A special thanks to all of our generous sponsors that have made the 2019 Four Corners Veterinary Symposium possible!
MY WORLD JUST ISN’T THE SAME

UPSIDE DOWN

Credelio (lotilaner)

For more information, visit Credelio.com or speak with your Elanco representative today.
Are you looking for a caring, dignified, and respectful way to honor your beloved companion? At Albuquerque Pet Memorial Service, Inc. we offer a wide selection of urns, keepsakes, and jewelry to create the perfect memorial for your best friend. Our caring and professional staff are ready to care for you and your family in your time of need. We offer free home removal, Equine included, in Albuquerque and Corrales (a pick-up fee is applicable outside of these areas). We also pick up and deliver, free of charge, from and to ANY veterinary clinic in our service area (charges may apply for Equine services). Our service area extends as far North as Taos, as far West as Gallup, East Mountains, as far South as Truth or Consequences, and everything in between! We also highly respect and offer discounts to our Military (both active duty and veteran) and their families, first responders, rescue and foster families, senior citizens and more!

www.albuquerquepetmemorial.com
A FIRST-OF-ITS-KIND NUTRITION THAT FOCUSES ON MICROBIOME HEALTH,
NEW Hill’s® Prescription Diet® Gastrointestinal Biome with ActivBiome+™ Technology revolutionizes the way you address fiber-responsive Gi issues.

GREAT-TASTING NUTRITION SHOWN IN CLINICAL STUDIES TO:

1. Resolve diarrhea in as little as 24 hours and promote healthy stool1
2. Limit future episodes of diarrhea in 100% of dogs1
3. Nourish and activate the microbiome to release beneficial anti-inflammatory and antioxidant compounds2

Ask your Hill’s rep about this revolutionary, great-tasting nutrition.
Learn More: HillsPet.com/Microbiome

1Hill’s data on file. Two-month clinical study evaluating dogs with chronic diarrhea. 2Hill’s data on file. Clinical study on microbiome changes in dogs.
©2019 Hill’s Pet Nutrition, Inc. ®/™ Trademarks owned by Hill’s Pet Nutrition, Inc.
Introducing the latest advancement for in-clinic chemistry testing.

Meet the all new Heska Element DC5X™ Veterinary Chemistry Analyzer. In contrast with other chemistry solutions, Element DC5X is a true professional grade instrument that can easily and quickly handle five times the workload. Element DC5X supports two-way communication with practice management systems, one-touch patient and panel selection, multiple sample “load and go” freedom, and the highest levels of process and quality automation. Contact your Heska representative to step up to Professional Grade clinical chemistry. Your time, your team, your confidence, and your patients will thank you.

Element DC5X is the new, undisputed leader in clinical confidence and speed for high-volume, specialty and group practices.

www.heska.com  800.464.3752
©2018 Heska Corporation. All Rights Reserved. Specifications and appearance may be changed without notice. HESKA is a registered trademark and Element DC5X is a trademark of Heska Corporation. FUJIFILM is a registered trademark of FUJIFILM Corporation 18A00883
WITH CARECREDIT, COST WON'T COME BETWEEN YOU AND YOUR RECOMMENDED CARE.

The CareCredit credit card gives clients a way to pay for the care you recommend. CareCredit can be used for everything from exams and lab tests to surgery, pet food, medicine and parasite control.* In addition, 94% of cardholders are highly satisfied with CareCredit.

Already enrolled? Call 800-859-9975, option 1, then 6, to learn how CareCredit can help more pets get the care they need.
To get started with CareCredit, call 844-812-8111 and ask for the one-time enrollment fee of $59 by Oct. 31, 2019.

*Subject to credit approval. 1: Cardholder Engagement Study, Q2 2018.
We are the 24/7 solution for your Veterinary Practice

Software and hardware management for the tools of your trade:

- PACS
- XRAY
- DICOM
- Ultrasound
- All Other Cloud Solutions

505-938-9520

We support all practice management software including:

- Henry Shein
- ezyVet
- IDEXX
- AVImark

Rook Advisors
Helping you make the right moves
info@rookadvisors.com
www.rookadvisors.com
MENALU COMPOUNDING PHARMACY - Veterinary Compounding & Sterile Veterinary Compounding

Menaul Compounding Pharmacy is an independently owned pharmacy in Albuquerque, New Mexico, where compounding is our specialty. We are able to compound a large variety of medications specifically tailored to pets' needs. By way of training, equipment, technology, and chemicals, we can customize dosages and strengths, eliminate preservatives, make combination drugs, change flavors and colors, and customize formulations and routes of delivery. Our ingredients used for compounding comply with strict guidelines to always ensure the highest quality product. Our priority is to fill each and every prescription with great care and precision and to consistently provide one hundred percent satisfaction and excellent service to our customers.

Veterinary doctors' offices can fax or phone in prescriptions. We also provide shipping for our customers to make it as easy and convenient to do business with Menaul Compounding Pharmacy. We encourage you to experience the quality, expertise, competitive pricing and friendly service of our pharmacy.

Menaul Compounding Pharmacy is able to:
- Customize Dosages & Strengths
- Compound Discontinued Pet Medications
- Prepare Sterile Veterinary Compounds

We also provide:
- Flavored Liquids and Capsules
- Ophthalmics
- Otics
- Transdermal Gels

---

ROYAL CANIN

THE ONLY CHOICE YOU NEED TO MAKE.

TWO CONDITIONS. ONE SOLUTION

SACRIFICE + STIMULATING PERFORMANCE

Managing your pet's nutritional needs is already a big job, and an important one, you're sure to appreciate the added challenge. Making a decision about what diet best performs both conditions simultaneously is a herculean task, and an overwhelming burden on the client. Canin offers a solution.

Now you can manage both conditions at the same time with the new Royal Canin double-effect compound. Royal Canin, the leading compounding pet nutrition expert, is offering a new compound in its line of pet nutrition products. This new compound is specially designed to address the nutritional needs of pets suffering from both conditions, making it a convenient and effective solution.

---

Virbac

Powerful Integrated Technology
The new best practice in veterinary care

Visit our booth for a quick demo and a free tote bag!
Visbiome Vet is a high potency veterinary product that supports normal inflammatory responses in the GI tract.

- 112.5 Billion live bacteria per capsule
- 8 strain proprietary probiotic blend
- Peer-reviewed, controlled, multi-center Clinical data
- Refrigerated shipping, storage and temperature monitoring to ensure maximum potency
- Dispensed by veterinarians and veterinary pharmacy

Visit [www.visbiomevet.com](http://www.visbiomevet.com) or call 844-FIT-GUTS (343-4887)

---

Order [WEDGEOOPEXTRX.COM](http://WEDGEOOPEXTRX.COM)
Phone: 800.331.8272
Fax: 800.589.4250

DEDICATED ACCOUNT MANAGER

Proud Sponsor of the
Four Corners Veterinary Symposium

---

ProHeart® 12
(moxidectin)

Ask your Zoetis or distributor representative for details

---

INTRODUCING Redonyl® Ultra Soft Chews
(Ultra-micronized Palmitoyl etheraminolamido)

An ultra-small ingredient that offers ultra-big support for skin health.

Redonyl Ultra Soft Chews provide a convenient, easy to administer, concentrated source of PEA to support skin health in dogs.

- Ultra-micronized PEA (PEA-am) has increased absorption.
- Hypoallergenic soft chew contains no wheat, beef or chicken.
- 100 mg and 200 mg chews for dogs of all sizes

To order or schedule a lunch and learn, call your Dechra representative or call (866) 682-0660.

For Technical Support Contact Dechra Veterinary Products at:
866-933-2472, www.dechra-us.com, support@dechra.com

Dechra is a registered trademark of Zoetis Pharmaceuticals LLC. Redonyl is a trademark owned by dechra for patents US 8,225,292, US 8,981,063
Special Thanks To

WINSTON FOTO
Saturday
August 24, 2019
General Session
7:00 a.m. – 4:30 p.m.
<table>
<thead>
<tr>
<th>Stop Time</th>
<th>Start Time</th>
<th>CE Minutes</th>
<th>Topic / Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:15 am</td>
<td>7:00 am</td>
<td>60</td>
<td>Welcome and Introduction</td>
</tr>
<tr>
<td>8:15 am</td>
<td>7:15 am</td>
<td>60</td>
<td>&quot;Why Is Nothing Working!? Common roadblocks in the work up and management of dermatology cases.&quot;</td>
</tr>
<tr>
<td>9:15 am</td>
<td>8:15 am</td>
<td>60</td>
<td>&quot;Feline Nutrition for Health and Disease: From Kittens to Geri’s.&quot;</td>
</tr>
<tr>
<td>10:15 am</td>
<td>9:15 am</td>
<td>60</td>
<td>&quot;Beyond Dental Cleaning.&quot;</td>
</tr>
<tr>
<td>10:30 am</td>
<td>10:15 am</td>
<td>Break</td>
<td>Break</td>
</tr>
<tr>
<td>12:00 pm</td>
<td>10:30 am</td>
<td>90</td>
<td>&quot;The Role and Medical Management of Military Working Dogs in Combat.&quot;</td>
</tr>
<tr>
<td>1:00 pm</td>
<td>12:00 pm</td>
<td>Lunch</td>
<td>Lunch</td>
</tr>
<tr>
<td>2:00 pm</td>
<td>1:00 pm</td>
<td>60</td>
<td>Canine Heart Failure: The Good, The Bad, The Ugly</td>
</tr>
<tr>
<td>3:00 pm</td>
<td>2:00 pm</td>
<td>60</td>
<td>&quot;Introduction to Cannabinoid Medicine: What Veterinarians Need To Know.&quot;</td>
</tr>
<tr>
<td>3:15 pm</td>
<td>3:00 pm</td>
<td>Break</td>
<td>Break</td>
</tr>
<tr>
<td>4:15 pm</td>
<td>3:15 pm</td>
<td>60</td>
<td>&quot;Synergistic Veterinary Practice Teams: Part I.&quot;</td>
</tr>
<tr>
<td>4:30 pm</td>
<td>4:15 pm</td>
<td>Break</td>
<td>Break</td>
</tr>
<tr>
<td></td>
<td>4:30 pm</td>
<td>Charity Check Presentation</td>
<td>Charity Check Presentation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SATURDAY SOCIAL HOUR BEGINS!</td>
</tr>
</tbody>
</table>
**Why Is Nothing Working!? Common roadblocks in the work up and management of dermatology cases.**

Rebecca Mount, DVM, Diplomate of the American College of Veterinary Dermatology  
Dermatology For Animals, Albuquerque, New Mexico

**Definition of Canine Atopic Dermatitis:**  
Canine atopic dermatitis (CAD, atopy) is defined as a genetically predisposed inflammatory and pruritic disease with characteristic clinical features associated with IgE antibodies to environmental allergens (Olivery, et al 2001). The exact prevalence of canine atopic dermatitis in the general population is unknown, but is thought to affect up to 15% of the general population. There are no pathognomonic clinical signs, and the diagnosis is based on the exclusion of other inflammatory and pruritic skin condition (Hensel, et al 2015).

**Definition of Feline Environmental Allergies:**  
While cats are also commonly diagnosed with pruritic skin disease that are thought to be associated with IgE antibody driven reactions to environmental allergens, it has not been confirmed if this syndrome corresponds to atopic dermatitis as seen in humans and dogs. (Miller et al, 2013)

**Roadblock Number 1: There is no one size fits all therapy for management of atopic dermatitis.**

Treatment of canine atopic dermatitis and environmental allergies in cats is commonly life long and often multimodal, utilizing pharmaceuticals, topicals, and/or immunotherapy.

**Systemic Treatment Options for Atopic Dermatitis/Environmental Allergies:**

**Antihistamines:** Response to oral type I antihistamines is variable in dogs and cats and may provide a limited benefit when used prior to atopic flares (Olivery et al, 2015). Overall, antihistamines are well tolerated, with minimal to no sedation noted. (Miller et al, 2013). Antihistamines are most commonly used as a first line therapy and are often combined with frequent bathing and omega fatty acid supplements. Due to their limited efficacy, benefit will likely only be noted in mild cases (Olivery et al 2015).

**Glucocorticoids:** Oral prednisone, prednisolone, or methylprednisolone, methylprednisolone, or dexamethasone in cats have been shown to very effectively reduce clinical signs in both dogs and cats with environmental allergies. Side effects of oral steroids are generally proportional to drug potency, dosage, and duration of administration (Olivery et al 2015). Due to the extensive side effect profile of glucocorticoids, the ideal use is for control of acute flares. If long term steroids are necessary, discussion of long term risks with owners is advised, and the goal of therapy should be to taper to the lowest effective dose (Miller et al, 2013).

**Cyclosporine:** Cyclosporine is an oral calcineurin inhibitor with numerous immune modulating properties that has been shown to be effective in managing moderate to severe cases of canine atopic dermatitis and feline environmental allergies. Due to its slower onset of action, it is not recommended for the control of acute allergic flares (Olivery et al, 2015). The most common adverse event in both dogs and cats is GI upset (vomiting, diarrhea, or nausea). Other less common side effects in dogs include: hirsuitism, gingival overgrowth, and papillomatosis.

**Oclacitinib (Apoquel ®; Zoetis Inc.):** Oclacitinib is a novel JAK inhibitor that inhibits the activity of cytokines IL-2,4,6,13 and 31, which play a role in pruritus and inflammation associated with canine atopic dermatitis (Gonzales et al, 2014). It is approved for twice daily use for up to fourteen days and
once daily use long term. Due to its speed of onset, oclacitinib can be used for management of acute flares and/or long term for chronic disease (Olivery et al, 2015). Oclacitinib is not labeled for dogs under 1 year of age. Overall oclacitinib is considered well tolerated, with gastrointestinal effects and lethargy being the most common side effects. Uncommon side effects include increased susceptibility to infections. Use of oclacitinib in cats is considered off label.

**Lokivetmab (Cytopoint®; Zoetis Inc.):** Lokivetmab is a caninized monoclonal antibody that selectively binds and neutralizes IL-31. Advantages of lokivetmab include its safety profile, rapid onset of activity, infrequent dosing, and lack of age restriction on use (Souza et al, 2018). Based on its mechanism of action, it can be utilized in acute or chronic cases of allergic dermatitis. Monoclonal antibody therapeutics are species specific and use in cats is contraindicated.

**Allergen Specific Immunotherapy (ASIT):** ASIT is the mixture of allergen extracts that can be given subcutaneously or sublingually (Scott et al 2013) with the goal of inducing immunological tolerance to environmental allergens. ASIT is believed to alter the course of allergic disease and is the only therapy with the potential to prevent development of further allergies (Griffin et al, 2015). ASIT is generally formulated based on the results of intradermal and/or serological allergy testing. Efficacy of ASIT has been reported to be between 50-100%, with an average of 75-80% of patients having at least a 50% reduction in clinical signs associated with environmental allergies (Griffin et al, 2015). Adverse reactions to ASIT are rare (less than 5%) with local adverse reactions being more common than systemic reactions (anaphylaxis) (Griffin et al, 2015). Due to its delayed onset of action, ASIT is generally only considered for the treatment of chronic disease.

Guide posts for successful therapy include: improvement in quality of life of owner and pet, minimization of clinical signs (pruritus, recurrent infection, etc.). It is important to emphasize that response to therapy should not be used as a substitute for a through work up of allergic causes (Miller et al, 2013). Additionally, serologic or intradermal allergy tests are not considered diagnostic for atopic dermatitis and should only be used if the owner wishes to pursue immunotherapy as part of a patient’s treatment plan once atopic dermatitis has been definitively diagnosed.

**Roadblock 1.5: Owner compliance**
In a recent paper by Gedon et al, they concluded that “the chronic and often severe nature of the disease, the costly diagnostic workup, frequent clinical flares and lifelong treatment are challenging for owners, pets and veterinarians. Patience and excellent communication skills are needed to achieve a good owner compliance and satisfactory clinical outcome for the animal.” Factors that should be considered when formulating a therapeutic plan include: patient’s response to therapy, potential side effects of therapy, owner compliance, and financial feasibility for owners.

**Roadblock Number 2: Treating the “wrong” secondary infection**

Secondary infections are a common sequela of allergic and inflammatory dermatoses that can change the overall level or distribution pattern of pruritus (Hensel et al 2015). Pruritus associated with infectious organisms will be non-responsive to most anti-pruritic therapies used for treatment of allergic dermatitis and can skew the perceived response to therapy.

Bacterial skin infections (pyoderma) caused by Staphylococcus species in dogs and cats are common in allergic patients. *Staphylococcus pseudintermedius* is the most common species associated with canine and feline pyoderma. Clinical signs associated with superficial pyoderma include: papules, pustules, epidermal calli, scale, and crusts (Beco et al, 2013). Common clinical signs associated with deep
pyoderma include: folliculitis and furunculosis, ulceration or draining tracts with hemorrhagic to purulent exudate, and variable pain (Beco et al., 2013). Pruritus is commonly seen with both superficial and deep pyoderma and may mimic or exacerbate the itch level seen with allergic disease.

The key components for managing bacterial pyoderma include: correct diagnosis, selecting an appropriate antibiotic, ensuring an antibiotic is given at the correct dose and frequency, ensuring an antibiotic is given for an appropriate duration, and diagnosing and treating any underlying disease promoting increased colonization and reoccurrence of bacterial pyoderma (Beco et al., 2013).

Dermatitis caused by *Malassezia pachydermatis* is commonly seen in atopic dogs and rarely in allergic cats. *Malassezia* dermatitis in dogs commonly results in erythematous skin with greasy or waxy, scale (yellow). Lichenification and hyperpigmentation are also commonly seen in chronic cases. In some cases it can mimic pyoderma with crusting and papular eruptions. *Malassezia* infection of the claw beds or claws can produce a reddish brown discoloration of the nail or associated hair (Scott et al., 2013). Pruritus is often marked and true hypersensitivity reactions to *Malassezia* organisms are seen. Treatment of Malassezia dermatitis is based on severity of disease in the affected animal. Therapies include topical and systemic anti-fungal agents and control of underlying inflammatory conditions.

Unfortunately the only way to differentiate between a bacterial pyoderma and *Malassezia* dermatitis is cytological evidence supporting a diagnosis. Cytology is an invaluable tool for the work up and management of skin and ear disorders, allowing for the identification of inflammatory, infectious, and neoplastic factors (Miller et al., 2013). There are a number of different cytological methods including: adhesive tape strips, direct impression smears, indirect impression smears, and fine needle aspirates (Miller et al., 2013, Beco et al., 2013). Cytology also allows for quantification of microbes, allowing the clinician to critically evaluate the response to antimicrobial therapy. Ultimately, cytology should be performed on all cases prior to initiating antimicrobial therapy.

**Roadblock Number 3: It’s not responding cause it’s resistant**

Staphylococci are the most common opportunistic pathogen in veterinary dermatology (Weese et al., 2010). Methicillin and multi-drug resistant strains of staphylococci have emerged as significant complicating factors in the treatment and management of canine and feline pyoderma. Infection is often related to reduced immunity associated with abnormalities in the skin barrier due to primary underlying skin diseases (Hiller et al., 2014). *Staphyloccocus pseudintermedius* is the most common strain isolated from canine skin infections. Other potential pathogenic species include: *S. aureus, S. schleiferi*, and other coagulase negative staphylococci.

Resistant infections should be considered when there is incomplete cytological or culture based resolution of bacteria despite antimicrobial therapy. Hiller et al outlined the five situations that suggest antimicrobial resistance is playing a role and a bacterial culture is indicated. The five situations include: less than 50% reduction of lesions within 2 weeks of initiating appropriate systemic antimicrobials, emergence of new lesions 2 weeks or more after initiating therapy, presence of lesions after 6 weeks of an appropriate therapy, rod shaped bacteria seen cytologically, or history of previous resistant infection in a pet (Hiller et al., 2014).

In general, patient risk factors for the development of resistant bacterial infections include: antibiotic therapy within the last 6 months, corticosteroid treatment within the previous 6 months, previous recent hospitalization, and/or veterinary contact within the last 4 weeks (Nienhoff et al., 2011). In dogs with resistant pyoderma, repeated history of antimicrobial drug therapy was the most important risk factor in both primary care and referral settings (Eckholm, et al, 2013). Antimicrobial factors that contribute to the
development of resistant bacterial infections include: incomplete courses of antibiotics, inappropriate dose or duration of antibiotics, and use of fluoroquinolones as first line antibiotics.

In order to address the growing prevalence of resistant pyoderma, guidelines for antimicrobial use in canine superficial bacterial folliculitis were outlined in 2014 and are a great reference for the management of pyodermas.

**Roadblock Number 4: It Might be Superficial Mites**

Aside from fleas, other ectoparasitic conditions that can contribute to marked pruritus and skin disease include sarcoptic mange and cheyletiellosis (Hensel et al, 2015).

**Sarcoptic Mange:**

Dogs: *Sarcoptes scabiei var canis* infestations result in intense, non-seasonal pruritus. Sarcoptic mange commonly affects “cooler” areas of the body, including ears, elbows, abdomen, and hocks. Clinical lesions include crusted papules, alopecia, erythema, thick yellow crusts (particularly on ear margins and elbows), and lesions consistent with self trauma (excoriations). A positive pinnal pedal reflex is often suggestive of a sarcoptic infestation. Wildlife, including coyotes and foxes, are common carriers. Pets with increased contact with wildlife or other dogs (doggie day care, grooming, etc) have an increased risk of infestation. Superficial skin scrapings are the diagnostic of choice, but confirmation of mites, eggs, or fecal pellets are only seen in 20-50% of cases (Miller et al, 2013). If suspicion is high based on history or clinical presentation, a parasite treatment trial is recommended.

Cats: *Notoedres cati* infestations result in mark, non-seasonal pruritus and self trauma. The most common lesion is thick cursing on the pinnae, face, and neck. Notoedres cati is more common in outdoor cats with exposure to wildlife carriers.

**Treatment Options:**

1) Selemectin containing topical products (i.e. Revolution®; Zoetis Inc.) every 14 days for 3 doses. Off label dosing at 14 days improves speed of recovery. (Miller et al, 2013). Safe for dogs and cats.

2) Extra label use of Ivermectin weekly for 6 doses. Higher risk of side effects, particularly in dogs with ABCB1 mutation. Less frequently used with new medications that are available.

3) Isoxazolines (Nexgard®, Bravecto®, and Simparica®) - Research supports efficacy, but considered an extra label use.

4) 2.5% Lime sulfur dips weekly for 4-6 weeks. Although effective, lime sulfur dips often have poor compliance due to the labor intensive nature and mess/odor associated with use.

Fiprinol based products tend to fail. Make sure to treat all in contact animals and the environment.

**Cheyletiellosis:**

*Cheyletiella yasguri* is the causative agent in dogs and *Cheyletiella blakei* is the causative agent in cats. Clinical signs in dogs and cats are highly variable and range from apparently unaffected to intense pruritus (Miller et al, 2014). Some animals will show marked erythema and scaling or thinning of hair/hair barbering secondary to self trauma. Diagnosis is made by identifying the mites or eggs from a superficial skin scrape or tape prep of the scale and hair. Mites are only found in 15-58% of cases (Curtis, 2004). Based on clinical suspicion, a parasite treatment trial may be recommend with negative diagnostics.

**Treatment Options:**

Most topical spot on products, including fipronil, are effective for treatment of *Cheyletiella spp.*, although off label dosing frequencies are often recommended (Miller et al, 2013). Again, all in contact animals should be treated.
Roadblock number 5: If it isn’t responding like allergies, it might be an allergy mimicker

There are many inflammatory conditions that can have overlapping clinical presentations with allergic disease. Below is a brief summary of the top five allergy mimickers I see in my practice.

**Actinic Dermatosis (Solar keratosis):** Actinic keratoses are solar induced hyperplastic and dysplastic lesions that occur due to excessive and repeated ultraviolet light exposure. Lesions are most common in lightly pigmented and sparsely haired areas and are most common in short coated breeds of dogs and lightly pigmented cats. Clinical lesions in dogs included inudrated, erythematos patches which may progress to erythematous, scaly patches and darkly crusted plaques. Erosions and ulcerations with secondary cellulitis can be seen in more chronic cases. Evidence of solar induced neoplasms, cutaneous hemangiomas/hemangiosarcomas and squamous cell carcinomas may be seen as well. Actinic damage is typically progressive and can be managed, but not cured. Biopsy may help confirm suspicion (Gross et al, 2005).

**Topical Hyperglucocorticoidism:** Cutaneous changes may result from iatrogenic overuse of high potency steroids (i.e. triamcinolone, betamethasone, mometasone). Glabrous areas are more commonly affected. Clinical lesions include: decreased elasticity of the treated skin, comedones, atrophy of scars, progressive erythema, milia, or focal calcinosis cutis. Diagnosis is generally based on history of injudicious use of a topical product containing a steroid. Treatment is discontinuation of all topical steroids. Resolution may take 2-3 months.

**Pemphigus Foliaceous (PF):** PF is an immune mediated disease in cats and dogs that results in pustular lesions that generally progresses to erosions and serous crusting. Pruritus is variable with PF. Lesions often affect the head, face, ears, nasal planum, and footpads, but can be generalized. The pruritus and crusting can often appear similar to lesions seen with allergic disease and secondary pyoderma. In many cases of PF there are systemic signs preceding or in addition to the cutaneous signs, including fever, malaise, etc. which may help differentiate from allergic disease. Cytological samples of pustules and crusts reveal numerous neutrophils, occasional eosinophils, +/- acantholytic keratinocytes. A biopsy is recommended for the definitive diagnosis of PF (Miller et al, 2013).

**Sebaceous Adenitis (SA):** SA is an idiopathic disease, with a possible immune mediated component, resulting in destruction of the sebaceous glands. Clinical signs are variable depending on the coat quality. In long coat breeds, early signs may include hair color and texture change and progressive hair loss with scaling/follicular casting. In short coated breeds, annular areas of scaling and alopecia are the most common appearance. Pruritus and erythema are variable in SA. Lesions are most commonly generalized, but the legs and paws may be spared. Diagnosis is made via biopsy (Miller et al, 2013).

**Epitheliotrophic Lymphoma:** Affected patients will most commonly present with an acute onset of generalized pruritic exfoliative erythroderma. Additional clinical signs include: pruritic cutaneous plaques or nodules and ulceration of mucocutaneous junctions or mucosal surfaces. Depigmentation of the mucous membranes and footpads are commonly seen. Diagnosis is made via biopsy. This differential should be considered in older patients with acute onset of pruritus, consistent clinical signs, and no prior history of pruritic dermatoses (Miller et al, 2013).
References:


Olivry, T., DeBoer, DJ., Griffin, CE. The ACVD task force on canine atopic dermatitis forewords and lexicon. *Veterinary Immunology and Immunopathology.* 2001;81:143-146.


BEYOND THE DENTAL CLEANING

Kris Bannon, DVM, FAVD, Dipl AVDC
Veterinary Dentistry and Oral Surgery of New Mexico, LLC
Algodones, NM
www.vetdentistrynm.com

Many owners, and many veterinarians as well, tend to think of dental procedures as “all about the teeth”. And yes, dental issues are a common problem in general practice. As a matter of fact, periodontal disease is the most commonly diagnosed disease in small animal medicine. But when is a “dental” no longer just a dental? Let’s look beyond the dental cleaning at other problems that might occur in the oral cavity.

Halitosis is most commonly associated with periodontal disease. And truly, periodontal pockets are the most common reason for halitosis. The odor comes from Volatile Sulfur Compounds (VSCs) produced by oral bacteria during the breakdown of protein. The anaerobic, predominately gram-positive, bacteria are the best at this breakdown. Thus with deeper periodontal pockets, more anaerobes flourish, and consequently more malodor occurs. Treatment of the periodontal pockets will decrease the total number of anaerobes in the mouth, improving the overall health.

However, there are other reasons for halitosis as well. Teeth that have endodontic lesions or retained tooth roots can also have odor, especially if there is a pathway into the mouth such as a draining tract. Other primary oral reasons for halitosis can include electrical cord injury, palatal foreign bodies, osteonecrosis of the jaw, and neoplasia.

Some systemic diseases will be associated with halitosis, such as those that cause oral ulcerations or de-epithelization. The most common canine systemic diseases associated with gingival or mucosal ulceration are epitheliotrophic lymphoma, systemic LUPUS, erythema multiforme, pemphigus and advanced kidney disease. Chronic ulcerative paradental syndrome (CUPS), more recently known as buccal mucositis, is another possibility. This differs from the systemic diseases because it is primarily a contact ulceration within the mouth, where the tooth and the mucosa come into contact. This is not normally associated with any other health issues.

Maxillofacial trauma can result in many dental and oral abnormalities. If trauma occurs in a young animal, development of the teeth, jaw bones, and temporomandibular joints can be affected. In older animals, traumatic injuries can present in many ways. Evaluation of maxillofacial injuries by 3D reconstruction has been shown to identify significantly more fractures than by skull radiographs alone. One study showed that in dogs, 1.6 times more fractures were identified by CT scan than by two-dimensional skull radiographs. In cats, there were twice as many fractures identified by CT scan. Overall in this study, the average number of maxillofacial injuries per patient identified by CT scan were 7.6 in dogs and 7.7 in cats.

Addressing maxillofacial injuries requires not only appropriate healing of the bones and of the soft tissues. Injuries and fractures of the teeth also need to be identified and addressed, which will not heal the way that bone fractures will heal. The patient also needs to eat comfortably, so they need to return to a normal, or at least an atraumatic occlusion. This can sometimes require
multiple stages of treatment so that the initial injuries of facial structure can be treated, then secondary treatment of dental structures can be evaluated and treated as well.

If all of these factors are not accounted for, the maxillofacial injuries may heal, but the patient may still suffer. Especially in cases where the maxilla and mandible are both fractured near the temporomandibular joint (TMJ), this can allow the maxilla and the mandible to attempt to heal together, which will fuse the patient’s jaw closed. Although manual manipulation to keep this from happening has often been attempted, this typically results in a very poor success rate. And in some cases, it actually worsens the situation further by causing more harm. Patients with maxillomandibular fusion can often survive for a period of time without someone noticing a problem because animals are extremely adaptive to their situation. However, surgical intervention is required to release the fusion and allow the patient to return to comfortable and hopefully relatively normal function.

Cleft lips and cleft palates can occur as a birth defect, or they can be traumatic in origin. If the patient is born with a cleft lip or palate, they may require supplemental nutrition via tube feeding to survive. Regular and frequent monitoring of their development and growth will determine the proper time for surgical intervention. Timing for surgical repair for each patient varies depending on the location and size of the defect, and whether or not the dentition is involved.

References available from the author upon request.
The natural diet of cats in the wild is meat-based (e.g. rodents, birds, insects, small mammals), and, as such, they are metabolically adapted to utilize protein and fat preferentially as energy sources without the need for or ability to utilize effectively dietary starches. The evolutionary differences of these obligate carnivores mandates cats to use protein for maintenance of blood glucose levels and as an energy source even when sources of protein in the diet are limiting or sources of CHO are present in the diet. The significant difference in protein requirements observed between cats and omnivores, such as dogs, illustrates this important metabolic distinction. More importantly, when protein is limited in the diet, cats will immediately use muscle tissue from their body to meet their protein and amino acids needs. The interested reader is referred to several reviews for more information and detail on cats as carnivores (MacDonald et al, 1984, Zoran 2001). The National Research Council (NRC) publishes recommendations for all nutrient requirements in animals. For more than 40 years, the NRC has stated that cats require a minimum of 1.9 g protein/kg body weight per day or 23% protein ME to maintain nitrogen balance (proteins for normal body function) and prevent amino acid deficiencies (NRC, 2006). However, in making these widely accepted recommendations, the NRC did not take into consideration the amount of protein that would be used by cats for gluconeogenesis or energy needs, and, in particular, the amount of dietary protein required to maintain healthy muscle mass. Recently, Laflamme and coworkers reported that while the NRC recommendations remain valid for meeting the minimum requirements for essential protein functions in cats (e.g. immune function, plasma proteins, protein turnover), adult cats that did not consume at least 5.2 g protein/kg body weight per day (e.g.12 g protein/100 kcal or approximately 40-45% protein ME) lost lean body mass (measured by Dual Energy X-ray Absorptiometry [DEXA] – the preferred method for measurement of body composition) over time (Laflamme & Hannah 2013, Salaun et al, 2016). Thus, cats literally start to use their own muscle to meet their protein needs when the amount of protein in their diet does not exceed 40%ME. This finding is important, not just as an indicator of optimal protein for maintenance of health, but because lean body mass (muscle) is a key driver of metabolism. Muscle mass is critical to normal energy metabolism, normal insulin function, and skeletal/bone mass maintenance, as well as many other essential metabolic functions. (Atlantis 2009, Landi et al 2016). Typical feline diets, including over-the-counter (OTC) and many therapeutic dry cat foods are 30-38% ME protein, This means that even if the diet is complete and balanced, it will still result in the loss of muscle mass over time; muscle mass loss is faster in diets with low quality protein, as the protein is less digestible, or with protein levels in the lower end of that range or less. These increased protein requirements in cats are also why protein malnutrition can occur more quickly in sick, injured, or anorectic cats and may be a key risk factor for aging felines. Thus, one of the first and most important changes to recommendations in providing healthy nutrition for all cats is to feed diets with at least 12g/100 kcal or greater than 40% ME of a high-quality animal based protein.

In addition to the needs for a larger amount of protein in the diet of adult cats for maintenance of muscle mass and the optimal health that goes with it, recent studies in cats over 12 years of age show that aging cats actually have an increased need for protein, fatty acids and certain vitamins (Sparkes 2011). In a lifetime study of geriatric cats, researchers found that with each year of age beyond twelve, healthy geriatric cats have a naturally occurring, but progressive, loss of their ability to digest and absorb protein and fatty acids – so much so that by the ages of 15 or beyond, they have nearly a 25% reduction in their digestive efficiency (Sparkes, 2011, Laflamme & Gunn-Moore 2014).

The main reasons healthy geriatric cats lose body weight and muscle as they age is due to a combination of 1) the general use of lower protein/lower fat adult or senior diets, and many therapeutic diets, 2) reduced activity due to osteoarthritis or indoor lifestyle which contributes to loss of muscle, and 3) the phenomenon of sarcopenia (e.g. muscle loss due to the combination of aging and chronic inflammation) (Freeman 2011). There is little debate that in aging animals, many diseases and disorders that cause or are associated with inflammation are common, but recent evidence in people over the age of 50 suggests that diets high in simple sugars and highly digestible CHO are believed to contribute to increased pro-inflammatory states in elderly humans – a connection not yet studied in cats but likely to be a factor in the loss of muscle (Kalinkovich 2016). In summary, to preserve muscle and provide optimal nutrition for senior and geriatric cats, feed diets with at least 40% ME protein, and in many geriatric cats a
higher amount of high quality, highly digestible protein is required: 9.2 g/kg body weight or greater than 15g/100 kcal or approaching 50% ME protein.

In addition to their increased protein needs, diets for senior cats need to have more energy from fat (e.g. > 20% fat), with increased omega-3 fatty acids and B vitamins (especially cobalamin) (Sparkes 2011, Laflamme & Gunn-Moore 2014). These findings have created significant discussion among internists, nutritionists, and feline medicine experts about what constitutes the proper amount of protein in diets of aging cats with diseases that may or may not be impacted by the protein or CHO levels in the diet: hyperthyroidism, chronic enteropathies and triad disease, lower urinary tract diseases, and most importantly, CKD. There are increasing studies considering the role of high protein nutrition in aging cats with specific diseases, but particularly in the most common diseases of hyperthyroidism (Peterson & Eirmann 2014), diabetes (Hill et al 2015), and kidney disease (Scherk & Laflamme 2016).

In the opinion of this author, with the exception of the late stages of CKD, there are few (if any) indications to reduce the amount of protein in a cat’s diet. First, there are a myriad of other important therapeutic options that can be used to manage most of these diseases. Further, in hyperthyroidism, diabetes, or gastrointestinal diseases, the loss of lean muscle due to these diseases will compound the cat’s disability and increase risk of other co-morbidities, and loss of lean muscle will be accelerated by using lower protein diets (e.g. iodine deficient diets, diets for gastrointestinal disease with < 40% ME protein, and high fiber diets for diabetes).

That brings us to the issue of protein in cats with CKD. The most important clinical goals for cats with IRIS stage I (non-azotemic) or stage II (mildly azotemic) CKD are 1) maintenance of hydration (e.g. maintain renal blood flow), 2) maintenance of normal phosphorus levels. (Protein deprivation at this stage is not only not indicated, it is detrimental to the cat and other mechanisms of phosphorus control in the diet are available.) (Kidder & Chew 2009), and 3) controlling other risk factors (e.g. hypertension, hypokalemia) (Scherk & Laflamme 2016). Traditional renal diets have 23-27% ME protein. Vastly lowering protein levels in the diet will lower blood urea nitrogen (BUN) (low dietary protein) and creatinine (due to muscle mass loss), but these reductions can give the clinician a false sense of security that the disease is being well managed. In fact, it is maintenance of renal blood flow and glomerular filtration rate (GFR) that will maintain renal function and prolong life, all the while preserving the quality of life. Maintenance of renal blood and function is best accomplished by controlling hypertension, maintaining hydration, and preventing hyperphosphatemia and the onset of renal secondary hyperparathyroidism, and will not be achieved by simply changing their diet. Furthermore, in most cats with advanced renal disease, e.g. stage 3 or 4, one of the greatest issues in maintaining their quality of life is food intake. There is clear evidence that cats prefer high protein diets over diets high in CHO (Salaun 2016), and because food intake is an important factor in both feline well being and their owners perception of quality of life, there is further reasoning for not restricting their dietary protein to the level found in “renal diets”. In cats with stage 4 disease have signs of uremia or hyperphosphatemia that can no longer be obtained with other means, and then, and only then, would a mild restriction of protein (30-38%ME) be included in the plan – and only if the cat will eat enough of the diet to meet its nutritional and caloric needs. The key point is that there is a fine line between feeding a diet that is ideal for a disease process and feeding a diet that is better for the overall health of the animal, and this is clearly a situation in which the veterinarian must balance the two.

The water needs of cats reflect their early status as desert dwelling animals and their development as strict carnivores; they obtained most of their water requirements from prey. Cats have a less sensitive response to thirst and dehydration than dogs or other omnivores, and they adjust their water intake to the dry matter content of their diet (not the moisture content) (Anderson 1982). Contrary to commonly held beliefs, this means that cats eating dry cat foods will consume approximately 10-15% less water (both in the diet and by drinking) as compared to cats eating canned foods. Feeding canned foods increases water intake and urine volume – two physiologic functions that are vital to overall health. In older cats that tend to produce less concentrated urine, increasing water consumption becomes even more important to avoid dehydration and development of pre-renal azotemia. Importantly, in addition to their need for water, feeding canned foods to cats from an early age helps to ensure that cats will eat foods of a wide variety and also provides a vehicle for administering medications more easily and less stressfully when medications are needed later in life. Cats fed only a single type of food (e.g. dry) become habituated to that type of food and lose a willingness to consume new or different foods. Food flexibility (which is based on types, flavors and formulas) is only maintained in cats if they eat a variety of foods throughout their life. Thus, feeding some canned food (as well as dry and different flavors) is essential to...
creating a healthy diet profile for cats over their lifetime (Bradshaw J, et al 1996). In short, healthy cats need to be food flexible to prevent nutritional deficiencies and to allow dietary changes as their health needs change; this can only be achieved by continuous dietary changes throughout their lifetimes.

In summary, to provide optimal nutrition for all cats it is ideal to feed a complete and balanced diet. This can be a commercial or a homemade diet depending on the preference of the owner for whole versus processed food sources and their willingness to actively participate in providing an appropriate diet for their cats. The ideal feline diet should contain >40% ME of an animal based, highly digestible protein with less than 10% ME of CHO. Furthermore, veterinarians and cat owners must truly grasp and accept the unique metabolic and nutritional requirements of this hunter and obligate carnivore that we have attempted to domesticate and hold captive in our indoor environment. We must provide nutritional and environmental resources that not only allow them to survive, but to thrive.

References
THE ROLE AND MEDICAL MANAGEMENT OF MILITARY WORKING DOGS IN COMBAT

James T. Giles III, DVM, MS, DACVS-SA

Key Points:

- Military Working Dogs injured in combat sustain significant injuries that require collaboration between veterinary and human providers in a “One Health” approach
- The use of negative pressure wound therapy in canine combat wounds improved wound management and reduced morbidity during transport
- Obtaining appropriate blood products for MWDs in an operational environment remains a significant challenge
- Definitive care for working dogs injured in combat zones routinely spans multiple continents and a multitude of providers and agencies

Military working dogs (MWDs) are utilized in substantial and increasing numbers in current military operations and play a vital role in both protecting human lives and supporting military objectives. MWDs are trained to perform a variety of important roles such as explosive, mine and narcotic detection, patrol/attack work and are even a component of therapy for Servicemembers with combat and operational stress, to name just a few. Similar to the human Servicemembers they serve, MWDs are susceptible to both combat and non-combat related injuries in the operational environment. Contract Working Dogs (CWDs), which are owned by a private entity and perform a Department of Defense mission, are also utilized extensively and typically perform a non-combat security mission. MWDs are vital and life-saving assets to current military operations and they may incur severe injuries in performing their duty. The need for effective MWD teams has increased significantly with the prevalence of improvised-explosive devices (IED) in recent years. In 2008, GEN David Petraeus aptly noted "The capability that military working dogs bring to the fight cannot be replicated by man or machine. By all measures of performance, their yield outperforms any asset we have in our inventory. Our Army would be remiss if we failed to invest more in this incredibly valuable resource.” At a time when IEDs represent one of the greatest threats to our Servicemembers, MWDs remain our greatest countermeasure to that threat. It is important to remember that the purpose of the MWD is to save human lives and maintaining their health and proficiency is critical to military operations. Anytime an MWD team detects an explosive device before it detonates, that results in humans not being killed, maimed or injured.
Issues such as non-veterinary provider care for MWDs, medical evacuation, damage control resuscitation and surgery, blood and plasma transfusion capability, canine post-traumatic stress syndrome and the use of negative pressure wound therapy for substantial wounds are all important to MWD health care during combat deployment.

Health care for the MWD begins at the point of injury and continues as the MWD moves through the various echelons of care. MWD handlers are extensively trained in first aid procedures and are typically the first responder for their dogs. There are occasions when handlers are also casualties and other Servicemembers perform first aid for the MWD. There is a principle for pre-hospital care of the casualty in a combat environment called Tactical Combat Casualty Care (T-C3). It is utilized for human medical care in combat operations which prioritizes the most common life-threatening combat injuries and minimizes the health care provider and patient’s exposure to enemy forces. A similar scheme has been adopted for MWD pre-hospital care in combat operations called Canine-Tactical Combat Casualty Care. The acronym M²ARCH² is followed: Muzzle for safety and control Massive hemorrhage, Airway management, Respiratory distress, Circulatory failure, Hypothermia and Head injury.

While there is veterinary specific health care for MWDs in most operational environments, there is not an MWD specific means for medical evacuation (MEDEVAC). MWDs travel on the same MEDEVAC platforms in place for human casualties from the point of injury/illness to medical care. There is a higher priority placed upon the human casualties, however, MEDEVAC missions are performed routinely for injured MWDs and they receive similar care. The MWD is ideally transported to a veterinary facility, although, the mission may necessitate they go to a human medical treatment facility for care. MWDs are often assessed and treated by several human health care providers (HCPs) in the pre-hospital phase. Specific MWD Clinical Practice Guidelines are in place to guide HCPs in emergent MWD care.

Veterinary care in a developed operational environment, such Operation Enduring Freedom in Afghanistan, is provided by the Medical Detachment Veterinary Service Support (MDVSS). This organization has 5 Veterinary Service Support Teams (VSST) with 1 general practitioner veterinarian (64A) and 1 Animal Care Specialist (68T) each, to provide Role 1 and Role 2 veterinary care. There is 1 Veterinary Medicine and Surgery Team (VMST) with a veterinary clinical specialist (64F) and 3 68Ts providing Role 1- Role 3 veterinary care. Role 1 care is nonsurgical treatment by a 68T or veterinarian for minor wounds, injuries or illnesses, preventive medicine, analgesia, emergency intervention for airway, hemorrhage, and fracture immobilization. Role 2 veterinary care includes veterinarian-directed resuscitation and stabilization and may include advanced trauma management, emergency medical procedures, and emergency resuscitative surgery. Role 3 veterinary care includes consultation and referral for advanced veterinary diagnostic, therapeutic, and surgical procedures. This level of care requires a veterinary clinical specialist (64F) with training in surgery, internal medicine, or critical care. In the combat theater, this facility is typically co-located with a Role 3 human hospital for equipment and technical support.
Patients that will not return to duty in a short time frame or with injuries that exceed in theater capabilities are transported to a Role 3 veterinary hospital outside the combat theater via aeromedical evacuation (AE) on fixed-wing medical aircraft. CWDs are not eligible for AE, it is the responsibility of the owning entity to evacuate them from theater. From Iraq and Afghanistan, MWDs traveled to Dog Center Europe (DCE), a robust Role 3 facility in Kaiserslautern, Germany, for definitive care. Those requiring more substantial care or significant physical rehabilitation travel via AE to the only Role 4 facility within the US Army Veterinary Corps; the Department of Defense Military Working Dog Veterinary Service (DODMWDVS) in San Antonio, Texas.

Similar surgical principles for combat injuries are followed for MWDs and human Servicemembers, in that definitive care for high-energy and contaminated wounds is often delayed until the patient is out of the combat theater. This provides more time for assessment and treatment, a cleaner patient environment and reduced morbidity. This is not the case for CWDs as they often receive definitive care and recover in theater; evacuation out of theater is the responsibility of the owning entity and not the DOD. Transporting unstable and critical MWDs out of theater with limited veterinary personnel remains a challenge; consequently, MWDs often remain in theater until stable enough to travel several days with limited medical attendants.

