consequence. That is, a behaviour will "work" only in particular conditions. The appropriate use of operant conditioning can greatly

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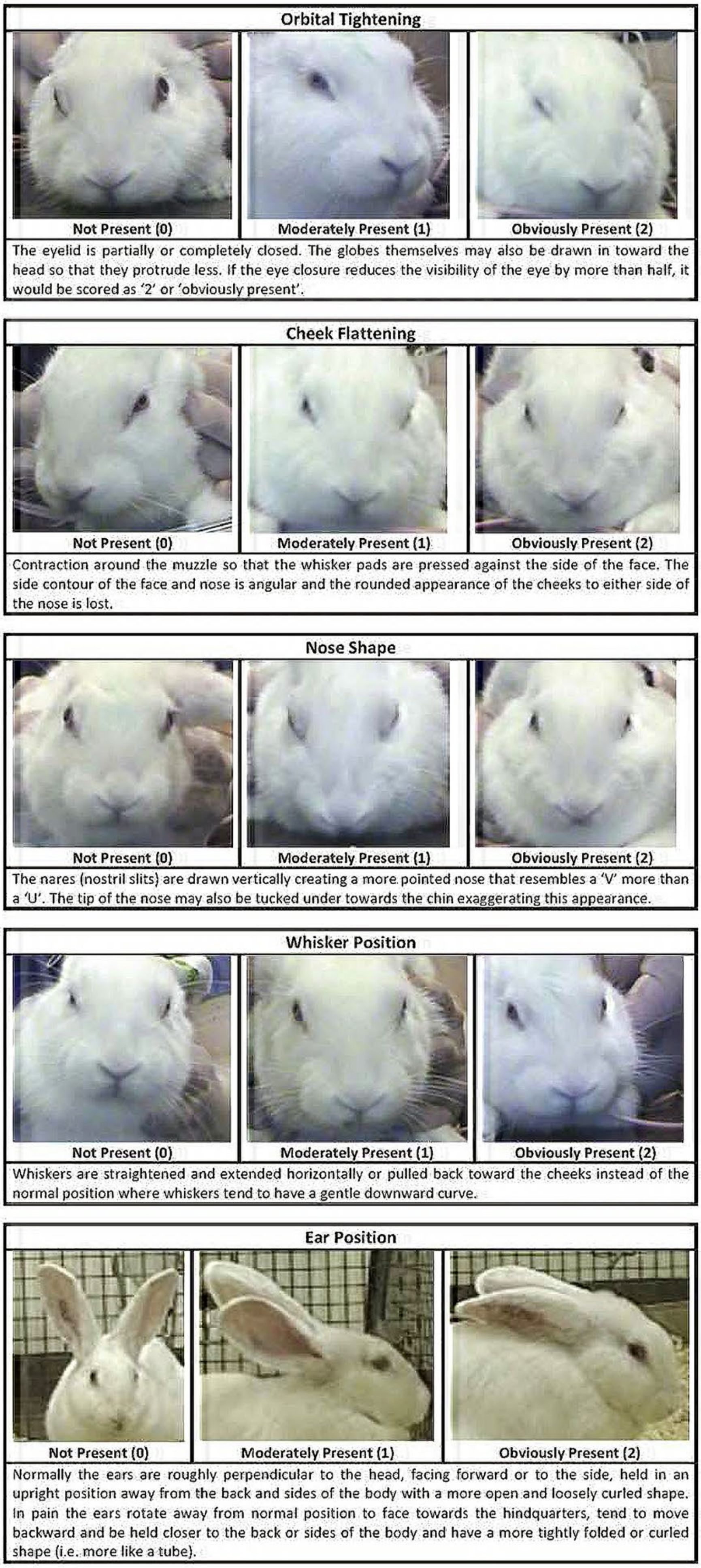

Figure 3. Rabbit Grimace Scale progression of pain in a rabbit face. Keating, Thomas, Flecknell, & Leach, & Leach, 2012.