Prior to 2011, there had been a significant issue with MWD wounds degrading during the 48-72 hour AE to Germany. Veterinary medical attendants did not travel with the MWD and wound care often did not occur at appropriate intervals. In July 2011, the use of negative pressure wound therapy (NPWT) during initial management and AE to Germany was incorporated into MWD wound management and represented a vast improvement in wound care. Additionally, veterinary or 68T attendants traveled with the MWD and handler if significant care was required. The implementation of NPWT to wounded MWDs created a substantial step forward in improving wound quality and reducing morbidity during aeromedical evacuation.

Management of MWD blood products differs greatly from the human counterpart in there is no feasible means to ship MWD blood components into the operational theater. The military logistical chain exists for cold-chain shipping of human blood components, but animal blood products are not permitted to accompany those shipments. Private transport of canine blood components is too cost prohibitive to be a solution. The organic capabilities of the MDVSS only support the collection and administration of fresh whole blood (FWB). Fresh whole blood is suitable for many clinical conditions in the MWD, however, there are times when fresh frozen plasma (FFP) or platelets are a critical need. There are currently no shelf stable canine blood components available that serve as a suitable substitute.

The FWB need has been reasonably met by the MDVSS instituting a walking blood bank and pre-screening donors to be available when the need for transfusion arises. The need for FFP was temporarily abated in OEF by use of plasma apheresis. In 2011, initial efforts began to develop an FFP collection and distribution program out of Kandahar Airfield (KAF). In 2012, the MDVSS obtained their own apheresis unit and it was designated for animal use only. The KAF apheresis
team was instrumental in helping to establish this capability in training veterinary personnel to operate the unit. This enabled the collection and storage off FFP at KAF and subsequent distribution to other veterinary sites throughout Afghanistan. Additionally, this apheresis unit was used to collect platelets when the clinical need occurred. This capability has been a tremendous asset for treating sick and injured MWDs in Afghanistan, however, it is an ad hoc capability that only exists in Afghanistan. It is not organic to the MDVSS for other operational environments. There have been indications for future DoD policy changes to allow shipment of animal blood products into the combat theater.

MWDs are vital and life-saving assets to current military operations and they incur severe injuries in performing their duty. Providing advanced surgical care for MWDs in an austere environment is challenging and requires a creative “One Health” approach, with substantial collaboration across veterinary and human echelons of medical care. Veterinary units rely heavily upon the human hospitals for equipment and material support. The MWDs routinely receive advanced care on multiple continents, from multiple providers of various disciplines, to restore them to health and hopefully either a return to duty or retirement and adoption.
Heart failure: the heart is unable to pump enough blood to supply the body’s metabolic needs.¹ Heart failure can occur due to myocardial dysfunction (systolic=contraction and/or diastolic=relaxation failure) or other conditions (volume overload or ventricular filling impairment).¹

- Short-term adaptive response¹
  1. Frank-Starling Law: ↑ volume (preload) = ↑ cardiac myofiber stretch = ↑ contractility
  2. Neurohormonal responses to help maintain blood pressure.
     - Norepinephrine = ↑ sympathetic tone (SNS)
     - Renin-Angiotensin Aldosterone System (RAAS)—sodium retention and vasoconstriction.
     - Myocardial remodeling (decrease wall stress)—concentric and eccentric hypertrophy

- Long-term maladaptive response¹
  1. Na+ retention (RAAS) = pulmonary congestion
  2. Vasoconstriction (RAAS/SNS) = increase afterload
  3. Sympathetic stimulation = increase energy use
  4. Hypertrophy = leads to death of cardiac cells

Congestive heart failure: impaired cardiac function resulting in sodium and fluid retention, which leads to pulmonary edema, liver congestion, or systemic edema.²,³

Goal of cardiac therapy for heart failure.⁴
  1. Na+ Retention = diuretics
  2. Vasoconstriction = vasodilators
  3. Activation of RAAS = ACE-inhibitors
  4. Poor contractility = inotropic agents
  5. Norepinephrine toxicity=beta-blockers

Stages of Canine Heart Disease (2009 and 2019 ACVIM Consensus Statement)
Classification of heart failure provides a more efficient and systematic therapeutic approach for our canine patients. Previous classification schemes (NYHA and ISACHC) failed to account for the natural progression and continuous therapeutic requirements for heart failure.


**STAGE A:** Predisposed to the Development of Heart Failure

**STAGE B:** SUBCLINICAL / Structural Heart Disease

- **STAGE B1:** Minimal Structural Heart Disease (No Treatment)
- **STAGE B2:** Significant Structural Heart Disease (Treatment-EPIC/Clinical)

**STAGE C:** Structural Heart Disease / Current or Prior Clinical Signs

**STAGE D:** Refractory Heart Failure

**PIMOBENDAN**

Pimobendan is mainly a phosphodiesterase inhibitor III with calcium sensitization. By its effect, pimobendan will increase contractility (inotropic) and vascular smooth muscle dilation (vasodilator). Therefore, it is often referred to as an inodilator. Pimobendan is currently utilized for congestive heart failure, subclinical DCM (Dobermans), and Stage B2 degenerative valvular disease in canine patients.

**Phosphodiesterase Inhibitors**

Cyclic adenosine monophosphate is a product of the adenlylate cyclase activation. Phosphodiesterase inhibitors prevent the breakdown of cyclic AMP.●

- ↑ cAMP activates protein kinase (PK)
- ↑ cAMP → PK = ↑ contractility (heart muscle)
- ↑ cAMP → PK = ↑ vasodilation (vascular smooth muscle)

**Calcium Sensitization**

Most inotropic drugs increase intracellular calcium (Ca2+) to activate the contractile apparatus. Some drugs (i.e. pimobendan) can also sensitize contractile apparatus (Troponin C) to Ca2+, which can increase contraction without increasing intracellular Ca2+.

Important studies to know:

**Dilated cardiomyopathy**


- Randomized, Placebo-controlled, Blinded, Parallel Group, Multicentered.
- Preclinical Dilated Cardiomyopathy in Dobermans
- Pimobendan (n=39 dogs) and Placebo (n=37 dogs)
- Study Times: July 2006 to 2011
● Primary end-point
  - Development of CHF or Sudden Cardiac Death

● Median time to Primary End-Point
  - Pimobendan = 718 days vs. Placebo 441 days (9 months Benefit)

Degenerative Valvular Disease

● Single-blinded study
● Degenerative valvular disease (5 kg-20 kg)
● Benazepril (n=124 dogs) vs. Pimobendan (n=128 dogs)
  - Plus conventional therapy (i.e. furosemide, digoxin, etc.)
● Study times: October 2003 to October 2006
● Primary end-point
  - Sudden death, euthanasia due to CHF, or treatment failure
  - Pimobendan = 88/124 vs. Benazepril = 102/128

● Median time to primary end-point
  - Pimobendan = 267 days vs. Benazepril 140 days


● Prospective, Randomized, Placebo-controlled, Blinded, Multicentered Clinical Trial
● Degenerative Valvular Disease-Stage B2
● Pimobendan (n=178 dogs) and Placebo (n=174 dogs)
● Study Times: October 2010 to March 2015
● Primary end-point
  - Development of CHF, euthanasia for cardiac reason, or death presumed cardiac in origin.

● Median time to Primary End-Point
  - Pimobendan = 1228 days vs. Placebo 766 days (15-month Benefit)
  - VHS>10.5, LA/Ao ≥1.6, and LVIDN≥ 1.7
  - Murmur Grade: ≥3/6 systolic

References


5) Boehringer Ingleheim Vetmedin® Drug Information Sheet.

Introduction:

Cannabis has been integrated within human civilization for over 4000 thousands years. It has been used for food, fiber, fuel, and as medicine. The naturally occurring phytocannabinoids and terpenes produced by cannabis exert a profound physiologic effect on both humans and animals. By accessing the endocannabinoid system, cannabis has multiple actions as example; anti-inflammatory, analgesic, anti-neoplastic, and anticonvulsant, all while promoting homeostasis within the body. The keys to successfully using cannabis as medicine in veterinary patients lies in understanding the physiology of the endocannabinoid system and how cannabis interacts with it.

The Endocannabinoid System:

The endocannabinoid system (ECS) was originally discovered by Israeli researcher Raphael Mechoulam in the 1970’s. A complex regulatory system that is present in almost every system in the body that helps maintain balance and homeostasis. The endocannabinoids are generated on demand by the body, especially in times of stress, disease or injury.

The ECS consists of three major components: receptors, endocannabinoids, and regulatory enzymes. Endocannabinoid receptors are present on neurons throughout the body. A variety of ECS receptors are found including G-Protein coupled receptors, ligand gated ion channels, and nuclear receptors. While there are many specific receptors, the most commonly found are the CB1 and CB2 receptors. CB1 is the most abundant protein bound receptor found throughout the CNS. In addition to the CNS however, CB1 is found in a variety of tissues including fat cells, liver cells, musculoskeletal tissues, the G1 tract, cardiovascular tissues, peripheral nerves, and the reproductive tract. CB1 plays a role in modulating mood, cognition, inflammation and pain, appetite, nausea, cancer proliferation and more. It is also responsible for the psychoactive effects of THC. CB2 receptors are predominantly found in the peripheral nervous system and the immune system. CB2 is frequently expressed on T and B lymphocytes, NK cells, mast cells and macrophages as well as cells of the spleen, liver, kidneys, bone and skin. CB2 receptors function in immune modulation and in mediating inflammation. Research also indicates they play a role in maintaining bone density.

The endocannabinoids are lipid-derived neurotransmitters that bind the endocannabinoid receptors. These ligands are generated on-demand rather than being stored within cells. Two endocannabinoids, anandamide (AEA) and 2-Arachidonoylglycerol (2-AG) interact with CB1, CB2 and the other endocannabinoid
receptors. AEA is the primary endogenous ligand for CB1 and 2-AG is the primary endogenous ligand for CB1.

The degradation enzymes are responsible for disposing of the endocannabinoids after they bind to the receptor/provide appropriate function. The two major degradation enzymes are Fatty Acid Amide Hydrolase (FAAH) and Monoacylglycerol Lipase (MAGL). FAAH provides enzymatic degradation of both endocannabinoids (predominantly AEA), MAGL hydrolyzes 2-AG specifically. It should be also noted that COX-2 also metabolizes AEA and 2-AG.

**The Cannabis Plant:**

There are several plant constituents in cannabis of medicinal interest. Of most interest are the phytocannabinoids. Other important compounds within the plant are terpenes and flavonoids which also contribute to the medicinal profile of cannabis. Phytocannabinoids are exogenous, plant-based compounds that act on endocannabinoid receptors in the body. There have been over 200 phytocannabinoids isolated from cannabis. These compounds have varying affinity for endocannabinoid receptors as well as other receptors in the body. Delta-9-Tetrahydrocannabinol (THC), is one of the most well known and well studied of the phytocannabinoids. THC is a partial agonist of both CB1 and CB2 receptors and is phytomimetic for AEA. THC’s binding affinity for CB1 receptors is responsible for its notorious psychoactivity. Some of the known physiologic effects of THC include: analgesia, anti-tumor, anti-inflammatory, anti-glaucoma, GI protectant, bronchodilator, sleep-aid, anti-convulsant, sedative, anti-nausea, appetite stimulant and neuroprotectant. THC appears to be extremely safe and partially because it doesn’t cause respiratory depression at any dose (unlike opioids). From a veterinary perspective, there is no known LD$_{50}$ for cannabis in dogs. Doses of greater than 3000 mg/kg of pure Δ$^9$-THC have been given in research models without resulting in a fatality.

Cannabidiol (CBD), is a CB1 and CB2 antagonist although it has relatively low binding affinity for both receptors. It is actually a negative allosteric modulator at those receptors, which results in displacing THC off the orthostatic site. This in turn, causes reduction in psychoactivity. The known physiologic effects of CBD include: anti-inflammatory, anti-tumor, anxiolytic, anti-convulsant, cardioprotective, anti-hypertensive, and may reduce insulin resistance.

There are multiple other phytocannabinoids that have published physiologic effects including tetrahydrocannabinolic Acid (THC-A), cannabidiolic acid (CBD-A), cannabigeric acid (CBG-A), tetrahydrocannabinvarin, (THCV), and cannabichromine (CBC).

Another important compound within the plant that has physiologic effects on its own as well as works synergistically with the above phytocannabinoids are terpenes. Terpenes are volatile hydrocarbons found in the essential oils of cannabis,
and many other plants. Terpenes are produced for protection (anti-bacterial and anti-fungal), chemical signaling, and as attractants. There have been over 200 distinct terpenes isolated from cannabis. Terpenes are responsible for cannabis’ smell and taste as the cannabinoids are odorless and tasteless. Terpenes have been

**Dosing and Toxicity:**

THC is the limiting factor when it comes to dosing veterinary patients and careful selection of products and proper dosing is essential. Dogs in particular have higher amounts of CB1 receptors in their cerebellum compared to any other species. When dogs receive excessive amounts of THC (either via accidental ingestion or overdose) they develop a unique toxicity known as Static Ataxia. Excessive THC exposure in dogs can also lead to urinary incontinence, severe lethargy/stuporous appearance, agitation, tachycardia or bradycardia (dose dependent), hypersalivation, and hypothermia.

Ultimately, safe and effective use of cannabis requires an understanding of the milligram amounts of THC and CBD (or other cannabinoids and terpenes), the ratio of cannabinoids, confirmation the product is void of any toxins, solvents, pesticides or heavy metals. Similar to dosing conventional medicine, it is essential we know exactly what our patients are receiving. Confirming the accuracy via obtaining a certificate of analysis (COA) for the product is essential. Some important factors to keep in mind is; firstly, the importance of the Entourage Effect which is the quantity and distribution of major and minor cannabinoids, terpenes, and flavonoids and how they affect the degree of biological activity as well as the spectrum of diseases treated. Secondly, using the appropriate ratio of THC and CBD as well as the appropriate dose are critical to success. Keep in mind, there is the possibility of drug interaction, albeit rare, (due to CBD inhibiting CYP450).

**Conclusion:**

While the legal status of cannabis products continues to play out, it is critical that we continue to push for quality scientific data to support therapeutic evidence. Similar to what is noted in the human medical cannabis circles, the veterinary side will continue to evolve as well. Looking for specific cannabinoid and terpene profiles for various ailments and for ECS support is essential to growth and more profound clinical efficacy.
References:


Foll, B. L. Faculty of 1000 evaluation for Cannabidiol is a negative allosteric modulator of the cannabinoid CB1 receptor. 2018. Post-publication Peer Review of the Biomedical Literature.

Goldstein, B. (2016). Cannabis revealed: How the worlds most misunderstood plant is healing everything from chronic pain to epilepsy.


Leadership is often an oversight in veterinary medicine - and is occasionally misperceived as being applicable to only owners and managers of the practice. However, in reality, leadership applies to every person in the practice, regardless of the role they play. Don’t all team members lead clients through appointments, decisions and communications every day? The truth is, leadership starts at the top and trickles down to every person on the staff. Everything you do and say (as an owner, practice manager, associate veterinarian, lead technician, lead CSR) - gives the remainder of the team permission to behave and communicate the same way.

- A team is only a good as their leader
- Team members mimic leadership behaviors

Every wonder why teams seem disconnected? Why they don’t work together; why they have personality conflicts that interfere with their jobs; or why your practice has high employee turnover? Most often, leadership restricts the team from knowing the business' goals; hire’s warm bodies instead of the ‘right person’; fails to create an effective training plan; and most commonly, prevents the team from obtaining “emotional ownership” of the practice. How can a team member contribute to practice goals, if they don’t know what those goals are? How is a new employee supposed to ‘fit in’ if they are a misfit from the beginning? It's time to stop the madness and create positive, influential cultures that enable you as a leader to love your job and build up the team around you.

**Team Values**

Creating the right culture starts with VALUES. Values can be defined as the beliefs within a practice that guide actions, unite the team and define its brand. What do you value as a leader? Respect, honesty, transparency and integrity may be a few examples that come to mind. Identifying the values of your practice is a great team exercise. Every person becomes more accountable when they can contribute to defining the “words” that represent the practice. The next step is to define each value. What are the expected behaviors associated with that value? Again, using your team to define behaviors begins to breed accountability in each team member. Third, write these values and behaviors down and place them in the employee handbook, use them in job descriptions, performance evaluations and talk about them everyday. Simply having the values established is not enough. The fourth step in this process is to self evaluate. Are YOU modeling these behaviors day in and day out? Be honest with your self evaluation. If you are having “people issues” within your team, you may need to look in the mirror to determine if your own behaviors are helping or hurting the practice.

Use your values to help achieve the vision and mission of the practice. The vision is the desired future for the business; it also helps build the strategic framework for the future. The mission is a brief description of the practice’s specific focus, that when committed to during every interaction, every day, helps archive the vision. These are the goals that every team member must know and be able to participate in. When the team knows
the goals, they can obtain emotional ownership in the practice. Example vision and mission statements:

- **Vision:** "ABC Animal Hospital will be the most trusted and recommended healthcare resource for pet owners of the ABC community."
- **Mission:** "To thoughtfully educate, communicate and provide superior service to our clients in a way that improves the lives of their pets ever day".

Now ask each team of the practice (CSR, Technicians, Assistants, DVMs, Practice Manager) to identify how they will contribute to the mission statement in their role. And ask again, often.

**Leadership and Management: The Synergistic Effect**

Leadership and management must be synergistic. You can’t have one without the other, and one cannot supersede the other. Your strengths in leadership and management fuel your team’s performance. They complement one another, perhaps are even co-dependent.

Management without leadership may ensure things get done, but there may be no guarantee that the results are moving the practice in an intentional direction while uplifting the people inside it along the way. And leadership without management may communicate inspiring visions, but they may never materialize without planned action. To get your practice where you want it to go, strength in both leadership and management is necessary.

Take the time to establish exceptional leadership practices today. Behave, act and communicate as you would expect others to, and lead with established values. You, your culture, team members, clients, and patients deserve it. In addition, as a leader you become intrinsically satisfied. Now what is better than that?
Sunday
August 25, 2019
General Session
8:00 a.m. – 5:15 p.m.
<table>
<thead>
<tr>
<th>Stop Time</th>
<th>CE Minutes</th>
<th>Topic/Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00 am</td>
<td></td>
<td>Welcome and Introduction</td>
</tr>
<tr>
<td>8:15 am</td>
<td>30</td>
<td>&quot;New in Canine Melanoma Treatment&quot;</td>
</tr>
<tr>
<td>8:45 am</td>
<td></td>
<td>&quot;PAIN: MAKE IT STOP!&quot;</td>
</tr>
<tr>
<td>10:00 am</td>
<td>90</td>
<td>&quot;Surgical Management of Degenerative Lumbar Sacral Stenosis (DLSS) in Dogs&quot;</td>
</tr>
<tr>
<td>10:15 am</td>
<td></td>
<td>&quot;Anaphylaxis&quot;</td>
</tr>
<tr>
<td>10:30 am</td>
<td></td>
<td>Lunch</td>
</tr>
<tr>
<td>11:00 am</td>
<td>60</td>
<td>&quot;Cranial Cruciate Ligament Tears in Dogs: Literature Review and My Personal Recommendations&quot;</td>
</tr>
<tr>
<td>11:30 am</td>
<td></td>
<td>&quot;Synergistic Veterinary Practice Teams: Part 2&quot;</td>
</tr>
<tr>
<td>12:00 pm</td>
<td>60</td>
<td>&quot;The lessons learned from two major disasters: Hurricane Harvey and the California Camp Fire Disaster&quot;</td>
</tr>
<tr>
<td>1:00 pm</td>
<td></td>
<td>&quot;Effects of Social Media on our Profession&quot;</td>
</tr>
<tr>
<td>3:00 pm</td>
<td>60</td>
<td>&quot;Effects of Social Media on our Profession&quot;</td>
</tr>
<tr>
<td>3:15 pm</td>
<td></td>
<td>Closing!</td>
</tr>
</tbody>
</table>

**Sunday, August 25th, 2019 (7.5 CE Hours)**

Presenter:
- Phil Padrid, DVM, Director of Specialty Services, VCA
- Barbara Kitchell, DVM, PhD, DACVIM
- Margie Scherk, DVM, DABVP
- James T. Giles III, DVM, MS, DACVS-SA
- Christa Berhardt, DVM, MS, DACVECC
- Sean Gallivan, DVM, MS, DACVS-SA
- Heather Prendergast, DVM, PHD, DACVIM
- Deb Zoran, DVM, PHD, DACVIM
- Phil Padrid, DVM, Director of Specialty Services, VCA
Tumors of melanocytic origin are the most common malignancies of the oral cavity, skin and eyes in dogs. These tumors are somewhat breed associated, with Dobermen and miniature schnauzers reportedly having more benign cutaneous melanomas, while miniature poodles are more affected by malignant cutaneous melanomas. Chow Chows, Golden retrievers, and Scotties may be more affected by malignant oral lesions, while boxers and German Shepherd dogs are relatively less affected in a recent study. These lesions typically affect older dogs with a slight male predominance reported by some.

Melanomas are either benign or malignant tumors that arise as a result of unregulated replication of melanocytes. These lesions may be difficult to characterize along the spectrum of benign to malignant behavior, and undifferentiated tumors are particularly hard to discriminate from other cell types, as lesions may be amelanotic and may assume epithelioid, mesenchymal or round cell characteristics. The immunohistologic diagnosis of melanoma is beyond the scope of this review, and readers are referred to the excellent work of a number of pathologists in the literature for a more thorough discussion.

Melanomas account for 4% -7% of all types of canine tumors, 9% - 20% of skin tumors, 33% of malignant oral tumors, and are the most common canine intraocular tumors. In cats, melanoma is uncommon and accounts for approximately 1% of all feline neoplasms. Uveal and oral melanomas are more malignant than cutaneous melanomas in cats. The oral cavity represents the fourth most common site of cancer in dogs. Malignant melanoma is the most common canine oral neoplasm, which has a fair to a poor prognosis. In dogs, this tumor arises most commonly in the gingiva, but may also occur in the palatine, labial or buccal mucosa. Melanomas of the oral cavity are almost uniformly malignant compared to cutaneous melanomas, which are most commonly benign. Greater than 90% of oral melanomas in canines are malignant while less than 50% of cutaneous melanomas and 18% of intraocular melanomas are malignant in the dog. The exception to this malignant trend in oral melanomas appears to be lesions that are pedunculated on the lips, which can have a more benign biologic behavior. Though lingual and digital (nail bed) melanomas are rare, melanoma of the digits in dogs has a high metastatic rate with affected dogs developing pulmonary metastasis prior to or after surgery.

Oral melanomas in dogs have a poor prognosis, with only about 25% of patients historically surviving one year after treatment. Local-regional tumor recurrence and systemic metastasis contribute to treatment failure. Therefore, even if complete surgical excision of the primary tumor is possible, tumor spread via metastasis remains a concern. However, recent papers have suggested a more favorable outcome from complete surgical excision of oral melanomas in dogs, and suggest that adjuvant therapy may not contribute a great deal to overall survival for the general dog population. A multidisciplinary approach to treatment, including surgery, radiotherapy,
chemotherapy, immunomodulatory therapy, and novel approaches such as electrochemotherapy, may all be required to enhance patient survival depending on stage and individual patient characteristics.

Surgical excision is indicated when the tumor can be completely excised without the result compromising the quality of life. Surgical resection with 1-2 cm margins is recommended where feasible. There is a definite survival advantage when more radical surgical approaches are employed, with 480 day median survival for aggressive surgery vs. 74 day median survival for more conservative resection reported in one study. Mandibular melanoma has traditionally been believed to have a more favorable prognosis than maxillary disease, possibly because of the improved potential for radical mandibulectomy as opposed to maxillectomy. Regional lymph nodes should be excised at the time of primary tumor resection. Microscopic evidence of metastasis may be detected even in lymph nodes of normal size. In a retrospective study of lymph nodes resected from 100 dogs with oral melanoma, 47% had nodal metastasis on histologic evaluation. Significantly, while 70% of these node positive dogs had enlarged lymph nodes, 30% of dogs with nodal metastasis on histology had normal lymph node size on physical examination. Thus, while enlarged lymph nodes often indicate metastasis, normal lymph nodes on palpation cannot rule it out.

**Radiation Therapy** - The use of radiation is limited to an adjunctive role, because most melanomas are relatively resistant to radiotherapy, and radiation therapy to the local tumor bed does not address the life-limiting problem of systemic spread. There are inherent advantages in using radiotherapy in the head and neck region with its anatomical complexity and cranial nerves and other vital structures in high concentration. Aggressive surgery can result in functional as well as cosmetic abnormalities. While most veterinary patients can compensate for loss of function and are not bothered by cosmetic alterations, these complications do represent a significant barrier to some clients. A benefit of radiotherapy is that regional lymph nodes can also be irradiated. Radiation therapy protocols for melanoma typically involve coarse fraction delivery (hyperfractionation), such as 8 Gy per fraction delivered in 3 or 4 doses. This type of protocol was reported to result in an overall response of 83% (complete response: 53%, partial response: 30%, no response or stable disease: 17%). The same protocol induced remission in 3/5 cats treated for oral melanoma and resulted in a median survival time of 146 days. A variety of other protocol schemes have been reported, including 36 Gy delivered in 4 fractions, 30 Gy delivered in 3 fractions, and 45 Gy or more delivered in 12-19 fractions of 2-4 Gy per fraction. In a large case series reported from NCSU, 140 dogs radiated with one of the 3 previously described fractionation schemes showed no superior method of radiation. Dogs treated with radiation therapy had a median time to first event (recurrence or metastasis) of 5 months and median survival of 7 months. Radiation delivered in course fractions, in conjunction with chemotherapy such as the non-traditional alkylating agent temozolomide, may result in tolerable adverse effects and in increased local tumor control.

**Chemoimmunoradiotherapy** - In human medicine, a new trend toward combining radiation with chemotherapy and immunotherapy is emerging as a potentially helpful modality. In chemoimmunoradiotherapy, a single 9 gy fraction of radiation is given to
the tumor in situ, which releases tumor associated antigens into circulation. This sets the stage for the addition of potent immunotherapeutics, such as PD-1 and CTLA-4 monoclonal antibodies, which in turn facilitate immune recognition of the cancer cells that remain.

**Chemotherapy** for metastatic disease or as an adjunct to surgery and radiation therapy has largely been reported anecdotally or through small case series. Drugs used in adjuvant or salvage settings include dacarbazine in veterinary oncology as in human oncology, and evidence of response to systemic carboplatin and lomustine chemotherapy have also been noted. Intralesional therapy with cisplatin or carmustine resulted in an 80% local tumor control rate when delivered in a time-release collagen gel matrix formulation.

Melanomas have been found to express Cox-2 at high levels and may therefore respond to this signaling as a growth factor. Adjunctive treatment with a Cox-2 inhibitor such as piroxicam, or with newer, more selective coxibs, is worthy of additional investigation. Recent genomic studies have identified Cox-2 expression as the most common “hit” in gene expression studies of canine melanoma tumors. European studies have suggested that selective Cox-2 modulators such as celecoxib have high levels of efficacy against canine melanomas in cell culture, but the levels required to achieve this effect in vitro may not be achievable in vivo. Additionally, evidence of efficacy of a combination of cisplatin (50 mg/M2 IV with a 6 hour saline diuresis) plus piroxicam (0.3 mg/kg daily PO) induced responses in dogs treated for oral melanoma. Renal toxicity was dose limiting and requires careful monitoring.

**Immune, Vaccination, and Gene Therapy** – A recent development in human melanoma therapy has been to harness the power of the immune system to combat the metastatic version of the tumor. Since 2010, immunotherapy with and CTLA-4 monoclonal antibodies, such as the licensed agent ipilimumab, and monoclonal antibodies against the programed cell death receptor PD-1 such as pembrolizumab or nivolumab, or its ligand PDL-1, have been very important in contributing to longer human survivals. These newer monoclonal antibodies are entirely humanized, so it is not expected that they would be useful in combating the canine disease over long periods of treatment due to formation of anti-human canine neutralizing antibodies. However, canine versions of these monoclonal antibodies are under development, and these strategies are expected to have an impact on a variety of solid tumors beyond melanoma through their activity as major activators of the immune response. It will be interesting to see what the future holds for veterinary medicine as monoclonal antibody therapy becomes more available.

It has long been appreciated that melanoma is a tumor type capable of undergoing remission with immunologic stimuli. The evidence for this observation dates back to the time of Coley’s toxin, and was further validated through increased disease control and survival achieved by the use of liposome encapsulated muramyl tripeptides in canine oral melanoma therapy. In fact, even use of a topical immunostimulatory agent, imiquomod, has demonstrated responses in canine cutaneous melanoma therapy.

Long-term survival of dogs with advanced malignant melanoma was achieved after
DNA vaccination with xenogeneic human tyrosinase antigen, available in the United States from Meriel (now Boehringer Ingelheim) (Oncept®). This xenogeneic vaccine contains human DNA coding for the gene tyrosinase, which is highly expressed in melanocytes as part of the production of melanin pigment. In the engineered vaccine construct, the gene is under the control of a strong cytomegalovirus (CMV) promoter, which results in production of the human protein in canine muscle. The vaccine is introduced to muscle by use of a needle-less bioinjector system. Once the dog begins to produce the human protein, the canine immune system recognizes the human tyrosinase enzyme and is hopefully sufficiently potent to break self-tolerance to eradicate remaining microscopic (or in some cases even macroscopic) melanoma tumor burden in the dog. The CVM viral proteins, and the DNA itself through expression of viral CpG DNA sequences, act as a potent internal adjuvant to boost the immune system. The vaccine is administered on a 2-week basis for 4 treatments, then as booster injections every 6 months. Responses have been seen even in dogs with transient tumor progression. Optimally, dogs should have the tumor burden reduced to a tumor stage of T0 by surgery and/or radiation therapy prior to vaccination. In the Phase I trial, median survival for 9 dogs treated was 389 days, with complete responses reported and greater that 588-day survival for one dog with bulky non-resectable disease. Dogs that demonstrated antigen-specific antibody responses were more likely to have positive responses clinically. Expanded trials have been reported that demonstrate improved disease free interval and survival over historical controls for dogs with oral and also digital melanomas. However, not all studies of the xenogenic melanoma vaccine have shown such successful results. There are certainly cases that suffer recurrence during the course of the vaccine induction (the dosages given every 2 weeks for 4 treatments). During this period of time, the immune system may be challenged by stress of recent therapies, such as surgery and radiation. If there is a greater than anticipated tumor burden at the outset, it may be beyond the capabilities of an impaired immune response to quell. A study by Ottnod, et. al. in 2013 showed that for 45 dogs, 30 of which had Stage II and III melanomas, there was no difference in disease control or survival when compared with dogs who were similarly managed with surgery but did not receive the vaccine. This data was in opposition to other published studies of the vaccine’s efficacy. This study has been criticized by not achieving complete local tumor control through surgery in all the dogs, which is cited as a requirement for optimum vaccine performance. A large, multicenter retrospective study is being conducted in several veterinary cancer centers to gain a larger cohort for verification of the vaccine’s true impact in dogs with melanoma at various stages.

Other immune approaches under study for canine oral melanoma include treatment with allogeneic and autologous tumor cell vaccines, gene therapy, cytokines, and antibodies, along with novel delivery systems such as electrochemotherapy. The rationale for tumor cell vaccines is based on the idea that attenuated transfected tumor cells may serve as an antigen source, while an immunoadjuvant vehicle can induce expression of immunostimulatory cytokines concurrently. Promising results were noted in a trial using an electrovaccination approach delivering a xenogenic DNA molecule (human chondroitin sulfate proteoglycan-4) as the active agent. Further tests of this approach are ongoing in Europe.

New comparative genomic studies of canine melanoma tumors suggest that
Melanomas are analogous to rare forms of melanoma in human beings. Most human melanomas are of actinic origin (sunlight induced). These tumors often express a signature V600E mutation in the BRAF gene, which is the subject of new, targeted therapies. Drugs such as the V600E targeted small molecular inhibitor dabrafenib and vemurafenib have become the standard of care for humans with melanomas bearing this mutation. Dogs do not express this mutation except in very rare cases, unfortunately, so these newer human targeted therapies will not have a significant impact in treating the canine disease. However, less common forms of human melanoma do express gene changes in concert with those commonly seen in the dog, which include NRAS and PTEN mutations. Therapies targeting these altered pathways may find their way into veterinary oncology soon. The MEK kinase inhibitor Trametinib is used in concert with dabrafenib in human metastatic melanoma. Trametinib is a drug that may have a role to play in canine melanoma therapy in the future. Similarly, the c-kit receptor has been detected on canine melanoma tissue, and mutations in Exons 11 and 13 have been found to be contributory to a subset of human melanoma cases. Thus, kit-targeted receptor tyrosine kinase inhibitors such as imatinib, masitinib, and toceranib may also be useful in treatment of canine malignant melanoma of various sites. Toceranib may also contribute to immunomodulation in tumor bearing dogs as an underlying mechanism of action. Canine melanoma cell lines were found to be sensitive to the combination of a MEK kinase inhibitor in combination with a PI3K/mTOR inhibitor. We are currently assessing a similar combination in clinical patients. Many studies of molecularly targeted therapeutics for canine melanoma therapy are ongoing. With advances in molecular study of canine tumors, new approaches using novel commercially available agents will be interesting for exploration in canine melanoma in the future.

References - Available from the author upon request.
Over the past three decades, there has been increased awareness of pain and attention to the alleviation of pain in cats. Investigation has focused primarily on chronic musculoskeletal pain. The purpose of this presentation is to address not only musculoskeletal but also other types of pain. For an excellent review of all types of pain, the reader is referred to the WSAVA Guidelines for recognition, assessment and treatment of pain1.

INTRODUCTION

Pain isn’t just about how it feels; it is also about how it makes you feel. It results in suffering and a feeling of hopelessness. According to the International Association for the Study of Pain, pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage.

Pain may be nociceptive, associated with injury (thermal, chemical or traumatic/surgical), inflammatory or neuropathic. There is a lot of overlap, and, regardless of type, if adequately controlled and primary or secondary inflammation resolve, pain should not become irreversible.

Acute pain is associated with tissue damage and serves to change behaviour in order to minimize or avoid damage. It is beneficial in that it helps to optimize conditions in which healing can take place. It is self-limiting and stops once healing is complete. Chronic pain, on the other hand, persists beyond the expected healing process without a clear end-point. It is maladaptive and dysfunctional and does not support healing. It can have significant effect on physical wellbeing and psychology of the sufferer. Chronic pain may be considered a disease state. Chronic pain may be present as a result of ongoing medical inflammation (e.g., intestinal, lower urinary tract, oral/dental, musculoskeletal) or secondary to unrelenting nociceptive stimulation (injury and associated inflammation).

Neuropathic pain is a term that refers to pain that is directly caused, or instigated, by dysfunction of, injury to, or primary lesion in the nervous system. As damaged nerves fire spontaneously, they become hyper-responsive to even normal stimuli. This pathophysiology results from sequential changes occurring in the peripheral nervous system, spinal cord, brainstem and brain1.

Neuropathic pain is often a result of surgery, especially amputations (e.g., tail, limb, onychectomy) or fractures when appropriate analgesic agents have not been used or used for a long enough duration. Nerve compression and diabetes also result in neuropathic pain as can any chronic, unrelenting pain regardless of cause2. Neoplasia, and probably interstitial/sterile idiopathic cystitis, are considered to be “mixed” as they have both inflammatory and neuropathic characteristics.

UNDERSTANDING PAIN

Tissue damage stimulates the nociceptors; this results in transduction (i.e., translation of the stimulus), transmission of the signal to the spinal cord where it is modulated (amplified or dampened) and then transmission to the brain where the original stimulus is ultimately perceived (in the frontal cortex and limbic system). It is likely that emotional and psychological elements play a role in cats as they do in people3.

Acute pain must be treated until inflammation is sufficiently resolved that the pain pathway won’t be aggravated anew. All patients need to be sent home with analgesic medication post-operatively, regardless of how “routine” the procedure is4-6. If inadequate analgesia was provided following surgery or other trauma, or wasn’t administered for long enough, permanent changes to the central nervous system may occur resulting in the patient experiencing excessive and inappropriate pain. Persistent nociceptive input results in “wind-up”, an increase in the excitability of the sensory neurons of the spinal cord. These hyperexcitable cells amplify the signal that is sent to the brain resulting in changes to receptors and a decrease in inhibitory signals descending from the brain. Thus, the patient has a lower threshold to pain, experiencing it at a lower intensity than is expected (“allodynia”), has a greater pain response, experiencing more pain than expected for a given stimulus.
("hyperalgesia"), and may have pain over wider regions than expected. In other words, it is important, not only to provide pain relief, but to provide it for a long enough period\(^3\). (See Figure 1.)

![Allodynia vs Hyperalgesia](image)

**Figure 1**: Allodynia, hyperalgesia vs normal stimulus response curve. Image excerpted from Medscape: Vinik A, Simpson D.\(^3\)

**PREDICTING PAIN**

Animal species have been used for decades as models for some types of human pain. While these studies don’t reflect naturally occurring pain, it is clear that cats experience pain under similar situations that humans do. The WSAVA Guidelines include tables that suggest what level of pain a given condition might result in. The document also cautions that every situation and every individual is unique. Erring on the side of overestimating pain is justified as long as appropriate analgesic therapy is used safely.

*If you think it might hurt you, assume it hurts your patient.*

<table>
<thead>
<tr>
<th>Severe-to-excrutiating</th>
<th>Moderate-to-severe (varies with degree of illness or injury)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central nervous system infarction/tumours</td>
<td>Immune-mediated arthritis</td>
</tr>
<tr>
<td>Fracture repair where extensive soft tissue injury exists</td>
<td>Capsular pain due to organomegaly</td>
</tr>
<tr>
<td>Ear canal ablation</td>
<td>Traumatic diaphragmatic rupture</td>
</tr>
<tr>
<td>Articular or pathological fractures</td>
<td>Trauma (i.e. orthopaedic, extensive soft tissue, head)</td>
</tr>
<tr>
<td>Necrotizing pancreatitis or cholecystitis</td>
<td>Ureteral/urethral/biliary obstruction</td>
</tr>
<tr>
<td>Bone cancer</td>
<td>Glaucoma</td>
</tr>
<tr>
<td>Aortic saddle thrombosis</td>
<td>Panosteitis</td>
</tr>
<tr>
<td>Neuropathic pain (nerve entrapment/inflammation, acute intervertebral disc herniation) Inflammation (extensive e.g. peritonitis, fascitis – especially streptococcal, cellulitis)</td>
<td>Hemorrhagic disc herniation</td>
</tr>
<tr>
<td></td>
<td>Traumatic diaphragmatic rupture</td>
</tr>
<tr>
<td></td>
<td>Ureteral/urethral/biliary obstruction</td>
</tr>
<tr>
<td></td>
<td>Glaucoma</td>
</tr>
</tbody>
</table>

| Meningitis                                                                           | Panosteitis                                                |
| Spinal surgery                                                                       | Hemorrhagic disc herniation                                |
| Burn injury                                                                          | Traumatic diaphragmatic rupture                             |
| Limb amputation                                                                      | Ureteral/urethral/biliary obstruction                       |
| Thrombosis/ischaemia                                                                 | Glaucoma                                                   |
| Hypertrophic osteodystrophy                                                          | Panosteitis                                                |
|                                                                                     | Hemorrhagic disc herniation                                |
|                                                                                     | Traumatic diaphragmatic rupture                             |
|                                                                                     | Ureteral/urethral/biliary obstruction                       |
|                                                                                     | Glaucoma                                                   |
Uveitis
Early or resolving stages of soft tissue injuries/inflammation/disease
Intervertebral disc disease
Mesenteric, gastric, testicular or other torsions
Peritonitis with septic abdomen
Mucositis
Oral cancer
Mastitis
Dystocia
Extensive resection and reconstruction for mass removal and corrective orthopaedic surgery (osteotomies; cruciate surgery; open arthrotomies)

**Moderate**
Soft tissue injuries (i.e. less severe than above)
Urethral obstruction
Ovariohysterectomy
Cystitis
Diagnostic arthroscopy and laparoscopy
Osteoarthritis

**Mild-to-moderate**
Dental disease
Otitis
Superficial lacerations
Mild cystitis
Chest drains
Abscess lancing
Castration

**CHRONIC PAIN: ESPECIALLY OLDER CATS BUT IN ANY AGE**
Oral diseases such as periodontal disease, root exposure, resorptive lesions, stomatitis and oral ulcers and masses are all painful. Bacterial cystitis and pyelonephritis are more frequent in older cats, but the prevalence of

---


**RECOGNIZING PAIN**
The signs of pain are generally more subtle in cats than in dogs. Some objective clinical signs indicative of pain include:

- Inability to rest/sleep
- Inappropriate activity level
- Sitting in the back of the kennel
- Mental attitude/demeanour (stupor or anxiety)
- Changes in attitude/personality
- Poor hair coat
- Lack of comfort when palpated
- Facial expression, staring, fixed gaze, dilated pupils, “squinty” eyes
- Lack of appetite and thirst
- (Self-mutilation)
- Vocalizations
- Posture
- Tachycardia
- Tachypnea
- Body temperature and blood pressure may be increased or decreased.

Paying attention to body posture, facial expression, and response to handling, including gentle palpation of any surgical or injury sites, helps assess the level of pain or comfort. But, because the experience of pain is individual, so the patient’s state should be reassessed frequently. In addition, adults and older individuals are generally more stoic making it even harder to detect pain than in the kitten. Seriously ill or obtunded patients are especially difficult to assess for pain as they are less likely to display behavioural signs of distress when compared to an otherwise healthy cat who has been injured.

*Pain as an experience differs for each individual. Observe and adjust doses to make every patient comfortable.*
interstitial/sterile cystitis or inflammatory bowel disease does not differ from younger cats; inadequately addressed, these may cause on-going pain. The likelihood of neoplasia increases with increasing age. The need for analgesia MUST be considered as part of any treatment plan for the older cat. “Routine” procedures including blood collection, intravenous catheter placement, restraint of a thin or arthritic patient are uncomfortable.

Recognition of chronic pain and arthritic pain is relatively recent. The incidence of degenerative joint disease (DJD) appears to be much more common than previously thought and is probably a major cause of discomfort in ageing cats. In three studies retrospectively assessing radiographs taken of cats over 12 years of age or of any age the prevalence of findings suggestive of DJD was 90%, 22% and 34%, respectively with older cats showing radiographic changes. Only 4%, 33% and 16.5% had notation of restricted mobility in the medical record indicating that appropriate questions were not being asked of owners, that cats do not experience or that they don’t show discomfort from these joint changes.

A recent study prospectively evaluated cats of all ages to determine the prevalence of radiographic signs of DJD. Most (92%) cats had radiographic evidence of DJD; 91% had at least 1 appendicular site affected and 55% had ≥ 1 site of axial DJD. Affected joints in descending order of frequency were hip, stifle, tarsus, and elbow. The thoracic segment of the spine was more frequently affected than the lumbosacral segment. Grading the severity of each of the radiographic changes identified, they found that for every 1-year increase in age, the expected total DJD score increased by an estimated 13.6%. They concluded that radiographically visible DJD is very common in domesticated cats, even in the young and is strongly associated with age.

Yet lameness is not a common clinical sign of this problem in cats: signs are insidious or often attributed to ageing. They include inappropriate elimination (often adjacent to the litter box), decreased grooming, developing antipathy for being combed, reluctance to jump up or down, sleeping more, moving less, withdrawing from human interaction, and possibly even hiding. When activity monitors were attached to cats’ collars, activity counts increased with meloxicam suggesting alleviation of musculoskeletal discomfort.

Wherever possible, the underlying cause of the pain should be identified and corrected.

IDENTIFYING CHRONIC PAIN
Because cats are solitary survivors, they are notoriously secretive in revealing discomfort and disabilities. When the presenting concerns from the client fail to include observations of pain, questions regarding behavioural or lifestyle changes may elicit clues. Changes in awareness, personality and interaction, an inappropriate activity level, reduction in playing, aggression, changes in sleeping patterns and litter box use may be present. Other indicators of on-going pain include a decrease in mobility or ease of jumping (up or down), inappetence or altered eating behaviours and a poor coat from lack of grooming. Adults and older individuals are generally more stoic making it even harder to detect pain than in the kitten. Seriously ill or obtunded patients are especially difficult to assess for pain as they are less likely to display behavioural signs of distress when compared to an otherwise healthy injured cat.

Examination may reveal reluctance to being handled or having a particular body part palpated or manipulated and may result in self-defensive behaviour. Sedation/anaesthesia may be needed to properly assess oral and dental problems or for imaging. Radiographic, ultrasonographic or advanced imaging (MRI/CT) may be warranted to identify the underlying problem. Quantitated sensory testing may be undertaken to help localize the neuropathic lesion using different types of stimuli to identify the type (and therefore location) of nerve fiber affected.

Elimination trials may be undertaken to verify and alleviate pain. For example, a local block may be used to assess oral/dental problems or a regional block for a joint or paw. An analgesic trial, usually based around opioids with or without non-steroidal anti-inflammatory drugs (NSAIDs) should also be considered when there is a suspicion of pain. The truest assessment of the presence of pain is response to analgesics resulting in return to normal behaviours.
There are no pathognomonic or unique clinical signs that characterize pain or that are present in every painful individual. Cats cannot directly communicate their discomfort to us. Several pain scoring systems exist, however they are either for assessing acute pain or have not been validated. The Feline Musculoskeletal Pain Index is the exception and may be a starting point for non-musculoskeletal pain. Fear (especially in the clinic) may look like pain and some patients may be experiencing both. With patients and in a quiet, calm environment, it can be easier to identify signs of pain. Look for at least three indicative signs in the history, behavioural changes and examination. (See Figure 2).

Figure 2: Triangulation for identifying chronic pain. Adapted from Bergadano

The experience of pain is different for every individual, both in severity, duration and impact. An analgesic regimen, using single or multiple agents, needs to be tailored to the individual’s needs through empathic and repeated assessment.

PREVENTING AND TREATING CHRONIC PAIN

Wherever possible, pre-emptive analgesia should be used to prevent stimulation of nociceptors and transduction of pain. Central sensitization can be prevented at the level of the N-methyl-D-aspartate (NMDA) receptors in the dorsal horn of the spinal cord. Ketamine is used, not only for its properties as a dissociative analgesic agent, but also specifically to block these receptors, thereby acting as an analgesic and as an anti-hyperalgesic agent.

When pre-existing inflammation, inadequate peri-operative analgesia with resultant neuropathic pain exist, or if the cause of pain cannot be treated, then an effective analgesic protocol must be developed in order to provide the patient with the best quality of life possible. Providing multimodal, balanced analgesia impacts multiple sites of the pain pathway while reducing the risk of negative effects from any one class of drug. This may be achieved through the concurrent use of an opioid with an NSAID and possibly amantadine (NMDA receptor antagonist) for maladaptive pain. Analgesic choices and doses for cats are listed in Table 1.

Analgesia for chronic musculoskeletal disease

The cat with joint pain is often an older patient who may have concurrent problems (e.g., renal disease) including some that may affect drug metabolism. Like painful patients of any age, they may be in a physiologic state that affects drug disposition, the most common ones being dehydration, inadequate tissue oxygenation, electrolyte or acid-base imbalances and malnutrition. The most common concern regarding NSAID side effects is the possible consequence of using this class of drug in a dehydrated patient resulting in effects on gastric mucosal health or on renal function. Dehydration may be subclinical and difficult to assess in the very young and in the older cat due to the unreliability of skin elasticity in these age groups. (Stool consistency [i.e., pellets rather than formed logs] can be helpful in evaluating hydration.)

Opioids are safe for pain relief in any age group and are excellent when used at the same time as other agents, especially NSAIDs. They are not, however, a first drug of choice for cats with arthritic pain as they are not very effective for DJD. This is not to suggest that they shouldn’t be used for “break-through” pain or for comfort during diagnostic testing. If they produce adverse side-effects (e.g., euphoria, constipation and inappetence) in an individual patient they may be reserved for palliative hospice care.
Pharmacokinetic data is lacking for safe, long-term use of many NSAIDs in cats. Carprofen half-life varies from nine to over 40 hours in cats. As most NSAIDs have long half-lives in cats when compared to other species, one precaution to avoid toxicity is to reduce the frequency of administration but not below label frequency. Interestingly, despite having a short half-life of under 2 hours in blood, robenacoxib (Onsior®) its effect persists for 24 h in clinical studies.

Metacam® 0.5 mg/ml oral suspension has been granted a licence in the EU for the alleviation of inflammation and pain in chronic musculoskeletal disorders in cats. The registered dose is 0.1 mg/kg on the first day followed by 0.05 mg/kg orally once daily. This is the first NSAID licensed for long-term use in cats.

Numerous efficacy studies have been performed regarding both of these NSAIDs. In one, clients felt that cats treated for one month with meloxicam were more willing to jump achieving progressively higher heights during the study. Evaluation of the cats by the veterinarian at the end of the month showed a significant reduction of gait stiffness. Three studies have evaluated long-term safety of this agent in older cats; one concluded that this agent is safe, efficacious and palatable for musculoskeletal pain at 0.01-0.03 mg/kg PO q24h for a mean treatment duration of 5.8 months; no deleterious effect on renal function was detected in cats studied. Gastrointestinal upset in 4% of cats was the only adverse effect noted. The second and third, reviewed the medical records of cats over 7 years of age treated for a minimum of 6 months with a daily maintenance dose of 0.02 mg/kg meloxicam and concluded that this dose does not hasten progression of renal disease in aged cats or aged cats with pre-existent stable IRIS stage 1-3 renal disease.

In 2015, a paper reported on the safety of robenacoxib (1–2.4mg/kg) for daily, month long treatment of DJD in cats including 40 with chronic kidney disease IRIS stages 2-4. There was no evidence of increased risk in the frequency of reported adverse events, or in deterioration in renal variables in the subgroup of cats with concurrent CKD. In the European Union, Onsior® tablets received a licence in 2018 for treatment of pain and inflammation associated with musculoskeletal disorders for both short and long-term in cats. Additionally, there is an injectable formulation labelled for treating pain and inflammation associated with surgery (single dose: 2 mg/kg subcutaneously before surgery).

Excretion and metabolism of meloxicam have been studied in cats. After oral administration, the major route of excretion is fecal and the main pathway of biotransformation is by oxidation, rather than by their limited glucuronidation pathway. Additionally, 21% of the recovered drug was eliminated in urine (2% as unchanged meloxicam, 19% as metabolites) and 79% in the feces (49% as unchanged meloxicam, 30% as metabolites).

A comprehensive review of the long-term use of NSAIDs in cats was published in 2010. This document may be accessed free-of-charge at: http://www.catvets.com/guidelines/practice-guidelines/nsaids-in-cats in Spanish, French, German and Japanese. In addition, an educational client brochure (Spanish, French) regarding the safe use of NSAIDs in cats is also available at the same web link. To minimize the risks of NSAIDs, it is important to:

- Select appropriate patients: individuals should maintain hydration and not be hypovolemic, hypotensive or in congestive heart failure.
- Obtain a complete list of medications the cat is receiving or has access to.
- Base the dose on lean body weight and consider titrating, once pain is controlled, to lowest daily dose that maintains comfort.
- Use a balanced approach: include nutritional, adjunctive and environmental components.
- Use gastroprotectants to treat or prevent gastric upset.
- Ensure communication with clients through verbal and written instructions.
- Recognize adverse reactions promptly and discontinue the NSAID.
- Monitor blood work q 2-4 months (high risk patients) or q6 months (low risk patients).
- A washout period of 3-5 days should be used if transitioning from one NSAID to another; a longer washout period is indicated (7-10 days or longer) when switching to, or from, aspirin or a corticosteroid.

Additional, alternate analgesic agent(s) should be used during the washout period.
A suitable protocol for a cat with pain from musculoskeletal disease might be baseline NSAID with intermittent use of an opioid (such as burprenorphine) when “break-through” pain is evidenced by a decrease in appetite, mobility or social interaction. Gabapentin may be added for ongoing care.

Environmental modifications: Regular nail trimming helps by maintaining proper joint relationships. Ramps and steps to favourite sleeping spots are helpful. Warm, soft, padded sleeping places for stiff, painful, possibly bony joints should be considered. Raising food and water bowls may help the cat with cervical vertebral changes. Adding a litter tray to reduce the distance between boxes may reduce accidents as well as encourage regular voiding and defecation. The rim of the tray mustn’t be too high, nor the opening into the box too small. It should be scooped several times a day to encourage use.

Feeding a diet that is supplemented with eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA) +/- green-lipped mussel (GLM) extract and glucosamine/chondroitin sulfate may be beneficial. Disease-modifying agents such as polysulfated glycosaminoglycan, glucosamine and chondroitin sulfate may improve joint health.

Additional modalities (therapeutic exercise, acupuncture, cold laser therapy) while no scientific studies have been done to support efficacy, may also play a role in providing comfort for a cat with musculoskeletal discomfort.

The author recommends that for chronic administration of NSAIDs in cats, it is good clinical practice to use the lowest effective dose based on lean body weight, tapering to the lowest effective daily dose (off-label) and to avoiding use in, (or use lower initial doses) in cats with renal disease. Ensure that the patient is hydrated and give the NSAID with food. Individual patients respond differently to the same agent and dose. In most cases, NSAIDs are most effective when used in conjunction with other treatment modalities.

**ANALGESIA FOR NEUROPATHIC PAIN**

Neuropathic pain may be caused by inadequately alleviated traumatic or surgery-induced pain, such as onychectomy (declaw) or amputation. Clients may remark that their cat doesn’t jump as high as before the procedure or walks as if on glass or eggshells. Alternately, they may note decreased activity, increased aggression, inappetence starting months or even years after surgery. While the initiating event may be known, it is imperative that radiographs of affected paws be taken to rule out a bone remnant, a surgically treatable problem. When none is found, neuropathic pain is treated by addressing “wind-up” while concurrently providing analgesia. Analgesics alone are ineffective. Amantadine is used off-label to block the NMDA receptors in the spinal cord, however, because it lacks analgesic effects, an opioid plus NSAID are used concurrently. The regime suggested by Gaynor is outlined in Table 2.

Another condition, feline orofacial pain syndrome (FOPS) is a disorder of cats with behavioural signs of oral discomfort and tongue mutilation. There is suggestion that it is inherited in an autosomal recessive manner. It is believed to be neuropathic in nature and characteristically includes exaggerated licking and chewing movements and pawing at the mouth; in some extreme cases mutilation of tongue, lips and buccal mucosa occurs. It appears to be triggered by mouth movements (grooming, eating)\. Like idiopathic cystitis, it occurs at irregular intervals with the cat appearing to be pain-free in between these episodes. In both, external factors can also influence the disease such as anything causing stress or anxiety as well as other illness. Therapy for FOPS includes ruling out other causes of facial and oral pain, any dental disease discovered should be treated. An attempt to identify and eliminate environmental stresses and triggers should be made. Pain relief requires multiple agents including NSAIDs plus phenobarbital, carbamazepine, gabapentin or amitriptyline. Treatment is long-term and may not be successful in some cases.

**NOVEL MEDIATORS OF PAIN**

New mediators of pain have been identified and are being studied as therapeutic targets. These include nerve growth factor (NGF), piprants, neurokinin-1 antagonists, selective neurotoxins and cannabinoids.

- **Nerve growth factor**
  This mediator of inflammatory and neuropathic pain is elevated in models of chronic and animal pain. Hyperalgesia is alleviated by inhibition of NGF. Numerous approaches are being evaluated, (e.g., monoclonal
antibodies) to negate its effect. Risks and benefits of Tanezumab have been studied in human medicine for interstitial cystitis, osteoarthritis, diabetic neuropathy and post-herpetic neuralgia. A felinized anti-NGF monoclonal antibody (NV-02, Frunevetmab, Nexvet Biopharma) has been developed; multicenter clinical trials are underway.34-35.

- **Pripants**
  Pripants and substances that antagonize prostaglandin E2 EP4 receptor, i.e., further down the inflammatory cascade than NSAIDs thereby not interfering with the "housekeeping" actions of COX enzymes. While not yet approved for use in cats, grapiprant (Galliprant®, Elanco) has been studied in this species and has received FDA approval for use in dogs with DJD.36

- **Neurokinin-1 antagonists**
  This class of drug prevents substance P from binding to NK-1 receptors. Maropitant is typically used as an antiemetic but may provide visceral analgesia in dogs (as indicated by reduced anaesthetic requirements during ovariohysterectomy).

- **Selective neurotoxins**
  Two selective neurotoxins have been studied in dogs: resiniferatoxin and substance P-saporin. These selectively inhibit or destroy cells in receptors. It is too early to say whether these will play a role in veterinary analgesia.

- **Cannabinoids**
  The use and benefits of medical marijuana for people continue to be investigated. Cannabinoids interact with receptors in the endocannabinoid system. These include cannabidiol (CBD), cannabinol (CBN) and tetrahydrocannabinol (THC) receptors. Fractions that target CBD and CBN receptors (e.g., as in hemp oil) but not THC receptors might be of use; THC is dangerous for small animals. Research is lacking for use for cannabinoids in cats at this time.

### Table 1: Analgesic choices for pain in cats

<table>
<thead>
<tr>
<th>Drug Class</th>
<th>Drug</th>
<th>Follow-Up Analgesia or Chronic Pain Moderate-Moderate Pain</th>
<th>Follow-Up Analgesia or Chronic Pain Moderate-Severe Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OPIOIDS</strong></td>
<td>Butorphanol</td>
<td>0.1-0.4 mg/kg IV, IM, SC q2h</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Buprenorphine</td>
<td>0.01-0.03 mg/kg IM, IV, SC q6-8h; 0.01-0.03 mg/kg q6-8h bucally</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morphine*</td>
<td></td>
<td>0.1-0.2 mg/kg IV q1-4h or 0.1-0.5 mg/kg IM q2-6h</td>
</tr>
<tr>
<td></td>
<td>Fentanyl</td>
<td></td>
<td>0.004-0.01 mg/kg IV q 20 min or 0.001-0.004 mg/kg/h CRI or fentanyl patch 12.5-25 mcg/h q 4-5 d</td>
</tr>
<tr>
<td><strong>OPIOID REVERSAL OR TITRATION</strong></td>
<td>Naloxone: for reversal/titration of opioid dose:</td>
<td>Dilute 0.1 ml of 0.4 mg/ml naloxone in 5 ml 0.9% NaCl; administer at 1.0 ml/minute to effect</td>
<td>Same</td>
</tr>
<tr>
<td><strong>NSAIDs</strong>*</td>
<td>Meloxicam</td>
<td>0.1 mg/kg PO on d1, then 0.05 mg/kg PO q24h long term; consider titrating to lowest effective daily dose (off-label)</td>
<td>Same</td>
</tr>
<tr>
<td></td>
<td>Robenacoxib</td>
<td>1-2 mg/kg PO q24h for 3 days (US, Canada), 6 days (EU); 2 mg/kg SC once before surgery (EU)</td>
<td>1-2 mg/kg PO q24h (EU)</td>
</tr>
</tbody>
</table>


Fractions that target CBD and CBN receptors (e.g., as in hemp oil) but not THC receptors might be of use; THC is dangerous for small animals. Research is lacking for use for cannabinoids in cats at this time.
<table>
<thead>
<tr>
<th>Drug</th>
<th>Dosage</th>
<th>Administration</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ketoprofen</td>
<td>≤ 2.0 mg/kg SC once, then &lt; 1.0 mg/kg q24h for 4 days maximum</td>
<td>Same</td>
<td></td>
</tr>
<tr>
<td>Tolfenamic acid</td>
<td>≤ 4.0 mg/kg SC, PO q24h, for 3-5d</td>
<td>Same</td>
<td></td>
</tr>
<tr>
<td><strong>NMDA RECEPTOR ANTAGONISTS</strong></td>
<td><strong>Ketamine</strong></td>
<td>0.5 mg/kg IV prn (q 30 min)</td>
<td>0.1-0.5 mg/kg/h IV CRI combined with morphine</td>
</tr>
<tr>
<td>Amantadine</td>
<td></td>
<td>3-5 mg/kg PO q24h for neuropathic pain</td>
<td></td>
</tr>
<tr>
<td><strong>SEDATIVES for chronic pain</strong></td>
<td><strong>Midazolam</strong></td>
<td>0.1-0.5 mg/kg IV, IM q8-12h</td>
<td>Same</td>
</tr>
<tr>
<td></td>
<td><strong>Diazepam</strong></td>
<td>0.1-0.5 mg/kg IV q12h</td>
<td>Same</td>
</tr>
<tr>
<td></td>
<td><strong>Acepromazine</strong></td>
<td>0.01-0.05 mg/kg IV q1-2h or 0.02-0.1 mg/kg IM, SC q2-6h</td>
<td>Same</td>
</tr>
<tr>
<td></td>
<td><strong>Medetomidine</strong></td>
<td>0.02-0.05 mg/kg IM q 4-6h or 0.01-0.02 mg/kg IV prn</td>
<td>Same</td>
</tr>
<tr>
<td><strong>TRICYCLIC ANTIDEPRESSANT</strong></td>
<td><strong>Amitriptyline</strong></td>
<td>2.5-12.5 mg/cat PO q24h</td>
<td><strong>Gabapentin</strong>** 5-10 mg/kg PO q12-24h for mild-moderate post-op, follow-up, chronic or neuropathic pain</td>
</tr>
</tbody>
</table>

* Morphine: Pretreat with Benadryl if administering IV.  
** Hydromorphone: Caution: doses of 0.1 mg/kg and higher can cause hyperthermia in some patients; severe hyperthermia is an indication to change analgesic class.  
*** Meloxicam: The author and all cited studies are referring to Metacam® throughout this article. Compounded formulations lack third party, mandated and assessed quality control (QC); there is known potency variability between compounders and even between batches from the same compounder.  
**** Gabapentin: Taper dose when withdrawing drug. Do not discontinue abruptly.

Table 2: Off-label protocol for alleviating neuropathic pain from onychectomy (Gaynor)  
Administer concurrently: Amantadine 3 mg/kg PO q24h X 21 days,  
+ Buprenorphine 0.01-0.02 mg/kg buccally q12h X 2-3 days,  
+ Meloxicam starting at 0.05 mg/kg PO q24h X 4 days => tapering to 0.05 mg/2 kg PO q24h X 4 days => followed by 0.05 mg/cat PO q24h X 4 days and finally => 0.05 mg/cat PO q48h X 5 days.  
†The ISFM and AAFP consensus guidelines: Long-term use of NSAIDs in cats recommends daily dosing rather than other frequencies.

**REFERENCES**  
2. Robertson SA, Lascelles BDX. Long-Term Pain in Cats: How Much Do We Know about This Important Welfare Issue? J Fel Med Surg 2010; 12: 188-199  


GUIDELINES FOR RECOGNITION, ASSESSMENT AND TREATMENT OF PAIN

WSAVA Global Pain Council members and co-authors of this document:

Karol Mathews DVM DVSc DACVECC (Canada)
Peter W Kronen Dr Vet Med, DVM DECVAA (Switzerland)
Duncan Lascelles BSc BVSc PhD DSAS DECVS DACVS MRCVS (USA)
Andrea Nolan MVB DVA PhD DECVAA DECVPT MRCVS (UK)
Sheilah Robertson BVMS (Hons) PhD DACVAA DECVAA DECAWBM (WSEL)
DACAW MRCVS (USA)
Paulo VM Steagall MV MS PhD DACVAA (Brazil/Canada)
Bonnie Wright DVM DACVAA (USA)
Kazuto Yamashita DVM MS PhD DJCVS (Japan)
SECTION 3: PAIN MANAGEMENT PROTOCOLS

25. Castration and ovariohysterectomy/ovariectomy in cats ........................................... 30
26. Castration and ovariohysterectomy/ovariectomy in dogs ........................................... 31
27. Orthopaedic surgery ..................................................................................................... 32
28. Soft tissue surgery ....................................................................................................... 33
29. Loco-regional techniques .............................................................................................. 35
30. Ophthalmic procedures ................................................................................................. 41
31. Dental procedures ........................................................................................................ 42
32. Emergency and critical care ........................................................................................... 45
33. Medical pain ................................................................................................................ 46
34. Pregnant or lactating patients ..................................................................................... 47
35. Neonatal or paediatric patients ..................................................................................... 49
36. Neuropathic pain .......................................................................................................... 50
37. Degenerative joint disease ............................................................................................ 52
38. Cancer-related pain ...................................................................................................... 52
39. WSAVA humane euthanasia overview ......................................................................... 54

Acknowledgements ........................................................................................................... 54

Recognition of sponsors .................................................................................................... 55

References and further reading ........................................................................................ 55
The ability to experience pain is universally shared by all mammals, including companion animals, and as members of the veterinary healthcare team it is our moral and ethical duty to mitigate this suffering to the best of our ability. This begins by evaluating for pain at every patient contact. However, and despite advances in the recognition and treatment of pain, there remains a gap between its occurrence and its successful management; the inability to accurately diagnose pain and limitations in, and/or comfort with, the analgesic modalities available remain root causes. Both would benefit from the development, broad dissemination, and adoption of pain assessment and management guidelines.

The World Small Animal Veterinary Association (WSAVA) is an ‘association of associations’ with 91 current members representing over 145,000 small animal veterinarians globally. As such, it is the global voice of the small animal veterinary healthcare team and has a long-standing and successful history of developing global guidelines on the recognition, diagnosis, and/or treatment of common small animal ailments having a global relevance. To date, these have included hepatic, gastrointestinal, and renal diseases; vaccine guidelines; and nutritional recommendations. Standardization efforts are one of the WSAVA’s core activities, which also include animal welfare, continuing education, and the World Congress; the pain assessment and management guidelines have unique relevance to all.

Based on this background, the Global Pain Council (GPC) was established and charged with the task of developing pain assessment and treatment guidelines having universal relevance, taking into account regional differences in attitude, education and available analgesic modalities. These guidelines will be used to enshrine pain assessment as the 4th vital sign and be the foundation for further continuing education efforts based on regional variations to ensure both clinical relevance and the impetus for advancement.

**GPC Vision:** An empowered, motivated, and globally unified veterinary profession that effectively recognizes and minimizes pain prevalence and impact.

**GPC Mission:** To raise global awareness and provide a call to action based upon an understanding that all animals are sentient and can therefore feel pain and suffer from it. Through the identification of regionally specific resources for recognizing and treating pain, and targeted education, the Global Pain Council strives to elevate the level of confidence and competence in applying pain treatments.

**Use of this document**

This document is designed to provide the user with easy-to-implement, core fundamentals on the successful recognition and treatment of pain in the day-to-day small animal clinical practice setting. While not intended to be an exhaustive treatise on the subject matter, the text does provide an extensive reference list and there is additional material on the WSAVA website (www.wsava.org) designed to provide resources for those wanting to further their knowledge of this subject matter based on the current literature.

There are no geographic limitations to the occurrence of pain, nor to the ability to diagnose it. The only limiting factors are awareness, education, and a commitment to include pain assessment in every physical examination. As such, the pain assessment guidelines herein should be easily implemented regardless of practice setting and/or location.

In contrast, there are real regional differences in the availability of the various classes of analgesics, specific analgesic products, and the regulatory environment that governs their use. This represents a significant hurdle to the ideal management of pain in various regions of the world, irrespective of the ability to diagnose. In the treatment section of these guidelines, these issues are taken into account by the provision of ‘tiered’ management guidelines beginning with comprehensive pain management modalities that represent the current ‘state of the art’ followed by alternative protocols that may be considered where regulatory restrictions on analgesic products prevent ideal case management. Owing to space limitations, tiered management cannot be listed for all situations, but the analgesics available can be selected from the recommended management. It should also be recognized that in some situations, whether due to etiology or available analgesics, euthanasia may be the only moral or ethical (hence viable) treatment option available. Humane methods are presented.

Sections are given on the various product and procedure modalities including pharmacology, mechanism of action, indications, contraindications, dosing, and practical clinical notes to help guide the reader in tailoring the therapeutic protocol to the needs of the individual patient.

Recognize this document as providing guidelines only, with each situation unique and requiring the individual assessment and therapeutic recommendations that only a licensed veterinarian can provide. There are a number of statements that are the collective opinion of the authors, based on their cumulative experience with pain management gained within their respective fields but not yet
evidenced via published data. It is the view of the group that providing this guidance is important in areas where to date there is little published work to underpin clinical pain treatment in dogs and cats.

The contents should also be put into context of the following pain assessment and management tenets:

• Pain is an illness, experienced by all mammals, and can be recognized and effectively managed in most cases
• Pain assessment should accompany every patient assessment
• Treat predictable pain — pain associated with surgery is 100% predictable
• Pain assessment is key to determining the degree and duration of pain treatment but should not replace the adage of treating predictable pain
• Perioperative pain extends beyond 24 hours and should be managed accordingly
• Practice preventive (preemptive) pain management — initiate appropriate treatment before a procedure to prevent the onset of pain, and continue this to prevent occurrence of pain for the duration of time commonly recommended for the problem or which the patient requires
• Response to appropriate treatment is the gold standard to measure the presence and degree of pain.

We can't always know that our patient does hurt, but we can do our best to ensure that it doesn't hurt

SECTION 1: INTRODUCTION TO PAIN, ITS RECOGNITION AND ASSESSMENT

1. UNDERSTANDING PAIN

Pain is a complex multi-dimensional experience involving sensory and affective (emotional) components. In other words, ‘pain is not just about how it feels, but how it makes you feel’, and it is those unpleasant feelings that cause the suffering we associate with pain. The official definition of pain by the International Association for the Study of Pain (IASP) is: “an unpleasant sensory and emotional experience, associated with actual or potential tissue damage, or described in terms of such damage”. Pain is a uniquely individual experience in humans and animals, which makes it hard to appreciate how individuals feel. In non-verbal patients, including animals, we use behavioural signs and knowledge of likely causes of pain to guide its management. The conscious experience of pain defies precise anatomical, physiological and or pharmacological definition; furthermore, it is a subjective emotion that can be experienced even in the absence of obvious external noxious stimulation, and which can be modified by behavioural experiences including fear, memory and stress.

At its simplest, pain is classified as either acute or chronic. The distinction between acute and chronic pain is not clear, although traditionally an arbitrary interval of time from onset of pain has been used – e.g. pain of more than 3 months’ duration can be considered to be chronic.

Acute pain is generally associated with tissue damage or the threat of this and serves the vital purpose of rapidly altering the animal’s behaviour in order to avoid or minimize damage, and to optimize the conditions in which healing can take place, stopping when healing is complete. Acute pain varies in its severity from mild-to-moderate to severe-to-excruciating. It is evoked by a specific disease or injury; it serves a biological purpose during healing and it is self-limiting. Examples of acute pain include that associated with a cut/wound, elective surgical procedures, or acute onset disease e.g. acute pancreatitis. In contrast, chronic pain persists beyond the expected course of an acute disease process, has no biological purpose and no clear end-point and in people, as well as having an effect on physical wellbeing, it can have a significant impact upon the psychology of the sufferer.

Chronic pain is generally described in human medicine as pain that persists beyond the normal time of healing, or as persistent pain caused by conditions where healing has not occurred or which remit and then recur. Thus acute and chronic pain are different clinical entities, and chronic pain may be considered as a disease state.

The therapeutic approaches to pain management should reflect these different profiles. The therapy of acute pain is aimed at treating the underlying cause and interrupting the nociceptive signals at a range of levels throughout the nervous system, while treatment approaches to chronic pain must rely on a multidisciplinary approach and holistic management of the patient’s quality of life.

Many dogs and cats suffer from long-term chronic disease and illness which are accompanied by chronic pain. During the lifetime of the animal acute exacerbations of the pain may occur (breakthrough pain), or new sources of acute pain may occur independently which may impact on the management of the underlying chronic pain state (‘acute on chronic pain’). For these animals aggressive pain management is required to restore the animal’s comfort.
Pain is a subjective emotion, which can be experienced even in the absence of obvious external noxious stimulation, and which can be enhanced or abolished by a wide range of behavioural experiences including fear and memory. Adaptive 'physiological' pain announces the presence of a potentially harmful stimulus and thus has an essential protective function. In contrast, maladaptive pain represents malfunction of neurological transmission and serves no physiological purpose, leading to chronic syndromes in which pain itself may become the primary disease. Conscious perception of pain represents the final product of a complex neurological information-processing system, resulting from the interplay of facilitatory and inhibitory pathways throughout the periphery and central nervous systems. Several distinct types of pain exist, classified as nociceptive, inflammatory and neuropathic. Cancer pain often displays characteristics of both inflammatory and neuropathic pain.

The conscious experience of acute pain resulting from a noxious stimulus is mediated by a high-threshold nociceptive sensory system. The basic neuroanatomy of this system is reviewed elsewhere. Nociceptors represent the free endings of primary sensory neurons, with their cell bodies located in the dorsal root and trigeminal ganglia. The primary afferent nerve fibres which carry information from these free nerve endings to their central location consist of two main types: unmyelinated C-fibres and myelinated A-delta fibres. Following tissue trauma, changes in the properties of nociceptors occur such that large-diameter A\β fibres, normally not associated with nociception, may also transmit 'pain information'. Unmyelinated C-fibres are activated by intense mechanical, chemical and thermal stimuli contributing to the 'slow burn' sensation of pain. The A\β fibres conduct impulses more quickly and contribute to the rapid 'stab' of the acute pain response and function primarily as a warning, is protective, resulting in rapid withdrawal from the stimulus. Delay of withdrawal results in C-fibre activation, the intensity of which is dependent on injury. There is also a population of so-called 'silent' nociceptors, which may become active during inflammation or tissue damage such as occurs in inflammatory bowel disease and cystitis, for example.

Primary afferent fibres carrying sensory information from nociceptors synapse in the dorsal horn of the spinal cord. The fibres of 'nociceptive' responsive cells of the spinal cord project to various higher centres involved in pain transmission, both ipsilaterally and contralaterally to their site of origin. Several spinal-brainstem-spinal pathways are activated simultaneously when a noxious stimulus occurs, providing widespread positive and negative feedback loops by which information relating to noxious stimulation can be amplified or diminished (descending inhibitory pathways). The cerebral cortex is the seat of conscious experience of pain. The cerebral cortex exerts top-down control and can modulate the sensation of pain. Central pain associated with a cortical or subcortical lesion can result in severe pain, which is not associated with any detectable pathology in the body.

Pain is considered to consist of three key components: a sensory-discriminatory component (temporal, spatial, thermal/mechanical), an affective component (subjective and emotional, describing associated fear, tension and autonomic responses), and an evaluative component, describing the magnitude of the quality (e.g. stabbing/pounding; mild/severe). Undoubtedly, an animal’s pain experience is similarly composed, although our tendency is to focus on pain intensity alone.

Clinical pain

The nociceptive sensory system is an inherently plastic system and when tissue injury or inflammation occurs, the sensitivity of an injured region is enhanced so that both noxious and normally innocuous stimuli are perceived as painful. The clinical hallmarks of sensitization of the nociceptive system are hyperalgesia and allodynia. Hyperalgesia is an exaggerated and prolonged response to a noxious stimulus, while allodynia is a pain response to a low-intensity, normally innocuous stimulus such as light touch to the skin or gentle pressure. Hyperalgesia and allodynia are a consequence of peripheral and central sensitization. Peripheral sensitization is the result of changes in the environment bathing nociceptor terminals as a result of tissue injury or inflammation. Chemical mediators are released by damaged cells which either directly activate nociceptors, or sensitize the nerve terminals. This results in long-lasting changes in the functional properties of peripheral nociceptors. Trauma and inflammation can also sensitize nociceptor transmission in the spinal cord to produce central sensitization. This requires a brief but intense period of nociceptor stimulation (e.g. a surgical incision, intense input following tissue trauma, or following nerve injury). As a result, the response threshold of the central neurons falls, their responses to subsequent stimulation are amplified and their receptive fields enlarge to recruit additional previously 'sleeping' afferent fibres into nociceptive transmission.

Inflammatory pain is usually responsible for acute postoperative pain, until the wound has healed. It has a rapid onset and, in general, its intensity and duration are related directly to the severity and duration of tissue damage. The changes in the nociceptive system are generally reversible and normal sensitivity of the system should be restored as tissue heals. However, if the noxious insult was severe, or if a focus of ongoing inflammation persists, then pain will persist as is the case in dogs with chronic inflammatory diseases such as arthritis, otitis, gingivitis, dermatitis and back pain.

Neuropathic pain is defined as pain caused or initiated by a primary lesion, injury or dysfunction in the peripheral nervous system or central nervous system. There follows a plethora of changes in the peripheral nervous system, spinal cord, brainstem and brain as damaged nerves fire spontaneously and develop hyper-responsivity to both inflammatory and normally innocuous stimuli. In humans, neuropathic pain is commonly manifested in, for example, post-amputation phantom limb pain and post-herpetic
neuropathy; furthermore, it has been suggested that neuropathic pain is the major cause of long-term post surgical pain in humans. It is surprising, therefore, that neuropathic pain is not described in animals more commonly; however, this may be due to lack of awareness of the potential for neuropathic pain and its recognition. Prevention of neuropathic pain is frequently accomplished by appropriate selection and duration of administration of analgesic(s).

**Post-surgical pain:** persistent post surgery remains a problem in humans, particularly following major surgery, with a minority of these patients experiencing severe chronic pain, often neuropathic in nature. The risk of persistent post-surgical pain in dogs and cats has not been quantified; however, it is likely to occur. Veterinarians should be aware of the potential for chronic pain to exist.

**Breakthrough pain (BTP)** may occur with all painful conditions (e.g. arthritis). It is defined as an abrupt, short-lived, and intense pain that ‘breaks through’ the analgesia that controls pain. The analgesic protocol should be re-assessed by careful examination and observation to ensure there is no new underlying problem causing pain. Veterinarians may be unaware of the occurrence of BTP in patients with persistent pain unless specific questions are asked of the client.

**Chronic pain:** there is no direct link between the duration or intensity of injury which transforms acute transient pain into chronic pain. However, as with neuropathic pain, appropriate management of acute pain is essential to prevent establishment of chronic pain. As noted, the pain information processing systems display plasticity, driven by peripheral and central sensitization. This plasticity can be reversible, as is commonly the case in acute inflammatory pain; or it can be long-lasting which is associated with changes expressed in the phenotype of the nociceptive cells and their expression of proteins involved in pain processing.

### 3. RECOGNITION AND ASSESSMENT OF ACUTE PAIN IN CATS

Acute pain is the result of a traumatic, surgical, medical or infectious event that begins abruptly and should be relatively brief. This pain can usually be alleviated by the correct choice of analgesic drugs, most commonly opioids and non-steroidal anti-inflammatory drugs (NSAIDs). For successful relief of pain, one must first look for it and recognize it. It is recommended that assessment of pain is incorporated into Temperature, Pulse and Respiration (TPR) examinations, making pain the 4th vital sign we monitor. Cats that have been injured or undergone surgery should be monitored closely and pain must be treated promptly to prevent it from escalating. Treatment must be continued until the acute inflammatory response abates. The degree of trauma dictates the intensity and duration of the inflammatory response but treatment may be required for several days. Feral cats require preemptive administration of analgesics based on the severity of the proposed surgical procedure rather than based on their behaviour; in addition, interactive pain assessment is not possible in this population.

Neuroendocrine assays measuring β-endorphin, catecholamines and cortisol concentrations in plasma have been correlated with acute pain in cats; however, these are also influenced by other factors such as anxiety, stress, fear and drugs. Objective measurements such as heart rate, pupil size and respiratory rate have not been consistently correlated with signs of pain in cats – therefore we depend on subjective evaluation based on behaviour. A multidimensional composite pain scale (UNESP-Botucatu) for assessing postoperative pain in cats has been validated and can be applied in the clinical setting as a useful tool.

**Pain assessment and recognition**

Take into consideration the type, anatomical location and duration of surgery, the environment, individual variation, age, and health status. The cat should be observed from a distance then, if possible, the caregiver should interact with the cat and palpate the painful area to fully assess the cat’s pain. A good knowledge of the cat’s normal behaviour is very helpful as changes in behaviour (absence of normal behaviours such as grooming and climbing into the litter box) and presence of new behaviours (a previously friendly cat becoming aggressive, hiding or trying to escape) may provide helpful clues. Some cats may not display clear overt behaviour indicative of pain, especially in the presence of human beings, other animals or in stressful situations. Cats should not be awakened to check their pain status; rest and sleep are good signs of comfort but one should ensure the cat is resting or sleeping in a normal posture (relaxed, curled up). In some cases cats will remain very still because they are afraid or it is too painful to move, and some cats feign sleep when stressed.

**Facial expressions and postures:** these can be altered in cats experiencing pain: furrowed brow, orbital squeezing (squinted eyes) and a hanging head (head down) can be indicators of pain. Following abdominal surgery a hunched position and/or a tense abdomen is indicative of pain. Abnormal gait or shifting of weight and sitting or lying in abnormal positions may reflect discomfort and protection of an injured area. Comfortable cats should display normal facial expressions, postures and movement after successful analgesic therapy. Figure 1 provides examples of normal postures and facial expressions and those that may be indicative of pain.

**Behavioural changes associated with acute pain in cats:** reduced activity, loss of appetite, quietness, hiding, hissing and growling (vocalization), excessive licking of a specific area of the body (usually involving surgical wounds), guarding behaviour, cessation of grooming, tail flicking and aggression may be observed. Cats in severe pain are usually depressed, immobile and silent. They will appear tense and distant from their environment.

**Dysphoria versus pain:** thrashing, restlessness and continuous activity can be signs of severe pain in cats. However, these can also be related to dysphoria. Dysphoria is usually restricted to the early postoperative period (20–30 min) and/or associated...
with poor anaesthetic recoveries after inhalant anaesthesia and/or ketamine administration and/or after high doses of opioids. Hyperthermia associated with the administration of hydromorphone and some other opioids may lead to anxiety and signs of agitation in cats.

4. RECOGNITION AND ASSESSMENT OF ACUTE PAIN IN DOGS

Acute pain occurs commonly in dogs as a result of a trauma, surgery, medical problems, infections or inflammatory disease. The severity of pain can range from very mild to very severe. The duration of pain can be expected to be from a few hours to several days. It is generally well managed by the use of analgesic drugs. The effective management of pain relies on the ability of the veterinarian, animal health technician and veterinary nurse to recognize pain, and assess and measure it in a reliable manner. When the dog is discharged home, owners should be given guidance on signs of pain and how to treat it.

Objective measurements including heart rate, arterial blood pressure and plasma cortisol and catecholamine levels have been associated with acute pain in dogs; however, they are unreliable as stress, fear and anaesthetic drugs affect them. Thus, evaluation of pain in dogs is primarily subjective and based on behavioural signs.

**Pain recognition**

Behavioural expression of pain is species-specific and is influenced by age, breed, individual temperament and the presence of additional stressors such as anxiety or fear. Debilitating disease can dramatically reduce the range of behavioural indicators of pain that the animal would normally show e.g. dogs may not vocalize and may be reluctant to move to prevent worsening pain. Therefore, when assessing a dog for pain a range of factors should be considered, including the type, anatomical location and duration of surgery, the medical problem, or extent of injury. It is helpful to know the dog’s normal behaviour; however, this is not always practical and strangers, other dogs, and many analgesic and other drugs (e.g. sedatives) may inhibit the dog’s normal behavioural repertoire.

Behavioural signs of pain in dogs include:

* change in posture or body position (Figures 2 and 3)
* change in demeanour (Figure 4)

**FIG 1. Illustrations of normal postures and facial expressions and those that may be indicative of pain. (A) A cat with a normal posture – the cat’s head is up, the cat is alert and the eyes are open. (B) A cat resting after surgery in a normal relaxed and curled up position. (C) This cat is ‘flat out’ and tense after surgery – also note the facial expression. (D) and (E) These cats have had abdominal surgery; the hunched posture and low hung head are suggestive of pain. Note also that the eyes are either held shut or half closed and appear “slanted” or “squinted” compared to the cat in Figure 1A.**
• vocalization
• altered reaction to touch
• altered interaction with people (e.g. reduced interaction, aggression)
• altered mobility (e.g. lameness, reluctance to move)
• reduction in appetite.

**Pain assessment protocol**

The most important step in managing acute pain well is to actively assess the dog for signs of pain on a regular basis, and use the outcomes of these assessments (through observation and interaction) along with knowledge of the disease/surgical status and history of the animal to make a judgement on the pain state of the dog. It is recommended that carers adopt a specific protocol and approach every dog in a consistent manner to assess them for pain. Dysphoria should be considered where panting, nausea, vomiting or vocalization occurs immediately following opioid administration.

- Observe the dog in its kennel/bed and consider its demeanor and posture
- Approach the dog and interact with it, calling its name, and consider its response
- Touch the dog (around a wound/damaged tissue as appropriate), and consider its response (normal, aggressive, flinching etc.).

Where a dog is judged to be in pain, treatment should be given immediately to provide relief. Dogs should be assessed continuously to ensure that treatment has been effective, and thereafter on a 2–4 hourly basis.

**Pain measurement tools:** these should possess the key properties of validity, reliability and sensitivity to change. Pain is an abstract construct so there is no gold standard for measurement and as the goal is to measure the affective component of pain (i.e. how it makes the dog feel), this is a real challenge. This is further compounded by the use of an observer to rate the dog’s pain. Few of the scales available for use in dogs have been fully validated. Simple uni-dimensional scales, including the Numerical Rating Scale (NRS), the Visual Analogue Scale (VAS) and the Simple Descriptive Scale (SDS) (Figure 5), have been used. These scales require the user to record a subjective score for pain intensity. When using these scales, the observer’s judgment can be affected by factors such as age, gender, personal health and clinical experience, thus introducing a degree of inter-observer variability and limiting the reliability of the scale. However, when used consistently, these are effective as part of a protocol to evaluate pain as described above. Of the three types of scales described (and there are others in this category), the NRS (0 to 10) is recommended for use due to its enhanced sensitivity over the SDS and increased reliability over the VAS.

Composite scales include the Glasgow Composite Measure Pain Scale and its short form (CMPS-SF), and the French Association for Animal Anæsthesia and Analgesia pain scoring system, the 4A-Vet. The CMPS-SF, validated for use in measuring acute pain, is a clinical decision-making tool when used in conjunction with clinical judgement. Intervention level scores have been described (i.e. the score at which analgesia should be administered), thus it can be used to indicate the need for analgesic treatment. The instrument is available to download online. The 4A-Vet, which is also available online, is available for use in cats and dogs, although evidence for its validity and reliability have not yet been demonstrated. The Colorado State University (CSU) acute pain scale for the dog combines aspects of the numerical rating scale along with composite behavioural observation, and it has been shown to increase awareness of behavioural changes associated with pain. The University of Melbourne Pain Scale combines physiologic data and behavioural responses. Japanese Society of Study for Animal Pain (JSSAP) Canine Acute Pain Scale (written in Japanese) is a numerical rating scale combined with behavioural observation and can be downloaded from the website. All of the composite scales above are easy to use and include interactive components and behavioural categories.
i) Simple Descriptive Scale (SDS)
No pain, Mild pain, Moderate pain, Severe Pain
Categories may be assigned numbers for data collection purposes; however, they are not numerical values.

ii) Numerical Rating Scale (NRS)
0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10.
0: no pain; 10, maximum pain possible

iii) Visual Analogue Scale (VAS)

|--------------------------|-----------------
| No pain                  | maximum pain possible |

Using the scales: The observer makes an assessment of the amount of pain a dog is experiencing based on their observation of and interaction with the dog, and their clinical judgement. A category (SDS) or number (NRS) is selected, or a mark made on the line (VAS) to reflect that judgement.
5. RECOGNITION AND ASSESSMENT OF CHRONIC PAIN IN CATS

Chronic pain is of long duration, and is commonly associated with chronic diseases e.g. degenerative joint disease (DJD), stomatitis and intervertebral disk disease. It may also be present in the absence of ongoing clinical disease, persisting beyond the expected course of an acute disease process – such as neuropathic pain following onychectomy, limb or tail amputation. As cats live longer there has been an increased recognition of chronic pain associated with certain conditions, which has a negative impact on quality of life (QoL).

In recent years, treatment options for some cancers in companion animals have become a viable alternative to euthanasia, and managing chronic pain and the impact of aggressive treatment protocols has become a challenging and important welfare issue.

Pain recognition is the keystone of effective pain measurement and management. The behavioural changes associated with chronic pain may develop gradually and may be subtle, making them most easily detected by someone very familiar with the animal (usually the owner).

Owner assessments are the mainstay of the assessment of chronic pain, but how these tools should be constructed optimally for cats is not fully understood. Many of the tools for measuring chronic pain in humans measure its impact on the patient’s QoL, which includes physical and psychological aspects. Very little work has been performed in cats, but there are some studies assessing QoL or health-related quality of life (HRQoL) in cats being treated with antiviral agents,21 and cats with cardiac disease,22,23 cancer24 and diabetes mellitus.25 There is a growing understanding of behaviours that may be associated with the chronic pain of musculoskeletal disease in cats.26,27 Recently, progress has been made in developing an owner-directed instrument for the assessment of chronic musculoskeletal pain in cats,28,29,30 and also in understanding what owners consider to be important for their cat’s QoL.31 At the present time, there are no validated instruments available. However, we recommend that behaviours are assessed in these broad categories:

- General mobility (e.g. ease of movement, fluidity of movement)
- Performing activities (e.g. playing, hunting, jumping, using a litter-box)
- Eating, drinking
- Grooming (e.g. scratching)
- Resting, observing, relaxing (how well these activities can be enjoyed by the cat)
- Social activities involving people and other pets
- Temperament.

Each of these should be assessed and ‘scored’ in some manner (e.g. using either a descriptive, numerical rating or visual analogue scale). Re-evaluation over time will help determine the impact of pain, and the extent of pain relief.

6. RECOGNITION AND ASSESSMENT OF CHRONIC PAIN IN DOGS

Chronic pain is of long duration and is commonly associated with chronic diseases. It may also be present in the absence of ongoing clinical disease, persisting beyond the expected course of an acute disease process. As dogs live longer there has been an increase in the incidence of painful chronic conditions such as osteoarthritis (OA) and in recent years the treatment of cancer in companion animals has become a viable alternative to euthanasia. For many chronic conditions, chronic pain is a challenge as is the impact of aggressive treatment protocols. Treatment options for chronic pain are complex, and response to treatment is subject to much individual variation. Accordingly the veterinarian must monitor health status effectively on an ongoing basis in order to tailor treatment to the individual.

Chronic pain recognition

Pain recognition is the keystone of effective pain management. The behavioural changes associated with chronic pain may develop gradually and may be subtle, so that they can only be detected by someone very familiar with the animal (usually the owner). In people, chronic pain has both a physical and a psychological impact which adversely affect the patient's QoL. For many chronic conditions, chronic pain is a challenge as is the impact of aggressive treatment protocols. Treatment options for chronic pain are complex, and response to treatment is subject to much individual variation. Accordingly the veterinarian must monitor health status effectively on an ongoing basis in order to tailor treatment to the individual.