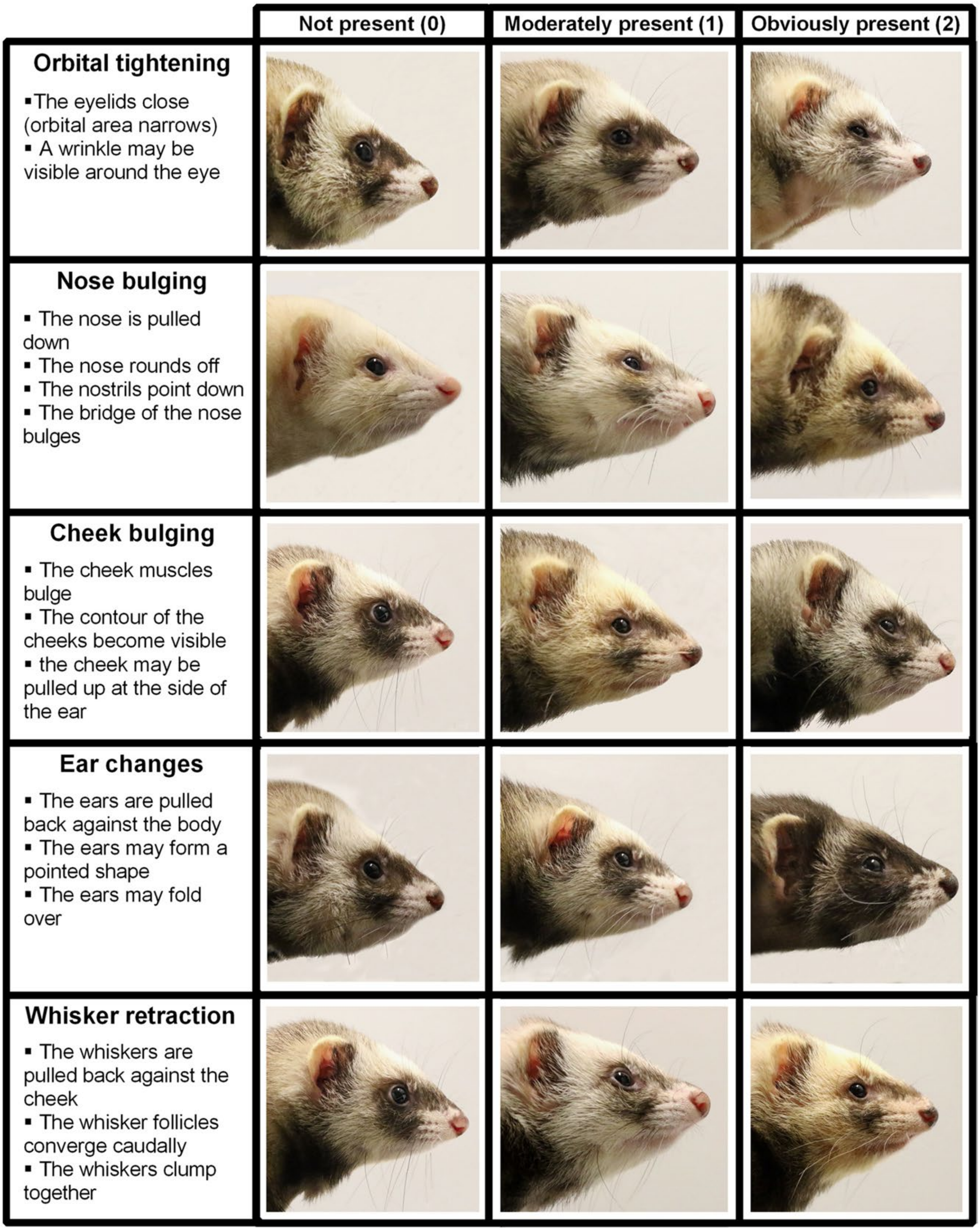

Figure 4. Ferret Grimace Scale progression of pain in a ferret face. Reijgwart et al.,2017.

facilitate examination and administration of medications when it is used to train zoo animals to reliably exhibit specific behaviours (Crowell-Davis, 2008). In working with zoo animals, positive reinforcement, in which the animal repeats a behaviour because it learns that the behaviour results in a specific, desirable or pleasant consequence, is most commonly used. The primary operant conditioning technique used to train zoo animals is called shaping. In shaping via positive reinforcement, the animal is reinforced for behaviours that are progressively more and more like the desired end behaviour. Training requires weeks of regular practice and must be maintained through regular reinforcement of the desired behaviours. Usually, food is the best reinforcer. It must be highly motivating and appropriate to the individual animal and the species (Crowell-Davis, 2008). In the use of physiotherapy for zoo animals, operant conditioning allows them to receive the benefits of the physiotherapy techniques administered, while

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Figure 5. Elephant depression noticing downcast head and eyes plus lax trunk. Courtesy Stephen Cital.

associating a pleasant reward (mostly food) with the therapy. The discovery of classical conditioning is attributed to the Russian physiologist Ivan Pavlov (1849–1936).

In operant conditioning, often called instrumental conditioning, the animal learns to do things for their consequences. Edward Lee Thorndike (1874–1949) is credited as a pioneer in operant conditioning.

Physical rehabilitation

Creativity is essential for exotic and zoo animal physical rehabilitation. In the case of zoo animals, the zookeeper (person who attends to the daily feed, water, comfort and hygiene of the animal) can be employed in the Home Exercise Program (HEP). Exercises such as weight-shifting, balance blocks and discs, cavaletti rails, physioballs, treadmills and wobble boards can be taught through use of associative learning: classical conditioning or operant conditioning.

Because creativity is going to play a huge role in physical rehabilitation for exotics and zoo animals, begin by looking at documented studies for what has been used in various species. Most of these studies have been performed in lab animal research.

Mice – experimentally, mice have been used in human research with land treadmills (Al-Jarrah et al, 2007). Running wheels are a good way to increase mouse strength and endurance. Little planks, wobble boards or rocker boards can be made for mice. Swimming experiments have been conducted in mice (Can, 2012).

Cavaletti rails have been made for mice as well as weave cones. Massage and PROM can be used in mice. Depending upon the size of the laser head, laser therapy has been used in mice experimentally. (Trawitzki, Lilge, de Figueiredo, Macedo, & Issa, 2017).

Rats – experimentally, rats have been used in human research with land treadmills (Selin Cevik, 2018). Little planks, wobble boards or rocker boards can be made for rats. Cavaletti rails have been made for rats as well as weave cones. Massage and PROM can be used in rats. Swimming experiments have been conducted in rats (Alaei, Moloudi, & Sarkaki, 2008). Experimentally, therapeutic laser has been used in rats (de Oliveira, 2018).

Rabbits – experimentally, rabbits have been used in human research with land treadmills (Thu, Kim, & Han, 2017). Equipment used for physical rehabilitation in cats can be utilised on rabbits. Massage and PROM can be used in

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Figure 6. Dog being worked over cavaletti rails by Mary Ellen Goldberg. Courtesy Mary Ellen Goldberg.

rabbits. Swimming experiments have been conducted in rabbits (Thu et al., 2017). Underwater treadmills have been utilised in rabbits. Experimentally, therapeutic laser has been used in rabbits (Wang et al., 2014).

Ferrets – experimentally, ferrets have been used in human research with land treadmills (Raichlen, Foster, Gerdeman, Seillier, & Giuffrida, 2012). Equipment used for physical rehabilitation in cats can be utilised on ferrets. Massage and PROM can be used in ferrets. Swimming experiments have been conducted in ferrets (Fish & Baudinette, 2008). Experimentally, therapeutic laser has not been used in ferrets; however, guidelines exist in the literature (Mayer & Ness, 2017).

Birds – equipment used for physical rehabilitation in dogs and cats can be utilised on birds, especially duck and chickens. Cavaletti rails and weave cones have been used in birds. Massage and PROM can be used in birds. Small perching birds can have exercises for their legs and feet with grasping. Laser therapy has been utilised in many bird species like macaws, cockatoos, budgerigars, chicken and ducks (Ness & Mayer, 2017) (Figure 7).

Reptiles – equipment used for physical rehabilitation in dogs and cats can be utilised on turtles or tortoises. Experimentally, treadmills have been used on land and water tortoises (Landberg, Mailhot, & Brainerd, 2003; Pankaew & Milton, 2018). Therapeutic laser has been used on snakes, turtles and lizards (Mayer & Ness, 2017) (Figures 8 and 9).