- Vitality and mobility – how energetic, happy, active/ lethargic, contented, playful is the dog; ease of lying, sitting, jumping up, tolerance to exercise
- Mood and demeanour including states of alertness, anxiety, whether it is for example withdrawn, sad, dull, confident, its playfulness and sociability
- Levels of distress (e.g. vocalization [moaning, groaning], demeanour [e.g. depressed] and response to other dogs and humans)
- Indicators of pain (e.g. comfort levels, stiffness, lameness).
Chronic pain measurement

Owner assessments are the mainstay of the assessment of chronic pain in dogs. Functional assessment, QoL and HRQoL tools have been developed and used.\textsuperscript{32,33} QoL measures used in veterinary medicine vary from simple scales tied to certain descriptors of behaviours\textsuperscript{34} to broad, unconstrained assessments.\textsuperscript{35-37} Questionnaires have been developed to assess HRQoL in dogs with DJD, cardiac disease,\textsuperscript{38} cancer,\textsuperscript{39,40} chronic pain,\textsuperscript{41,42} spinal cord injuries\textsuperscript{13,14} and atopic dermatitis,\textsuperscript{45} while some are less specific.\textsuperscript{46,47}

Several instruments focused mainly on functional assessment (Clinical Metrology Instruments, CMIs) have been developed for canine OA and have undergone a variable degree of validation.\textsuperscript{13,35,48-52} Such questionnaires typically include a semi-objective rating of disease parameters such as ‘lameness’ and ‘pain’ on either a discontinuous ordinal scale or a visual analogue scale.

At the present time, the most fully validated instruments available are:

- GUVQuest\textsuperscript{41,42}
- Canine Brief Pain Inventory\textsuperscript{53}
- Helsinki Chronic Pain Index (available on request to author)
- Texas VAS Instrument (available on request to author)
- Liverpool Osteoarthritis in Dogs (available on request to author)
- JSSAP Canine Chronic Pain Index (can be downloaded from the JSSAP website)\textsuperscript{20}.

GUVQuest is an owner-based questionnaire developed using psychometric principles for assessing the impact of chronic pain on the HRQoL of dogs, and is validated in dogs with chronic joint disease and cancer. The Canine Brief Pain Inventory (CBPI) has been used to evaluate improvements in pain scores in dogs with OA and in dogs with osteosarcoma. The Helsinki Chronic Pain Index (HCPI) is also an owner-based questionnaire and has been used for assessing chronic pain in dogs with OA and, along with the CBPI, has been evaluated for content validity, reliability\textsuperscript{48,51} and responsiveness.\textsuperscript{35,51} The CMI from Texas A&M\textsuperscript{13} has been investigated for validity and reliability but not responsiveness. The Liverpool Osteoarthritis in Dogs (‘LOAD’) CMI has been validated in dogs with chronic elbow OA, and has been shown to be reliable with satisfactory responsiveness.\textsuperscript{49} Recently, its validity for both forelimb and hind limb OA was demonstrated.\textsuperscript{54} The JSSAP Canine Chronic Pain Index is an owner-based questionnaire written in Japanese and has been used for assessing chronic pain in dogs with OA.

Out of this work some key messages have emerged:

- Owner information is a key resource when assessing chronic pain
- Owners may need prompting and close questioning to report changes in their dog’s behaviours as they may not associate these changes with chronic pain
- There is an evidence base for the behaviours that alter in association with chronic pain (see above); these should be the basis of exploration with owners
- Changes in dogs’ behaviours may be subtle, and take place gradually. Veterinarians need to ensure that when questioning the owner they prompt owners to reflect over a period of time (months)
- The veterinarian may find it useful to identify behaviours from the owner that can be used as marker behaviours to help determine response to treatment.

Recognizing chronic pain – osteoarthritis as an example

Evaluating the canine OA patient consists of a combination of a veterinary assessment or examination, and the owner’s assessment. The overall assessment of the negative impact of OA on the patient involves an evaluation of four broad categories:

- Mobility (the quality of moving freely)
- Activity (the ability to perform specific activities)
- Pain (adverse sensory and emotional experience)
- Affective effects (mood, feelings).

These are all interconnected. \textit{Careful assessment of these four categories and their adverse effects will guide the prioritization of treatment strategies}. To fully assess these four categories, the clinician needs to gather data on:

- Body balance, muscle mass, muscle health
- Ease of movement and mobility
- Gait and limb use
- Joint-associated pain and mobility
- Other factors affecting mobility (such as neurological disease, patella luxation, cruciate ligament insufficiency, systemic medical disease)
• Ability to perform specific activities
• Level of engagement, happiness.

Such a complete assessment will involve input from both the veterinarian (physical and orthopaedic examination) and the owner (owner completed QoL, HRQoL and Functional Assessments) and forms a baseline for future assessment.

7. ASSESSING RESPONSE TO TREATMENT OF PAIN IN CATS AND DOGS

Assessing the response to pain treatment/intervention strategies is a fundamental aspect of effective pain management. Too often dogs and cats are given one-off doses of analgesic drugs without effective follow-up. Methods of assessing pain in dogs and cats, both acute and chronic, are described in other sections.

Key principles of assessing response to treatment:

• Adopt a rigorous protocol for assessing pain severity. Whether this is based on one of the currently available instruments for assessing pain or on a locally developed approach, it is critical to interact with the animal, and use a knowledge of normal behaviours and behaviours indicative of pain to assess the dog or cat
• Adopt the above protocol/approach for all animals in your care
• Involve the owner in assessing pain and response to treatment through effective open questioning techniques
• Undertake a baseline assessment of the level of pain at the initial consultation
• Repeat assessments on a regular basis and, in particular, at an appropriate time after treatment. The interval between repeat assessments will depend on the nature of the pain (acute/chronic), the intensity of the pain and the success of therapy.

Acute pain
Dogs and cats should be assessed on a regular basis following surgery, in the early recovery period every 15–30 minutes (depending on the surgical procedure) and on an hourly basis thereafter for the first 6–8 hours after surgery. Thereafter, if pain is well controlled, 3–6 hourly assessment is recommended. The exact time interval depends on the severity of the surgery, the type of drugs used to manage pain and other factors relating to the animal’s physical status. If in doubt about pain status re-assess the animal in 15 minutes.

Chronic pain
Dogs and cats should be assessed on a regular basis guided by the evidence below:

• Owners are a key information source for animals with chronic pain
• Owners may need prompting and close questioning to report changes in their cat’s or dog’s behaviour as they may not associate these changes with chronic pain
• Changes in cat’s and dogs’ behaviour may be subtle, and take place gradually. When questioning owners, prompt them to reflect over a period of time (months).

There is an evidence base for the key domains of behaviour that alter in association with chronic pain (see Sections 5 and 6). This should be the basis of exploration with owners at initial presentation and on subsequent re-evaluation of progress.

8. NEUROPATHIC PAIN

Neuropathic pain55 (defined as pain caused or initiated by a primary lesion or dysfunction in the peripheral or central nervous system) is associated with nerve root and plexus avulsion injuries and central nervous system pathology. Any chronic pain condition can subsequently develop a neuropathic component due to the continual nociceptive barrage and subsequent changes in the functioning of the nervous system.56 Behavioural patterns described by owners such as repeated chewing, biting or scratching at the same site, spontaneous crying and adverse reaction to touch where no pathology is visible may be indicators of neuropathic pain. Excessive sensitivity (hypersensitivity) on examination suggests a neuropathic component to pain, and a poor response to standard (NSAID, opioid) analgesics may also suggest the presence of neuropathic pain. Should neuropathic pain be suspected, both the causal condition, and the neuropathic pain state itself should be addressed. Physical examination for identifying neuropathic pain should include testing for the following:57,58

• Hyperalgesia is considered to exist when the animal responds adversely, and more aggressively, to a noxious stimulus (e.g. pin prick) either directly on the area of the body from which the pain originates (primary) or in an uninjured adjacent area (secondary)
Allodynia (pain elicited from non-injured tissues by non-noxious stimuli – tactile allodynia [Aβ stimulus]) is considered to exist when the animal responds adversely to light touch applied to normal (non-injured) tissues distant from the area of primary hyperalgesia or hyposensitivity.

### 9. PERCEIVED LEVEL OF PAIN ASSOCIATED WITH VARIOUS CONDITIONS

The designation of conditions into categories below is intended to serve only as a guide. Pain may vary according to the patient and the condition. Each patient should be assessed individually.

<table>
<thead>
<tr>
<th>Severe-to-excruciating</th>
<th>Moderate-to-severe (varies with degree of illness or injury)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central nervous system infarction/tumours</td>
<td>Meningitis</td>
</tr>
<tr>
<td>Fracture repair where extensive soft tissue injury exists</td>
<td>Spinal surgery</td>
</tr>
<tr>
<td>Ear canal ablation</td>
<td>Burn injury</td>
</tr>
<tr>
<td>Articular or pathological fractures</td>
<td>Limb amputation</td>
</tr>
<tr>
<td>Necrotizing pancreatitis or cholecystitis</td>
<td>Thrombosis/Ischaemia</td>
</tr>
<tr>
<td>Bone cancer</td>
<td>Hypertrophic osteodystrophy</td>
</tr>
<tr>
<td>Aortic saddle thrombosis</td>
<td></td>
</tr>
<tr>
<td>Neuropathic pain (nerve entrapment/inflammation, acute intervertebral disc herniation)</td>
<td></td>
</tr>
<tr>
<td>Inflammation (extensive e.g. peritonitis, fascitis – especially streptococcal, cellulitis)</td>
<td></td>
</tr>
</tbody>
</table>

- **Severe-to-excruciating**
  - Central nervous system infarction/tumours
  - Fracture repair where extensive soft tissue injury exists
  - Ear canal ablation
  - Articular or pathological fractures
  - Necrotizing pancreatitis or cholecystitis
  - Bone cancer
  - Aortic saddle thrombosis
  - Neuropathic pain (nerve entrapment/inflammation, acute intervertebral disc herniation)
  - Inflammation (extensive e.g. peritonitis, fascitis – especially streptococcal, cellulitis)

- **Moderate-to-severe (varies with degree of illness or injury)**
  - Immune-mediated arthritis
  - Capsular pain due to organomegaly
  - Traumatic diaphragmatic rupture
  - Trauma (i.e. orthopaedic, extensive soft tissue, head)
  - Ureteral/urethral/biliary obstruction
  - Glaucma
  - Uveitis
  - Early or resolving stages of soft tissue injuries/inflammation/disease
  - Mesenteric, gastric, testicular or other torsions
  - Mucositis
  - Mastitis
  - Extensive resection and reconstruction for mass removal and corrective orthopaedic surgery (osteotomies; cruciate surgery; open arthrotomies)

- **Moderate**
  - Soft tissue injuries (i.e. less severe than above)
  - Ovariophysectomy
  - Diagnostic arthroscopy and laparoscopy

- **Mild-to-moderate**
  - Dental disease
  - Superficial lacerations
  - Chest drains
  - Castration

Data from K Mathews.

### 10. COMMON PAIN MISCONCEPTIONS

**‘Opioids cause respiratory depression in dogs and cats’**

*False.* This misconception has arisen from the fact that humans are very sensitive to the respiratory depressant effects of opioids. However, this is not the case in dogs and cats and opioids have a wide safety margin in healthy patients. In sick animals, opioid drugs should be titrated to effect to minimize the risk of respiratory compromise. For this to occur, the patient must be markedly mentally depressed.

**‘Non-steroidal anti-inflammatory drugs are toxic in dogs and cats’**

*False.* As most pain is associated with inflammation NSAIDs are the mainstay of analgesia for both acute and chronic pain in dogs and cats, and are widely and safely used in many animals around the world. The analgesic benefits far outweigh the potential risks. However, it is essential that the individual patient is screened for potential risk factors prior to administration and monitored during treatment. Many of the NSAIDs licensed for use in humans have a narrow safety margin in animals and should be used with caution. Where approved drugs are available, they should be used preferentially.

**‘If I alleviate pain, the animal will move and disrupt its suture line/fracture repair’**

*False.* The use of pain to control movement following surgery is unethical. Where activity needs to be controlled, other means should be adopted (e.g. cage confinement, controlled leash walking). Controlled walking exercise is essential for postoperative orthopaedic surgery.
repair to ensure appropriate ‘stress’ for bone healing and to maintain muscle mass to support the limb. Non-use results in bone and muscle atrophy. Without analgesic administration, movement may be too painful. Non-treated pain associated with abdominal or thoracic incisions prevents normal ventilation/oxygenation.

‘Newborn and infant animals don’t feel pain’
False. Animals of all ages feel pain.

‘Analgesics mask signs of patient deterioration’
False. Appropriate pain relief eliminates pain as a potential cause for signs of patient deterioration (e.g. tachycardia).

‘Anaesthetics are analgesics and therefore prevent pain’
False. The majority of anaesthetics (inhalant, propofol, barbiturates) block conscious perception of pain but are not analgesic as nociception is still occurring during the unconscious state. The pain generated during the anaesthetic state will be experienced upon awakening. Ketamine, however, has anti-hyperalgesic and some analgesic properties.

SECTION 2: PAIN MANAGEMENT

11. GENERAL APPROACHES TO THE TREATMENT OF PAIN

Pain is a complex phenomenon, which is different in every individual and involves both a sensory (nociception) and affective (emotional) component. Decades of research into pain management indicate that pain is best managed early and aggressively; it is harder to combat pain once it is well established than it is to manage pain before it becomes severe. Clearly this is not always possible but when it is, prevention should be the focus of the analgesic plan. In the treatment of all pain, the aim is to abolish it or, at the very least, to reduce it to a minimum.

The term **preemptive** analgesia has been used to describe the treatment of pain using analgesic drugs given in advance of the pain stimulus occurring; the underlying theory behind such an approach is based on the premise that by reducing the magnitude of nociceptive input to the spinal cord, peripheral and central sensitization are reduced and thereby perioperative pain and hyperalgesia are reduced. However, this is a somewhat restricted view of the events which trigger postoperative and acute inflammatory pain. The focus of what is termed **preventive analgesia** is to reduce the impact of the total peripheral nociceptive barrage associated with noxious pre-, intra- and postoperative or traumatic stimuli. Drugs with a demonstrated preventive effect in humans include the NSAIDs, local anaesthetics and N-methyl-D-aspartate (NMDA) antagonists (e.g. ketamine). These drugs not only reduce the severity of acute post-surgical pain, but in some cases also reduce the incidence of chronic (persistent) postoperative pain.

Analgesic drugs all have the potential to cause side effects. When pain is moderate or severe, the veterinarian should consider combining drugs that act at different sites in the pain pathway to provide optimal analgesia; multimodal analgesia (sometimes referred to as balanced analgesia) is the name given to this approach to treating pain. Combining different classes of analgesic drugs allows the veterinarian to optimize the management of pain, while limiting the occurrence of side effects. Drugs most commonly used in multimodal analgesia include opioids, NSAIDs, local anaesthetics, NMDA antagonists and alpha2 adrenoceptor agonists.

The choice of drug(s) used to treat pain will depend on the underlying cause of pain and the severity and duration of pain. Administering chronic pain will require drugs or drug preparations with a long duration of action, and possibly a range of adjunct therapies. Knowledge of the pharmacology of analgesic drugs in each species is required to optimise drug choice. Factors including age, breed and physical status may influence drug pharmacology and consequently the efficacy and dosing regimen of analgesic drugs. For example, when compared to ‘adults’, drugs in very young animals (puppies and kittens less than 12 weeks of age) and geriatric animals (>75% life expectancy) often have a different pharmacokinetic profile which may alter the effective dose and dosing interval. It is unwise to extrapolate pharmacokinetic data from one species to another; this is particularly true between the dog and the cat.

For the management of acute pain or acute exacerbations of chronic pain, in particular severe pain, drugs should be titrated to effect, and a multimodal approach used. Dosing intervals are influenced by the severity of pain, patient factors and the combination of drugs used, and should be modified according to patient response.

**Acute pain**
Acute pain is initiated by a traumatic, surgical or infectious event and begins abruptly and should last a predictable length of time, correlating with the severity of the insult.

**Perioperative pain**
There are four key time-points when the choice of analgesic strategy will influence a patient’s postoperative pain status; these are the preoperative; intraoperative; immediate postoperative (‘in hospital’); and later postoperative periods (‘at home’). The most important
time periods to consider are the preoperative and intraoperative periods – time periods when postoperative pain can be prevented, or very much reduced, via the concept of preventive and multimodal analgesia. To prevent re-initiation of pain, treatment should continue until the inflammatory response is minimal.

An effective perioperative pain management regimen would normally incorporate drugs from several different classes. Pain relief can also be provided by non-drug therapies. Although the scientific evidence supporting these therapies is largely lacking in veterinary medicine, several modalities are often used including local hypothermia (cold therapy) and hyperthermia; passive range-of-motion exercises; massage; therapeutic exercise; hydrotherapy; ultrasound and electrical stimulation. Surgical technique can have an important impact on perioperative pain. Gentle tissue handling and techniques that minimize trauma (e.g. small incisions; arthroscopy, laparoscopy) should be employed whenever possible. The site of surgery also impacts on pain; after intrathoracic and intra-abdominal procedures, movements that place tension on the incision (such as deep breathing and coughing) increase the intensity of pain. The face, mouth and anal/perianal area appear to be highly sensitive sites and surgery in these areas is likely to be associated with significant pain. Where inflammation is present, such as metritis or pyometra, the degree of pain experienced during and after ovariohysterectomy may be greater than that associated with the routine procedure which might warrant more frequent or higher dosing of analgesics over a longer period of time.

Chronic pain
This is pain of long duration. In humans, chronic pain is often accompanied by fear, anxiety, depression and anger, which can exacerbate pain and its negative impact on the patient's QoL. It is estimated that at least 30% of pet dogs and cats that are seen by veterinarians can be classified as 'senior' and this population is likely to have a high prevalence of chronic pain. However, chronic pain is often not diagnosed as it is often mistaken for 'getting old'. Veterinarians treating animals with chronic disease should consider the potential for accompanying chronic pain, even in the absence of immediately obvious signs. The changes in behaviour that accompany chronic pain may be insidious in onset and subtle.

The approach to treatment depends on the underlying cause of pain, its duration at presentation and how well it has been managed previously. Chronic disease may not be static and acute exacerbations of previously well-controlled pain can occur and these can be especially challenging to treat. A multimodal approach (combination therapy) is likely to be most effective and owner education is essential. The mainstays of treatment of chronic pain are the NSAIDs; however, adjunct drug therapies, physical and other approaches (e.g. acupuncture, surgery) may play an important role in management. There is a wide range of NSAIDs licensed for long-term use in dogs; they are most commonly given orally and long-acting injectable preparations are available. In cats, the only NSAID currently approved for long-term use is meloxicam.

Although many non-drug therapies are suggested to be effective for the management of chronic pain, there is little evidence behind their efficacy, and almost nothing known about potential side effects. In addition, drug side effects, disease progression or comorbidities can be mistaken for worsening pain, leading to additional treatments that are at best non-efficacious, or at worst detrimental. One example is the dog with chronic OA which then develops neurological disease and is prescribed additional drugs in an attempt to alleviate what is thought to be only pain-related difficulty in mobility. In all chronic pain cases, non-drug treatments should be used alongside drug treatments, and there should be regular evaluation to detect beneficial and unwanted effects, and regular reassessment of the patient’s pain.

12. OPIOIDS

What they are
Opioids are drugs that have opiate-like activities and are the cornerstone of effective pain treatment. They vary in their receptor specificity, potency and efficacy, resulting in different clinical effects. Opioids are usually divided in four groups: full agonists (morphine, methadone, fentanyl and its derivatives, pethidine [meperidine], etc); agonist-antagonists (butorphanol and nalbuphine), partial agonists (buprenorphine), and antagonists (naloxone, nalmefene and naltrexone) that are in general devoid of agonist activity. They have high efficacy and are remarkably safe. However, butorphanol and nalbuphine exhibit a ceiling effect where increasing dosages above those recommended will not confer further analgesia, only side effects. Most opioids are controlled substances with the benefit of reversibility. Individual variability after opioid administration may be observed due to differences in pharmacokinetic-pharmacodynamic effects, gender, age and genotype, among others. With the exception of remifentanil, these drugs are metabolized by the liver into active and/or inactive metabolites. Tramadol is considered to be an opioid. Dogs, unlike cats and humans, cannot form appreciable quantities of the active metabolite and potential analgesia may be due to the serotonin reuptake inhibition.

How they work
Opioids bind to opioid receptors (μ, κ, δ and nociceptin, and their subtypes) in the central and peripheral nervous systems inhibiting release of excitatory neurotransmitters from afferent fibres in the spinal cord, thereby inhibiting synaptic transmission of painful stimuli. Postsynaptically, enhanced K+ efflux causes neuronal hyperpolarization of spinal cord projection neurons and inhibits ascending nociceptive pathways. Opioids do not interfere with motor function.

16

Journal of Small Animal Practice © 2014 WSAVA
Indications
Opioids produce analgesia, euphoria, mydriasis (cats) or miosis (dogs), sedation or excitement, and several other physiological effects depending on the animal species. Opioids are efficacious analgesic drugs for treatment of moderate to severe pain. Their analgesic effects depend on the dose, route of administration, delivery system and species to which the drug is given. Opioids are widely used in the perioperative setting as part of multimodal and/or preemptive or preventive analgesic protocols as well as for inhalant anesthetics-sparing effects. They are also widely administered in emergency and critical care patients (i.e. pancreatitis, burns, traumas, meningitis). Epidural administration of morphine is used for postoperative analgesia in the clinical setting. Opioids do not cause excitement (“morphine-mania”) in cats if appropriate doses and intervals are used. Using the IV route, sedation normally occurs in dogs. Intravenous and intramuscular administration is preferred; however, butrenorphine given by the oral transmucosal route has been demonstrated to produce effective antinociception in cats.

Side effects
Most common side effects, usually associated with excessive doses, include vomiting (pre-medication), dysphoria, nausea, panting, bradycardia, and histamine release (morphine and pethidine [meperidine] especially when given IV), urinary incontinence / retention and respiratory depression. Less commonly, inappetance, restlessness, constipation, and hypothermia or hyperthermia (usually after hydro-morphone in cats) can be observed. Any of these adverse effects are readily reversed with careful titration of naloxone (see Table 1).

Contraindications
The clinician must balance the pros and cons of opioid administration as some adverse effects may be clinically irrelevant when pain management is a priority.

Drug interactions
Opioids are combined with benzodiazepines, alpha, adrenoceptor agonists or acepromazine (neuroleptanalgesia) in order to improve sedation while minimizing side effects. Opioids may have a synergistic effect when combined with NSAIDs and local anaesthetics as

### Table 1. Suggested doses (mg/kg) and dosing frequencies of opioid analgesic drugs in cats and dogs

<table>
<thead>
<tr>
<th>Opioid analgesic</th>
<th>Dog (mg/kg)</th>
<th>Cat (mg/kg)</th>
<th>Route of administration</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morphine*</td>
<td>0.3–1 q 2–4h</td>
<td>0.2–0.4 q 4–6h</td>
<td>IM</td>
<td>Cautious use with IV administration due to histamine release</td>
</tr>
<tr>
<td>Pethidine (meperidine)</td>
<td>3–5 q 1–2h</td>
<td>3–10 q 1–2h</td>
<td>IM</td>
<td>Do not administer IV due to histamine release</td>
</tr>
<tr>
<td>Methadone*</td>
<td>0.5–1 q 3–4h</td>
<td>0.3–0.6 q 4h</td>
<td>IM, IV (dogs)</td>
<td>Has NMDA receptor antagonist properties</td>
</tr>
<tr>
<td>Oxymorphone</td>
<td>0.05–0.2 q 4h</td>
<td>0.03–0.1 q 4–6h</td>
<td>IM, IV</td>
<td>May cause hyperthermia in cats</td>
</tr>
<tr>
<td>Hydromorphone*</td>
<td>0.05–0.2 q 2–6h</td>
<td>0.025–0.1 q 4–6h</td>
<td>IM, IV</td>
<td>Weak affinity for opioid receptors</td>
</tr>
<tr>
<td>Tramadol</td>
<td>4–6 q 6–8h</td>
<td>2–4 q 6–8h</td>
<td>IM, IV, PO</td>
<td>Noradrenaline (norepinephrine) and serotonin re-uptake inhibitor</td>
</tr>
<tr>
<td>Fentanyl**</td>
<td>Bolus 2–5 µg/kg + CRI 3–6 µg/kg/h</td>
<td>Bolus 1–3 µg/kg + CRI 2–3 µg/kg/h</td>
<td>IV</td>
<td>Doses may be increased for inhalant anaesthetic-sparing effect or for maximum analgesia</td>
</tr>
<tr>
<td>Alfentanil³</td>
<td>Bolus 20–50 µg/kg + CRI 30–60 µg/kg/h</td>
<td>Bolus 10–30 µg/kg + CRI 20–30 µg/kg/h</td>
<td>IV</td>
<td>Doses may be increased for inhalant anaesthetic-sparing effect or for maximum analgesia</td>
</tr>
<tr>
<td>Sufentanil⁴</td>
<td>Bolus 0.2–0.5 µg/kg + CRI 0.3–0.6 µg/kg/h</td>
<td>Bolus 0.1–0.3 µg/kg + CRI 0.2–0.3 µg/kg/h</td>
<td>IV</td>
<td>Doses may be increased for inhalant anaesthetic-sparing effect or for maximum analgesia</td>
</tr>
<tr>
<td>Remifentanil</td>
<td>6–12 µg/kg/h</td>
<td>4–6 µg/kg/h</td>
<td>IV</td>
<td>Doses may be increased for inhalant anaesthetic-sparing effect or for maximum analgesia. It does not require a bolus</td>
</tr>
<tr>
<td>Butorphanol</td>
<td>0.2–0.4 q 1–2h</td>
<td>0.2–0.4 q 1–2h</td>
<td>IM, IV</td>
<td>Limited analgesic efficacy in most cases of moderate or severe pain.</td>
</tr>
<tr>
<td>Pentazocine</td>
<td>1–2 q 2–4h</td>
<td>1–2 q 2–4h</td>
<td>IM, IV</td>
<td>Limited analgesic efficacy in moderate or severe pain</td>
</tr>
<tr>
<td>Nalbuphine</td>
<td>0.3–0.5 q 2–4h</td>
<td>0.2–0.4 q 2–4h</td>
<td>IM, IV</td>
<td>Limited analgesic efficacy in moderate or severe pain</td>
</tr>
<tr>
<td>Buprenorphine</td>
<td>0.01–0.02 q 4–8h</td>
<td>0.02–0.04 q 4–8h</td>
<td>IM, IV, OTM [cats]</td>
<td>Can be given oral transmucosally to cats.</td>
</tr>
<tr>
<td>Naloxone (antagonist)</td>
<td>0.04 q 0.5–1h*</td>
<td>0.04 q 0.5–1h*</td>
<td>IM, IV</td>
<td>Dilute and titrate IV dose to effect when reversing opioid side effects in painful patients. Mix 0.1 mL (cats, small dogs) or 0.25 mL of naloxone (0.4 mg/mL) with 5–10 mL saline. To avoid adverse effects, titrate this at 1mL/min until the side effects have subsided; using this technique analgesic effects will be maintained. Repeat as required after ~ 20–30 min. If administering IM, give an initial dose of 0.01mg/kg and repeat at 10 min intervals until opioid side effects have been antagonized. Analgesia cannot be guaranteed using the IM route.</td>
</tr>
<tr>
<td>Nalmefene (antagonist)</td>
<td>0.25–0.30 µg/kg q 1–2h</td>
<td>0.25–0.30 µg/kg q 1–2h</td>
<td>IM, IV</td>
<td></td>
</tr>
</tbody>
</table>

*Lower dosages are recommended to start for patients with health problems. †Titration of dose is recommended to avoid adverse effects. ‡Bolus or loading doses should be given slowly or to effect to avoid sudden bradycardia and hypotension.
part of multimodal analgesia. Mixing of different groups of opioids (i.e. buprenorphine and butorphanol) can result in unpredictable effects and it may not offer any advantages.

Special considerations
Opioid tolerance is widely reported in humans but is rarely a problem with short-term use in veterinary medicine. There are reports of opioids causing hyperalgesia in humans and rats; however, this has not been documented yet in small animal practice.

13. NON-STEROIDAL ANTI-INFLAMMATORY DRUGS (NSAIDs)

What they are
NSAIDs are drugs that exert antipyretic, anti-inflammatory and analgesic effects. NSAIDs are the mainstays of relief from mild-to-moderate pain. Chemically they can be divided into salicylates (ASA) and carboxylic acid derivatives. The latter comprise most drugs: indoles (indomethacin), propionic acids (carprofen), enolic acids (phenylbutazone), oxicams (meloxicam), fenamates (mefenamic acid) and coxibs (deracoxib, firocoxib, robenacoxib). Availability of veterinary licensed products with a COX-1 sparing and COX-2 preferential profile has improved the safety profile of this class of drugs. Most drugs are commonly administered per os but some drugs exist in injectable form. NSAIDs are generally metabolized in the liver and may have active metabolites.

How they work
NSAIDs influence the expression of arachidonic acid derivatives in the body. This relates largely to the production of prostaglandins catalyzed by the enzyme cyclooxygenase (COX); however, for salicylates inhibition of nuclear factor kappa-B (NF-κB) may have an important role, and dual inhibitors (tepoxalin), inhibit lipoxygenase (LOX), reducing leukotriene production.

COX exists in two forms: COX-1 and COX-2. COX-1 produces a range of prostaglandins (PGs) and thromboxanes involved in many physiological processes including vascular homeostasis, gastroprotection, renal blood flow, blood clotting, reproduction, wound healing, bone metabolism, nerve development and growth, and immune responses while COX-2 products are mainly PGE2 and prostacyclin – both important mediators of inflammation, although having hemostatic, gastrointestinal and important renal constitutive functions as well.

Both COX-1 and COX-2 are expressed constitutively, but are also induced in higher concentrations at times of inflammation and in certain cancer types. COX-1 and COX-2 are present within the spinal cord where the PGs produced function as nociceptive neurotransmitters independent of an inflammatory response. At the brain stem, NSAIDs induce antinociception by activating the descending inhibitory pathway inhibiting transmission of pain signals at the dorsal horn. While COX selectivity may be beneficial to reduce side effects and inflammation (the main indication of these drugs), it is important to note that both enzyme forms are required at certain concentrations for normal body functions. The specificity of NSAIDs for COX-1 vs. COX-2 form is species-specific. The 50%-inhibitory concentration ratio (IC50\textsubscript{COX-1}/IC50\textsubscript{COX-2}) is a measure of how much drug is needed to inhibit each isoenzyme by 50%. The actual value to the ratio, however, depends on the method, the test situation and assay used, and no clinically relevant gold standard for comparing NSAID inhibition of each isoenzyme has been established. The comparison of selectivity between single drugs on the basis of this ratio remains difficult.

Paracetamol (acetaminophen) is a non-acidic NSAID that likely acts on a splice variant of COX-1 present in the central nervous system, and it may influence the opioidergic, serotonergic and cannabinoind systems. Paracetamol has analgesic and antipyretic effects but little if any anti-inflammatory activity. It has been used for chronic pain in dogs as part of a multimodal approach with minimal gastrointestinal effects. While it seems a promising treatment option due to good central analgesic and antipyretic effects in dogs, it should not be given to cats. Paracetamol readily induces methaemoglobinemia in cats. Dipyrone (metamizole) is a weak NSAID with analgesic, antipyretic and spasmolytic properties. Its mechanism of action appears to be related to the inhibition of both peripheral and central COX enzymes. The administration of metamizol (25–35 mg/kg TID IV) has been shown to provide adequate postoperative analgesia after ovariohysterectomy in dogs. Since this is a phenolic compound, it should be used with caution in cats.

Indications
NSAIDs are effective analgesics and of significant benefit across the spectrum of pain intensities. NSAIDs are administered in the perioperative period, as well as in other acute and chronic pain states such as OA, cancer and other inflammatory conditions. In moderate-to-severe pain they should be used as part of a multi-modal protocol. When used for chronic pain conditions (e.g. OA pain), they are often titrated to the lowest effective dose although there is no evidence that downward dose titration results in greater safety.

There are individual differences, however, in their clinical effectiveness and in case of an unsatisfactory response, switching NSAID may be warranted, and should follow a washout period of several days (this has not been scientifically supported). Particular caution is advised when switching from a non-selective, or COX-1 selective to a COX-2 selective drug. Should mucosal erosions be present, or suspected, caution should be exercised if using COX-2 selective drugs, as these may retard mucosal healing.
Table 2 provides dosing recommendations for NSAIDs.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Indication</th>
<th>Species, Dose, Route</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ketoprofen[^4]</td>
<td>Surgical and chronic pain</td>
<td>Dogs: 2.0 mg/kg, IV, SC, IM 1.0 mg/kg PO 0-2 mg/kg IV, SC 0-1 mg/kg PO 0-3 mg/kg SC Cats: as for dogs</td>
<td>Once postoperative Once per day for up to 3 additional days</td>
</tr>
<tr>
<td>Meloxicam[^4]</td>
<td>Surgical pain/acute musculoskeletal</td>
<td>Dogs: 0.2 mg/kg IV, SC 0.1 mg/kg PO Cats: 0.3 mg/kg SC Or, Up to 0.2 mg/kg SC 0.05 mg/kg PO</td>
<td>One dose only; do not follow-up with any additional dosing.</td>
</tr>
<tr>
<td></td>
<td>Chronic pain</td>
<td>Dogs: 0.2 mg/kg IV, SC 0.1 mg/kg PO Cats: 0.1 mg/kg SC</td>
<td>Once per day for up to 4 additional days On Day 1 Once per day to follow; use the lowest effective dose</td>
</tr>
<tr>
<td></td>
<td>Cimicoxib[^4]</td>
<td>Dogs: 2 mg/kg PO</td>
<td>Once daily for 4 to 8 days</td>
</tr>
<tr>
<td>Mavacoxib[^4]</td>
<td>Chronic pain</td>
<td>Dogs: 2 mg/kg PO</td>
<td>Once daily; use lowest effective dose</td>
</tr>
<tr>
<td>Robenacoxib[^4]</td>
<td>Surgical pain/acute musculoskeletal</td>
<td>Dogs: 2 mg/kg SC 1 mg/kg PO Cats: 2 mg/kg SC 1 mg/kg PO</td>
<td>Once followed by oral Once daily Once daily for total of 6 days or as licensed Once daily; use lowest effective dose</td>
</tr>
<tr>
<td></td>
<td>Chronic pain</td>
<td>Dogs: 1 mg/kg PO</td>
<td></td>
</tr>
<tr>
<td>Carprofen[^4]</td>
<td>Surgical pain</td>
<td>Dogs: 4 or 4.4 mg/kg SC, IV, PO 2 or 2.2 mg/kg SC, IV, PO Cats: 2 to 4 mg/kg SC, IV</td>
<td>Once per day for up to 4 days Every 12h for up to 4 days One dose only; do not follow-up with any additional dosing.</td>
</tr>
<tr>
<td></td>
<td>Chronic pain</td>
<td>Dogs: 4 or 4.4 mg/kg PO 2 or 2.2 mg/kg PO</td>
<td>Once daily; use lowest effective dose Once daily; use lowest effective dose</td>
</tr>
<tr>
<td>Etodolac[^4]</td>
<td>Chronic pain</td>
<td>Dogs: 10–15 mg/kg SC, PO</td>
<td>Once daily; use lowest effective dose</td>
</tr>
<tr>
<td>Deracoxib[^4]</td>
<td>Surgical pain</td>
<td>Dogs: 3–4 mg/kg PO</td>
<td>Once daily for up to 7 days</td>
</tr>
<tr>
<td></td>
<td>Chronic pain</td>
<td>Dogs: 1–2 mg/kg PO</td>
<td>Once daily; use lowest effective dose</td>
</tr>
<tr>
<td>Firocoxib[^4]</td>
<td>Surgical pain</td>
<td>Dogs: 5 mg/kg PO</td>
<td>Once daily for up to 3 days</td>
</tr>
<tr>
<td></td>
<td>Chronic pain</td>
<td>Dogs: 5 mg/kg PO</td>
<td>Once daily; use lowest effective dose</td>
</tr>
<tr>
<td>Tepoxalin[^4]</td>
<td>Chronic pain</td>
<td>Dogs: 10 mg/kg PO</td>
<td>Once daily; use lowest effective dose</td>
</tr>
</tbody>
</table>
Contraindications
In a few patients NSAIDs may cause adverse effects: these are most commonly related to the gastrointestinal tract and, less frequently, the renal system. Adverse effects appear commonly in conjunction with hypovolaemia, hypotension or co-treatment with drugs influencing kidney function, and these clinical scenarios should be corrected or stabilized prior to NSAID use. Similarly, NSAIDs should be used cautiously in animals with pre-existing renal disease and, if contemplated, should follow a risk-benefit assessment and close monitoring regimen appropriate for the patient's condition. Periodic monitoring is recommended with long-term use. NSAIDs with selective COX-1 antagonism (e.g., ketoprofen, aspirin, ketorolac) have been reported to cause inhibition of coagulation via anti-thromboxane activity. This class of NSAIDs should be avoided preoperatively, and only administered postoperatively when adequate clot formation has occurred (usually upon completion of surgery), this is especially important for non-compressible surgical procedures and dental extractions. While there is no clear evidence stating that the use of NSAIDs in patients with hepatic disease is an absolute contraindication, gastrointestinal ulceration is known to be more frequent in animals with hepatic disease. Paracetamol should not be used in cats.

Drug interactions
NSAIDs should not be given together with other drugs that affect arachidonic acid derivatives and leukotrienes. A higher incidence of severe side effects is described when co-administered with corticosteroids. COX-2 inhibitors should not be co-administered with aspirin, since this may enhance the risk of gastrointestinal mucosal injury. NSAIDs should be given very cautiously when ACE-inhibitors, diuretics, warfarin, phenobarbitone or chemotherapeutics are administered, if at all.

14. ALPHA2 ADRENOCEPTOR AGONISTS

What they are
Alpha2 adrenoceptor agonists are non-controlled drugs (xylazine, romifidine and [dex] medetomidine) that produce sedation, hypnosis, analgesia and muscle relaxation. The analgesic effects are normally short-lived in comparison with the sedative effects of these drugs. They vary in their receptor specificity and potency (xylazine < romifidine < [dex] medetomidine). Alpha2 adrenoceptor agonists have the benefit of sedative reversibility when an antagonist (atipamezole or yohimbine) is given; however, analgesia is also reversed. Dexmedetomidine is the pharmacologically active enantiomer found in the racemic preparation of medetomidine, and is approximately (with specific differences) twice as potent as the latter. Sedative effects vary from 30 min to 90 min depending on the drug, route of administration and dose used. These drugs are metabolized by the liver and excreted by the kidneys.
**How they work**

These drugs bind to different alpha<sub>2</sub> adrenoceptor subtype receptors in the dorsal horn of the spinal cord (spinal analgesia), cerebral cortex and locus ceruleus (sedation and supraspinal analgesia) which are present on noradrenergic and non-noradrenergic neurons. Noradrenaline (norepinephrine) is the endogenous ligand for these receptors. These drugs inhibit the release of excitatory neurotransmitters through complex signal transduction and intracellular mechanisms causing membrane hyperpolarization in a similar way to opioid analgesic drugs. Alpha<sub>2</sub> agonists also bind to their receptors in the vascular endothelium causing peripheral vasoconstriction with increases in systemic and pulmonary vascular resistance while decreasing cardiac output in a dose-dependent manner. Consequently, a reflex or centrally-mediated bradycardia and bradyarrhythmias (first and second degree atrioventricular block) may be observed.

**Indications**

Alpha<sub>2</sub> adrenoceptor agonists are widely used for sedation for non-invasive procedures (radiographs, ultrasound examinations, minor laceration repair, wound debridement, bandage placement, biopsies, etc) and as part of neuroleptanalgesia and balanced anaesthesia protocols. They are considered analgesic adjuvants in a variety of clinical settings as they can supplement analgesia while reducing stress response. Small doses may be administered during recovery from anaesthesia, particularly in cases of emergence delirium and dysphoria. Their use is generally reserved to healthy animals that can tolerate significant haemodynamic changes and/or with feral and/or aggressive animals. Further studies may elucidate the advantages and disadvantages of these drugs when administered by other routes of administration (continuous rate infusion, oral transmucosal, epidural, intra-articular and/or part of local anaesthetic blocks).

**Side effects**

Most common side effects include hyper and/or hypotension, bradycardia, hypothermia, decreases in sympathetic tone and gastrointestinal motility, increases in urinary output, transient hypoinsulinaemia and hyperglycaemia. Other less common side effects such as emesis, salivation, bradyarrhythmias may be observed.

**Contraindications**

These include animals with cardiopulmonary disease with or without arrhythmias or conduction disturbances, significant systemic disease, preexisting hypo/hypertension, diabetes mellitus and liver/renal failure. Caution should be exercised when using in patients with trauma. The use of anticholinergics in combination with alpha<sub>2</sub> agonists may be contraindicated if peripheral vasoconstriction and possible hypertension are present.

**Drug interactions**

Concurrent use of alpha<sub>2</sub> adrenoceptor agonists and opioids may improve analgesia due to a synergistic effect. These drugs have significant injectable and inhalant anaesthetic-sparing effects. Opioid requirements are usually reduced when alpha<sub>2</sub> adrenoceptor drugs are used.

**Special considerations**

Some animals appear unaffected by the administration of alpha<sub>2</sub> adrenoceptor agonist drugs.

---

**15. LOCAL ANAESTHETICS**

**What they are**

Local anaesthetics (LAs) are drugs that reversibly bind to Na<sup>+</sup> channels and block impulse conduction in nerve impulses. LAs contain an aromatic ring (lipophilic) at one end and an ionizable group at the other and an intermediate chain in between, which can be either an ester (tetracaine, procaine, benzocaine) or an amide (lidocaine, bupivacaine, ropivacaine, mepivacaine, prilocaine and their respective mono-isomers). Potency is directly related to lipid solubility while onset is inversely associated with pKa and lipophilicity; increased protein binding and potency, and the vasoactivity of the LAs correlate with increased duration of action. The intermediate chain determines their metabolism (amides, liver; esters, liver and pseudocholinesterases in plasma). LAs are the main drugs used for loco-regional anaesthesia and analgesia.

**How they work**

LAs stabilize the cell membrane, rendering it non-susceptible to electrical stimuli by altering Na<sup>+</sup>-channel conformation. LAs block small unmyelinated C-fibres and myelinated A<sub>D</sub> fibres before other sensory and motor fibres (unmyelinated A<sub>C</sub>, A<sub>B</sub> and A<sub>δ</sub>). In a neuraxial blockade (epidural, intrathecal) from least to most sensitive to LAs are: autonomic, pain, proprioception, and motor fibers. Recovery of sensation is expected to be in the reverse order. In a peripheral nerve block (brachial plexus), in contrast, fibre sensitivity
from least to most is: motor, proximal sensitive, distal sensitive.91 When administered systemically, lidocaine blocks the ectopic afferent neural activity at the NMDA receptor within the dorsal horn.

**Indications**

**Topical anaesthesia.** To aid intubation, lidocaine spray. To desensitize only the skin and upper subcutaneous layers, eutectic mixture of LAs (EMLA) cream (lidocaine and prilocaine) (generally used to aid vascular catheterization). To desensitize mucous membranes, lidocaine gel. Studies in humans and animal models have indicated that lidocaine patches provide analgesia of the skin and underlying tissues and can reach deep tissues to provide perioperative analgesia, for example for joint surgery and large surgical wounds.92,93

**Infiltration anaesthesia:** consists of injection of LAs into tissues that surround the area of interest or into joints. Blocking transmission of stimuli in defined, specific, peripheral nerves represents the larger part of loco-regional applications. These techniques can be accomplished by using anatomical knowledge or, in case of some distal limb blocks, even by palpation of the nerve itself. LAs can also be delivered through diffusion (wound soaker) catheters placed within large wounds, especially amputation sites. This technique is best applied as part of a multimodal analgesic protocol.

Neuraxial blockade can be achieved by either epidural or intrathecal application of LAs. Other drugs (opioids, alpha, agonists, and others) can also be applied via these routes either alone or together with LAs provided they are sterile and preservative free. It should be noted that single use of morphine with preservative has been used epidurally without problems – repeat dosing should be avoided.

**Systemic:** lidocaine can be administered intravenously either as a bolus or as a constant rate infusion in dogs to provide pro-kinetic, anti-arrhythmic, inhalant-anaesthetic sparing and anti-inflammatory effects.

**Contraindications**

Ester (prilocaine, benzoica) LAs may cause allergic reactions in some animals and methaemoglobinemia in cats. Loco-regional, particularly neuraxial techniques, should not be performed if there is skin infection at the puncture site. Other contraindications for neuraxial blockade include coagulation disorders, spinal cord trauma, hypovolaemia and sepsis. Toxicities usually result from high plasma concentrations affecting the central nervous system first (except bupivacaine) before cardiovascular depression and death.94 Central nervous toxicity may manifest as head pressing, star gazing and with increasing doses as stupor and coma. Due to its cardio toxicity, bupivacaine should not be used intravenously. Other signs of toxicity may include allergic reactions and range from urticaria to anaphylaxis. If clinical signs of toxicity occur, the administration/infusion should be stopped immediately and in severe cases of cardiac signs, an intravenous lipid emulsion (4 mL/kg bolus, followed by 10 min of 0.5 mL/kg/min of Intralipid®) can be administered to augment chances of survival in cardiac arrest after bupivacaine overdose.95

**Caution**

When combining different local anaesthetics, do not exceed the maximum dose of either drug.

**Drug interactions**

Adrenaline (epinephrine) may be added as a local vasoconstrictor to decrease tissue absorption (1:200,000 = 5 µg/mL; 1:400,000 = 2.5 µg/mL) and increase duration of effect; with erroneous intravascular injection this may cause short-lived tachycardia. This formulation must not be injected into the extremities due to the risk of tissue necrosis.

The maximum recommended doses are based on clinical experience, and designated, species-specific studies are needed to confirm these in dogs and cats. If using lidocaine spray for intubation, the amount of lidocaine used needs to be taken into consideration in total lidocaine dosing. (The dose per spray for xylocaine is 10 mg per spray action and for ‘Intubeaze’ it is 2-4 mg).

### Table 3. Local anaesthetics

<table>
<thead>
<tr>
<th>Agent</th>
<th>Relative lipid solubility</th>
<th>Relative potency</th>
<th>pKa</th>
<th>Onset (min)</th>
<th>Plasma protein binding (%)</th>
<th>Duration (min)</th>
<th>Maximum recommended dose (mg/kg) Dogs/Cats</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low potency, short duration</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procaine 0.5–1%*</td>
<td>1</td>
<td>1</td>
<td>8.9</td>
<td>Slow</td>
<td>6</td>
<td>60–90</td>
<td>12/6</td>
</tr>
<tr>
<td>Chloroprocaine 2–3%</td>
<td>1</td>
<td>1</td>
<td>9.1</td>
<td>Fast</td>
<td>7</td>
<td>30–60</td>
<td>12/6</td>
</tr>
<tr>
<td><strong>Intermediate potency and duration</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mepivacaine 1.5%</td>
<td>2</td>
<td>2</td>
<td>7.6</td>
<td>Fast (3–10)</td>
<td>75</td>
<td>120–240</td>
<td>4.5/3</td>
</tr>
<tr>
<td>Prilocaine</td>
<td>2</td>
<td>2</td>
<td>7.7</td>
<td>Fast (1–4)</td>
<td>55</td>
<td>120–240</td>
<td>8/4</td>
</tr>
<tr>
<td>Lidocaine 1–2%</td>
<td>3.6</td>
<td>2</td>
<td>7.7</td>
<td>Fast (5–10)</td>
<td>65</td>
<td>90–200</td>
<td>8/6</td>
</tr>
<tr>
<td>Articaine</td>
<td>52</td>
<td>4</td>
<td>7.8</td>
<td>Fast (2–5)</td>
<td>65</td>
<td>30–45</td>
<td>7/3</td>
</tr>
<tr>
<td><strong>High potency, long duration</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetracaine <em>0.1–0.5%</em></td>
<td>80</td>
<td>8</td>
<td>8.6</td>
<td>Slow (20–60)</td>
<td>80</td>
<td>180–600</td>
<td>3/1</td>
</tr>
<tr>
<td>Bupivacaine 0.25–0.75%</td>
<td>30</td>
<td>8</td>
<td>8.1</td>
<td>Intermediate (10–20)</td>
<td>95</td>
<td>180–600</td>
<td>2/1.5</td>
</tr>
<tr>
<td>Levobupivacaine 0.125–0.75%</td>
<td>30</td>
<td>8</td>
<td>8.1</td>
<td>Intermediate (10–15)</td>
<td>96</td>
<td>180–600</td>
<td>2/unknown</td>
</tr>
<tr>
<td>Etidocaine 0.5–1.5%</td>
<td>140</td>
<td>6</td>
<td>7.7</td>
<td>Fast</td>
<td>95</td>
<td>180–600</td>
<td>8/4</td>
</tr>
<tr>
<td>Ropivacaine 0.75%</td>
<td>14</td>
<td>4</td>
<td>8.1</td>
<td>Intermediate (15–20)</td>
<td>94</td>
<td>90–360</td>
<td>3/1.5</td>
</tr>
</tbody>
</table>

*Ester local anaesthetics
There is no convincing scientific evidence for the beneficial effect of mixing two local anesthetic drugs and there may even be a decrease in duration of effect or a prolongation of onset of one local anaesthetic when adding another one.

Repeat dosing of local anaesthetics is usually based on the duration of action (e.g. bupivacaine, every 6 hours), but the optimal doses to use for repeat dosing have not been determined, nor have the pharmacokinetics of repeat dosing in clinical patients been fully elucidated.

There may be differences between a calculated maximum dose of the local anaesthetic and the volume required. These volume deficits can be augmented with NaCl 0·9% solution; however, this dilutes the local anaesthetic and reduces effectiveness. For lidocaine and bupivacaine, concentrations of <0·125% and <0·25%, respectively, are not recommended.

### 16. ANALGESIC DELIVERY TECHNIQUES AND TOOLS

The method by which a drug is delivered can have a significant effect on its efficacy. Drug delivery systems (DDS) are important to minimize toxicity and improve efficacy.

#### Techniques

**Sustained release systems** include any DDS that achieves slow release of a drug over an extended period of time (days). Such systems provide 'hands-off' analgesia, minimize systemic side effects and drug accumulation, reduce fluctuations in drug plasma concentrations and may not require infusion devices.96

A new long-acting transdermal fentanyl solution has been shown to produce similar postoperative analgesia to buprenorphine in dogs undergoing surgery. Population pharmacokinetics and safety of this compound have been reported in this species.97,98 Transdermal patches (fentanyl, lidocaine and buprenorphine) are adhesive patches that are placed on the skin to deliver a specific dose of drug through the skin and into the plasma. The patch provides a controlled release of the drug through a porous membrane with a drug reservoir.73,93,99 In cats, the analgesic effects of fentanyl patches can be highly variable due to the individual variability in its pharmacokinetics. In dogs undergoing orthopaedic surgery, this compound appears to provide adequate postoperative analgesia when administered with a NSAID.73 Fentanyl patches have a long onset period and must be in place at least 12h (cats) to 24 hours (dogs) before analgesia is required. Therefore, other analgesic drugs should be available in the meantime.

**Constant rate infusion**: continuous administration of a set dose regimen through an electronic delivery device in order to maintain constant plasma levels.

**Target-controlled infusion**: based on complex algorithms, infusion rates are administered by a delivery device to obtain a specific plasma (effect site) concentration in order to produce a desired effect.

#### Tools

**Infusion devices**: Volumetric infusion pumps work with different delivery systems (peristaltic, piston, shuttle). They can deliver high volumes with low accuracy (±10%). Syringe pumps use a stepper motor with a drive screw and are suitable for administering potent and more concentrated analgesics with high accuracy (±5%). A calculator feature allows the user to enter body weight, drug concentration and the infusion rate.100

**Wound infusion catheters**: These are flexible indwelling catheters that are embedded near, or in, surgical sites that are used to deliver intermittent infusions of local anaesthetics101 (continuous infusions have been show to lead to unequal distribution).102

**Electrical nerve locators (ENLs)**: These devices can be used to facilitate neural blockade of brachial plexus, tibial and femoral nerves, epidurals, among other local blocks. Clinical use of ENLs helps with needle placement and may shorten onset time, prolong duration of action, and reduce risk for nerve injury. They consist of a constant-current generator (low frequency and duration) that is connected to an insulated needle and a remote electrode that is attached to the skin. The needle is advanced toward the nerve until the desired motor response is obtained. The volume of local anaesthetic to be injected varies from 0·05–0·3 mL/kg. As the solution is injected, the nerve is mechanically displaced and motor response is lost.103

**Epidural catheters**: Catheterization is usually accomplished by using commercial kits (19-, 20- and 24-gauge sizes) that include the catheter and a Tuohy needle, which has a curved bevel that facilitates direction of the threaded catheter through the epidural space. These catheters are usually inserted through the lumbo-sacral intervertebral space and allow intermittent or continuous administration of analgesic drugs for prolonged postoperative periods or animals in severe pain. Dislodgement or coiling, and contamination of the catheter are the most common complications with this technique.104

### 17. ADJUNCTIVE DRUGS

There are several drugs that can be incorporated into a pain management protocol that do not fall into the major traditional classes of analgesic. These include ketamine (at sub-anaesthetic doses), amantadine, gabapentin, imipramine and amitriptyline. These drugs
are not considered ‘standalone’ analgesic agents and are most often used in conjunction with opioids, NSAIDs, local anaesthetics and alpha2 adrenoceptor agonists. Ketamine is used intravenously on a short-term basis – amantadine, gabapentin, imipramine and amitriptyline are given orally and are used long-term. These drugs may play a more prominent role in the treatment of chronic (mal-adaptive) pain as we gather more scientific and clinical trial based information on their use in dogs and cats.

**Ketamine**

*Mode of action:* By binding to NMDA receptors, ketamine can modulate central sensitization and exert an anti-hyperalgesic effect. Ketamine may also act at opioid, monoaminergic and muscarinic receptors and at voltage sensitive Ca++ channels.

*Indications:* As part of a multimodal perioperative pain management plan for major surgery, in trauma patients or as part of a desensitization treatment for chronic pain patients. For surgery, treatment should be started prior to surgery and continued for up to 24 hours afterwards. Ketamine is administered in addition to other analgesic species such as opioids and NSAIDs. Beneficial effects including improved appetite and lower pain scores have been shown after soft tissue and major orthopaedic surgery. In trauma patients treatment should begin as soon as possible after initial triage.

*Recommended dose:* Dogs, bolus (loading dose): 0.5–1.0 mg/kg IV followed by constant rate infusion (CRI) at 0.12–0.6 mg/kg/h; the higher infusion rates are used during surgery and then tapered following surgery, and in severe pain states where dosages >2mg/kg may be required. Cats, bolus (loading dose): 0.5 mg/kg IV followed by constant rate infusion at 0.3–1.2 mg/kg/h; some cats will be sedated at these doses.

**Amantadine**

*Mode of action:* Inhibition of NMDA responses; may cause NMDA receptors to remain closed.

*Indications:* Dogs with osteoarthritic pain that is refractory to NSAID treatment alone. Amantadine may be beneficial in patients with other long-standing pain syndromes with a neuropathic component.

*Recommended dose:* Dogs: 3–5 mg/kg *per os*, once daily.105 Pharmacokinetic data are available in cats but there are no published clinical data on its use as an adjunctive analgesic agent; however, doses similar to those used in dogs are recommended. Amantadine is excreted renally and this should be taken into consideration when it is used in animals with decreased renal function. High doses (40 mg/kg and above) are known to cause seizures.

**Gabapentin**

*Mode of action:* Not yet fully elucidated; gabapentin may modulate pain by altering trafficking of the alpha2 subunits, by suppressing glutamate and substance P and modulating GABA receptors located in the dorsal horn of the spinal cord.106 Gabapentin activates the descending inhibitory pathway by inducing norepinephrine release which subsequently induces analgesia due to spinal alpha2 adrenoceptor stimulation.

*Indications:* Developed as an anti-seizure medication, gabapentin has been used perioperatively in laboratory animals with induced nerve damage, and as part of a multimodal treatment regimen in humans with long-standing pain with a neuropathic component. There are very few published studies assessing its analgesic action in dogs for the treatment of acute surgical pain,107,108 and its use in cats with pain related to major trauma unresponsive to traditional analgesic therapy.109 Human and laboratory animal studies, and anecdotal veterinary evidence, supports further studies for prophylaxis against, and for, long-standing pain with a known or potential neuropathic component (e.g., diabetic neuropathy, pelvic trauma, amputation, IVDD) in both cats and dogs.110,111

*Recommended dose:* Start treatment at 10mg/kg *per os* for dogs q8-12h, 5mg/kg *per os* for cats q12h and increase or decrease depending on therapeutic response. Treatment is frequently required for several weeks and gradual withdrawal is recommended. Side effects may include sedation and ataxia.

**Imipramine and amitriptyline**

*Mode of action:* Tricyclic antidepressants (TCAs) block reuptake of catecholamines, thereby enhancing adrenergic transmission. Amitriptyline also has NMDA receptor antagonist properties and less potential for serotonin toxicity when compared to imipramine.

*Indications:* TCAs may be effective adjunctive analgesics for a range of neuropathic conditions and can be used in combination with environmental modifiers for treatment of cats with inflammatory bowel disease and feline lower urinary tract disease (FLUTD).112,113 The addition of imipramine or amitriptyline may prove successful in managing refractory chronic pain.

*Recommended doses:* Amitriptyline, dogs: 1–2 mg/kg orally q12–24h; cats: 2.5–12.5 mg/cat orally q24h. Imipramine, dogs: 0.5–1 mg/kg orally q8h: cats 2.5–5 mg/cat orally q12h. Many of these products are unpalatable and may require creative methods of administration. Clinical improvement can be seen within 48 hours of initiating amitriptyline treatment when combined with other analgesics, or when used in combination with corticosteroids for feline inflammatory bowel disease, and continued improvement may be seen over time. It has been reported that it can take up to 2–4 weeks for these drugs to achieve maximal effectiveness.113 However, environmental modification is an essential component of treatment.

**Duloxetine**

*Mode of action:* Serotonin re-uptake inhibitor (SRI) and noradrenaline (norepinephrine) re-uptake inhibitor (NRI) mixed compounds.
Indications: Duloxetine, a mixed SRI and NRI, is approved in humans for the treatment of diabetic neuropathy,\textsuperscript{114} and in both neuropathic and inflammatory pain models analgesic activity has been demonstrated.\textsuperscript{115} Some reports suggest that mixed compounds may be beneficial for the treatment of neuropathic pain, whereas compounds with greater affinity for noradrenaline (norepinephrine) re-uptake inhibition may be more beneficial for the treatment of visceral pain.\textsuperscript{115} As these agents gain more popularity in human medicine for treating neuropathic pain they are likely to be used more widely in animals; however, caution should be used extrapolating from humans to animals and species-specific studies should be undertaken.

Some analgesic (some pure mu agonists) or adjunctive analgesic agents with SRI capability (e.g. tramadol, imipramine, duloxetine) may, when combined, induce serotonin toxicity. This may be more of a concern when the patient is also receiving selective SRIs (e.g. fluoxetine [Reconcile, Prozac]), TCAs, monoamine oxidase inhibitors (e.g. selegiline [L-Deprenyl, Anipryl]) prescribed for anxiety in dogs.\textsuperscript{113} The serotonin syndrome is characterized by neuromuscular hyperactivity, fever, tachycardia, tachypnea and agitation.\textsuperscript{114}

PLT (Prednoleucotropin)
PLT is a mixture of two drugs; cinchophen, a NSAID, and prednisolone, a corticosteroid. It is licensed in the UK for the treatment of osteoarthritis in dogs.

18. NON-ANALGESIC DRUGS IN THE MANAGEMENT OF THE PAINFUL PATIENT

Glucocorticosteroid (GCs)
GCs are among the most misused class of drugs in veterinary medicine. There is little evidence-based medicine that supports the administration of these drugs in the clinical setting for analgesia. These drugs are useful in the management of hypoadrenocorticism, allergic and autoimmune disorders, and specific inflammatory conditions. It is the resolution of these illnesses that confers the analgesia. The combination of GCs with NSAIDs is contraindicated due to the increased incidence of side effects.\textsuperscript{116}

Inhalant anaesthetics
These are used for general anaesthesia in animals. They have favourable pharmacokinetic characteristics with predictable and rapid adjustment of anaesthetic depth. Most common agents are halothane, isoflurane and sevofurane but none have analgesic properties.

Maropitant
Maropitant is a neurokinin-1 receptor (NK-1) antagonist used to treat and prevent emesis in dogs by blocking NK-1 receptors in the chemoreceptor trigger zone in the CNS. The NK-1 receptor and its ligand, substance P, are present in spinal cord sensory afferents involved in nociception and substance P vesicles are present in spinal cord ascending projections to brain areas used for nociceptive processing. Studies in mice and rabbits have demonstrated that NK-1 receptor antagonists consistently induce analgesia to visceral noxious stimulation. Maropitant may decrease inhalant anaesthetic requirements after IV administration in dogs. At this point, there is no clear evidence that maropitant should be used as an analgesic in the clinical setting.\textsuperscript{117}

Acepromazine (ACP)
ACP is one the most widely used tranquillisers in veterinary medicine; it has no analgesic properties. The administration of ACP decreases injectable and inhalant anaesthetic requirements while decreasing blood pressure, cardiac output and stroke volume.\textsuperscript{118} ACP is widely used in the perioperative period (neuroleptanalgesia) and may cause hypothermia.

19. PHYSICAL REHABILITATION

Physical rehabilitation is the objective assessment, diagnosis and treatment of musculoskeletal and neurological impairments including but not limited to acute, subacute and chronic pain in tissues including intra-articular, capsular, ligamentous, muscular, central and peripheral neural tissues. The physical rehabilitation assessment utilizes careful evaluation of posture, gait, function, strength, muscle extensibility, passive range of motion and joint play to create a problem list and develop an assessment from which targeted treatment interventions are developed.\textsuperscript{119}

Treatments for pain may include physical modalities, manual therapy and therapeutic exercise. Choice of treatment intervention should be based on the target tissue healing response and the chronicity of the injury which determines treatment frequency, intensity and duration. Reassessment of response to treatment should occur at each treatment. Overall, the greatest efficacy is seen with exercise and cooling modalities.

Therapeutic exercise
Exercises improve blood and lymph flow, increase soft tissue support to skeletal and spinal structures, increase tendon and ligament pliability. Simple exercise such as static weight-bearing can generally be utilized in the acute phase of injury, with gradual amplification
of difficulty as healing progresses and strength improves. In humans, exercise is has been shown to provide very significant levels of pain relief, with analgesic effects as large or larger than those seen with NSAIDs associated with strengthening and aerobic exercise.120

**Physical modalities**

Physical modalities can be used to diminish pain, promote soft tissue healing, improve muscle extensibility and facilitate muscle strengthening. Physical modalities that have been studied in human and animal models include but are not limited to the following.

**Thermotherapy (heat):** Application of heat to tissues increases distensibility and increases blood flow to facilitate healing. Heat activates heat-sensitive nociceptors and may be pro-nociceptive early in disease states, but can have analgesic effects after the inflammatory state has subsided, when muscle and fascia restrictions predominate.121

**Cryotherapy:** Cooling techniques are inexpensive, readily available, are associated with robust evidence of analgesia and can substantially reduce the degree of damage in acute injury. Mechanisms for these effects include decreased bleeding and swelling due to local vasoconstriction, reduced pain via local effects as well as facilitation of descending inhibitory mechanisms.122

**Laser:** Application of low level laser therapy (660 nm, 9 J/cm²) has been shown to decrease indicators of neuropathic pain and increase function in a rodent model of peripheral nerve entrapment neuropathy.123

**Electrical stimulation:** Transcutaneous electrical nerve stimulation (TENS) provides analgesia for about half of human patients with moderate pain.124

**Phonophoresis:** Application of pulsed therapeutic ultrasound for percutaneous lidocaine absorption increases the analgesic effect when compared to continuous ultrasound.125

**Pulsed electromagnetic therapy:** Application of non-thermal, non-invasive electromagnetic therapy can result in pain reduction in humans with knee OA.126

**Shock wave therapy:** Deformation of tissues using high-intensity sound waves leads to a cascade of beneficial effects such as neovascularisation ingrowth, reversal of chronic inflammation, stimulation of collagen and analgesia,127 and in humans with lower back pain.

**Manual techniques**

The application of hands-on treatments can effect tissues mechanically and physiologically to decrease pain, increase circulation, reduce swelling, increase soft tissue extensibility and normalize joint mobility:

**Joint mobilization:** In human and rat models manual application of forces through inflamed and non-inflamed joints increases mechanical nociceptive thresholds.128

**Trigger point pressure:** Manual treatment of trigger points can have beneficial effects, however in healthy human subjects, mechanical stimulation of trigger points induces central sensitization129 and antagonist muscle activity.130 Manual treatment of trigger points should be complimentary to other pain treatments.131

**Massage:** See Section 23.

### 20. DIET AND SUPPLEMENTS

Based in Part on WSAVA Nutrition Assessment Guidelines Committee Dietary factors and dietary supplements with beneficial effects on pain (see references and further reading).36,122-152 It should be noted that dietary supplements do not require proof of safety, efficacy, or quality control to be marketed. Therefore careful selection of type, dose, and brand is important to avoid toxicities or lack of efficacy.

**Optimal body condition (4-5/9)**

Weight loss in dogs and cats that are even mildly overweight can significantly reduce pain from OA and other orthopaedic conditions. This is one of the reasons that nutrition screening evaluation is a critical component of the examination of every pet, but particularly those in which pain is identified. When pain is identified, a more thorough nutritional evaluation is warranted to determine the cause of overweight body condition. Based on this information, a specific plan can be developed for the animal to achieve optimal body condition.

**Optimal nutrition (especially in young growing animals)**

Fast growth rate can increase the risk of developmental orthopaedic diseases, especially in large and giant breed dogs. These diseases not only affect the young animal but also can contribute to OA and pain in later life. Nutriently unbalanced diets are especially detrimental during growth so careful attention should be paid to all animals’ diet histories during this critical phase. Dogs and cats should be fed a diet that meets growth requirements until at least 1 year of age (up to 18 months in giant-breed dogs).

**Dietary supplements with potential benefits for pain management**

**Omega-3 polyunsaturated fatty acids:**

- The omega-3 fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) have anti-inflammatory effects which may reduce inflammation and pain from OA
• Indications – adjunctive treatment for chronic pain. Studies conducted in dogs and cats suggest modest benefits of EPA and DHA on pain from OA. High doses of omega-3 fatty acids may alter platelet function and may cause gastrointestinal side effects in some animals.

• The optimal dose has not been determined but studies of dietary omega-3 fatty acids at a dose of 0.41 g/100 kcal EPA and 0.34 g/100 kcal DHA (approximately 170 mg/kg EPA and 140 mg/kg DHA from the canine studies) have shown benefit. Veterinary diets marketed for dogs with OA are all enriched in omega-3 fatty acids but the amounts vary. Omega-3 fatty acids (i.e., EPA+DHA) also can be provided as supplements.

• The total EPA+DHA dose is the primary factor to consider; the ratio of omega-3 to omega-6 fatty acids appears to be of much lower importance.

• Note that there are other omega-3 fatty acids (e.g., the plant-based omega-3 fatty acid, alpha-linolenic acid) which do not have similar effects to EPA and DHA. Therefore, it is important to assess the total dose of EPA and DHA, rather than just the dose of total omega-3 fatty acids.

Glucosamine and chondroitin

• Glucosamine and chondroitin may have benefits in OA through their anti-inflammatory effects. There is no evidence for ‘chondroprotective effects’.

• Indications – adjunctive treatment for chronic pain. Studies of glucosamine and chondroitin have been contradictory in terms of beneficial effects on pain; effects appear to be low to modest, at best. Glucosamine is an amino sugar, and although no adverse effects on glucose regulation have been seen in studies of healthy dogs or cats, studies of glucosamine supplementation in diabetic animals has not been reported.

• The optimal dose has not been determined.

Green-lipped mussels (Perna canaliculus)

• Components of green-lipped mussels include omega-3 fatty acids (EPA, DHA, and eicosatetraenoic acid [ETA]), chondroitin, glutamine, zinc, copper, manganese, and vitamins C and E. Although the exact mechanism of action is unknown, green-lipped mussels appear to have anti-inflammatory effects.

• Indications – adjunctive treatment for chronic pain. Both supplemental and dietary green-lipped mussels have been studied in dogs. Not all studies showed positive results but this may be related to study design issues.

• Adverse effects are unlikely.

• The optimal dose is unknown. One study which provided 11 mg/kg body weight/day showed no significant effects, while studies providing approximately 17–75 mg/kg body weight/day had positive results. Some veterinary diets and certain over-the-counter diets contain supplemental green-lipped mussels.

The strength of evidence for benefits on pain and locomotion is low for other supplements (hydroxycitric acid, turmeric extract (P54FP), beta-1,3/1,6 glucans, gelatin hydrolysate,undenatured type II collagen, special milk protein concentrate). Avocado and Soy unsaponifiables are oily compounds that have been evaluated as disease-sparing agents in dogs, humans and horses. These supplements are standardized at 1/3 avocado and 2/3 soy. In preclinical studies inhibition of IL-1β and stimulation of collagen synthesis by chondrocytes have been identified. In the very limited clinical data in dogs and horses, there appears to be a disease modifying effect, but an analgesic augmentation is less evident.

21. NURSING AND SUPPORTIVE CARE

Quality nursing care (tender loving care) should be applied to small animals as an adjunct to other therapies for managing pain and stress. It is important to create an environment where the animal is emotionally and physically comfortable.

Assess the entire animal – not just the painful part. Other areas of pain will often be found. Stress and anxiety can intensify pain. The following actions can all reduce stress and anxiety: sitting with the animal, turning down the lights, decreasing noise, keeping cats and dogs separate. The environment may affect pain.

Nursing care techniques

Massage: Gentle pressure, compression and rocking can soothe patients both physically and psychologically if they are accustomed to close human contact.

Application of warmth or cold: Cold compress during acute injury can reduce swelling and provide analgesia. Cold compress generally needs to be in place for 15–20 minutes to be effective. Warm compress is generally more comfortable after the acute phase has
passed, but can aid tissue relaxation and as a precursor to massage or stretching. Warm compress generally needs to be in place for 10–15 minutes.

Patient handling: When handling and moving an animal avoid painful areas (surgical/trauma site, osteoarthritic joints, etc.), even when the animal is anaesthetized or sedated to avoid inflicting a painful stimulus which can begin a new pain cascade. Long bone injuries should always be immobilized with a cast or splint before moving the patient.

Bedding and positioning: The creation of a soft, cushioned surface for the animal to rest on will help prevent additional pain. Laying for long periods on a hard or cold surface is very uncomfortable and predisposes to anxiety, heightening the sensation of pain and the potential for decubital ulcers. Rolled blankets or pillows can facilitate the patient being able to choose the most comfortable body posture. Furthermore, the patient can be assisted with positioning that encourages elevation of injured limbs to reduce oedema, or facilitates ventilation.

Changing positions: Turning, a patient (down side up) every 4 hours prevents muscle stiffness, decubital ulcers, pulmonary atelectasis, and gives an opportunity for pain assessment and analgesic adjustment if required.

22. ACUPUNCTURE

What it is
Acupuncture is the placement of fine needles at defined locations in the body that are rich in neurovascular or muscular structures in order to stimulate an endogenous response directed at analgesia, healing and immune modulation. Acupressure is the application of pressure to the same specific point locations for similar indications.

Mode of action
Neuroanatomical approach: Due to the complexity of constructing and interpreting placebo controlled trials in acupuncture, the practice of acupuncture rests heavily on physiological data showing measurable changes in endogenous analgesic mechanisms. There is considerable evidence of measurable physiological effects, for example: enkephalins, endorphins, serotonin, norepinephrine, purines, glutamate, neuropeptides, cannabimimetic, ion channel modifiers, modification of transcription, and through additional modification of associated cell types such as interneurons, microglia and astrocytes. A body of work has developed showing the effects of acupuncture as neuro-modulation. From this evidence a logical and rational approach to treatment can be made, utilizing point locations that are based upon known neuro-anatomy and effects measured through fMRI, chemical changes, and microscopic deformation of soft tissue structures. While these points often occur in the same locations as the meridian points, the rationale for their use is often different when approaching acupuncture from an evidence-based perspective, and has been shown to be more effective and repeatable between practitioners.

Metaphysical approach: Acupuncture can be based on a metaphysical framework that involves moving invisible energy, called chi or qi. This approach has added to the clinical expertise of acupuncture treatment for pain, but cannot be corroborated by research, as chi is, by definition, immeasurable.

Indications
Somatic pain including:
- Spinal conditions, post-surgical conditions, trauma, wounds, chronic pain such as osteo-arthritis.
- Myofascial trigger point pain: Often described as ‘dry needling’ by physical therapists.

Visceral pain:
May be targeted with superficial treatments such as acupuncture due to the overlap of neural innervation along myotomes, dermatomes and shared locations of spinal processing.

Side effects
Risks of acupuncture are very low and include unintentional puncture of vital structures (especially lungs), infection (especially without the use of sterile, single-use needles), and introduction of foreign material. Intentional implantation of foreign material (such as gold beads or pieces of metal) cannot be recommended, and has been shown to cause long-term harm to patients.

Special considerations
Acupuncture is a complex intervention, and requires additional training. However, the supplies are accessible, and acupuncture is seldom regulated in the same fashion as pain-controlling pharmaceuticals.

Sterile, single use needles are essential. Advanced training in acupuncture is available in many regions throughout the world. Acupuncture can be integrated into veterinary pain treatments with an understanding of muscle function and anatomy and nerve function and anatomy.

Several human studies have shown efficacy of acupressure, a modality that is not limited to individuals trained in the placement of needles.

Acupuncture is a valuable adjunct, when used properly, to pharmaceutical approaches, and is meant to be used in a multi-modal regimen rather than a stand-alone therapy in most instances.
23. MEDICAL MASSAGE

**What it is**
The manipulation of soft tissues in order to generate a change in texture, mobility, blood flow and lymphatic drainage; and to provide relief from stress, anxiety and pain.

**Mode of action**
The pressure generated by massage strokes generates changes in various measurable physiological phenomena on tissue and cellular levels, within the chain of electrochemical reactions in the local area of massage, as well as in the organism as a whole.164,165

* **Tissue effects:** Collagen deformation releases fascia restrictions and improves regional blood flow. Direct pressure releases myofascial trigger points in affected and compensatory muscle groups. Soft, stroking massage techniques mobilize oedema and lymphatic fluid.

* **Cellular effects:** When direct mechanical pressure is applied, the signal is rapidly transferred from the cell surface receptors to distinct structures in the cell and nucleus, including ion channels, nuclear pores, nucleoli, chromosomes, and perhaps even individual genes, independent of ongoing chemical signaling mechanisms.166 Furthermore, mechanical stimuli (massage or soft tissue mobilization) have been shown to stimulate healing through fibroblast function and recruitment.166

* **Homeostatic effects:** A reduction in stress hormones and an increase in endorphins, serotonin, norepinephrine results from massage and tissue mobilization.167

**Indications**
After a thorough myofascial and pain evaluation have been performed, and appropriate treatment has been initiated, the practitioner and/or nursing staff can apply medical massage to the following cases:166–171

* Stress and anxiety: Touch, gentle stroking, gentle compression and rocking
* Allodynia: Gentle compression, laying on of hands
* Postoperative: Focus on compensatory muscles
* Gastrointestinal disease/discomfort: Work on back muscles
* Amputation: Focus on compensatory muscles, massage opposite limb
* Geriatric: Gentle massage for tight muscles can help alleviate pain associated with age-related diseases, even if the tension is not directly related to the reason for hospitalization
* Vestibular: Focus on cervical muscles, assess and massage scapular muscles as needed
* Respiratory (therapy depends on level of patient stress). Can perform calming massage (laying on hands, gentle compression, rocking) or work specifically on compensatory muscles
* Pneumonia: Gentle tapotements (cup hands and alternately tap) cranial and caudal over rib cage, massage latissimus.

**Contraindications**172

* Elevated body temperature (> 104°F [39.5°C])
* Massaging a swollen postoperative limb that could release clots into the systemic circulation
* Shock, open or bleeding wound, acute sprain or trauma – torn muscle, internal bleeding, diseases of the nervous system, acute nerve irritation, pregnancy, neoplasia, inflammatory conditions, fungal skin issues, acute stages of viral diseases, patient unable to provide feedback (heavy sedation, anaesthesia, mentally inappropriate, loss of sensation from neurologic injury, etc.)
* Massage must be carefully titrated to the individual needs and requirements. Massage that is too firm can lead to more muscle and fascial tension, and increase the stress response.

24. SALVAGE SURGICAL PROCEDURES

In some cases a surgical approach to the alleviation of pain is a good option. This may be chosen because pharmacological and adjunctive therapies such as acupuncture, rehabilitation and dietary intervention have failed, for example severe and incapacitating DJD. Examples of these techniques are listed below. Many of the patients undergoing these procedures will have been in pain for a considerable period of time, and comprehensive analgesic techniques should be employed to prevent acute pain on top of a sensitized state resulting in upregulation of chronic postoperative pain that will compromise outcome as has clearly been shown in humans.

**Limb amputation**

* **Indications:** Irreparable limb fracture, appendicular osteosarcoma, otherwise inoperable neoplasia, as an alternative to complex internal or external fixation of a limb fracture, to prevent damage to the distal limb following brachial plexus avulsion, salvage procedure following failed fracture repair.
In most cases recovery time is rapid and animals adapt well to having three limbs. Amputation is best reserved for animals that have no musculoskeletal disease in their other limbs and are not overweight or obese.

**Total joint replacement**

*Indications:* To relieve pain in a diseased joint.

These procedures (total hip replacement, total elbow replacement, total knee replacement, custom joint replacement) are technically advanced and demanding procedures requiring specialized equipment. If performed correctly, they can eliminate all joint pain.

**Excision arthroplasty**

*Indications:* To relieve pain in a diseased joint.

Conditions that cause pain in the joint include DJD, subluxation, luxation, and intra-articular fracture. Most often performed in the hip joint (femoral head and neck excision) this procedure is less technically demanding than total joint replacement and can be performed to relieve pain in the hip joint of dogs (especially small and medium sized dogs) and cats with good success. However, effective perioperative analgesic techniques and aggressive physical rehabilitation are required to optimize outcome.

**Arthrodesis**

*Indications:* To relieve pain in a diseased joint.

Arthrodesis techniques aim to permanently eliminate movement of a joint and the pain associated with this; however, the procedure usually results in mechanical (functional) lameness.

**Denervation**

*Indications:* To relieve pain when medical therapies have failed, as an alternative to arthrodesis.

Sensory denervation techniques have been described for the canine hip (coxofemoral joint) and elbow. In most cases this technique is performed to alleviate the pain related to DJD in these joints when other treatments such as medical, surgical and adjunctive therapies have failed. Motor function can usually be well maintained when these procedures are correctly performed.

The procedures outlined above constitute major surgery with the potential to cause severe pain (acute and persistent) if adequate perioperative analgesia is not provided for a sufficient duration of time. A multimodal approach is recommended with an emphasis on local analgesia.

---

**SECTION 3: PAIN MANAGEMENT PROTOCOLS**

**25. CASTRATION AND OVARIOHYSTERECTOMY/OVARIECTOMY: CATS**

Castration and ovariohysterectomy/ovariectomy performed in cats are associated with pain of varying severity which is influenced by the degree of surgical trauma. For this reason surgery should be performed with careful tissue handling and adherence to good surgical principles. General anaesthesia and preventive/multimodal analgesia techniques are strongly recommended. There are many options available for perioperative management. The protocol below is one example. Postoperative treatment with analgesics may be required for up to 3 days after surgery.

**Castration**

*Preoperative:*

- **Neuroleptanalgesia** to include opioid + acepromazine (0.01–0.05 mg/kg) OR alpha₂ +/- ketamine (5–10 mg/kg IM: the higher doses are selected for cats that are more difficult to handle)
- **Induction of anaesthesia:** In some cats an opioid, an alpha₂ adrenoceptor agonist and ketamine will provide sufficient analgesia and anaesthesia for a castration
  - **Intravenous:** Propofol to effect (3–10 mg/kg), ketamine (3–5 mg/kg) + diazepam or midazolam (0.25 mg/kg), or alfaxalone (3–5 mg/kg). Note: if an alpha₂ adrenoceptor agonist has been used preoperatively these doses may be lower
  - **Intramuscular:** An alpha₂ adrenoceptor agonist + ketamine (5–10 mg/kg) or tiletamine/zolazepam (3–4 mg/kg).

**Maintenance of anaesthesia:** Inhalation anaesthesia or ketamine or propofol or alfaxalone IV to effect. Note: in many cases a castration can be completed without the need for maintenance anaesthesia drugs; however, there should be a plan for extending the anaesthesia time in the event the cat becomes responsive or complications arise. Equipment should also be available for endotracheal intubation.

**Local anaesthetic techniques:** Intra-testicular block and pre- and/or post-surgery skin infiltration with lidocaine.

**Postoperative analgesia:** NSAID.
Protocol without controlled drugs
Preoperative: combination of a NSAID and an alpha₂ adrenoceptor agonist. Otherwise as above.

Protocol with limited availability of analgesic drugs
Preoperative: Alpha₂ adrenoceptor agonist ± NSAID.
Induction and maintenance of anaesthesia: Any available induction agents; injectable or inhalant.
Local anaesthetic techniques: Intra-testicular block and pre- and / or post-surgery skin infiltration with lidocaine.
Postoperative analgesia: NSAID.

Ovariohysterectomy/ovariectomy
Preoperative:
• Analgesia: Opioid ± ketamine (5–10 mg/kg IM; the higher doses are selected for cats that are more difficult to handle)
• Sedation: Acepromazine (0·01–0·05 mg/kg IM) or alpha₂ adrenoceptor agonist
• Induction of anaesthesia:
  o Intravenous: Propofol to effect (3–10 mg/kg), ketamine (3–5 mg/kg) + diazepam or midazolam (0·25 mg/kg), or alfaxalone (3–5 mg/kg). Note: if an alpha₂ adrenoceptor agonist has been used preoperatively these doses may be lower
  o Intramuscular: An alpha₂ adrenoceptor agonist + ketamine (5–10 mg/kg) or tiletamine/zolazepam (3–4 mg/kg).

Maintenance of anaesthesia: Inhalation anaesthesia or ketamine or propofol or alfaxalone IV to effect (1/3 or 1/2 of initial dose).
Note: in many cases an ovariohysterectomy or ovarioectomy can be completed without the need for maintenance anaesthesia drugs; however, there should be a plan for extending the anaesthesia time in the event the cat becomes responsive or complications arise; venous access is recommended.
Local anaesthetic techniques: Incisional and intraperitoneal/ovarium ligament block with lidocaine.
Postoperative analgesia: NSAID.

Protocol without controlled drugs:
Preoperative: Combination of a NSAID and an alpha₂ adrenoceptor agonist. Otherwise as above.

Protocol with limited availability of analgesic drugs:
Preoperative: Alpha₂ adrenoceptor agonist ± NSAID.
Induction and maintenance of anaesthesia: Any available induction agents; injectable or inhalant.
Local anaesthetic techniques: Epidural or incisional and intraperitoneal/ovarium ligament block with lidocaine.
Postoperative analgesia: NSAID.
Analgesia may be supplemented after most surgical techniques by application of non-drug modalities such as cold therapy, laser therapy, acupuncture, nursing care, mild exercise and massage.

26. CASTRATION AND OVARIOHYSTERECTOMY/OVARIECTOMY: DOGS

Castration and ovariohysterectomy/ovariectomy performed in dogs is associated with pain of varying severity and is influenced by the degree of surgical trauma. General anaesthesia and preemptive/multimodal analgesia techniques are strongly recommended. There are many options available for perioperative management; below are examples of some. Postoperative treatment with analgesics may be required for up to 5 days after surgery. The same NSAID should be used pre- and postoperatively.

Protocol for castration
Preoperative:
• Analgesia: Opioid
• Sedation: Acepromazine and/or benzodiazepines (midazolam or diazepam 0·25–0·4 mg/kg IM; diazepam is best given IV - painful IM); alpha₂ adrenoceptor agonist
• Induction of anaesthesia:
  o Intravenous: Propofol to effect (3–5 mg/kg), ketamine (3–5 mg/kg) + diazepam or midazolam (0·25 mg/kg), or alfaxalone (1–2 mg/kg)
  o Intramuscular: Alpha₂ adrenoceptor agonist + ketamine (3–5 mg/kg) or tiletamine/zolazepam (3–4 mg/kg).

Maintenance of anaesthesia: Inhalation anaesthesia or propofol, alfaxalone or ketamine (1/3 or 1/2 of initial dose) to effect; venous access is recommended. Equipment should also be available for endotracheal intubation.
Local anaesthetic techniques: Intra-testicular block, incisional block.
Postoperative analgesia: NSAID.

**Protocol without controlled drugs:**
*Preoperative:* Combination of a NSAID and an alpha₂ adrenoceptor agonist ± tramadol (2–5 mg/kg IM)

Otherwise as above.

**Protocol with limited availability of analgesic drugs:**
*Preoperative:* Alpha₂ adrenoceptor agonist ± NSAID.
*Induction and maintenance of anaesthesia:* Any available injectable or inhalant agent; venous access is recommended.

Local anaesthetic techniques: Intra-testicular block, incisional block.
Postoperative analgesia: NSAID.

**Protocol for ovariohysterectomy/ovariectomy**
*Preoperative:*

- Analgesia: Opioid
- Sedation: Acepromazine and/or benzodiazepines or alpha₂ adrenoceptor agonist
- Induction of anaesthesia:
  - Intravenous: Propofol to effect (3–5 mg/kg), ketamine (3–5 mg/kg) + diazepam/midazolam (0.25 mg/kg) or alfaxalone (1–2 mg/kg).
  - Intramuscular: Alpha₂ adrenoceptor agonist + ketamine (5.0–7.5 mg/kg) or tiletamine/zolazepam (3–4 mg/kg).

*Maintenance of anaesthesia:* Inhalation anaesthesia, or propofol, alfaxalone, ketamine (¼ or ½ of initial dose) to effect; venous access is recommended.

Local anaesthetic techniques: Incisional and intraperitoneal/ovarium ligament block.
Postoperative analgesia: NSAID.

**Protocol without controlled drugs:**
*Preoperative:* Combination of a NSAID and an alpha₂ adrenoceptor agonist ± tramadol (2–5 mg/kg IM).

Otherwise as above.

**Protocol with limited availability of analgesic drugs:**
*Preoperative:* Alpha₂ adrenoceptor agonist ± NSAID.
*Induction and maintenance of anaesthesia:* Any available induction agent; venous access is recommended.

Local anaesthetic techniques: Epidural or incisional and intraperitoneal/ovarium ligament block.
Postoperative analgesia: NSAID.

Analgesia may be supplemented after most surgical techniques by application of non-drug modalities such as cold therapy, laser therapy, acupuncture, mild exercise, nursing care and massage.

### 27. ORTHOPAEDIC SURGERY

Orthopaedic surgery can result in moderate-to-severe postoperative pain. Surgery should be performed under general anaesthesia combined with aggressive perioperative analgesia. Preventive and multimodal analgesic techniques should be employed for all procedures. The balance between pre-, intra- and postoperative analgesia will depend on the severity of the preoperative condition and the location and magnitude of surgical trauma. Frequent pain assessment should be performed and when pain is not successfully controlled, alternative or additional analgesics or analgesic techniques should be employed to improve patient comfort. NSAIDs provide excellent perioperative analgesia, and should be used unless contraindicated. The administration of an approved NSAID is recommended. The same NSAID should be used postoperatively as is used preoperatively – that is, switching between drugs should be avoided. Nerve transection (e.g. during limb amputation) or manipulation, may lead to severe chronic pain (neuropathic pain). In such cases, anecdotal evidence suggests gabapentin, included in a multimodal regimen, may have a role in prevention of chronic neuropathic pain in veterinary patients; however, no suitably designed clinical studies have investigated this. (Refer to Section 17 Adjunctive Analgesia & Section 36 Neuropathic Pain).

Note: The choice of opioid, alpha₂ adrenoceptor agonist or NSAID used will vary based on availability, personal preferences and contraindications. Loco-regional anaesthetic techniques such as intra-articular, incisional and specific nerve blocks, wound infusion catheters or combinations thereof before and/or after surgery are highly recommended in all cases. Such techniques become mandatory when opioids and other controlled analgesic drugs are not available. Longer acting local anaesthetic agents such as bupivacaine or ropivacaine are recommended due to their prolonged duration of action. The systemic administration of lidocaine is contraindicated in cats due to its cardiovascular depressant effects.
Protocol for orthopaedic surgery

Preoperative: Combination of an opioid and a NSAID, ± alpha2 adrenoceptor agonist, ± ketamine (cats).

Intraoperative: Boluses and/or infusions of opioids, alpha2 adrenoceptor agonists, ketamine and/or lidocaine. These drugs may not be required if an effective local anaesthetic block has been performed.

Immediate postoperative (24 hours): Combination of a NSAID (if not administered preoperatively) and continue intraoperative infusions or boluses with gradual reduction in doses. Adjunctive analgesics, non-drug therapies (especially cold therapy), careful padding and positioning, and gentle massage of compensatory regions (back, and non-operated limbs)

Later postoperative days: Opioid administration (injectable, transdermal, oral, transmucosal) with titration to effect and gradual discontinuation and/or NSAIDs. Icing of the affected regions should be continued for a minimum of 3 days, at which point it can be alternated with heat therapy prior to stretching and gentle weight-bearing (with icing following these therapies). Adjunctive analgesics including lidocaine patches (evidence supports their use in human studies) and non-drug therapies, local anaesthetic administration via a diffusion catheter may be employed until discharge from hospital if needed.

Example of a protocol for dogs undergoing femoral fracture repair

Preoperative: NSAID (24 h dose; ideally one approved for dogs), morphine 0·5 mg/kg IM, acepromazine 0·05 mg/kg IM.

Induction of anaesthesia: propofol to effect IV.

Maintenance of anaesthesia: Inhalation anaesthesia with lumbosacral epidural administration of bupivacaine 0·5% (1 mL/5 kg before surgery.

Immediate postoperative (for 24 h): Morphine 0·3–0·5 mg/kg IM (every 4–6 h depending on evaluation or as needed), icing, range of motion, and other non-drug techniques.

Later postoperative days: Buprenorphine 0·01 mg/kg IM, q6–8h for up to 3 days and NSAID (same drug as preoperative, starting 24h after preoperative dose), q24h for up to 7 days after surgery and continue with non-drug techniques.

Example of a protocol for cats undergoing femoral fracture repair

Preoperative: NSAID (24h dose; ideally one approved for cats), morphine 0·3 mg/kg IM, medetomidine 0·01 mg/kg IM.

Induction of anaesthesia: Propofol to effect IV.

Maintenance of anaesthesia: Inhalation anaesthesia with lumbosacral epidural administration of 0·5% bupivacaine (1 mL/5kg before surgery).

Immediate postoperative (for 24h): Morphine 0·2–0·3 mg/kg IM (every 4–6h depending on evaluation or as needed), icing, range of motion, and other non-drug therapies.