Aquatic species – Therapeutic laser has been used in aquatic mammals, birds, invertebrates and fish (Stremme, 2017). In the case of penguins, physical rehabilitation equipment that is used in dogs and cats could be effective. With aquatic mammals such as dolphins (Manire et al., 2018) and manatees (Cray, Dickey, Brewer, & Arheart, 2013) or whales (Smith, Pacini, & Nachtigall, 2018), it is common for them to undergo rehabilitation from injury or stranding with the objective to be released back into the wild. Rehabilitation devices have been made for fish species when they have suffered from swim bladder disease (Anderson 2013; Robson, 2013).

Non-human primates – experimentally, non-human primates have been used in human research with land treadmills (Capogrosso et al., 2016). Equipment used for physical rehabilitation in dogs and cats can be utilised on non-human primates. Massage and PROM can be used in non-human primates.

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Figure 7. Duck being worked over cavaletti rails. Courtesy Wendy Davies.

No swimming experiments have been conducted in non-human primates. However, swimming pools have been used as environmental enrichment for captive macaques (*Macaca* sp.) (Robins & Waitt, 2011). The swimming behaviour of bonnet macaques has been described (Agoramoorthy, Smallegange, Spruit, & Hsu, 2000). Experimentally, therapeutic laser has not been used in non-human primates; however, guidelines exist in the literature (Boesch, 2012).

Zoo animals – here is where your mind is your limit, so to speak. The author has attempted to provide a brief review of literature for what has been previously attempted.

Physical rehabilitation of a lesser flamingo was successfully accomplished by using swimming and a support sling for developing the ability to regain strength to walk (McEntire & Sanchez, 2017). Progression of therapy consisted of bird being placed in modified sling; two 30-minute swimming sessions added; bird assisted to a standing position every 12 hours; bird standing on its own; use of sling discontinued.

Physical rehabilitation following surgery for angular hind limb deformity of a 2-year-old neutered male pet serval cat is noted (Summa, Eshar, Bichot, Smith, & Moens, 2015). Nutrition was addressed as well as the surgical procedure. A right tibial corrective osteotomy was followed by internal rotation and

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Figure 8. Theraband™ use in a Komodo dragon. Courtesy Stephen Cital.

Figure 9. Theraband™ use in a Komodo dragon. Courtesy Stephen Cital.

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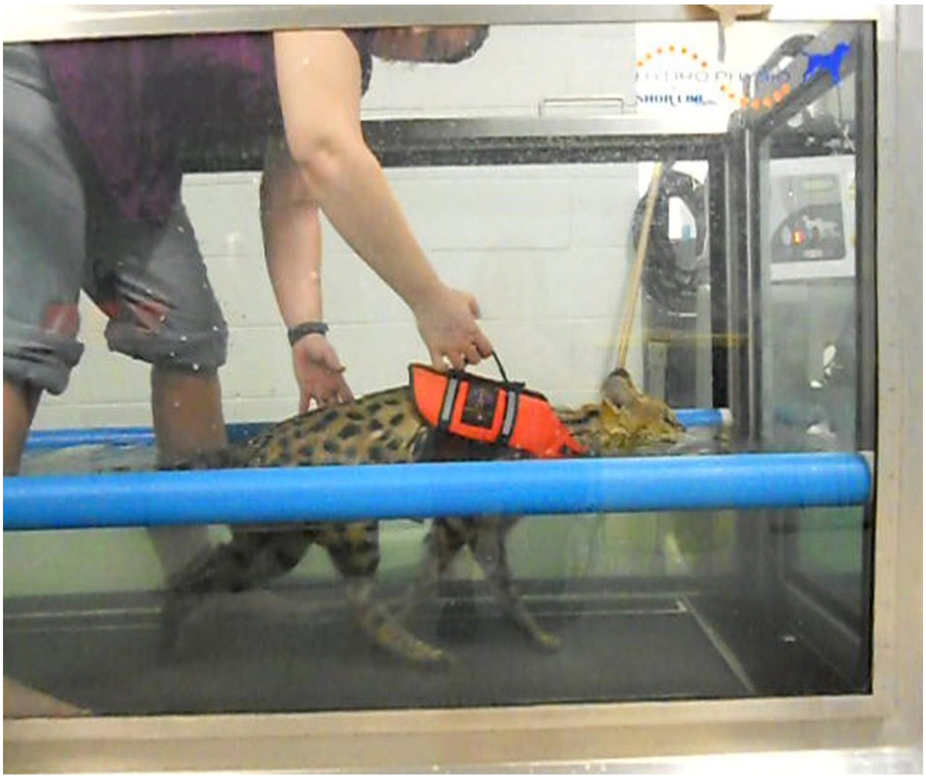