Later postoperative days: Buprenorphine 0·02 mg/kg IM or OTM, q6–8h for up to 3 days after surgery and NSAID (same drug as preoperative, starting 24h after preoperative dose), q24h for up to 7 days after surgery. Please see label for approved NSAIDs for use in cats. Continue with non-drug techniques.

Protocol without controlled drugs:

See above, without the opioid. Injectable tramadol may be administered in the perioperative period. The use of local anaesthetic techniques, particularly regional blocks, intravenous lidocaine infusion intra- and postoperative, non-drug therapies combined with NSAIDs becomes critical when opioids are not available.

Protocol with limited availability of analgesic drugs:

See above without the opioid. Non-drug therapies, ketamine, and lidocaine infusions, and acupuncture may be used in the intraoperative period. A combination of low dose alpha, adrenoceptor agonist, tramadol, NSAID (not if administered preoperatively), non-drug therapies, further regional blocks or continuous wound block (wound catheters) are employed in the immediate postoperative period. Continuous intra-articular infusions of local anaesthetic are contraindicated as this can result in significant cartilage damage, and the risk of ascending contamination leading to infection high. For later postoperative days, NSAIDs are administered as required-paracetamol (acetaminophen) (not in cats) or dypirone, amantadine and/or gabapentin, non-drug therapies are employed.

If pain is severe, cannot be controlled with the available resources and is likely to be prolonged, euthanasia should be considered.

28. SOFT TISSUE SURGERY

Soft tissue surgery may cause mild, moderate or severe postoperative pain. Preventive and multimodal analgesic techniques should be employed and local anaesthetic techniques included whenever possible. The balance between pre-, intra- and postoperative analgesia will depend on the severity of the preoperative condition and the location and magnitude of surgical trauma. Where postoperative pain is not successfully controlled with NSAIDs, alternative or additional analgesics or analgesic techniques should be employed. Major soft tissue
surgery may lead to chronic pain which may have a neuropathic component. To date no veterinary studies have been performed assessing the benefit of adding gabapentin to the perioperative anaesthetic and analgesic protocol in surgical situations where there is significant nerve damage. However, based on its use in human medicine there may be potential value for use in the prevention of neuropathic pain.

Note: The choice of opioid, alpha2 adrenoceptor agonist or NSAID used will vary based on availability and contraindications. Loco-regional anaesthetic techniques such as intra-articular, incisional and specific nerve blocks, wound infusion catheters or combinations thereof before and/or after surgery are highly recommended in all cases. Such techniques become mandatory when opioids and other controlled analgesic drugs are not available.

**Minor soft tissue surgery**
*Pre-and intraoperative:* Combination of an opioid, NSAID ± alpha2 adrenoceptor agonist ± ketamine (cats). Local anaesthetic techniques.
*Postoperative analgesia:* NSAIDs (unless administered preoperatively) ± opioid and/or non-drug therapies.

**Protocol without controlled drugs:**
Same as above but without the opioid.

**Protocol with limited availability of analgesic drugs:**
*Pre-and intraoperative:* Combination of alpha2 adrenoceptor agonists, tramadol, a NSAID and local anaesthetic technique.
*Immediate and later postoperative (24h):* NSAID (unless administered preoperatively), paracetamol (acetaminophen) (not in cats) or dypirone, and non-drug therapies.

**Major soft tissue surgery**
*Preoperative:* Same as for minor soft tissue surgery.
*Intraoperative:* Boluses or infusions of opioids ± alpha2 adrenoceptor agonists ± ketamine ± lidocaine. These drugs may not be required if an effective local anaesthetic block has been performed.
*Immediate and later postoperative (24 hours):* NSAID (unless administered preoperatively), continuous infusions or boluses of drugs used intraoperatively as needed ± other adjunctive drugs and non-drug therapies such as cold therapy and acupuncture.

<table>
<thead>
<tr>
<th>Example of a protocol for a dog undergoing a perineal hernia repair</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preoperative:</strong> NSAID (24h dose; ideally one approved in dogs), morphine 0.5 mg/kg IM, and acepromazine 0.02 mg/kg IM.</td>
</tr>
<tr>
<td><strong>Induction of anaesthesia:</strong> ketamine 5 mg/kg and diazepam 0.25 mg/kg IV, or to effect.</td>
</tr>
<tr>
<td><strong>Maintenance of anaesthesia:</strong> Inhalation anaesthesia with lumbosacral epidural administration of 0.5% bupivacaine (1 mL/5kg before surgery).</td>
</tr>
<tr>
<td><strong>Immediate postoperative (24h):</strong> Morphine 0.3 mg/kg IM (every 4–6h depending on evaluation, or as needed), non-drug techniques such as cold therapy.</td>
</tr>
<tr>
<td><strong>Later postoperative days:</strong> NSAID (same drug as preoperative, starting 24h after preoperative dose), q24h and buprenorphine 0.01 mg/kg IM, q4h up to 3 days postoperatively.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Example of a protocol for a cat undergoing a surgical removal of injection site sarcoma</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preoperative:</strong> NSAID (24h dose; ideally one approved in cats), morphine 0.2 mg/kg IM, ketamine 5 mg/kg and midazolam 0.25 mg/kg IM.</td>
</tr>
<tr>
<td><strong>Induction of anaesthesia:</strong> Propofol to effect IV.</td>
</tr>
<tr>
<td><strong>Maintenance of anaesthesia:</strong> Inhalation anaesthesia with constant rate infusions of fentanyl 10 μg/kg/h following a loading dose of 2 μg/kg IV and ketamine 0.6 mg/kg/h. Infiltration anaesthesia with local anaesthetics.</td>
</tr>
<tr>
<td><strong>Immediate postoperative (24h):</strong> Constant rate infusions of fentanyl 1–3 μg/kg/h and ketamine 0.12 mg/kg/h. Cold therapy ± acupuncture. Wound therapy catheter with administration of bupivacaine 0.5% (up to 2 mg/kg).</td>
</tr>
<tr>
<td><strong>Later postoperative days:</strong> NSAID (same drug as preoperative, starting 24h after preoperative dose) and buprenorphine 0.02 mg/kg IM, q6–8h up to 3 days postoperatively.</td>
</tr>
</tbody>
</table>

**Protocol without controlled drugs:**
See above, without the opioid. Injectable tramadol may be administered in the perioperative period. The use of local anaesthetic techniques, particularly regional blocks, lidocaine infusion intra- and postoperative, non-drug therapies combined with NSAIDs becomes critical when opioids are not available.

**Protocol with limited availability of analgesic drugs:**
See above without opioids. A combination of low dose alpha2 adrenoceptor agonist, NSAID (unless administered preoperatively), gabapentin, paracetamol (acetaminophen) (not in cats) or dipyrrone, amantadine, non-drug therapies, further regional blocks or continuous wound block (wound catheters).
Later postoperative days: NSAID as required non-drug therapies, further regional blocks or continuous wound block (wound catheters).

If pain cannot be controlled or ameliorated with available techniques and the prognosis is poor, consider euthanasia.

29. LOCO-REGIONAL TECHNIQUES

For all loco-regional anaesthetic techniques described herewithin, it is imperative to maintain sterile injection techniques (clipping and sterile preparation of the injection site). The techniques are described to be performed on the anaesthetized or deeply sedated (with analgesia as these are painful to perform) animal. After needle placement and before injection of local anaesthetic, an attempt to draw blood has to be made. If blood can be withdrawn, injections are not made, but the needle is repositioned. While many landmarks and nerves themselves can be palpated transcutaneously, use of neurostimulator or ultrasound localization techniques can reduce the risk of incomplete blocks and damage to the nervous, vascular and other structures. Where available, the use of a nerve stimulator may result in muscle contraction and limb extension/flexion and aid in correct needle placement. The volumes recommended in this text reflect the collective experience of the authors based on published data and the correct needle placement. The desensitized area of the limbs is indicated by the coloured area in the limb pictogram.

Infiltration anaesthesia

**Intratesticular block**

*Where:* Could be anywhere on the body, where there is enough superficial or organ soft tissue available to infiltrate: A surgical site, for example incisional line block, extirpation of a small tumour, particularly useful for ovariohysterectomies with intraoperative injection into the cranial edge of the ovarian ligament (0.2–0.3 mL/side in cats; 0.5–2 mL/side in dogs) and in orchiectomies (0.2–0.3 mL/side in cats; 0.5–1 mL/side in dogs).

*What:* Lidocaine with or without adrenaline (epinephrine), bupivacaine, mepivacaine, ropivacaine, sterile NaCl or water for injections may be added to increase volume.

*Technique:* By injecting in an inverse pyramid or V-shape around/along the incision site. Usually performed ‘blindly’.

*Desensitizes:* Pyramidal or V-shaped tissue area of injection site or testicles or ovaries.

**Ring block**

*Where:* Distal limb or tail.

*What:* Lidocaine, bupivacaine, mepivacaine, ropivacaine, sterile NaCl or water for injections may be added to increase volume. *Never adrenaline (epinephrine).*

*Technique:* By injecting at 0.3–0.6 mm depth around the limb to infiltrate around sensitive nerves and branches without individually localizing them.

*Desensitizes:* Frontlimb: N. ulnaris, N. medianus, N. radialis.
**What:** Bupivacaine 0.5% (2 mg/kg in the dog, 1 mg/kg in the cat).

**How:** Bupivacaine is diluted in 2 mL/kg and can be instilled directly into the intraperitoneal space before abdominal closure in dogs or cats undergoing abdominal exploratory surgery. Aseptic technique is required.

**Caution:** For cases without an open abdomen, it is essential to follow instructions given at www.wsava.org prior to performing this technique as patient and local anaesthetic solution preparation, landmarks, catheter type, and an immobile patient is required to avoid inadvertent laceration of abdominal organs.

**Desensitizes:** Peritoneum, abdominal viscera.

---

**Limb nerve blocks**

For peripheral nerve blocks, lidocaine, bupivacaine, mepivacaine, ropivacaine can be used according to the doses suggested in Table 3; sterile NaCl or water for injections may be added to increase volume. Lidocaine may be used with or without adrenaline (epinephrine) (1:200,000), unless otherwise indicated.

### N. Radialis

**Where:** Thoracic limb, lateral side of elbow.

**Volume:** Approximately 0.1 mL/kg.

**Technique:** Injection control under palpation of nerve (top figure, 10) and landmarks (centre figure: triceps muscle caudo-dorsally [8], radial carpal extensor muscle craniodistally [16], biceps muscle [12] and brachial muscle [13], at green dot), care has to be taken to avoid the cephalic vein in close proximity to the injection site (bottom figure, black arrow); correct placement of a nerve stimulator tip results in elbow/carpus extension.

**Desensitizes –** Red areas of figure.

---

**Landmarks**

<table>
<thead>
<tr>
<th>Triceps (8)</th>
<th>Brachialis (13)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Image" /></td>
<td></td>
</tr>
</tbody>
</table>

**Picture courtesy of Dr Isabelle Iff, www.vas-int.com**
### Nn. Medianus, ulnaris

*Where:* Thoracic limb, medial side of elbow.
*Volume:* Approximately 0.1 mL/kg.
*Technique:* Injection control under palpation of nerves (top figure [7 and 11], lower picture) and landmarks (top picture: triceps muscle [7,8] dorsally, biceps muscle [6] cranioventrally, at green dot). Injection sites are indicated by the black arrows in the lower picture. Care has to be taken to avoid the arterial and venous structures in close proximity to the injection sites. Correct placement of the nerve stimulator tip results in flexion and inside rotation of the carpus (*n. medianus*) and flexion of the toes (*n. ulnaris*).

### Nn. Femoralis, saphenous

*Where:* Pelvic limb, medial side of thigh, proximal.
*Volume:* Approximately 0.1 mL/kg.
*Technique:* Animal in lateral recumbency with one hindlimb on a table and the other abducted and stretched away. Injection control under palpation of the triangled area of injection through landmarks (Sartorius muscle (12), pectineous muscle (15) and iliopsoas muscle (5)). Care has to be taken to avoid the femoral artery and vein in close proximity to the injection site. Correct placement of the nerve stimulator tip results in extension of the knee joint.

---

**Landmarks**

*Biceps (6)*

*Triceps (7)*

*A. Brachialis*

*Puncture site: caudal of artery*

**Nerve stimulator:**

*N. medianus: Flexion, inside rotation corpus*

*N. ulnaris: Flexion Toes*

**Medial view**

*Desensitizes:* Blue areas of figure.

*Picture courtesy of Dr Isabelle Iff, www.vas-int.com*
Intravenous regional anaesthesia (IVRA/Bier-block)

*Where:* In the limbs, distal to the elbows or the knee joints.

*Technique:* The limb to be blocked is shaved and the catheter puncture site aseptically prepared (picture 1).

An intravenous catheter is placed into the distal limb (picture 2).

The distal limb is rendered low (empty) in circulating blood by applying a pressure bandage to it from distal towards proximal (picture 3) and a tourniquet to prevent new influx of blood into the limb.

Digital nerve blocks (RUMM)

*Where:* At the distal thoracic limb: the superficial branches of the radial, the dorsal and palmar branches of the ulnar, musculocutaneous and median nerve, particularly useful for toe amputations.

*Volume:* 0.1–0.2 mL at each of the injection sites.

*Technique:* Injection control under palpation of the nerves (yellow lines) or ultrasound is possible. Injection sites (red, green and violet dots) are lateral and proximal to the accessory carpal pad, and the dorso-medial aspect of the proximal carpus.

Desensitizes: Foot pad, toes and claws.

Intravenous regional anaesthesia (IVRA/Bier-block)

*Where:* In the limbs, distal to the elbows or the knee joints.

*Technique:* The limb to be blocked is shaved and the catheter puncture site aseptically prepared (picture 1).

A digital nerve block is performed at the distal thoracic limb: the superficial branches of the radial, the dorsal and palmar branches of the ulnar, musculocutaneous and median nerve, particularly useful for toe amputations.

*Volume:* 0.1–0.2 mL at each of the injection sites.

*Technique:* Injection control under palpation of the nerves (yellow lines) or ultrasound is possible. Injection sites (red, green and violet dots) are lateral and proximal to the accessory carpal pad, and the dorso-medial aspect of the proximal carpus.

Desensitizes: Foot pad, toes and claws.

Picture courtesy of Dr Isabelle Iff, www.vas-int.com

Picture courtesy of Dr Bob Stein, www.vasg.org
The tourniquet is placed just proximal to the elbow or the knee joint (picture 4) and the bandage subsequently removed.

The circulating blood of this part of the limb is replaced by lidocaine (picture 5).

Stimulation of the distal nerves of the limb using a nerve stimulator for percutaneous stimulation should not result in any muscle twitches (picture 6).

*Where:* Anywhere, where a wound soaker catheter can be implanted into or alongside a surgical site. This technique is particularly helpful for limb amputations, total ear canal ablations, serial mammary gland or larger tumour excisions. Local anaesthetic with or without adjuncts can be administered over time. Wound soaker catheters are specifically designed to distribute injectate evenly over the tissues that surround the length of the catheter.

*How:* During a surgery or under surgically sterile conditions a wound soaker catheter can be implanted into the wound or alongside incision lines or around the affected nerves and tissues.

*What:* Local anaesthetics as a bolus injection. Lidocaine or mepivacaine at 1–2 mg/kg bolus injection. Ropivacaine and bupivacaine can be administered intermittently at 1–2 mg/kg. The catheter can be left in place for 1–3 days, occasionally and with very strict aseptic precautions longer. Side effects are rare.

*Desensitizes:* The wound specific to placement.

*Caution:* Never leave the tourniquet on for longer than 90 or less than 30 minutes. Open the tourniquet slowly, as outrush of lidocaine into the systemic circulation may cause side effects.

*Side effects:* Are rare. Most side effects are due to improper placement of the block, or use of incorrect or faulty equipment. Hyper- and hypotension may result from tourniquet placement/loosening. Systemic (CNS) toxicity after tourniquet loosening may, however, occur.

**Wound soaker catheters**

*Picture courtesy of Dr Christine Egger*
**Intra-articular blocks**

*Where*: Application into the capsule of all limb joints. This is particularly useful for perioperative analgesia in patients undergoing joint surgery or arthroscopy. However, application can also be very helpful in chronic pain patients and, as in horses, for lameness diagnostics. Perioperative analgesia may last as long as 24 hours.

*Technique*: Meticulous care has to be applied to an aseptic technique (clipping, surgically preparing, draping and sterile gloves are to be used). Careful injection into the joint cavity is then performed, without injuring the articular surface. The details of the technique depend largely on the joint.

*What*: Lidocaine 1 mg/kg, bupivacaine 0.5 mg/kg, morphine 0.1 mg/kg. Other drugs are under investigation. When multiple joints have to be injected, total doses must not exceed maximum doses for the specific drug and species.

*Desensitizes*: Single joints, and, maybe due to leakage or diffusion, peri-articular tissues.

**Neuraxial blocks**

*Cautions*: Absolute contraindications to neuraxial anaesthetic techniques are infections (including skin) at the puncture site, sepsis, coagulation impairments, particularly thrombocytopenia, and change of anatomical landmarks (such as in multiple pelvic fractures) in absence of imaging techniques employable (radiography, ultrasound). Meticulous care has to be applied to sterile preparation of the puncture site and to all material used. Relative contraindications: In obese and pregnant animals, the size of the epidural and spinal compartments may be varied and puncture more difficult.

---

**Neuraxial blocks should be performed only by appropriately trained individuals and drugs used should be sterile and preservative free. Single epidural injections of morphine with preservative have been used with few complications but preservative-free is essential for repeated injections.**

---

**Epidural**

*Where*: At the lumbosacral junction, between the ligamentum flavum and the dura mater, or in cats also at the sacro-coccigeal junction. The lumbosacral junction can be palpated with the two tuberositas ischiaticae to the sides and the dorsal processes on the midline as shown in the radiograph.

*What*: 0.2 mL/kg up to a total of 6 mL using a spinal needle of appropriate size and length. The volume of the injectate is of paramount importance to the cranial spread of the injected drugs and thereby to the spinal segments reached by the drug. The volume indicated here will produce a spread up to L1-L2. Slow injection is also very important to achieve a homogenous distribution of the drug within the epidural space and not produce ‘patchy’ analgesia leaving some spinal nerves uncovered by drug action. Local anaesthetics; morphine may be added at 0.1 mg/kg or buprenorphine at 0.012 mg/kg, or medetomidine may be added at 0.001 mg/kg, or ketamine (0.4–2 mg/kg), sterile NaCl or water for injections may be added to increase volume, with or without adrenalin (1:200,000).

---

**Epidural Space**

*How*: Difficulty of identification of the epidural space remains a factor for block failure. Several techniques may be used to identify correct needle placement in to epidural space:
The ‘hanging-drop’ technique is a positive control mechanism, by which a drop of NaCl placed in the needle hub is “sucked” into the needle and epidural space by the vacuum prevailing this virtual space.

The ‘loss-of-resistance’ technique uses the different resistances (using NaCl or air) that the single tissue layers pose against needle advancement as indicators for the type of tissue the needle tip is advancing through. This test can be made ‘manually’, it is even more effective, if the pressure is measured and displayed. A first peak is encountered as the needle passes through the skin, the underlying subcutaneous tissues causes a decline in pressure, followed by a steady plateau as the needle is advanced through the muscle layers to be followed by a second, high peak in pressure, as the ligamentum flavum is encountered. Thereafter, a loss of resistance indicates needle tip placement in the epidural space. If the needle is advanced further, pressure increases again passing through the dura mater into the subdural/intrathecal/spinal space.

For the experienced user, ultrasound guidance may provide a useful help to increase block security.

Desensitizes:

Side effects: Hypotension, hypothermia, urinary retention (especially in males), infections, slowed hair regrowth.

30. OPHTHALMIC PROCEDURES

Procedures of the eye, eyelid and surrounding tissues are usually associated with mild to severe pain. Regional anaesthesia techniques in ophthalmology are important to achieve excellent analgesia in the intra- and early postoperative period, and to produce akinesia. Where an immobile eye is required, neuromuscular blockade is preferred, provided appropriate facilities to ventilate are available.173 The latter can be accomplished by anaesthetizing the zygomatic, lacrimal and ophthalmic nerves as shown in Figure 6. Insert the needle ventral to the zygomatic process, rostral to the cranial border of the vertical mandibular ramus and advance the needle in a caudo-medio-dorsal direction until the tip reaches the orbital fissure. Inject lidocaine 2% alone (0.25–0.5 mL) with or without 1:200,000 adrenaline (epinephrine). This should produce desensitization and immobility of the eye. This procedure should only be performed by trained personnel.

The conjunctiva and the cornea can also be desensitized by topical application of local anaesthetic drops (proxymetacaine, tetracaine, proparacaine). The number of applications should be limited since repetitive application particularly with tetracaine may cause epithelial or stromal keratitis.174 Topical application of local anaesthetic usually lasts about 15 minutes. While additional applications will deepen the degree of analgesia this also increases the risk for keratitis. Application of artificial tears is essential.

Where enucleation is performed a bupivacaine splash block can be applied once the globe is removed and haemorrhage is controlled, to provide up to 6 hours of partial analgesia. An NSAID and/or opioid is also required for optimal analgesia. Retrobulbar anaesthesia can be performed to produce local anaesthesia of the eye (Nn. Opticius, oculomotorius, trochlear, ophthalmicus and
maxillaris and *N. abducens*). The injection technique is not associated with high complication rates, as puncture of the globe, ciliary or scleral vessels or the optic nerve are rarely observed. High resistance to injection, however, may be indicative for intraneural injection into the optic nerve, and the injection must be stopped immediately and the needle repositioned: the curved needle should be inserted at the lateral third of the eye and directed medially and 1–3 mL of lidocaine alone or lidocaine with 1:200,000 adrenaline (epinephrine) are injected slowly after having assured (through aspiration) that no blood vessel is punctured.

Lidocaine (1 mg/kg IV bolus followed by CRI at 0·025 mg/kg/min) may provide intraoperative analgesia similar to that provided by morphine in dogs undergoing ocular surgery. However, caution should be used when combining CRI lidocaine with local administration of local anaesthetics to avoid toxicity. Lidocaine CRI is not recommended in cats.

The use of systemic NSAIDs (starting 24h before surgery) in ophthalmologic procedures is indicated, as they produce analgesia and decrease the risk of uveitis and aqueous humour-PGE production which leads to posterior chamber flare. As always care must be taken to avoid NSAID-induced side effects.

Intra- and postoperative administration of opioids and/or alpha2 adrenoceptor agonists may improve the analgesic effects of local anaesthetics and NSAIDs. Morphine produces miosis in dogs and mydriasis in cats. Opioids (e.g. methadone and buprenorphine), that do not cause vomiting and associated increases in intraocular pressure (IOP), are usually preferred.

The use of ketamine (0·5–1 mg/kg) has been associated with increased intraocular pressure due to increases in extraocular muscle tone. While there are clear species differences, and some conflicting results, it should be used with caution in patients where increased IOP may result in expulsion of ocular contents (e.g. corneal trauma) or any other manoeuvre that could potentially increase IOP (e.g. neck leashes). If ketamine is used, other drugs (such as benzodiazepines or alpha2 agonists) may be administered concomittantly to mitigate potential ketamine-induced increases in IOP.

Cool packs can be used to reduce swelling. For postoperative analgesia, NSAIDs can be given (systemic and/or topical) or, if pain is considered to be more severe or persistent, the addition of tramadol (4 mg/kg PO q8h) may be considered where available. Patients should receive artificial tears for 1–3 days postoperatively as general anaesthesia and opioids decrease tear production.

### 31. DENTAL PROCEDURES

Procedures in the oral cavity – including teeth cleaning should be performed under general anaesthesia with a secured airway (endotracheal intubation). All precautions, safety measurements, monitoring rules and standards apply. While simple teeth cleaning may be associated with only a minor degree of pain, gingivectomy, tooth extractions, root canal therapy and interventions of soft tissue and bony structures of the oral cavity are associated with moderate-to-severe pain. Refer to Table 3 for dosing instructions.

For painful procedures in the oral cavity, inclusion of loco-regional anaesthetic techniques is of paramount importance and the most common dental blocks are therefore herein described. The landmarks for needle insertion can be palpated either transmucosally or transcutaneously. If the latter is done, an aseptic injection technique is mandatory. After needle placement aspiration, with the syringe attached, is performed to confirm that the needle has not been inserted into a blood vessel. If blood is drawn into the syringe, do not inject, remove the needle slightly and re-test. If resistance to injection is experienced, do not continue as this may be associated with perineural injection with the potential of nerve damage.
Infraorbital block

*Blocks*: Nn. Infraorbitalis and alveolaris superior.

*Desensitizes*: Upper lip and skin of the upper lip from rostral end to the infraorbital foramen, dorsal part of the nasal cavity, ipsilateral superior incisors. With application of digital pressure over the foramen for one minute the local anaesthetic agent will diffuse caudally to the pterygopalatine fossa and block the entire quadrant.

*Technique*: The needle is inserted transmucosally (intraorally), just apical to the third maxillary premolar through the mucosal vestibule for only a few mm into the entrance of the palpable infraorbital foramen in dorso-caudo and slightly medial direction. Care has to be taken to not advance the needle too far, as damage to ocular, vascular or neural structures may occur.

*Volume*: 0.2–1.5 mL per side.

Inferior alveolar block:

*Blocks*: N. Inferior alveolar.

*Desensitizes*: Ipsilateral lower jaw and teeth with buccal and labial mucosa, skin of lower lip.

*Technique - transmucosal, intraoral approach*: With the animal in sternal recumbency and the mouth wide open, in larger dogs, the mandibular foramen may be palpated in the ventral fourth of the vertical part of the mandible, caudally to the last mandibular tooth and an intramucosal deposit of local anaesthetics be made.

*Technique - transcutaneous, extraoral approach*: On the medial side of the vertical part of the mandible, the angular process can be palpated and the needle is inserted just cranial to that and parallel to the mandible advanced for 0.5–2 cm.

The needle should be centred over the notch on the ventral aspect of the ramus in dogs and directed to the midpoint of the zygomatic arch in both dogs and cats.

Care has to be taken not to harm the lingual or hypoglosseal nerves which may result in loss of motor function of the tongue and subsequent self-mutilation.

*Volume*: Intraoral technique: 0.2–1.5 mL per side; extraoral technique: 0.2–1.5 mL.
**Mental block:**
Blocks: *N. alveolaris mandibularis.*
Desensitizes: Ipsilateral inferior incisors.
Technique: The needle is inserted transmucosally (intraorally) perpendicular to the direction of the canal and nerve; in cats and smaller dogs even the larger mental foramen is usually not palpable and the landmarks can be the frenulum labiale and the first and second mandibular premolar teeth between which the needle is inserted to a depth of 2/3 of the height of the mandible. In larger dogs, the foramen may be palpated. In small animals the needle is not inserted into the foramen to avoid neural damage.
Volume: 0.2–1 mL per side.

**Maxillary block:**
Blocks: *N. maxillaries.*
Desensitizes: Ipsilateral maxilla and maxillary teeth, roof of nasal cavity, skin of lateral part of nose and upper lip.

Technique – intraoral behind the last molar tooth: This transmucosal, intraoral technique is easiest performed with the animal in dorsal recumbency, when with a wide opening of the mouth a soft deflection in the mucosa can be palpated just behind the last molar tooth.
The needle is inserted into the mucosa at the palpated deflection in a dorsal direction. This technique is safe, but may not desensitize the last maxillary teeth. 

**Technique – extraoral, at the fossa pterygopalatina:** This transcutaneous, extraoral technique requires some expertise in order to avoid ocular, neural or vascular damage and is best performed with the animal in lateral recumbency. The needle is inserted perpendicularly to the skin along the ventral border of the zygomatic process and advanced in medio-rostral direction to the fossa. This can accomplished with less risk with an infraorbital block.

**Volume:** Intraoral technique: 0.2–0.5 mL per side; extraoral technique: 0.2–2 mL per side.

Furthermore, using very fine needles (26G and higher) local anaesthetics can be injected into the lateral periodontal ligament to desensitize single dental pockets, but feasibility is somewhat lower in dogs and cats than in humans. The use of cool packs to reduce the amount of swelling particularly due to intraoperative trauma and while the patient is anaesthetized should be taken into consideration.

32. EMERGENCY AND CRITICAL CARE

In addition to analgesia for pain control, many injured or ill animals will require analgesia to facilitate restraint, diagnostic and emergency procedures. As each animal will present with varying levels of injury or illness and be experiencing different degrees of pain, individual drug selection, and dosing to effect is essential, rather than considering a standard regimen for all patients. Painful animals may also be aggressive and chemical restraint is required to protect staff, and the patient from further (self-inflicted or iatrogenic) injury, and to facilitate a physical examination. These animals may appear stable even with severe injury or illness (especially cats) due to the ‘fight or flight’ response. Where blood or fluid loss may be present or suspected, fluid therapy is commenced prior to careful titration of the opioid to avoid potential adverse effects with standard dosing.

The use of NSAIDs in the emergency patient should be withheld until the volume, cardiovascular and renal status of patients is determined to be within normal limits and with no potential for deterioration. NSAIDs should never be administered to patients with evidence of/potential hemorrhage.

Due to the variability of diagnoses, animals admitted for ongoing critical care experience a variable degree of pain, which contributes to a catabolic state in these patients. In addition to the primary problem, there are the additive effects of pain due to placement/presence of IV, urinary, thoracic and abdominal catheters and drains. Many patients undergo frequent manipulations and procedures also contributing to the overall pain experienced. When considering analgesic selection, potential adverse effects should be minimized due to the often compromised organ function of these patients. Opioid analgesics and ketamine can still be used in patients with renal and hepatic insufficiency. Initial low dosing of the analgesic titrated to effect is required to reach therapeutic levels and avoid adverse effects; however, ongoing dosing with adjustments will be dependent on the individual patient as metabolism and excretion will be reduced (see below). Analgesia must be withdrawn slowly to avoid an abrupt return to a hyperalgesic state should pain still be present. Where the re-appearance of pain is identified, return to the previous dose for several more hours followed again by slow withdrawal. Analgesia and the induction of restful sleep is the goal. Continuous rate infusions are useful to achieve this. The following drugs, approximate dosages and combinations, are suggested for moderate to severe pain. Initially, start with a lower dose of an opioid. Should further analgesia be required, add lidocaine (not cats), or ketamine if needed. Where drug availability is limited, select a regimen from the following based on availability:

For severe pain opioids alone will not be sufficient and higher dosages than those in Table 4 may be required. Should adverse effects begin but pain is still not controlled, introduce ketamine. Add lidocaine if ketamine cannot control the pain.

**Loading dosages:** Titrate the opioid slowly to effect first, if needed add ketamine, if needed add lidocaine 2 mg/kg

**CRI:** The continuous dosing regimen is based on the loading dose and expected duration of action. Clinical experience indicates that the fentanyl and ketamine loading dose can be used as the hourly infusion even though the expected duration of a single dose is ~30 mins. For hydromorphone, methadone and morphine, the effective loading dose can then be used as the CRI dose over a 4-hour period (divide by 4 for the hourly dose) with frequent assessment and modification as duration of action may be prolonged, especially
where renal or hepatic dysfunction is present. Should the patient appear overdosed at any period of time, the CRI can be stopped for 30 minutes, or less if signs subside, and reinstated at one-half the previous dose rate. Or, careful titration of naloxone to reverse side effects (unless an emergency < 0.002 mg/kg may suffice; higher doses may result in hyperalgesia, hyperexcitability, cardiac arrhythmias and aggression. Refer to Table 1 for instructions). Where there are no contraindications/compromised organ function for NSAID use, addition is recommended where pain cannot be managed.

Where opioids are not available, lidocaine and ketamine as above, epidural anaesthesia, intrapleural or intra-abdominal local anaesthesia where indicated, diffusion catheters and various local blocks for post-surgical analgesia can be administered.

Anecdotally acupuncture has been used as an appropriate adjunct for the critically ill patient. There are minimal risks or side effects of acupuncture, although very debilitated patients may require fewer needles.

Other modalities to include in the critically ill patient are proper use of warmth for muscle spasm or pain, cold for regions of acute injury or inflammation, gentle pressure support for appendicular regions that are painful (or sometimes for abdominal pain). Furthermore, proper padding and positioning, patient mobilization and nursing care are critical for comfort in these patients.

33. MEDICAL PAIN

Medical pain discussed here is a ‘catch-all’ for conditions not primarily associated with surgery or trauma (examples below); however, they may occur secondarily. Treating the underlying problem alleviates discomfort; however, analgesics are required during the healing process.

Abdominal, pelvic and thoracic visceral pain occurs in conditions associated with distension and/or inflammation of hollow organs, ischaemia, pulmonary thrombosis, acute enlargement of solid organs resulting in stretching of the capsule and inflammation of any organ (e.g. pancreatitis, acute kidney injury, pneumonia/pleuritis). Visceral pain tends to be diffuse in nature; however, pain can be localized to an area within the cavity when pressure is applied externally. Thoracic visceral pain may be elicited on abdominal palpation; visceral pain may also be exhibited as referred pain at a distant cutaneous site.

Dermatologic diseases cause inflammation resulting in mild to excruciating pain (e.g. necrotizing fasciitis). Specific therapy to treat the underlying problem should alleviate the discomfort but analgesics may be required to manage pain effectively.

Further examples of medical pain and their severity can be found in Section 9.

Suggested analgesic regimens

Opioids are the first choice drugs in many emergency and critically ill patients.

### Severe pain

1. Mu agonist opioid (Table 4) commencing at the mid- higher dosage and titrate to effect.
2. NSAIDs, when haemodynamically stable and no contraindications, in combination with any of the opioids above
3. Locoregional anaesthetic techniques
4. Ketamine and/or lidocaine (dogs only) CRI
5. Intrapleural and intraperitoneal blocks for visceral pain (www.wsava.org)

### Moderate pain

1. Low-medium dose mu agonist opioid, IV followed by CRI: fentanyl, hydromorphone, methadone or morphine. (Refer to Table 4 for dosing). If only pethidine (meperidine) opioid available: 5–10 mg/kg IM or SC; Frequent IM or SC injections are painful and stressful and should be avoided where possible. OR
2. NSAID when haemodynamically stable and no contraindications, either alone or in combination with an opioid OR
3. Buprenorphine 0-02–0-04 mg/kg IV or OTM q4-8h for 3–5 days cats, 0-01–0-02 mg/kg IV q4-8h dogs, 0-02–0-04 mg/kg OTM small dogs (<10kg) for 3–5 days OR
4. Butorphanol 0.2–0.4 mg/kg IV q1–2h cats and dogs or CRI at 0.2 mg/kg/h after the loading dose

**Mild to moderate pain (non-hospitalized or hospitalized patients)**

1. NSAID of choice where not contraindicated AND/OR

2. Buprenorphine 0.02-0.04 mg/kg OTM q6-8h for 3–5 days cats, 0-0.02-0.04 mg/kg OTM q6–8h small dogs (<10kg) for 3–5 days OR

3. Tramadol 5mg/kg PO q8-12h for dogs, 2 mg/kg PO cats q12h may be of benefit, although there is little published evidence to support this

4. Lidocaine 2% viscous a 1:1 to aluminium hydroxide 64 mg/mL, (max dose 0.4mL/kg q8h) is effective in treating oral & oesophageal lesions b (personal communication, KM)

aLidodan 2%, Montreal, Canada (or similar product based on individual country).

**Adjunctive therapies (to be used with all levels of pain where indicated)**

* Anti-emetics are indicated where nausea and vomiting are present
* Acupuncture may be very useful for gastrointestinal and urinary cases in particular. Acupuncture may also be of benefit as an anti-emetic technique
* Medical massage and warm compress are recommended where indicated
* Environmental enhancement to reduce stress and anxiety. Pheromonatherapy may be helpful in cats and dogs.

**34. PREGNANT OR LACTATING PATIENTS**

Very little information is available about the pharmacology of analgesic drugs in dogs and cats during pregnancy and lactation; some information is presented from studies in humans and laboratory species.

**Pregnancy**

Physiological changes associated with the maternal-placental-foetal unit alter drug pharmacodynamics, pharmacokinetics and distribution to the foetus. The maternal factors that may alter drug absorption are decreased gastrointestinal motility, oesophageal reflux and vomiting; and an increased cutaneous blood flow, which may enhance absorption of transdermally administered drugs. Increased total body water, increased total body fat, reduced serum albumin, altered hepatic enzymatic activity and increased renal function are all factors that may alter the response of pregnant animals to analgesic drugs.

The placental barrier is considered to be a lipoprotein, therefore drugs with high lipid solubility are permeable. Drugs that are polar, ionized, protein-bound or water soluble are less likely to cross the placenta into the foetus. 

**Opioids:** Currently, opioids are commonly used for analgesia in pregnant dogs and cats. Methadone, morphine and hydromorphone are used during pregnancy in humans. Fentanyl, pethidine (meperidine), butorphanol and nalbuphine are more lipid soluble, and therefore may reach higher concentrations in the foetus. Opioids are frequently used preoperatively for caesarean section, and most puppies and kittens are successfully delivered and are vigorous. If the puppies or kittens are depressed after delivery, alongside provision of warmth, stimulation, and oxygen and application of suction as required, a drop of naloxone placed sublingually should reverse these effects; however repeat dosing may be required. Buprenorphine resulted in lack of milk production in animal studies, which may be a problem following caesarian.

**NSAIDs:** Due to possible teratogenicity and development-interfering effects, it is advised that NSAIDs are not administered to pregnant animals.

**Ketamine:** Ketamine rapidly crosses the placenta; however, no foetal effects have been observed during organogenesis and near delivery in rats, mice, rabbits and dogs. Ketamine increases uterine tone and should be avoided during pregnancy. An in-depth review of caesarean section in dogs is available.

**Alpha_2 adrenoceptor agonists:** Reduce uterine blood flow. Xylazine should not be used during pregnancy. Evidence regarding the use of medetomidine and dexmedetomidine in dogs and cats during pregnancy is not available.

**Local anaesthetics:** Generally considered to be safe and non-teratogenic – they are highly recommended.

**Herbal analgesic medications:** Due to a lack of information, these should be avoided

**Caesarean Section**

The physiologic changes associated with pregnancy outlined above influence the choice of anaesthetic and analgesic drugs for caesarean section in queens and bitches. All anaesthetic and analgesic agents cross the placental barrier.
There is more evidence-based information on caesarean section and neonatal vitality and survival for dogs than cats. Premedication is normally recommended to decrease maternal stress and anxiety and to reduce the doses of induction and maintenance agents; in addition the use of opioids provides pre-emptive analgesia. Decreased gastrointestinal motility and the enlarged uterus increase the risk of vomiting and aspiration. Aspiration of gastric contents is thought to contribute to maternal mortality. For this reason in addition the use of opioids provides pre-emptive analgesia. Decreased gastrointestinal motility and the enlarged uterus increase

Due to their high oxygen requirements and reduced functional residual capacity of the lungs, pregnant animals are at risk for hypoxaemia and oxygen desaturation can occur rapidly at induction of anaesthesia. Pre-oxygenation (3–5 minutes) using a face mask is recommended. Many animals undergoing caesarean section are dehydrated and even in elective situations, fluid losses can be large therefore intravenous fluids are recommended and should be started prior to induction of anaesthesia.

Drugs that are known to increase maternal and/or neonatal mortality include the alpha₁-adrenergic agonist xylazine and the inhalant agent methoxyflurane. There are no data on the effect of the newer alpha₁-adrenoceptor agonists, medetomidine and dexmedetomidine, on anaesthetic risk associated with caesarean section. However due to the potential for emesis and cardiovascular depression, these drugs as a class are best avoided.

There is some controversy regarding the use of NSAIDs in this setting due to potential uptake and negative effects in the suckling offspring. However, only a small percentage of the dam's dose of NSAID is secreted in milk and a single post-operative dose is regarded as a suitable compromise. NSAIDS should only be given if hypovolaemia and hypotension have been corrected (see Section 13 for details).

Neonatal vitality: In one study respiratory rate (RR) and neurologic reflexes of puppies were compared after dams received ketamine/midazolam, thioptenol, propofol or an epidural local anaesthetic. The RR was higher after epidural anaesthesia and neurologic reflexes were best after epidural, followed by propofol, thiopentol and ketamine/midazolam. See below for precautions on using epidural analgesia as a sole technique. Moon also reported that although ketamine did not increase puppy mortality it decreased the vigour of new-born puppies, therefore resuscitation efforts should be aggressive if ketamine is used. There was no difference in survival between puppies whose dams received propofol or alfalxalone. However, using a modified Apgar score puppy vitality was found to be superior when alfalxalone was used. There is a lack of published information on kitten vitality after caesarean delivery.

**Elective situation**

*Preoperative:* IM or IV opioid ± acepromazine (lower doses [0·01-0·03 mg/kg IM or IV] are usually sufficient). An opioid normally provides adequate sedation for venous access however acepromazine can be used if the dam is difficult to manage and requires more sedation than an opioid alone can provide.

*Induction and maintenance of anaesthesia:* IV alfalxalone to effect (3-5 mg/kg) or IV propofol to effect (3-10 mg/kg). Where propofol or alfalxalone are not available, ketamine or thioptenol could potentially be used with the understanding that they may decrease vigour of the offspring and resuscitation efforts should be aggressive. Following intubation, anaesthesia can be maintained with isoflurane. NOTE: The dam's requirements for inhalant agents may be reduced by 25-40% at term. Anaesthesia can be maintained with repeated boluses or a continuous rate infusion of propofol, but intubation and administration of oxygen is still required.

*Local anaesthetic techniques:* Pre-incisional and / or post incisional line block (lidocaine or bupivacaine).

*Epidural/Spinal analgesic techniques:* Morphine can be administered pre- or post-operatively to provide up to 18-20 hours of analgesia. See Section 29 for details.

*Postoperative analgesia:* NSAIDs, one dose; see Section for details. Opioids can be continued.

**Emergency situation with compromised dam**

*Preoperative:* Fentanyl IV (3-5 µg/kg).

*Induction and maintenance of anaesthesia:* IV etomidate (1-2 mg/kg) ± diazepam or midazolam (0·25 mg/kg), IV ketamine (3-5 mg/kg plus diazepam or midazolam (0·25 mg/kg); midazolam is shorter acting in both dam and offspring so is preferred when available. Following intubation anaesthesia can be maintained with isoflurane and fentanyl can be repeated.

*Local anaesthetic techniques:* See above

*Epidural/Spinal analgesic techniques:* See above

*Postoperative analgesia:* NSAIDs should only be considered if the bitch or queen is normovolaemic and normotensive. For choice of drugs see Section 13 for details. Opioids can be continued.

**Protocol without controlled drugs**

*Preoperative:* Acepromazine unless the bitch or queen is volume depleted. If the dam is compromised do not administer premedication drugs.
Induction and maintenance of anaesthesia: IV alfaxalone to effect (3-5 mg/kg), propofol to effect (3-10 mg/kg) or etomidate (1-2 mg/kg). Following intubation anaesthesia can be maintained with isoflurane. Anaesthesia can be maintained with repeated boluses or a continuous rate infusion of propofol, but intubation and administration of oxygen is still required.

Local anaesthetic techniques: See above

Epidural/Spinal analgesic techniques: See above

Postoperative analgesia: NSAIDs, one dose; see Section 13 for details.

Protocol with limited availability of anaesthetic and analgesic drugs

Prophylactic: Acepromazine (see indication for use above).

Induction and maintenance of anaesthesia: Depending on availability of drugs, choose from the protocols above.

Local anaesthetic techniques: Epidural local anaesthetic (lidocaine) can be used as a sole technique but with caution. NOTE: due to the decreased size of the epidural space in pregnant animals smaller volumes (25-30% reduction) of epidural local anaesthetic drugs are used. Epidural local anaesthetics cause sympathetic blockade with resultant vasodilation and hypotension which can be prevented or treated with intravenous fluids, but could be especially detrimental in compromised dams. With this technique the dam is conscious and therefore not intubated so there is an increased risk of aspiration; oxygen should be administered by face mask. The dam will also require to be manually restrained for surgery. See Section 29 for details on technique.

Postoperative analgesia: NSAIDs one dose; for choice of drugs see Section 13 for details.

**Lactation**

Characteristics of a drug which would facilitate secretion into milk are high lipid solubility, low molecular weight and the non-ionized (charged) state. It is estimated that the neonate receives approximately 1% to 2% of the maternal dose of a drug. Where analgesia is essential and there are concerns for potential toxicity in the offspring, the milk should be pumped and discarded for 12h before resuming suckling, and puppies and kittens should be bottle fed.

**Opioids:** The lipid solubility of the opioid influences its appearance in the milk; pethidine (meperidine)>sufentanil>fentanyl>morphine>hydromorphone, therefore a more hydrophilic opioid, such as morphine, may appear in smaller amounts than a more lipid-soluble opioid such as pethidine. It is recommended that suckling occurs after peak levels of the opioid have waned. Pethidine (meperidine), butorphanol, nalbuphine are not recommended. Where opioids are selected for analgesia, mothers and offspring should be carefully observed and monitored for signs of opioid adverse effects.

**NSAIDs:** Most NSAIDs are not lipid soluble, are highly protein bound to plasma proteins and may be present to a great degree in an ionised form in the plasma. It has been suggested that a single use of an NSAID is safe in nursing human mothers. Until studies are performed in lactating cats and dogs, NSAIDs should be administered with caution and as single doses only. Hemorrhage is a potential concern following the administration of non-COX selective, or COX-1 selective NSAIDs immediately after caesarian section, or even natural birth. In general, paracetamol is safe for use in dogs, but cannot be administered to cats.

**Local anaesthetics:** Lidocaine and its metabolites have low lipid solubility; at therapeutic doses the concentrations in milk are small and unlikely to be a risk. Incision line infiltration is highly recommended.

**Ketamine:** No reports on passage into breast milk were found, but it is expected to pass into breast milk. Herbal analgesic medications: Due to a a lack of information, these should be avoided.

## 35. NEONATAL AND PAEDIATRIC PATIENTS

Studies in neonates and infants show that when anaesthesia or analgesia was withheld, altered pain sensitivity and increased anxiety occurred with subsequent painful experiences, when compared to children receiving analgesia. This suggests that infants retain a ‘memory’ of a painful experience with subsequent altered response to a painful stimulus. This has also been shown in laboratory animals.

The term paediatric generally refers to the first six months of life. Due to important physiological changes which occur during this time frame, a further demarcation is defined as: neonatal (0–2 weeks), infant (2–6 weeks) weanling, (6–12 weeks) and juvenile (3–6 months). This distinction is made to highlight the metabolic changes that occur during these periods of maturation.

There tends to be apprehension in administering analgesic drugs, especially opioids, to young animals due to the often cited ‘decreased ability for drug metabolism and high risk of overdose’. While this may be a potential concern in the neonate, it is not necessarily so through all stages of maturation. While there are no reports in the veterinary literature suggesting increased dosing should be considered in the young cat or dog, personal experience with intensive monitoring of the young (3–6 month old) animal has shown opioid doses for analgesia may be equal to, and can be higher than, a mature adult emphasizing that administering the analgesic to effect, rather than a pre-determined dose, is the most important method of clinical dosing. However, young animals can be susceptible to the sedative effects of opioids. Opioids can be reversed with careful titration of naloxone should there be clinical evidence of CNS depression and respiratory depression, hypotension and bradycardia (unless an emergency,
<0.002 mg/kg may suffice; higher doses may result in hyperalgesia, hyperexcitability, cardiac arrhythmias and aggression. Refer to Table 1 for instructions). For all these reasons, frequent pain assessment and treatment should be evaluated on a case-by-case basis and tailored to patient needs.

The neonate has reduced clearance of many drugs as compared with older individuals largely because of:

- The greater body water content leading to a higher volume of distribution
- A larger fraction of body mass that consists of highly perfused tissues
- A lower plasma concentration of proteins that bind drugs
- Incomplete maturation of their hepatic-enzymes systems.²¹²

The hepatorenal system continues to develop until 3–6 weeks of age; this may result in reduced metabolism and excretion, which may require alterations in dosing and dosing intervals.²¹⁰ For all young animals, the presence of milk in the stomach may inhibit the absorption of some orally administered drugs, potentially resulting in lower blood concentrations.

**Opioids**

Lower doses of fentanyl or morphine are required for analgesia in the neonate (0–2 weeks) when compared to the 5-week-old puppy²¹³ or kitten. Puppies and kittens are also more sensitive to the sedative and respiratory depressant effects of morphine than adults. Fentanyl may be a more suitable opioid in the young paediatric and neonatal puppy or kitten; however, as it is short-acting continuous IV access and titration are required.²¹³,²¹⁴ Buprenorphine may be an alternative, and associated with minimal respiratory depression. Hydromorphone, oxymorphone and methadone may also be used; however, as with all opioids, starting at or below the lowest dose of the range and increasing to effect is recommended. Opioids can be reversed with titration of naloxone should there be clinical evidence of overdosing.

**Non-steroidal anti-inflammatory drugs**

NSAIDs are not recommended for animals less than 6 weeks of age; however, for some NSAIDs the age is older. It is essential to consult the package insert of all NSAIDs prior to using in young animals.

**Local anaesthetics**

Local anaesthetics are recommended, but careful dosing according to accurate body weight is imperative. Lidocaine is painful when infiltrated even with 27–30 gauge needles.²¹⁴ To reduce pain, buffering (a 20:1 mixture of local anaesthetic with 1 mEq/mL sodium bicarbonate; e.g. lidocaine 2% = 2mL:0.1mL), warming (36–37°) and slow administration is recommended. Mepivacaine does not induce pain on injection. A maximum dose of local anaesthetic is half the adult dose²¹⁵ for both kittens and puppies up to 10 days of age.

Topical LA creams (EMLA® Cream; AstraZeneca LP, Wilmington, DE, USA [prescription only mixture of lidocaine 2.5% and prilocaine 2.5%]; MAXILINE®, Ferndale Laboratories, Ferndale, MI, USA [over-the-counter. Onset time faster than EMLA cream]; ELA-Max® or L.M.X™; Ferndale Laboratories, Ferndale, MI, USA [liposome-encapsulated formulation of 4% lidocaine (OTC)]) are effective when used on intact skin to provide anaesthesia for IV catheter placement, blood collection, lumbar puncture and other minor superficial procedures.²¹⁶,²¹⁷ The creams should be covered with an occlusive dressing for at least 30 minutes prior to the procedure. Products containing adrenaline (epinephrine) should be avoided. Lidocaine 2% is also available as a sterile gel, and is used for local desensitization of the vaginal vault or penis prior to urinary catheter placement.

**Alpha₂ adrenoceptor agonists**

Alpha₂ agents are sedative analgesics and are not recommended due to the cardiovascular effects.

**Sedatives**

These should not be used in young animals, especially when less than 12 weeks of age.²¹⁸ Most sedatives have no analgesic properties and if used may mask pain behaviours.

**Nursing**

Suckling is analgesic in rat and human infants. Where any painful procedure is required in young animals, contact with the mother as soon as possible is recommended.²¹⁹ Other feeding procedures can provide distraction-related analgesia and comfort.

### 36. NEUROPATHIC PAIN

Neuropathic pain⁵⁵ requires several classes of medications and procedures as it cannot be adequately managed with a single pharmacological or non-pharmacological therapy.²⁷,²⁸,⁹¹,¹⁰⁴,²²⁰,²²¹ Prior to, and during any surgical procedure, various different analgesic drugs
and modalities can be used to reduce the inciting nociceptive afferent impulse. Many of these are continued postoperatively to reduce both peripheral (PNS) and central (CNS) sensitization.

**NSAIDs**

There is evidence to support an inflammatory response driving the pathophysiological changes of the peripheral and central nervous systems resulting in neuropathic pain and augmentation of pain processing by spinal prostanoids. While no studies are reported at this time, human clinical trials are currently underway investigating various modalities to target specific components of the neuro-inflammatory process. It is advised that NSAIDs be used in the treatment of neuropathic pain.

**Opioids**

Opioids may be included in a multimodal regimen to manage neuropathic pain, but not as a stand alone analgesic. Opioids may have reduced effectiveness, where tactile allodynia (Abeta stimulus) is a component of neuropathic pain and where opioid receptors in the descending inhibitory pathway are reduced or inactivated, which may occur in neuropathic pain. Also, the closer the nervous system lesion is to the CNS, the less effective opioids may be; peripheral nerve injuries tend to respond better to opioid therapy than nerve root injuries, which respond better than spinal cord injuries. The shorter half-life of fentanyl is an advantage in patients with acute CNS or PNS pain/injury as withdrawal for assessment is more easily planned. Opioids with less propensity to cause emesis (e.g., fentanyl, methadone, butorphanol) should be titrated cautiously in any trauma patient to avoid potential vomiting and wretching, which will cause a marked and sudden increase in intracranial pressure in patients with known, suspected or occult brain injury. The naloxone titration technique to reverse side effects of opioids is recommended (see Table 1). Buprenorphine OTM may be suitable for continuing home management for cats and small dogs.

**NMDA antagonists**

Low-dose ketamine is frequently used pre-, intra, and postoperatively to prevent and treat neuropathic pain. Following the administration of an opioid and an NSAID (when not contraindicated), an IV loading dose >0.5–4 mg/kg (to effect) of ketamine is administered, followed by a CRI 0.2–2+mg/kg/h. Amantadine (3–5 mg/kg once daily orally) may be continued after ketamine is discontinued for longer-term therapy at home.

**Local anaesthetics**

Lidocaine systemically administered has been shown to be effective in the treatment of several neuropathic pain disorders. Lidocaine infusions should not be used in cats. Lidocaine 5% dermal patches may be of benefit where pain originates. Pharmacokinetic studies of the lidocaine patch in dogs are reported; however, no analgesic efficacy studies have been reported in dogs or cats for IV infusions or transdermal patches for neuropathic or chronic pain.

**Anti-epileptics**

Studies in humans and laboratory animals indicate that perioperative administration of gabapentin to animals with nerve injury may reduce the potential establishment of, or ongoing, neuropathic pain. Based on blood concentrations in dogs, dose at 10 mg/kg PO q12h (5 mg/kg PO q12h in cats), increasing as needed to effect (dose range 10–15 mg/kg in dogs). The dose limiting side effect is sedation. Some animals need several weeks to months for resolution of pain, or longer. A benefit of long term administration of gabapentin following trauma was reported in three cats; however, to date there are no prospective veterinary studies investigating the long-term effects of multimodal analgesia including gabapentin.

**Alpha2 adrenoceptor agonists**

Medetomidine and dexmedetomidine may be added to a multimodal regimen. As an example, dexmedetomidine (1–2 µg/kg/h), in addition to low-dose fentanyl (3–4 µg/kg/h) and corticosteroids, can be effective for management of the severe pain associated with meningitis in the dog. Intra- and postoperative pain management for intervertebral disc herniation is another example. No observed adverse effects are noted at this low dose other than potential for increased urinary output.

**Acupuncture and medical massage**

These should be included in the analgesic regimen as soon as possible. Neuropathic pain is difficult to manage with pharmaceutical agents alone, therefore the use of acupuncture and other integrative techniques should be included as adjuncts to a multimodal pharmaceutical regimen.

**Serotonin and norepinephrine re-uptake inhibitors**

These (e.g., amitriptyline, dogs: 1–2 mg/kg orally q12–24h; cats: 2.5–12.5 mg/cat orally q24h, gabapentin [see above]) may be beneficial as a home medication in combination with those listed above, as the descending inhibitory system appears to be dysfunctional in neuropathic states.
37. DEGENERATIVE JOINT DISEASE

The management of DJD has grown in complexity in the past decade, and there are many recommendations for treatment of the pain and dysfunction associated with this disease. These include, but are not limited to, surgical intervention, systemic analgesic therapy (NSAIDs, paracetamol [acetaminophen] [not in cats], corticosteroids), local pharmacologic therapy (transcutaneous; intra-articular), home-based exercises, clinic-based therapeutic exercises, weight optimization, nutritional supplementation, massage, acupuncture, laser therapy, heat/cold therapy, neuromuscular electrical stimulation, transcutaneous electrical stimulation and joint mobilization. However, it should be remembered that DJD in any patient is not a single ‘type’ of problem – indeed, it is now becoming recognized that DJD presents differently in the growing, versus middle-aged, versus older cat or dog. DJD presenting at different ‘life-stages’ requires different approaches to optimize care. For example, in the growing dog surgical intervention may be a first line treatment in an attempt to limit the disease progression and the likelihood of pain in the future.

Regardless of the stage of disease or the treatments selected, the veterinarian should aim to maximize the benefit and minimize the risks associated with managing this disease. The mainstays of treatment involve methods to alleviate pain, and at all stages NSAIDs are the most predictable analgesics.

In cats and dogs, the broad categories of treatments for OA pain can be summarized as:

Non-surgery, non-drug treatment
- Weight management
- Diet modulation (type; amount)
- Exercise
- Physical rehabilitation and physical modalities
- Environmental modification
- Nutritional supplements
- Acupuncture.

Drugs
- ‘Base’ analgesics
  - NSAIDs
  - Paracetamol (acetaminophen) [not in cats]
  - Corticosteroids (treating the underlying immune-mediated disease resulting in polyarthritis)
- Adjunctive analgesics (e.g. tramadol, amantadine, gabapentin, tricyclic antidepressants)
- Postulated disease modifying drugs (e.g. polysulfated glycosaminoglycan)
- Neuroablative procedures.

Surgery
- Joint replacement (hip, elbow, knee)
- Excision arthroplasty
- Arthrodesis
- Joint denervation
- Stem cell therapies.

Currently, the greatest weight of evidence for efficacy is for weight management, NSAIDs, dietary optimization (amount and content), and exercise. 134,235

38. CANCER-RELATED PAIN

Cancer pain has varying degrees of severity that is dependent on duration, location and type of cancer. Inflammation due to tumour necrosis or direct pressure causes pain. Pain may originate from nerve root compression, from muscle spasms in the area of the lesions or directly from lesions, or from tissue that has been infiltrated. Most patients with cancer suffer pain to some degree. Some cancers such as lymphomas and leukaemia have a lower incidence of pain suffering in humans. However, even in these, the pain can be excruciating. The incidence and severity of pain associated with various cancer types in animals is not well documented.

One of the best documented is bone pain. Metastatic involvement of bone is a frequent cause of pain results from direct invasion of the bone, microfractures, increased pressure of endosteum, distortion of the periosteum or perileisional inflammation. Another important mechanism in the genesis of bone pain is the release of chemical mediators such as amines, peptides, fatty acids, potassium
and prostaglandins. Cancer pain, and bone pain in particular, is often associated with neuropathic like clinical signs. Therapies that decrease tumour activity, are anti-inflammatory, or are targeted against the changes in neuropathic pain can all have efficacy in cancer pain.

A particular type of bone pain is called ‘incident’ or ‘movement-related pain’. In humans, the pain is described as dull, constant and gradually increasing in intensity; movement and pressure worsen it. Incident pain usually has a sudden onset, reaching peak pain intensity within a few minutes and is a cause of breakthrough pain in a large number of human patients.

A multimodal drug approach to the control of cancer pain is recommended.\textsuperscript{236–238} NSAIDs are recommended with the addition of opioids and adjunctive drugs (such as gabapentin) as needed. Other modalities that can prove beneficial are bisphosphonates (clodronate, disodium pamidronate, ibandronate), chemotherapy and radiotherapy. Non-drug therapies should be used concurrently. The combination of acupuncture with drug therapy appears to be superior to either alone.\textsuperscript{237} Other forms of adjunctive therapy tend to improve quality of life in cancer patients, although it is not known if they directly induce analgesia.

The following algorithm is suggested (Figure 7). Dosages for analgesics selected can be found in the respective Sections.
39. WSAVA HUMANE EUTHANASIA OVERVIEW

The termination of companion animal life through euthanasia may be required for a variety of medical, behavioural, and animal population control reasons. Key animal welfare concerns and issues relative to selection of the method for humane euthanasia are outlined as follows:

- Stress avoidance (where possible)
- Stress mitigation (where likely or inevitable):
  - Animals being euthanized are not viewed by other animals
  - Bodies of euthanized animals are not viewed by other animals
- Humane method (will vary based upon local availability of restraint/drugs):
  - Performed by competent, trained personnel
  - Giving due consideration to the safety of those performing euthanasia
  - Minimally painful/stressful for the animal being euthanized
  - Rapid
  - Reliable
  - Death confirmed before animal remains are disposed of
  - Minimizes distress to public
- Protocol without drug restrictions:
  - Pre-euthanasia sedation/tranquilization followed by IV lethal drug or mixture of drugs (e.g. acepromazine/α₂ agonist may be administered via SQ/IM routes followed by IV pentobarbital overdose). IV bolus must be administered via IV catheter or after confirming venous access
  - In cases where pets are fractious/anxious, profound sedation may be followed by intraperitoneal injection of pentobarbital. Sedation must be adequate to abolish any reaction to needle puncture of the abdomen
  - Use of CO₂ chambers, anoxia, foaming agents and cyanide are unacceptable when alternative methods of euthanasia are available
- Protocols where legal availability of drugs is restricted:
  - Profound sedation or anaesthesia followed by IV potassium chloride or magnesium sulfate, or gunshot
  - Gunshot (where sedation is not available this procedure must be performed by trained personnel)
- Remains removal management in large-scale euthanasia events ought to consider environmental/wildlife impacts:
  - Relative to tissue residues of injectable drugs
  - Relative to contamination of soil/groundwater with animal decomposition/waste
  - Relative to environmental impacts of cremation/open air cremation
  - Relative to public sentiment regarding animal disposition
  - Relative to possibility of other animals seeing, smelling or finding and eating the carcasses.

Acknowledgements

The GPC members and the WSAVA would like to acknowledge the assistance of a number of other colleagues who have provided their expertise in preparing or reviewing various sections of this Treatise. WSAVA Humane Euthanasia Overview Prepared by the WSAVA Animal Wellness and Welfare Committee.

Dietary supplements with potential benefits in pain management
Prepared by: Narda G. Robinson, DO, DVM, MS, DABMA, FAAMA
Director, CSU Center for Comparative and Integrative Pain Medicine, Assistant Professor, Department of Clinical Sciences, Founder and Director, Medical Acupuncture for Veterinarians Program

Nursing care as an adjunctive non-pharmacologic treatment for pain
Prepared by: Nicole DiPierre BA, RVT, CCRP, CCMT

Medical massage as an adjunctive non-pharmacologic treatment for pain
Prepared by: Nicole DiPierre BA, RVT, CCRP, CCMT

Physical rehabilitation for pain management
Prepared by: Sasha Foster, MSPT, CCRT

Perioperative analgesia for dental procedures
Reviewed by: Ian J. Haws, DVM, FAVD, DACVD
Animal Dental Care, Guelph, Ontario, Canada (animaldentalcare.com)
Perioperative analgesia for ophthalmic procedures

Reviewed by: Chantale Pinard DVM, MSc, DACVO
Assistant Professor – Ophthalmology, Ontario Veterinary College, University of Guelph, Guelph, Ontario, Canada

Recognition of sponsors
The WSAVA and GPC would like to thank our sponsors:

Boehringer Ingelheim Vetmedica, Elanco, Novartis Animal Health, Zoetis, and Vétocinql

It is through their generous support and commitment to improving companion animal pain management globally that this initiative became a reality.

References
17. http://www.medved.unimontreal.ca/4avet/


2015 AAHA/AAFP Pain Management Guidelines for Dogs and Cats

Rationale: The robust advances in pain management for companion animals underlie the decision of the American Animal Hospital Association (AAHA) and American Association of Feline Practitioners (AAFP) to expand on the information provided in the 2007 AAHA/AAFP Pain Management Guidelines. The 2015 Guidelines summarize and offer a discriminating review of much of this new knowledge.

Relevance: Pain management is central to veterinary practice, alleviating pain, improving patient outcomes, and enhancing both quality of life and the veterinarian–client–patient relationship. These Guidelines support veterinarians in incorporating pain management into practice, improving patient care.

Approaches: The management of pain requires a continuum of care that includes anticipation, early intervention, and evaluation of response on an individual patient basis. A team-oriented approach, including the owner, is essential for maximizing the recognition, prevention and treatment of pain in animals.

Evidence base: The Guidelines include both pharmacologic and non-pharmacologic modalities to manage pain; they are evidence-based insofar as possible and otherwise represent a consensus of expert opinion. Behavioral changes are currently the principal indicator of pain and its course of improvement or progression, and the basis for recently validated pain scores. Post-surgical pain is eminently predictable but a strong body of evidence exists supporting strategies to mitigate adaptive as well as maladaptive forms. Chronic pain is dominated by degenerative joint disease (DJD), which is one of the most significant and under-diagnosed diseases of cats and dogs. DJD is ubiquitous, found in pets of all ages, and inevitably progresses over time; evidence-based strategies for management are established in dogs, and emerging in cats.

Introduction

Pain management is central to veterinary practice, not adjunctive. Alleviating pain is not only a professional obligation (recall the veterinarian’s pledge to ‘the relief of animal pain and suffering’) but also a key contributor to successful case outcomes and enhancement of the veterinarian–client–patient relationship. A commitment to pain management identifies a practice as one that is committed to compassionate care; optimum recovery from illness, injury or surgery; and enhanced quality of life.

These Guidelines continue the trend in all branches of medicine toward evidence-based consensus statements that address key issues in clinical practice. Although not a review article, this compilation is a force multiplier for the busy practitioner, consolidating in a single place current recommendations and insights from experts in pain management. These Guidelines are the product of a collaborative effort by the American Animal Hospital Association (AAHA) and the American Association of Feline Practitioners (AAFP). The recommendations of the Guidelines Task Force are evidence based insofar as possible and otherwise represent a consensus of expert opinion.

These Guidelines are designed to expand on the information contained in the 2007 AAHA/AAFP Pain Management Guidelines for Dogs and Cats. The 2015 Guidelines differ from the earlier version in several ways. The first sections are general concepts designed to set the stage for the remaining, more specific content. The 2015 Guidelines also discuss the importance of...
an integrated approach to managing pain that does not rely strictly on analgesic drugs. Because pain assessment in animals has become more scientifically grounded in recent years, various clinically validated instruments for scoring pain in both dogs and cats are described. The extensive list of published references includes numerous studies published within the past 3 years, reflecting the rapid pace of advances in managing pain for companion animals. The 2015 Guidelines summarize and offer a discriminating review of much of this new knowledge.

### Types of pain

All types of tissue injury can be generators of pain. Occasionally, pain may occur in the absence of those causative factors. Understanding the mechanisms of pain is the key to its successful prevention and treatment. The pain response is unique to each individual and involves two components:

- The sensory component is nociception, which is the neural processing of noxious stimuli;
- The affective component is pain perception, which is the unpleasant sensory and emotional experience associated with either actual or potential tissue damage.

Pain is the endpoint of nociceptive input and can only occur in a conscious animal. However, there is also involvement of autonomic pathways and deeper centers of the brain involved with emotion and memory. Hence, pain is a multidimensional experience; it is not just what you feel but also how it makes you feel.³

Acute pain has been defined as pain that exists during the expected time of inflammation and healing after injury (up to 3 months), and chronic pain is defined as that which exists beyond the expected duration associated with acute pain. Therapy should be focused on the underlying cause of pain (nociceptive, inflammatory or pathological), rather than on arbitrary labels based on duration.⁴

- **Nociceptive pain** occurs when peripheral neural receptors are activated by noxious stimuli (eg, surgical incisions, trauma, heat or cold).
- **Inflammatory pain** results gradually from activation of the immune system in response to injury or infection.
- **Pathological pain**, also called maladaptive pain, occurs when pain is amplified and sustained by molecular, cellular and microanatomic changes, collectively termed peripheral and central hypersensitization.

Pathological pain is characterized by hyperalgesia (exaggerated response to noxious stimulus), allodynia (painful response to non-noxious stimuli, such as touch or pressure), expansion of the painful field beyond its original boundaries, and pain protracted beyond the expected time of inflammation and healing. Under some conditions, genomic, phenotypic changes occur that create the condition known as neuropathic pain, whereby pain can be considered a disease of the central nervous system. Those changes are not necessarily chronologic. Maladaptive pain, or the risk for it, can occur within a matter of minutes of certain acute pain conditions (eg, nerve injury, severe tissue trauma, or presence of pre-existing inflammation).
Appropriate pain management requires a continuum of care based on a well thought out plan that includes anticipation, early intervention and evaluation of response on an individual patient basis. It should be noted that response to therapy is a legitimate pain assessment tool. Continuous management is required for chronically painful conditions, and for acute conditions until pain is resolved.

Figure 1: PLATTER approach to pain management
- **Plan**: Every case should start with a patient-specific pain assessment and treatment plan
- **Anticipate**: The patient’s pain management needs should be anticipated whenever possible so that either preventive analgesia can be provided or, in the case of pre-existing pain, it can be treated as soon as possible
- **Treat**: Appropriate treatment should be provided that is commensurate with the type, severity and duration of pain that is expected
- **Evaluate**: The efficacy and appropriateness of treatment should be evaluated; in many cases, using either a client questionnaire or an in-clinic scoring system
- **Return**: Arguably the most important step, this action takes us back to the patient – where the treatment is either modified or discontinued based on an evaluation of the patient’s response

The acronym PLATTER has been devised to describe the continuum of care loop for managing pain. The components of the PLATTER algorithm for pain management are **P**lan, **A**nticipate, **T**reat, **E**valuate and **R**eturn (Figure 1). The approach provides individualized pain management for any patient and is devised not on a static basis but according to a continuous cycle of plan–treat–evaluate based on the patient’s response.

**Continuum of care**

**Appropriate pain management requires a continuum of care.**

**Recognition and assessment of pain**

The patient’s behavior is key
Because animals are non-verbal and cannot self-report the presence of pain, the burden of pain assumption, recognition and assessment lies with veterinary professionals. It is now accepted that the most accurate method for evaluating pain in animals is not by physiological parameters but by observations of behavior. Pain assessment should be a routine component of every physical examination, and a pain score is considered the ‘fourth vital sign’, after temperature, pulse and respiration.\(^1,^2,^6\) Obtaining a thorough patient history from the owner can help determine abnormal behavior patterns that may be pain related. Pet owners should be educated in observing any problematic behavioral changes in their pet and to contact their veterinarian in such cases.

Pet owners and practitioners should have an awareness of behavior types that are relevant to pain assessment. Those include the animal’s ability to maintain normal behavior, loss of normal behavior, and development of new behaviors that emerge either as an adaption to pain or a response to pain relief (Figure 2). Because behavioral signs of pain are often overlooked or mistaken for other problems, the healthcare team must be vigilant in recognizing those anomalies in the total patient assessment.

**It’s not just about drugs**

Classic veterinary medical education places a strong emphasis on treatment of disease through pharmacology and surgery, the esoteric skills that are the domain of the trained clinician. Increasingly, evidence-based data and empirical experience justify a strong role for non-pharmacologic modalities for pain management. A number of those should be considered mainstream options and an integral part of a balanced, individualized treatment plan.

Examples of non-pharmacologic treatments supported by strong evidence include, but are not limited to, cold compression, weight optimization and therapeutic exercise. Treatment options gaining increasing acceptance include acupuncture, physical rehabilitation, myofascial trigger point therapy and therapeutic laser, among other modalities which are discussed later in these Guidelines. In addition, non-pharmacologic adjunctive treatment includes an appreciation of improved nursing care, gentle handling, caregiver involvement, improved home environment, and hospice care. Those methods have the critical advantages of increased caregiver–clinician interaction and a strengthening of the human–pet bond. That shared responsibility promotes a team approach and leads to a more complete and rational basis for pain management decisions.\(^5\)
Table 1  Acute postoperative pain scales

<table>
<thead>
<tr>
<th>Resource</th>
<th>Internet address</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorado State University Canine Acute Pain</td>
<td><a href="http://www.csanimalcancercenter.org/assets/files/csu_acute_pain_scale_canine.pdf">www.csanimalcancercenter.org/assets/files/csu_acute_pain_scale_canine.pdf</a></td>
<td>Psychological and behavioral indicators of pain</td>
</tr>
<tr>
<td>Scale</td>
<td></td>
<td>Response to palpation</td>
</tr>
<tr>
<td>Colorado State University Feline Acute Pain</td>
<td><a href="http://www.csanimalcancercenter.org/assets/files/csu_acute_pain_scale_feline.pdf">www.csanimalcancercenter.org/assets/files/csu_acute_pain_scale_feline.pdf</a></td>
<td>Same as above</td>
</tr>
<tr>
<td>Scale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Glasgow Short Form Composite</td>
<td><a href="http://www.newmetrica.com/cmps">www.newmetrica.com/cmps</a></td>
<td>Clinical decision-making tool for dogs in acute pain</td>
</tr>
<tr>
<td>Measure Pain Score</td>
<td></td>
<td>Indicator of analgesic requirement</td>
</tr>
<tr>
<td>Pain Scale</td>
<td></td>
<td>Includes 10 indicators of pain ranked numerically</td>
</tr>
</tbody>
</table>

### Pain scoring tools

Although there is currently no gold standard method for assessing pain in dogs and cats, the Guidelines Task Force strongly recommends utilizing pain scoring tools both for acute and chronic pain. It should be noted that those tools have varying degrees of validation, acute and chronic pain scales are not interchangeable, and canine and feline scales are not interchangeable. The use of pain scoring tools can decrease subjectivity and bias by observers, resulting in more effective pain management, which ultimately leads to better patient care.

### Acute pain: characteristics and causes

Acute pain involves both nociceptive and inflammatory components and can be caused by trauma, surgery and medical conditions or diseases. These Guidelines will focus on recognition, prevention and treatment of postsurgical pain.

### Multifactorial clinical measurement instruments for acute postsurgical pain

For dogs, a validated, widely used, multifactorial clinical measurement instrument (CMI) for acute pain is the Glasgow Short Form Composite Measure Pain Score. The 4AVet is another composite measure pain score for dogs, reportedly with more interobserver variability than the Glasgow short form, but less biased by sedation. Simple, online, practice-friendly numerical rating scales (0 to 4) for acute canine and feline pain have been developed (but not yet validated) by Colorado State University. In cats, a currently validated assessment tool is the UNESP-Botucatu Multidimensional Composite Pain Scale. That scale and video examples of how it is applied in clinical practice can be accessed online, and a description of Colorado State’s acute pain scales are included in Table 1.

### Practical approach to postoperative pain assessment

Validated CMIs are the foundation of rational pain assessment. Those assessment tools provide a simplified approach that encourages regular use by all healthcare members and are based on the following features:

- Observing the patient without interaction (ie, the patient’s orientation in the cage, posture, movement, facial expression, activity level and attitude; Images 1 and 2).
- Observing the patient while interacting with a care-giver (eg, what occurs when the cage door is opened or an animal is coaxed to move).
Observing the patient’s response to palpation of the surgical site (Image 3).

Assigning a numerical score using a dynamic interactive visual analog scale (eg, from 0 for no pain to 10 for the worst possible pain for that procedure).

The re-evaluation interval will depend on the procedure, expected duration of the chosen intervention, and previous pain score. Variability by different observers can be minimized by having the same team member assess the patient throughout the evaluation period. Ideally, the individual patient’s normal temperament should be known for the purposes of comparison with postsurgical appearance and behavior.

**Chronic pain: characteristics and causes**

Chronic pain is usually described as either pain that persists beyond the normal healing time or pain that persists in conditions where healing has not or will not occur. In some cases, pain signaling persists in the absence of gross tissue pathology.

The following basic principles are relevant to chronic pain in companion animals:

- Pet owners may not appreciate their pet’s behavior as being an indicator of chronic pain; however, what they might see is increasingly diminished function and mobility that indicate progressive disability. Examples include:
  - Diminished exercise tolerance and general activity.
  - Difficulty standing, walking, taking stairs, jumping or getting up.
  - Decreased grooming (cats especially; Image 4).
  - Changes in urination or defecation habits (Image 5).

- Under-recognized and undermanaged chronic pain can result in premature euthanasia. Conversely, proper recognition and management of chronic pain can be as life preserving as any other medical treatment in veterinary medicine.

- Degenerative joint disease (DJD) is the inclusive terminology that includes osteoarthritis (OA). Although DJD and OA are often used interchangeably in the literature and in practice, the broader term, DJD, will be used throughout these Guidelines.

**Multifactorial clinical measurement instruments for chronic pain**

Observation or reports (eg, in a pre-examination questionnaire) of behavioral changes or abnormalities is the first consideration in recognizing and assessing pain. Thereafter, several standardized, multifactorial CMIs for chronic pain are available to veterinarians, as summarized in Table 2. Such CMIs are chronic pain indices that primarily utilize pet owner observations and input. Ideally, patients with chronic pain should be evaluated with one of the multifactorial CMIs.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Multifactorial CMIs for chronic pain assessment in veterinary medicine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helsinki Chronic Pain Index (HCPI)</td>
<td></td>
</tr>
<tr>
<td>Canine Brief Pain Inventory (CBPI)</td>
<td></td>
</tr>
<tr>
<td>Cincinnati Orthopedic Disability Index (CODI)</td>
<td></td>
</tr>
<tr>
<td>Health-Related Quality of Life (HRQL)</td>
<td></td>
</tr>
<tr>
<td>Liverpool Osteoarthritides in Dogs (LOAD)</td>
<td></td>
</tr>
<tr>
<td>Feline Musculoskeletal Pain Index (FMPI)</td>
<td></td>
</tr>
</tbody>
</table>

Proper recognition and management of chronic pain can be as life preserving as any other medical treatment in veterinary medicine.
**Pharmacologic intervention of pain**

Effective pain management generally involves a balanced or multimodal strategy using several classes of pain-modifying medications. The rationale behind this approach is that it addresses targeting multiple sites in pain pathways, potentially allowing lower doses of each drug and minimizing the potential for side effects associated with any single drug. The choice of medication should be based on anticipated pain levels and individual patient needs. Anticipatory analgesia provided prior to pain onset is more effective than analgesia provided once pain has occurred, contributing to both a dose- and anesthetic-sparing effect.

**Opioids**

Opioids are the most effective drug class for managing acute pain and can play a role in managing chronic pain. An improved understanding of neuropharmacology and the development of novel formulations of opioids make it incumbent on veterinarians to remain familiar with their modes of action; the various subtypes within this drug class; and the prevention, recognition and treatment of adverse effects.

While a complete discussion of opioids is beyond the scope of these Guidelines, the Task Force makes the following recommendations for using this class of drugs in dogs and cats:

- Opioids should be used as a routine preoperative medicant, preferentially in combination with a tranquilizer/sedative (eg, acepromazine, midazolam, diazepam or α-2 adrenergic agonist such as dexmedetomidine), when the patient’s condition warrants their use.
- Full μ agonists elicit greater and more predictable analgesia than partial μ agonists or κ agonists. In dogs, the μ antagonist/κ agonist butorphanol, in particular, appears to provide limited somatic analgesia and a very short duration of visceral analgesia.\(^{12,13}\)
- In a comparison study, buprenorphine administered before surgery and during wound closure provided adequate analgesia for 6 h following ovariohysterectomy in cats, whereas butorphanol did not.\(^{14}\)
- In cats, the subcutaneous (SC) route of opioid administration is not recommended. Intramuscular (IM) and intravenous (IV) routes are preferred both pre- and postoperatively.\(^{15}\) The oral transmucosal or buccal route of administration for buprenorphine may have clinical efficacy as well.\(^{16,17}\)
- The individual effect of any opioid, including duration, may vary widely from patient to patient. Postoperative re-evaluation should be made frequently to determine ongoing opioid requirements.

- For a patient undergoing major surgery, whereby ongoing opioid administration can be anticipated, the clinician may choose from the following strategies:
  - Periodic readministration of parenteral opioids.
  - Constant or variable rate infusion. Calculators can be found online.
  - Long-acting formulations and technologies. For dogs there is a Food and Drug Administration (FDA) approved transdermal fentanyl product (Recuvrya; Elanco). Given this canine fentanyl product on the market, the Task Force discourages the use of human commercial fentanyl patches in dogs due to highly variable pharmacokinetics, and risk of either accidental or purposeful human exposure, with potential liability for extralabel use. There is not an expert consensus regarding the utility of fentanyl patches in cats. The FDA has more recently approved a concentrated injectable buprenorphine product for cats (Simbadol; Abbott), which has been formulated to provide a 24 h duration of action when administered as directed.
  - Oral opioids. Dogs exhibit a robust first-pass effect on oral opioids. No clinical studies document efficacy, but pharmacokinetics of codeine and hydrocodone suggest possible utility.\(^{18}\) No comparable studies exist for cats.
- Opioids are synergistic with α-2 adrenergic agonists, allowing them to be used in low-dose combinations, either with or without ketamine, to great effect for both sedation and analgesia.
- Opioids play a significant role in human medicine for the treatment of chronic pain and may play an underappreciated role in dogs and cats as well, especially for cancer-related pain and in palliative care patients. That said, clinicians must be vigilant with regard to long-term adverse effects such as constipation, drug tolerance and the potential for diversion by clients.

**Non-steroidal anti-inflammatory drugs**

The majority of conditions that cause pain have an inflammatory component. Non-steroidal anti-inflammatory drugs (NSAIDs) are a mainstay for management of chronic pain as well as for perioperative use. NSAIDs should be used for their central and peripheral effects in both dogs and cats after consideration of risk factors. There is no indication that any one of the veterinary-approved NSAIDs is associated with any greater or lesser incidence or prevalence of adverse events.\(^{19}\) Canine and feline veterinary-approved
**Obtain a complete medication history**. Avoid or use extreme caution with concurrent or recent use of NSAIDs and/or corticosteroids (including some nutritional supplements that may contain aspirin or other cyclooxygenase-inhibiting mechanisms). Practitioners should observe the following additional precautions due to potential drug interactions:

- Avoid with furosemide and use caution with angiotensin-converting enzyme inhibitors.
- Avoid with potentially nephrotoxic drugs (eg, aminoglycosides, cisplatin).
- Caution with use of additional multiple highly protein-bound drugs (eg, phenobarbital, digoxin, ciclosporin [cyclosporine], cefovecin, chemotherapy agents).

**Be discriminating in patient selection**. Be cautious or avoid NSAIDs in patients with the following existing/anticipated conditions:

- Low-flow states such as dehydration, hypovolemia, congestive heart failure and hypotension. In such cases, IV fluid support and blood pressure monitoring should be available for anesthetized animals.
- Renal, cardiac or hepatic dysfunction.

**Provide verbal and written client instructions** to avoid the medications described above and to discontinue and alert the hospital at the first sign of an adverse event (see below).

**Recognize the earliest signs of adverse events and withdraw NSAID treatment immediately** if those events occur, especially in the case of any GI signs in dogs and cats with diminished appetites.

**Perform laboratory monitoring**. The frequency will depend on the risk factor of the patient:

- Ideally within the first month of initiating therapy then 6 monthly thereafter in low-risk patients.
- For at-risk patients, monitor every 2–4 months depending on risk factor assessment.

**Utilize a balanced, integrated analgesic approach as part of NSAID-sparing strategies**.

**Consider washout periods**. Clinically relevant washout periods remain controversial and largely undefined. Based on pharmacokinetics, practitioners who wish to err on the side of caution may want to withhold meloxicam for 5 days and other NSAIDs or short-acting corticosteroids for 7 days prior to initiating treatment with another NSAID. In the case of long-acting corticosteroids, a longer washout period needs to be considered. Aspirin should not be administered because there are safer alternatives. If a course of treatment with aspirin has been started in a dog, the recommended washout period before starting an approved veterinary NSAID is up to 10 days.

**Use gastroprotectants** to either treat suspected gastropathy or prevent its occurrence, especially if no washout period occurs. Proton pump inhibitors, H2 antagonists, misoprostol (the drug of choice in humans) and sucralfate can be helpful.

**Dose optimization**. Base dosage on lean body weight. Although there is no definitive evidence that NSAID dose reduction lowers the risk of adverse events, some clinicians recommend titrating to the lowest effective dose.

NSAIDs have demonstrated acceptable safety profiles, which is in contrast to non-approved NSAIDs such as aspirin, ibuprofen, naproxen and meloxicam for human use.\(^{20-22}\) Long-term use of low-dose meloxicam is approved in cats in many countries other than the USA.

Adverse events related to NSAID use in dogs and cats can be minimized by appropriate use, as outlined in Figure 3. Although the overall incidence and prevalence of NSAID-related toxicity is unknown, it does appear to be very low relative to the number of doses administered.\(^{20}\)

Of the adverse events associated with NSAIDs, gastrointestinal (GI) toxicity is the most common. The GI clinical signs associated with NSAID toxicity in dogs include vomiting, diarrhea and inappetence.\(^{20,23-25}\) In cats, inappetence appears to be the most common adverse event. Although unlikely, it is possible for erosions and ulcers to be silent and occur prior to any clinical signs.\(^{23,26}\) Studies indicate that NSAIDs that spare cyclooxygenase (COX)-1 produce a lower frequency of GI lesions, although the more highly COX-2 selective inhibitors may actually produce more adverse events when underlying gastric damage is already present.\(^{19,27}\)

The leading risk factors for NSAID-associated GI perforations are incorrect dosing, concurrent use with other NSAIDs or corticosteroids, and continued use despite GI signs or anorexia.\(^{20,24}\) Signs of GI toxicity usually emerge within 2–4 weeks but can occur at any point during administration.\(^{28,29}\) It is critical that veterinarians communicate NSAID toxicity risk factors to pet owners (eg, providing client information that describes potential side effects, including the commercial circulars provided by drug manufacturers and instruction on when to stop medication and contact a veterinarian).
Another important side effect associated with NSAIDs is nephrotoxicity. When administered before anesthesia in healthy dogs with controlled modest hypotension, no adverse effect on renal function was detected. However, because some dogs in those studies did develop changes in renal parameters, the importance of maintaining a normotensive state during anesthesia is considered paramount when utilizing preoperative NSAIDs. Preoperative administration in dogs is superior in efficacy to postoperative use, consistent with results of multiple studies performed in humans. Similar studies have not been conducted in cats undergoing anesthesia, but one feline study revealed no alteration in glomerular filtration rate measured by iohexol clearance after 5 days of oral meloxicam. If IV access is not possible and normotension cannot be achieved with certainty, the Task Force recommends limiting the use of NSAIDs to postsurgical administration.

Idiosyncratic hepatocellular necrosis has been reported with various NSAIDs but remains exceedingly rare, at only 1.4 cases/10,000 dogs (0.052%), usually occurring between 2 and 4 weeks after starting treatment. Pre-existing elevated liver enzymes are not a risk factor. Idiosyncratic hepatocellular necrosis is not a true toxicosis but rather an intrinsic, heritable reaction to the molecule being administered.

Highly COX-2 selective NSAIDs have caused delayed bone healing in rabbit and rodent models, and one study in dogs demonstrated delayed healing of experimental tibial osteotomies following long-term NSAID use. That particular study may not be a clinically relevant model, and another study reported that normal tissue healing is rapidly restored once the NSAID is withdrawn. Further, of 299 dogs receiving deracoxib, carprofen and firocoxib in the FDA-approval process, none were reported to have delayed fracture healing or non-union fractures. Finally, no clinically significant bleeding dyscrasias have been reported with the use of veterinary NSAIDs.

Local anesthetics
This is the only class of drug that renders complete analgesia. The totality of evidence in human and animal studies reveals the predictable analgesic and anesthetic drug-sparing effects of local anesthetics. In addition, local anesthetics are reported to be antimicrobial and immunomodulating, and can diminish postoperative maladaptive pain states. They do not appear to delay tissue healing. Local anesthetics can be administered either directly at a simple incision site or at a specific nerve to provide analgesia to a large region (or area). A discussion of the many locoregional blocks that can be utilized in dogs and cats is beyond the scope of these Guidelines, but can be found in several readily accessible resources, and most of those blocks can be readily learned by clinicians.

Local anesthetics are considered safe, with adverse events generally limited to very high doses or inadvertent IV administration (bupivacaine especially). The Task Force supports the International Veterinary Academy of Pain Management position that, because of their safety and significant benefit, local anesthetics should be utilized, insofar as possible, with every surgical procedure.

α-2 Adrenergic agonists
α-2 Adrenergic receptors are located with opioid receptors. Thus, used together, opioids and α-2 adrenergic agonists are highly synergistic for sedation and analgesia. α-2 Agonists have a versatile dosing profile. That allows low- and even micro-doses in combination with opioids to be clinically useful and minimizes the cardiovascular effects. Clinicians should be mindful that cardiovascular side effects occur even with very low doses of α-2 adrenergic agonists, that lower doses will have a shorter duration of effect, and that analgesic effects have a shorter duration than the sedative effects.

Ketamine
Ketamine exerts a pain-modifying effect via its N-methyl-D-aspartate receptor antagonist actions. Subanesthetic ketamine constant rate infusion (CRI) in humans prevents pain and has antihyperalgesic and antiallodynic effects. Studies appear to support a similar clinical effect in dogs, although the analgesic effect of ketamine has not yet been studied in a feline surgical model. The International Veterinary Academy of Pain Management has adopted a position that the pain-modifying effects and safety profile of subanesthetic doses of ketamine warrant its use as part of a multimodal approach to transoperative pain management, especially in patients with risk factors that may predispose them to either exaggerated or maladaptive pain states.

Therapy should be focused on the underlying cause of pain (nociceptive, inflammatory or pathological) rather than on arbitrary labels based on duration.
Systemic lidocaine
There is strong evidence of the safety and beneficial effects of IV lidocaine on pain after abdominal surgery (although not for other surgeries eliciting somatic pain) in humans and possibly in horses, including both analgesia and return of bowel function.41 IV lidocaine is anesthetic-sparing in dogs and cats, but current evidence for a pain-modifying effect in these species remains inconclusive.42 Some investigators discourage the use of IV lidocaine in cats due to negative cardiovascular effects, but successful use in clinical practice has been anecdotally reported.43 Various formulations for a combination of morphine, lidocaine and ketamine CRIs have been described in dogs.44

Tramadol
In contrast to humans, tramadol in dogs has a very short half-life (1.7 h) and negligible amounts of the opioid M1 metabolite are produced.45-48 Pharmacodynamic studies demonstrate the anesthetic-sparing and pain-modifying effect of parenteral tramadol in dogs.49-53 Convincing evidence for a pain-modifying effect of oral tramadol, however, remains elusive, and already low plasma levels quickly diminish with sequential administration.54-57 One small study of oral tramadol did report a statistically significant increase of mechanical threshold levels in dogs, but only at the 5 and 6 h time points.48

In contrast to dogs, cats do produce the μ-agonist M1 metabolite. A pain-modifying effect has been demonstrated in both a thermal threshold and clinical surgical model.58,59 There is one case series involving the use of oral tramadol in a flavored compounded form (the drug is otherwise quite bitter). Dose titration, toxicity and safety data are currently lacking in both dogs and cats.60

Gabapentin
Gabapentin is an anticonvulsant with analgesic properties that may be primarily derived by down-regulating calcium channels.61 Because of its efficacy and tolerability, gabapentin is widely used in humans with neuropathic and other maladaptive pain conditions.62 Along with published clinical case reports in animals, the data suggest a strong rationale for using gabapentin in dogs and cats with similar conditions.63,64 One canine study suggested a disease-modifying effect in experimental DJD, but clinical studies are lacking.65 In cats, one unpublished study demonstrated a benefit of gabapentin in naturally occurring DJD (E Troncy 2013), and one case series of chronic musculoskeletal pain has also been published.66

There is encouraging evidence to support the use of gabapentin for postsurgical pain in humans,67-72 but not yet in dogs and cats. An 8–12 h dosing interval has been suggested based on one publication.73 The primary adverse effect in dogs appears to be somnolence (also the case in humans), which usually resolves with patient acclimation over several days, allowing for a tapering-up schedule.