Figure 10. Serval cat in an underwater treadmill. Courtesy Dawn Hickey.

Figure 11. Clouded leopard in a hyperbaric oxygen chamber. Courtesy Dawn Hickey.

stabilisation with a 2.7mm eight-hole locking compression plate and locking screws. Manipulation of the hind limbs showed no general valgus or varus deformity, but bilateral external rotation of the toes was confirmed and measured with a goniometer. Analgesics, bandaging and mild exercise were prescribed post-operatively. On re-evaluation 4 weeks later, the serval showed marked improvement in posture and gait (Figure 10).

Physical rehabilitation as adjunctive treatment has been performed on a Komodo dragon (Wolfe, et al., 2015). The patient has osteoarthritis that has worsened over the years. It was managed on and off by meloxicam, tramadol and gabapentin until analgesic treatment was no longer effective by itself. A physical therapist was brought in and she chose to use Wolfe Kinetic Technique™, which is a very gentle manual technique that is performed with the intent of changing movement patterns in a way that spreads out the work load of the body when the patient performs functional activities (Wolfe, 2012). In this Komodo dragon, initial treatment was on the thoracic spine, branching out into the scapular stabilisers, lumbar spine and pelvis. Keepers were instructed to perform daily, gentle, manual lateral rocking of the pelvis for 3–5 min. By the tenth treatment, keepers reported that the animal was able to easily negotiate a 12-inch step between the exhibits, an action which had not been observed for several years.

This case describes the diagnosis and successful treatment of symptoms in a couded leopard (*Neofelis nebulosa*) cub with swimmer-type syndrome (Nájera et al., 2014). The cub presented at 32 days of age unable to adduct both hind limbs and presented hyperextension of both tarsal joints. The treatment focused on gentle flexion and extension movements of the coxo-femoral, femoro-tibial and tibio-tarsal joints. Massaged areas included the main muscle groups of both hind limbs, working the thumb and index fingers from proximal to distal and vice versa. The cub appeared to tolerate the manipulation well and often rested during the procedure. For thermotherapy, warm water-soaked gauze was applied to both hind limbs twice daily for 10-minute periods. To prevent abduction of both hind limbs, a soft gauze bandage was applied as a hobble. At the seventh day of treatment, splints were provided to keep the limbs in normal alignment. All bandages were changed at least once a day and if soiled. After 3 days of splint application, the cub was able to stand and walk with the bandages. After 21 days of treatment, the cub was able to stand, walk and run with no bandages. At 5 months of age the cub was displaying normal locomotive behaviour (Figure 11).

Laser therapy or photobiomodulation has been described in the literature (Dadone & Harrison, 2017). Operant conditioning is especially beneficial for patients that are too large or dangerous to restrain manually. This therapy has been shown to reduce inflammation, reduce pain and promote healing in laboratory animals and in some domestic species (Draper, 2012; Pryor & Millis, 2015). Treated patients have been described (Dadone & Harrison, 2017) and are:

- Pododermatitis (bumblefoot) in Magellanic penguins (*Spheniscus magellanicus*)
- Chronic pododermatitis in ducks
- Chronic pododermatitis in red-tailed hawk (*Buteo jamaicensis*)
- Wing tip lesions in taptors
- Keel wound in a bald eagle (*Haliaeetus leucocephalus*)
- Pododermatitis in rabbits
- Complications from declaw surgeries in both a caracal (*Caracal caracal*) and a serval (*Leptailurus serval)* healed well when management included laser therapy
- Hygromas in three 2-year-old Amur tigers (*Panthera tigris altaica*) were successfully managed
- Cheek-patch dermatitis in an Asian elephant (*Elaphas maximus*)
- A trunk laceration in an Asian elephant (*Elaphus maximus*)

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Figure 12. Rabbit laser therapy, Courtesy Wendy Davies.

Figure 13. Rooster laser therapy for congenital feet deformities. Courtesy Dr Carolina Medina.

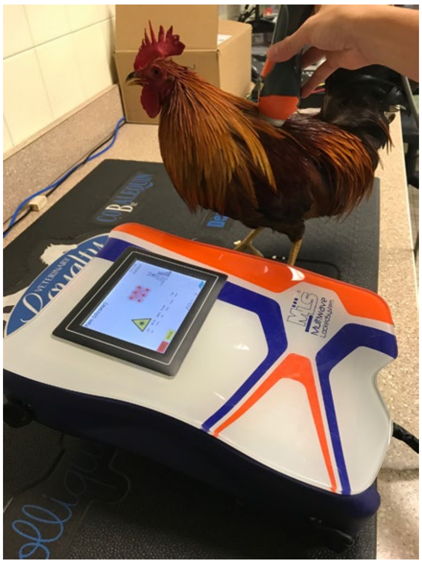

Figure 14. Rooster laser therapy for a deviated spine. Courtesy Dr Carolina Medina.

- Wound healing in bearded dragons (*Pogona vitticeps*)
- Septicaemic ulcerative dermatitis in a soft-shelled turtle (*Pelodiscus sinensis*)
- Shell lesions in a western pond turtle (*Actinemys marmorata*)
- Skin lesions in two mata mata turtles (*Chelus fimbriata*)
- Extensive thermal burns in a savannah monitor (*Varanus exanthematicus*)
- Lameness in an ostrich (*Struthio camelus*)
- Acute-onset torticollis in a 2-year-old male reticulated giraffe (*Giraffa camelopardalis reticulata*) showed marked clinical improvement using a combination of medical management, chiropractic adjustments, laser therapy and ROM exercises
- Nutritional metabolic bone disease and subsequent fractures in a 5-year-old spayed striped skunk (*Mephitis mephitis*)
- Acute-onset paresis in a Komodo dragon (*Varanus komodoensis*)
- A spinal cord injury in a bearded dragon (*Pogona vitticeps*) showed clinical improvement with multi-modal treatments that included laser therapy
- A closed distal metacarpal fracture in an orphaned newborn mountain bongo (antelope, *Tragelaphus eurycerus isaaci*)
- An acute presentation of severe front-leg lameness in an African elephant (*Loxodonta africana*) was managed with multimodal therapies that included laser therapy
- Four adult or geriatric gorillas (*Gorilla gorilla*) were treated with laser therapy for arthritis pain

Described is laser therapy for dental disease, musculoskeletal injuries and disease (birds and mammals), such as osteo-arthritis, lumbosacral disease and spondylosis (Dadone & Harrison, 2017) (Figures 12–17).

Conclusion

While massive amounts of published literature are not available, with what has been presented, one can only believe that to use therapeutic exercises, manual therapies and physical modalities on exotics, livestock and zoo patients all depends on the user's imagination. Pain management, acupuncture and physical rehabilitation are evidence-based for companion animals and equine patients. It stands to reason that eventually it will be so for all veterinary patients, no matter the species.

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Figure 15. A slender-tailed Meerkat receives voluntary laser therapy for arthritis from zookeeper Kirsten Kjorsvig and Janelle Brandt, RVT at the Great Plains Zoo in Sioux Falls, SD. The meerkat enters the box enclosure with inducement from treats. The box enclosure is to hold the meerkat in place for a specific area to receive laser therapy. It is not restrained in this box. Should the meerkat choose to leave the box, it can. This is an example of operant conditioning for a task with a zoo animal.

Figure 16. Janelle Brandt, RVT from the Great Plains Zoo in Sioux Falls, SD, performs voluntary laser therapy on a reticulated giraffe for arthritis relief.

Figure 17. Dr Anne Burgdorf and zookeeper Kirsten Kjorsvig from the Great Plains Zoo in Sioux Falls, SD, perform voluntary laser therapy to heal the wound of an eastern black rhino.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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