Amantadine
Amantadine exerts a pain-modifying effect as an N-methyl-D-aspartate receptor antagonist and remains a drug of interest for chronic pain (but not specifically for DJD) in humans.74 One study demonstrated utility as an adjunct to NSAIDs in dogs with refractory DJD,75 and there is one case report utilizing amantadine to treat neuropathic pain in a dog.76 Toxicity and pharmacokinetic studies have been performed in humans and cats,77,78 but not in dogs.

Tricyclic antidepressants
As a class, tricyclic antidepressants (TCAs) are the most effective medications for selective neuropathic pain conditions in humans.79 In dogs, there exists only a single case report where amitriptyline was used for neuropathic musculoskeletal pain.80

Selective serotonin (norepinephrine) reuptake inhibitors
These compounds exert their effect by increasing serotonin with or without norepinephrine in the synaptic cleft. At least one selective serotonin (norepinephrine) reuptake inhibitor (SS[N]RI), duloxetine, has a chronic pain label indication in humans. In dogs, bioavailability is poor and clinical efficacy is lacking.81

At this point in the Guidelines, the Task Force wants to emphasize the following:

Many drugs and compounds enhance either monoamines or serotonin expression. Caution should be used when such analgesic agents are used in combination. Examples include tramadol, TCAs (including amitriptyline and clomipramine), SS[N]RIs, amantadine, metoclopramide, selegiline, amitraz, mirtazapine and trazodone.

Acetaminophen
Acetaminophen is contraindicated in cats. In dogs, several early studies revealed a pain-modifying effect in orthopedic surgery, and pharmacokinetic data have been reported.82-84 The literature does not appear to indicate that acetaminophen has a proclivity towards hepatotoxicity in dogs.
Maropitant
Maropitant is a central antiemetic indicated for the treatment of acute canine and feline vomiting, which is often a postsurgical sequela and a contributor to the pain burden. Maropitant works through a blockade of substance-P binding to the neurokinin-1 receptor, which is involved in pain processing. The true pain-modifying effect of maropitant in dogs remains uncertain despite canine studies revealing an anesthetic-sparing effect and a non-inferior effect to morphine in an ovariohysterectomy model.\textsuperscript{85,86}

Bisphosphonates
Administered by IV infusion, this class of drug exerts antosteoclast activity and can contribute to pain relief in dogs with bone cancer.\textsuperscript{87}

Corticosteroids
Corticosteroids are not primarily analgesic drugs, but may exert a pain-modifying effect by reducing inflammation. Their utility as an analgesic therapy in dogs and cats has not been reported.\textsuperscript{88–89}

Polysulfated glycosaminoglycans
A parenterally administered polysulfated glycosaminoglycan (PSGAG) product has regulatory approval for the control of signs associated with non-infectious degenerative and/or traumatic arthritis of canine synovial joints. Independent studies support PSGAGs as safe and effective chondroprotectants with possible disease-modifying effects.\textsuperscript{92–94}

The bioavailability and distribution of PSGAGs to inflamed joints in cats has been demonstrated with extra-label SC administration.\textsuperscript{95}

Nutraceuticals and other oral supplements
Oral nutritional supplements represent a wide spectrum of compounds either as single agents or in combinations. Anecdotal evidence for a pain-modifying effect of those products remains mixed. If nutraceuticals and/or herbal supplements are made part of a treatment plan, the Task Force suggests mindfulness towards product quality control; awareness of the potential for drug interactions with other medications (eg, some over-the-counter joint products and herbal mixtures contain aspirin and some may contain herbs such as St John’s wort that interfere with serotonin release or reuptake); and avoidance of ingredients derived from endangered species.

In the future, evidence for the pain-modifying effect of cannabinoids and/or their commercial drug derivatives may become evident.

Increasingly, evidence-based data and empirical experience justify a strong role for various non-pharmacologic modalities for pain management.

Non-pharmacologic modalities for pain management

Weight optimization
Adipose tissue secretes a mixture of cytokines that circulate throughout the body, contributing to the pathology of many diseases, including DJD, and to the hypersensitization process in general. Either maintaining or regaining a lean body condition score is central to the treatment of chronic pain.

Acupuncture
The Guidelines Task Force holds that acupuncture offers a compelling and safe method for pain management in veterinary patients and should be strongly considered as a part of multimodal pain management plans.\textsuperscript{96} It is a minimally invasive treatment that, for most animals, is not uncomfortable, often pleasant, and can be used either alone or in addition to other pain treatment modalities (Image 6). Acupuncture has been recognized by the National Institutes of Health since 1998 as having applications in human medicine, especially pain management. There is a solid and still growing body of evidence for the use of acupuncture for the treatment of pain in veterinary medicine to the extent that it is now an accepted treatment modality for painful animals.\textsuperscript{97–101}

Image 6 Note how comfortable cats usually are for acupuncture therapy. Courtesy of Sheilah Robertson
Physical rehabilitation
Combined modality therapy to decrease pain and restore function is now considered an essential approach for musculoskeletal injury and postsurgical recovery. In the treatment of chronic disease, such as DJD or conformational abnormalities, rehabilitation should be considered an important component of an overall long-term treatment strategy.

The foundation of rehabilitation is therapeutic exercise that aims to restore musculoskeletal strength and function, endurance and proprioception, and reduce pain. Most commonly it involves exercise and manual therapy, including joint mobilizations, massage and myofascial release. Energy-based modalities are also often employed, including neuromuscular electrical stimulation, transcutaneous electrical nerve stimulation, cryotherapy with and without compression, therapeutic ultrasound, therapeutic laser and extracorporeal shockwave therapy.

Myofascial pain syndrome (MPS) is increasingly recognized as an important comorbidity in many chronic pain cases in animals. MPS is acknowledged for its importance role it plays in the pathology of DJD, repetitive strain injuries in performance dogs, or as a sequela to orthopedic surgery. The pathophysiology of myofascial pain is a complex syndrome involving motor, sensory and autonomic nerve components that is beyond the scope of these Guidelines, but is well described elsewhere. Treatment of MPS is often essential to regain full function of the affected limb, regardless of the underlying cause.

Nutrition management
In the overweight patient, the prime nutritional emphasis should be achieving a leaner body condition. Weight control diets fortified with omega-3 fatty acids have been shown to be effective at reducing signs associated with both canine and feline DJD.

Thermal modification
In acute injury, including surgical areas, cold compression has a demonstrable benefit in reducing pain and inflammation, and promoting return to function. In the case of chronic injury, heat can improve comfort and function through a variety of mechanisms.

Environmental modifications
There is strong evidence that the stress of hospitalization inhibits normal behaviors in animals, including eating, grooming, sleeping and elimination. Fear, anxiety, stress and distress lead to hyperalgesia in both humans and animals. Strategies to mitigate hyperalgesia, therefore, include providing bedding, blankets or clothing from home with familiar scents; allowing visitation of hospitalized pets; separating the dogs from the cats; placing cages so that animals do not see each other; using species-specific synthetic pheromones; and proper handling, especially during procedures (see box on page 262).

In patients with DJD, throw rugs and ramps will improve mobility and abilities at home (Image 7).

Chiropractic care
The Guidelines Task Force has not found sufficient, reliable, non-contradictory evidence for the use of chiropractic care for pain management in veterinary medicine at this time. That said, chiropractic care has many well-defined applications in human medicine that have been supported through reliable research.

Homeopathy
Incontrovertible evidence that homeopathy is effective in either human or veterinary medicine for the treatment of pain is lacking. Sole reliance on homeopathy to treat a painful condition is, in essence, withholding pain treatment. Thus, this Task Force discourages the use of homeopathy for the treatment of pain.
Managing surgical pain

The Task Force suggests that pain management for dogs and cats undergoing a surgical procedure includes the following:

- A peroperative opioid plus a tranquillizer/sedative (e.g., acepromazine and midazolam or diazepam and dexmedetomidine).
- Administration of an NSAID either pre- or postoperatively based on patient risk factors and clinician preference.
- A local anesthetic.

For patients undergoing procedures with risk factors for more severe, protracted or maladaptive postoperative pain states, the following interventions or drugs should be strongly considered:

- Cold compression.
- α-2 Adrenergic agonist.
- Ketamine CRI.
- Lidocaine CRI.
- Gabapentin.
- Epidural anesthetic(s).
Managing pain associated with DJD

Overview of DJD in companion animals

DJD, including OA, is one of the most significant and underdiagnosed diseases of cats and dogs. DJD is clinically relevant because of its overall prevalence and universal incidence in older animals. Whereas diagnostic approaches for canine DJD are well established, the best tools for diagnosis of feline DJD are still being developed.

The pain treatment continuum for DJD begins with the onset of disease, which usually starts at a very young age in dogs (eg, conformational etiology) and cats (unknown etiology), and persists throughout the animal’s life. Perhaps more so than any other pain condition, the management of DJD benefits from an integration of both pharmacologic and non-pharmacologic treatments. Once a diagnosis is made, treatment goals, expectations and outcome measures should be considered prior to initiating any treatment. The care-giver is an essential part of any treatment program and should be considered a part of the team.

Canine DJD: therapeutic considerations

Because early intervention can delay the onset and severity of DJD, the Task Force emphasizes that chief among all preventive and treatment modalities for canine DJD is weight optimization. Maintaining a lean body condition from an early age demonstrably minimizes DJD development in predisposed breeds. In overweight patients, weight loss alone, even a modest 6.1–8.85%, improves clinical signs of DJD.

There is strong evidence to support the use of NSAIDs for the management of DJD pain in dogs. Data on the safety and efficacy of long-term NSAID administration in dogs appear to suggest an overall benefit from this modality for a sustained period of time at labeled doses and intervals, provided the patient does not have additional risk factors. NSAID therapy should be tailored to suit every individual patient’s needs. Veterinary NSAIDs studied for chronic use (between 28 days and 1 year) demonstrated satisfactory safety profiles in dogs, with 95–97% of dogs able to receive their NSAID at labeled doses and intervals without adverse effects for the duration of the study.

There is currently no evidence that a higher risk for NSAID-induced adverse effects exists as the duration of treatment increases. Some dogs may require several weeks of NSAID treatment before clinical improvement is noted.

In addition to NSAIDs, there are other options to consider. First, PSGAGs are more likely to have a beneficial effect when given early in the disease process. As mentioned earlier, an FDA-approved product with established efficacy and safety is available. Secondly, data supporting analgesia and functional improvement from therapeutic exercise are well established in humans and are beginning to accrue in dogs. Thirdly, a systematic review analyzing data from several placebo-controlled blinded studies affirmed the utility of diets rich in eicosapentaenoic acid for dogs with DJD. Various other strategies can be (and often are) employed, but their supporting evidence is weak, conflicting or altogether lacking at present.

Feline DJD: therapeutic considerations

Until the early 2000s, little attention was paid to DJD in cats; however, estimates from published studies suggest that 40–92% of all cats may have some clinical signs associated with DJD. Feline DJD is now recognized as a serious welfare problem, particularly in older cats, which is a rapidly growing demographic. The most frequently affected joints appear to be the hip, stifle, tarsus, elbow, thoracolumbar and lumbosacral area. For each 1 year increase in a cat’s age, the expected total DJD score increases by an estimated 13.6%. Moreover, there is a dramatic increase in the prevalence and burden of DJD at about 10 years of age. A diagnosis of feline DJD is based on a thorough history reflecting changes in behavior and lifestyle, physical exam findings (Image 8), and possible radiographic evidence.

Perhaps more so than any other pain condition, the management of DJD benefits from an integration of both pharmacologic and non-pharmacologic treatments.
Behavioral changes are the most common signs of DJD-associated pain in cats. Feline DJD is usually bilateral—so, although cats rarely limp, they are likely to be stiff, have a less fluid gait, become less active (especially at night) and exhibit decreased jumping frequency or jumping height. Owners often note that their cats are very stiff going up or down stairs. The cat may resist handling, petting, or stroking of the back or limbs. Showing the owner a list of the common pain-related behaviors caused by DJD is helpful in making the diagnosis (Table 3).

It should be assumed that a senior cat has some DJD, and every effort should be made to incorporate gentle handling techniques (Images 9 and 10) and padded surfaces for the cat to lie on during the exam. A positive clinical response to analgesics will also indicate the presence of DJD. The first validated clinical metrology tool for the evaluation of feline musculoskeletal pain has now been produced and is available for use in practices (see Table 2).  

NSAIDs are the mainstay of pharmacologic treatment for DJD in other species, and there is considerable evidence to support their effectiveness in cats as well. In the USA, however, NSAIDs are not approved for long-term use in cats, and the potential side effects often deter many clinicians from routinely using them in cats. Renal toxicity is always a consideration with the use of NSAIDs; however, one retrospective study found that long-term use of meloxicam did not reduce the lifespan of cats >7 years of age with pre-existing, stable chronic kidney disease (CKD) compared with cats without CKD.

Low-dose meloxicam (ie, 0.01–0.03 mg/kg orally q24h) is effective in treating arthritic cats and is well tolerated, even in cats with CKD provided their clinical status is stable. Meloxicam is effective when administered once q24h and is palatable for most patients, making it easy to administer. In Europe, Australasia and many countries, meloxicam is approved for long-term use in cats at a dose of 0.05 mg/kg q24h. The oral route of administration and long-term use of meloxicam in cats remain off-label in the USA.

Robenacoxib is a COX-2 selective NSAID approved for surgical pain in cats. It has not been studied for either feline DJD or in older cats but there are long-term safety data in young cats (ie, 5 x the recommended dosage for 6 months and 10 x the recommended dosage for 6 weeks). Dosing on lean body weight, close monitoring of clinical status (especially appetite), regular laboratory monitoring, and appropriately modifying the treatment plan are recommended for cats receiving NSAIDs. NSAIDs should be used with caution on a case-by-case basis in cats with DJD, and cat owners should be advised that, in the USA, use of NSAIDs for feline DJD is an extra-label treatment.

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Signs of degenerative joint disease (DJD) in cats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavioral component</td>
<td>Indicators of DJD</td>
</tr>
<tr>
<td>Interaction with others</td>
<td>Withdrawal, hiding, increased ‘clinginess’, irritability when touched, aggression toward other cats or humans</td>
</tr>
<tr>
<td>Appetite</td>
<td>Declines but cat continues to eat</td>
</tr>
<tr>
<td>Posture</td>
<td>Hunched, head lowered, sitting or lying abnormally, squinting, facial expression indicating discomfort</td>
</tr>
<tr>
<td>Grooming</td>
<td>Declines, matting of fur, over-grooming of painful area</td>
</tr>
<tr>
<td>Litter box use</td>
<td>Decline in bowel movements, house soiling, inability to get into box</td>
</tr>
<tr>
<td>Play</td>
<td>Reduced overall, reduced jumping</td>
</tr>
<tr>
<td>Vocalization</td>
<td>Increased but decreased greeting and other pleasant vocalizations, hissing if touched on painful area, squinting if acute pain</td>
</tr>
<tr>
<td>Mobility</td>
<td>Not jumping as often or as high, hesitant to jump, difficulty getting up or down stairs, stiffness, less active, difficulty getting into or out of litter box, sleeping in more easily accessible locations</td>
</tr>
</tbody>
</table>

It should be assumed that a senior cat has some DJD, and every effort should be made to incorporate gentle handling techniques.
Treatment of DJD in cats should focus on environmental modification (Images 11 and 12) in addition to pharmacologic therapy. In addition to steps and ramps to facilitate access to favorite elevated areas, additional litter boxes with at least one low side will make access easier. Owners can also provide physical therapy by implementing play times using favorite toys to increase exercise and mobility.

**When pain persists: hospice and palliative care**

Hospice is designed to provide compassionate comfort and care to patients at the end of their lives and to support their families in the bereavement process. Hospice care for terminally ill patients is recommended when life expectancy is less than 6 months. Palliative care is the active, total care of patients with disease that is not responsive to curative treatment, with pain control being the paramount feature. The goal is achievement of the best quality of life (QoL) for patients and their families. This assumes ongoing assessment of QoL in the terminally ill patient. User-friendly QoL assessment scales are available to help veterinarians, veterinary staff and owners make proper assessments and decisions at the end of a patient’s life.150 It is generally agreed that the pet’s care-giver is best suited to evaluate QoL, but a team approach (discussed on page 266) emphasizing regular communication is important to provide empathetic support when end-of-life decisions are made.

An integrated approach that includes non-pharmacologic modalities is typically best for palliative care and hospice patients with cancer because their disease is often associated with features of both acute and chronic pain. In cases of palliative radiation, either a smaller number or lower doses of radiation can make treatment protocols more tolerable for the patient and agreeable to the owner.

Environmental modification, physical therapy (eg, massage, acupuncture and therapeutic laser) or ultrasound can be useful additions to the pain management plan. Providing nutritional support via feeding tube can be helpful where eating is otherwise difficult or painful.

In cases involving hospice and palliative care, it is important to encourage clients to have realistic expectations of the outcomes involving their pets. As well as explanations of probable outcomes, this involves providing the client with end-of-life choices involving the pet. Euthanasia is an option that relieves pain and suffering and should be discussed as a reasonable and humane alternative at an appropriate point. Euthanasia may be a topic that the veterinary team initiates if the pet owner does not.

**Euthanasia is an option that relieves pain and suffering and should be discussed as a reasonable and humane alternative at an appropriate point.**
A team approach and client education: creating an environment for success

Primary care practices should be committed to educating the healthcare team and its clients about prevention, recognition, assessment and treatment of pain. A team approach and consistent pain management messages directed at clients will help ensure patient comfort at all stages of treatment. The client is often considered the most important member of the healthcare team.

Each healthcare team member should be able to recognize pain-associated behavior in animals, as described earlier in these Guidelines, and know how to respond appropriately. Table 4 provides examples of how healthcare team members should respond to patients experiencing pain.

Staff training and education

Ideally, every healthcare team member should have a defined role in managing animal pain. Staff and client education should address conditions associated with pain; its prevention and treatment; and appropriate interaction, handling and nursing care involving the patient. Medical rounds and staff meetings are effective tools in making sure that all staff members are aware of the individualized pain management needs of every hospitalized patient. Having a patient advocate for each hospitalized animal will enable a highly accurate and individualized evaluation of the patient and ensure successful treatment. Recall that Table 1 lists pain indices relying on observation and input by clinical personnel. Those assessment tools complement the pain-scoring instruments based on owner observation and input, which are listed in Table 2.

Client education and instructions

With each pain management plan, it is important that the client be given specific instructions, both verbally and in writing. Potential adverse drug effects and action to be taken should be emphasized. It is advisable to provide a hands-on demonstration of how to administer medications and handle the pet at home. To reinforce verbal information about pain assessment, provide handouts that discuss general information about animal pain and any side effects of medications. Compliance will improve if the pet owner understands the treatment schedule and a demonstration of how to administer oral medications is given. Clients should be encouraged to address their concerns about the pet’s condition and treatment plan via e-mail, phone or follow-up consultations.

Acknowledgements

These Guidelines were prepared by a Task Force of experts convened by the American Animal Hospital Association and the American Association of Feline Practitioners. The AAHA secured sponsorship of an educational grant in accordance with their policies from Abbott Animal Health, Elanco Companion Animal Health, Merial and Zoetis. This report was subjected to review in accordance with both AAFP and AAHA policies.

Funding

These Guidelines were supported by an educational grant to AAHA from Abbott Animal Health, Elanco Companion Animal Health, Merial and Zoetis.

Conflict of interest

Mark Epstein has previously consulted for Abbott, Elanco and Merial. Sheilah Robertson is a key opinion leader for Novartis Animal Health.
Table 5  Summary of appropriate interventions for pain in dogs and cats

<table>
<thead>
<tr>
<th></th>
<th>Approved NSAIDs</th>
<th>Other analgesic drugs</th>
<th>Opioid premed ± tranquilizer/sedative</th>
<th>Local and/or regional anesthetic</th>
<th>Chondroprotectants (GAGs)</th>
<th>Acupuncture</th>
<th>Therapeutic joint diets</th>
<th>Therapeutic exercise</th>
<th>Weight management</th>
<th>Lifestyle/environmental change</th>
<th>Optimal surgical technique</th>
<th>Other non-pharma interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>DJD dog</td>
<td>X X</td>
<td>X (1)</td>
<td>X X X X X X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DJD cat (with CKD)</td>
<td>X (2)</td>
<td>X (1)</td>
<td>X X X X X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soft tissue abdominal surgery</td>
<td>X X (3)</td>
<td>X X X</td>
<td>X X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dental surgery</td>
<td>X X (3)</td>
<td>X X</td>
<td>X X X X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orthopedic procedure</td>
<td>X X X X X X X X X (4)</td>
<td>X (4)</td>
<td>X X X (4) X (4) X (4) X (4) X (4) X (4) X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital procedures:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV catheterization</td>
<td>X (5)</td>
<td>X (8)</td>
<td>X (6) X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urinary catheterization</td>
<td>X (9)</td>
<td>X (10)</td>
<td>X (6) X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bone marrow aspiration</td>
<td>X (9)</td>
<td>X</td>
<td>X (6) X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiography (painful and/or arthritic patient)</td>
<td>X (9)</td>
<td>X</td>
<td>X (6) X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anal sac expression</td>
<td>X (9)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ear cleaning</td>
<td>X (7)</td>
<td>X (7)</td>
<td>X (6) X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thoracocentesis and/or abdominocentesis</td>
<td>X X (9)</td>
<td>X</td>
<td>X (6) X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. Local or regional analgesia may be useful in localization of pain and short term relief of significant DJD pain
2. See discussion on pages 256–258 concerning the use of non-steroidal anti-inflammatory drugs (NSAIDs) in cats
3. The addition of other analgesic drugs will depend on patient characteristics and extent of the procedure
4. These interventions will be helpful pre- and postoperatively for the relief and/or prevention of postoperative and chronic pain
5. Ideally premedications should precede other preparations for general anesthesia such as placement of an IV catheter
6. These are invasive procedures and should be treated as such to optimize patient care and minimize trauma/tissue damage and post-procedural pain
7. The level of intervention will be tailored to the invasiveness of the procedure. Deep ear cleaning will require more significant intervention than superficial cleaning in most cases
8. In non-emergency settings (eg, routine pre-surgical application)
9. Chemical restraint in lieu of manual restraint when patient is fractious, distressed or otherwise intolerant of the procedure
10. Sterile lidocaine lubricant; caution in cases of urethral or bladder mucosal damage
GAGs = glycosaminoglycans, CKD = chronic kidney disease, DJD = degenerative joint disease

Abbreviations used in the Guidelines

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAHA</td>
<td>American Animal Hospital Association</td>
</tr>
<tr>
<td>AAFP</td>
<td>American Association of Feline Practitioners</td>
</tr>
<tr>
<td>CKD</td>
<td>Chronic kidney disease</td>
</tr>
<tr>
<td>CMI</td>
<td>Clinical measurement instrument</td>
</tr>
<tr>
<td>CRI</td>
<td>Constant rate infusion</td>
</tr>
<tr>
<td>COX</td>
<td>Cyclooxygenase</td>
</tr>
<tr>
<td>DJD</td>
<td>Degenerative joint disease</td>
</tr>
<tr>
<td>GAGs</td>
<td>Glycosaminoglycans</td>
</tr>
<tr>
<td>GI</td>
<td>Gastrointestinal</td>
</tr>
<tr>
<td>IM</td>
<td>Intramuscular</td>
</tr>
<tr>
<td>IV</td>
<td>Intravenous</td>
</tr>
<tr>
<td>MPS</td>
<td>Myofascial pain syndrome</td>
</tr>
<tr>
<td>NSAID</td>
<td>Non-steroidal anti-inflammatory drug</td>
</tr>
<tr>
<td>OA</td>
<td>Osteoarthritis</td>
</tr>
<tr>
<td>PSGAG</td>
<td>Polysulfated glycosaminoglycan</td>
</tr>
<tr>
<td>SS(N)RI</td>
<td>Selective serotonin (norepinephrine) reuptake inhibitor</td>
</tr>
<tr>
<td>SC</td>
<td>Subcutaneous</td>
</tr>
<tr>
<td>TCA</td>
<td>Tricyclic antidepressant</td>
</tr>
<tr>
<td>QoL</td>
<td>Quality of life</td>
</tr>
</tbody>
</table>
SUMMARY POINTS

- Effective pain management is an essential component of companion animal medicine. It reduces disease morbidity, facilitates recovery, enhances quality of life, and solidifies the relationship between the veterinarian, client, and pet.
- Behavioral changes are the principal indicator of pain and its resolution, for which there are now several validated clinical scoring instruments.
- Pain is not an isolated event but instead exists either as a continuum of causation, progression and resolution or as a chronic condition. Thus, treatment of pain should consist of a continuum of care in the form of anticipatory analgesia through the anticipated pain period followed by longer term or even chronic treatment that relies on periodic reassessment of the patient’s response.
- Effective pain management is integrative in two respects. First, it does not rely solely on pharmacologic methods but also uses a variety of non-pharmacologic modalities; not least of those is gentle handling and nursing care of the patient in the context of a stress-free physical environment. When considering either non-pharmacologic methods or hospice care that may be outside the immediate skills or services provided by the primary practice, the veterinarian should have a list of experts for referral in place. A second aspect of integrative pain management is the multimodal use of medications that either block or modify multiple pain pathways. A multimodal approach also reduces reliance on any single agent, minimizing the potential for adverse drug events.
- Pain management in clinical practice is a team effort, with the pet owner functioning as an integral part of the team. All healthcare team members should have a defined role in the practice’s approach to providing compassionate care to its patients. That enables the practice to speak with one voice and in a consistent manner in the implementation of pain management protocols.
- Client education is a key component that enables the pet owner to manage pain in the home setting. Direct involvement of the client in pain management efforts is consistent with the continuum of care concept and a demonstration of the practice’s commitment to the pet’s quality of life.
- A fully integrated approach to pain management, involving recognition and systematic assessment, pharmacologic and non-pharmacologic methods, and including both healthcare team members and the pet owner, ensures that everything possible has been done to relieve a patient’s pain once it enters the practice’s care.

References

4 Woolf CJ. What is this thing called pain? J Clin Invest 2010; 120: 3742–3744.
14 Warne LN, Beths T, Holm M, et al. Evaluation of the periopera-
51 Kongara K, Chambers JP and Johnson CB. Effects of tramadol, morphine or their combination in dogs undergoing ovariohysterectomy on peri-operative electroencephalographic responses


100 Petermann U. Comparison of pre- and post-treatment pain scores of twenty one horses with laminitis treated with acupoint and topical low level impulse laser therapy. AJTCVM 2011; 6: 13–25.
122 Kim YM, Lee JK, Abd el-atty AM, et al. Efficacy of dog-appeasing pheromone (DAP) for ameliorating separation-related behav-
Clinical Practice

2015 AAHA/AAFP pain management guidelines


Available online at jfms.com and catvets.com

Reprints and permission: sagepub.co.uk/journalsPermissions.nav

For reuse of images only, contact the Task Force Co-Chairs
Due to their evolution as a solitary, self-dependent species, cats are masters at hiding illness and geniuses at concealing pain. Signs of pain in cats are often extremely subtle, especially in comparison to dogs. As a result, clients are often incorrect in their expectations of what they will observe if their cat is in pain. While we can safely predict that many medical procedures and all surgeries performed on cats cause pain, we are much less effective at predicting the pain that cats might be experiencing from arthritis, dental disease, urogenital disease, skin disease, and a host of other sources of pain. The clinician caring for cats must be able to identify historical evidence of pain through careful questioning, as well as to identify pain during outpatient visits through careful observation. It is important to note that many cats being labeled as ‘fractious’ or ‘bad-actors’ are often acting in a defensive mode towards clinic staff because they are in fact in pain. Looking at these patients from the perspective of pain management, we can be highly successful in reducing uncooperative behaviour in our feline patients.

**Identifying Pain: Outpatient Assessment**

Pain assessment should be part of every consultation and physical examination, regardless of the reason for the visit. Cats in all age groups should be assessed for evidence of pain.

Obtaining a clinical history with an aim to identifying pain in our feline patients can be challenging. The clinical signs of chronic pain may be even harder to discern, as the patient has learned to cope with the pain, often developing alternative strategies for pursuit of daily activities. Most clients expect specific and obvious signs of pain. They may expect painful cats to vocalize, limp, or otherwise show pronounced signs of their pain. They may attribute changes in behaviour related to pain as merely being due to aging. Some of the subtle behaviour changes associated with pain reflect the ten subtle signs of sickness in cats (see The Healthcare Needs of Cats).

When discussing pain with clients, even the suggestion that their cat might be in pain can be upsetting because it might make the client feel that they have been missing the signs in their cat for short or even long periods of time. It is helpful to start with a series of questions that are included as part of the history regardless of the reason for the visit (see inset: Questions to ask clients about potential signs of pain).

**QUESTIONS THAT ASSESS MOBILITY CAN BE A USEFUL TOOL:**

- Is your cat less willing to jump up or down than previously?
- Is your cat unable to jump as high as previously?
- Does your cat need to use a chair or other object to reach the same height as previously?
- Does your cat show hesitation when trying to jump up or down from objects?
- Does your cat play with other animals or toys less than previously?
- Does your cat have difficulty getting into or out of the litter box?
- Have there been changes in your cat’s litter box use (e.g., elimination near the litter box)?
- Does your cat show signs of being stiff when he/she walks or runs?
- Does your cat have stiffness after waking up that improves with movement?
- Does your cat have difficulty going up and/or down the stairs?
- Is your cat lame when walking or running?
Common comments used in rationalizing changes related to pain:

• ‘He is getting old’

• ‘Not jumping up as he used to’, ‘misses jumps’

• ‘Sleeps a lot, but that is normal for his age’

• ‘Not using the litter box because he is mad at us/me’

• ‘Just doesn’t like to sit on that perch anymore’

Out-patient Observation and Handling
Observation of the patient during the initial consultation can be very beneficial to the clinician in identifying signs of pain. While taking the history, allowing the patient to roam freely about the consultation room will give the clinician time to observe gait, posture, body condition, and overall mental status of the patient. Changes in any of these may indicate pain. Careful handling of patients during their visit is critical. An assumption that every patient is in pain will reduce the risk of hurting a patient or generating a defensive, potentially aggressive response.

Carriers that open from the top allow gentle lifting of the cat out in cases where the cat will not voluntarily exit the carrier. Cats should not be dumped or pulled from their carriers. An attention to feline friendly handling techniques is essential. If a client has specifically noted a part of their cat’s body that is painful, particular care should be taken when assessing that body part. During the physical examination, the patient should be assessed for pain. The patient may be reluctant to be handled, have painful dental disease, dehydration, cachexia, or obvious wounds indicating pain. More subtle signs of pain during palpation may include wincing, grimacing, pinning ears backward, shifting of body weight, flicking of the tail, and attempts to escape. If a patient has a confirmed history of pain, obvious physical change indicating pain, or if the clinician has an index of suspicion that the patient may be in pain, pain medication should be administered prior to proceeding with the physical examination.

Identifying Pain: In-patient Assessment
Hospitalized patients should be monitored, assessed, and treated for pain regularly throughout their hospital stay. Initial pain assessments should be based on the observations made of the patient during their out-patient visit. Development of a clinical pain index, whether formal or informal, will standardize pain scoring within the practice. Assignment of specific individuals to conduct these assessments should be based on appropriate training, experience, and skill level.

Validated pain scoring systems for cats have been more difficult to develop than for the dog. One acute pain scale and one chronic pain assessment tool are undergoing development and validation and are recommended for the general practitioner:

Acute post-surgical pain:
Glasgow Feline Composite Measure Pain Scale: https://www.wsava.org/sites/default/files/Feline%20CMPS%20-%20SF.pdf

Chronic musculoskeletal pain:

Pain Prevention, Treatment, and Management
The most effective analgesic protocols are multi-modal in nature. Combining drugs and therapies that influence different parts of the pain pathway results in improved efficacy and reduced risk of adverse effects.

Various analgesic drugs and protocols are available for cats. For management of acute and peri-operative pain, opioids form the cornerstone of treatment. Combining opioids with other treatments, such as non-steroidal anti-inflammatory drugs (NSAIDs), constant rate infusions and regional anesthesia, improves analgesic efficacy.

The World Small Animal Veterinary Association Global Pain Council has a list of suggested pain management protocols for different situations: http://www.wsava.org/guidelines/global-pain-council-guidelines
Other pain management modalities may be incorporated, including:

- Potential disease modifying agents (e.g., glucosamine/chondroitin, polysulfated glycosaminoglycans)
- Environmental modification
- Therapeutic diets
- Physiotherapy

While some objective signs of pain can be determined by questioning clients and by repeatedly observing hospitalized cats, the most reliable assessment of the presence of pain is a return to normal behaviour in response to analgesic therapy.

Frequent assessment for pain is critical, not so much to determine if analgesia should be used, but rather whether additional modalities should be incorporated, if dose adjustments are needed, and to determine an appropriate duration of treatment.

Identifying and Treating Pain: Musculoskeletal Disease

A common reason for chronic pain in cats is musculoskeletal disease, degenerative joint disease (DJD) or arthritis. Based on radiographic evaluation in a number of studies, there is strong evidence to indicate that even young adult cats can have DJD. Therefore, DJD must be considered as a potential source of pain, even in young patients. Appropriate feline friendly handling techniques and application of analgesics to reduce pain-related stress should always be foremost in the clinician’s mind. For chronic degenerative musculoskeletal disease, multi-modal analgesia and other modalities should be considered.

Analgesics which might be employed alone or in combination include:

- Gabapentin
- Guidelines for the long-term use of NSAIDs in cats have been published (see Resources)
- Short-term narcotics for severe pain

Alternative modalities which may be used as an adjunct for DJD therapy include:

- Chondroitin/glucosamine
- Polysulfated glycosaminoglycans
- Omega fatty acid supplements
- Therapeutic diets for joint disease
- Environmental management: Ensuring the patient’s environment is comfortable and that resources are easy to access will benefit both patient and client

In many cases, a response to therapy may be the most successful means of convincing clients that the cat is suffering from DJD pain. Ongoing evaluation via communication with the client, regular recheck examinations, and assessment of response to therapy will improve quality of life and reduce morbidity in patients suffering from DJD.

ADDITIONAL RESOURCES

2015 AAFP/AAHA Pain Management Guidelines for Dogs & Cats: Cathealthy.ca/catvetspainmanagement


References available on request
For hospitalized cats, signs of fear and anxiety may be similar to signs of pain. For example, body temperature and blood pressure are difficult to use as assessments of pain. Some observations that can assist in the recognition of pain include:

- Tachycardia that persists after initial examination may suggest pain rather than fear or anxiety
- Tachypnea is frequently an indicator of pain; this is most easily evaluated by looking at the cranial abdomen, just caudal to the last rib
- Sitting in the back of the hospital cage rather than being interactive and interested may be a sign of pain or of fear
- Localized and repeatable discomfort on palpation of a body part may be more associated with pain than fear
- Changes in the patient’s behaviour; a normally compliant patient becomes defensive or vice versa

QUESTIONS TO ASK OWNERS ABOUT POTENTIAL SIGNS OF PAIN:

- Have you noticed changes in your cat’s sitting or sleeping position (e.g., lying flat out, difficulty settling down, resting in a hunched position)?
- Has there been a change in your cat’s sleeping or resting places (or hiding in unusual places)?
- Has there been a change in your cat’s energy level (i.e., more lethargic or more restless)?
- Has there been a change in your cat’s personality or attitude (e.g., changes in interactions, irritability, wanting more attention or less attention)?
- Have there been changes in your cat’s hair coat (e.g., matted hair, poor grooming)?
- Have you noticed a change in your cat’s facial expression (e.g., staring, fixed gaze, dilated pupils, “squinting” eyes)?
- Have there been any changes in your cat’s appetite or water consumption?
- Does your cat lick or bite at a body part?
- Is your cat more or less vocal than in the past? Are there changes in the type of vocalization?
- Have there been changes in your cat’s litter box use (including inappropriate elimination)?
Surgical management of Degenerative Lumbosacral Stenosis (DLSS) in Dogs

James T. Giles III, DVM, MS, DACVS-SA

DLSS is a common condition in military working dogs (MWDs), law enforcement dogs, and occurs in other working dogs and pets as well. DLSS is multifactorial condition causing compression of the cauda equina, resulting from intervertebral disc protrusion, hypertrophy of the dorsal longitudinal ligament and ligamentum flavum, ventral subluxation of the sacrum, osteophytosis, soft tissue hypertrophy, and nerve root fibrosis or adhesions. The high stress placed on the low back of working and agility animals can make clinical signs more apparent in dogs with risk factors for DLSS. DLSS can be a debilitating condition and is one of the leading causes of early retirement of military working dogs (MWDs).

Milder cases may respond to medical management and physical rehabilitation modalities. Some patients may have improved short-term outcomes with steroid epidural injections. The traditional surgical management has been decompression with a dorsal laminectomy, with or without stabilization of the lumbosacral joint. Lateral foraminotomy has been described, but is a technical challenge due to the anatomic location. Various stabilization techniques have been described, such as facet screws, String of Pearls (SOP) bone plates, pins or screws and polymethylmethacrylate (PMMA), and pedicle-screw rod fixation (PSRF) systems. Lumbosacral stabilization is a complex procedure with significant post-operative stress placed on the construct, and implant failure is a common complication.

Dogs with only central disc compression may respond well to a dorsal laminectomy, however, those with sacral subluxation or foraminal narrowing may not respond well to laminectomy alone. Challenges occur with stabilization methods in providing long-term distraction without implant failure, subsidence, or implant associated pain.

ArteMedics™ has developed the first commercially available PSRF system (Arcas™), which is similar in design to that used in humans, but size appropriate for canine spines. The Arcas™ system utilizes titanium polyaxial pedicle screws and titanium rods. The PSRF procedure involves placement of paired titanium pedicle screws into the body of L7 and the sacrum, mechanical distraction of the lumbosacral space, and stabilization with paired titanium rods locked into the pedicle screw. This procedure is performed in conjunction with a dorsal laminectomy.

We have had recent experience in performing lumbosacral stabilization with the ArteMedics™ PSRF system, in both MWDs and pets, with promising results. There is investigation into the placement of an interbody fusion implant in the lumbosacral space to provide additional stability, in conjunction with PSRF placement. With any surgery for DLSS, the threshold for returning MWDs to full working capacity is higher than improving comfort level in pets.

For dogs with clinical signs of DLSS not sufficiently controlled with medical management, surgical options with decompression or decompression and stabilization are viable options. Each case is unique and requires careful assessment to determine the appropriate treatment.
ANAPHYLAXIS
Christa Bernhard, DVM, MS, DACVECC
VCA Veterinary Care, Albuquerque, NM

Anaphylaxis is a severe systemic allergic reaction. It is classically considered to be a hypersensitivity type I (IgE mediated) reaction. However, anaphylaxis may be IgG or IgM mediated (historically called anaphylactoid reactions). Anaphylactic reactions can be triggered by a variety of antigens, most commonly venoms, vaccines, foods, and drugs (e.g. antibiotics, steroids, opioids, NSAIDs). Anaphylaxis can lead to severe acute shock and even death, especially if not treated in a timely manner.

Pathophysiology
There are two main pathways for anaphylaxis:
1. The Classic Pathway is IgE mediated, along with mast cells and basophils. Previous exposure to an antigen leads to production of IgG and then binding to the cell surface of mast cells and basophils. Following repeated exposure to the Ag, there is cross-linkage of IgE molecules, resulting in mast cell activation and release of histamine, heparin, cytokines, tryptase, leukotrienes, proteases, proteoglycans, etc. These mediators lead to vasodilation, vascular permeability, and other physiologic changes leading to shock.
2. The Alternative Pathway primarily involves IgG and macrophages. Platelet activating factor (PAF) is the significant mediator in this pathway, responsible for the development of shock. Typically, this pathway requires more antibody than the classic pathway.

When there is more IgG present than IgE, and when antigen levels are low, the antigen binds IgG first in blood/lymph prior to binding mast cell associated IgE, preventing development of anaphylaxis. When large amounts of antigen are present, the alternative pathway is triggered. When the amount of antigen exceeds IgG, there can be triggering of both pathways simultaneously.

Clinical Presentation and Diagnosis
Many systems are affected by anaphylactic reactions and may cause the following clinical signs:
Cardiovascular: tachycardia, hypotension, arrhythmias, syncope
Dermal/ocular: urticaria, erythema, pruritus, rash, edema, conjunctival hyperemia
GI/liver: nausea, vomiting, diarrhea, hepatic congestion, portal hypertension
Respiratory: cough, upper airway edema/obstruction, bronchospasm
*More common in cats than dogs

The clinical signs are non-specific and are primarily the result of massive vasodilation and circulatory shock, making diagnosis of anaphylaxis challenging. A 2017 JAVMA study (retrospective) concluded that all anaphylactic dogs in the study met criteria for systemic inflammatory response syndrome (SIRS). In comparing these patients to dogs with confirmed sepsis, both had similar GI signs, mentation changes, and bleeding abnormalities. In addition, both sets of patients had free abdominal fluid, thickened intestines, and a thickened gallbladder wall. Septic patients had higher band neutrophils, lower serum glucose, and lower globulin levels; anaphylactic patients had higher eosinophils and ALT.
The 2009 JVECC study by Quantz et al. looked at 96 dogs presenting for hypersensitivity reactions, dividing them into 2 groups: allergic reactions (mild or local) and anaphylactic reactions (moderate/severe systemic). The mean ALT in the anaphylaxis group was 402 which was significantly higher than that of the allergic group with a mean of 36. The anaphylactic group also had significantly thicker gallbladder walls (4.7 mm) compared to the allergic group (1.7 mm).

Biomarkers (currently used in human medicine):
Platelet activating factor (PAF) is a measurable biomarker that is released in anaphylactic reactions from degranulation of mast cells and basophils. It causes vascular permeability, chemotaxis of leukocytes, and activation of the arachidonic acid pathway, all of which contribute to anaphylactic shock. A 2008 NEJM study found that anaphylactic patients had significantly increased levels of PAF compared to the healthy control group. The proportion of patients with increased PAF also correlated with the severity of anaphylaxis.

Tryptase is a serine peptidase enzyme that is made and stored by mast cells and basophils. B-tryptase is stored in mast cell secretory granules and has a high plasma level with anaphylactic reactions. It is thought to cause bronchoconstriction and to interact with the complement and coagulation cascades. In human anaphylaxis, serum tryptase levels are significantly increased during severe anaphylaxis (hypotensive) within 15 minutes to 2 hours of the inciting cause.

Treatment
Epinephrine remains a mainstay of anaphylaxis treatment. Through the stimulation of β-adrenergic receptors, epinephrine increases the conversion adenosine triphosphate to cyclic adenosine monophosphate, which in turn directly inhibits the release of histamine and other mediators. At the same time, epinephrine acts a potent vasoconstrictor and positive inotrope, which aids in the treatment of circulatory shock. Recommended doses are 2.5 – 5 mcg/kg IV as a bolus, or 0.05 mcg/kg/min IV as a CRI.

Antihistamines also have an important role in treating anaphylaxis. H₁ blockers (e.g. diphenhydramine, chlorpheniramine, loratadine) primarily relieve dermatologic symptoms, and are more effective for local or minor allergic reactions. H₂ blockers (e.g. famotidine, ranitidine) can decrease stomach acid secretion and diminish GI signs.

Glucocorticoids are often administered for anaphylactic reactions, although they are not beneficial in the initial acute phase (first 4-6 hours). In the late phase, glucocorticoids may help decrease eosinophilic inflammation and block the arachidonic acid cascade. Specific drug protocols vary widely, but often dexamethasone is administered at 0.1 to 0.5 mg/kg.

Fluid therapy is vital in the treatment of circulatory (distributive) shock caused by anaphylaxis. It is recommended that a balanced electrolyte crystalloid (e.g. Lactated Ringers, Plasmalyte-A, or Normosol-R) be used. Normal saline (0.9% NaCl) is a reasonable alternative, although this can lead to hyperchloremia and worsening metabolic acidosis, especially if given in large amounts. The volume of crystalloids depends on the patient’s hemodynamic status and response to
therapy. Typically, a ¼ shock bolus is given initially (22 ml/kg for dogs; 11 ml/kg for cats), and then the patient is reassessed to determine if additional boluses are indicated.

Other treatments and supportive care may be indicated on a case by case basis. Ideally, the patient should be monitored in hospital for at least a few hours, or longer if severe signs occur. For respiratory signs associated with anaphylaxis, bronchodilators and oxygen may be beneficial. For refractory hypotension, addition vasopressor therapy can be considered.

**Key Points**

1. Anaphylaxis can be caused by a variety of antigens and may be fatal if untreated.
2. The signs of anaphylaxis are often non-specific and are often very similar to other forms of circulatory shock. While it is important to recognize and treat anaphylaxis as quickly as possible, it is also imperative that you rule out septic shock and monitor response to therapy closely.
3. Treatment of anaphylaxis generally includes epinephrine, antihistamines, glucocorticoids, and other supportive care.

**References**

Cranial cruciate ligament injury in dogs is one of the most common causes of pelvic limb lameness in dogs. It has been reported since 1926 and various surgical treatments are currently available. Previous surgical options such as Gortex grafts, fascia lata/patellar tendon grafts, and fibular head transpositions have been previously used but have fallen out of favor by most surgeons. Current popular options include lateral fabellar sutures, Tibial Plateau Leveling Osteotomy (TPLO), and Tibial Tuberosity Advancement (TTA). Other treatment methods such as the Cranial Closing Wedge Osteotomy (CCWO, Triple Tibial Osteotomy (TTO), TightRope Technique, Simitri-Stable-In-Stride, and Circular Tibial Osteotomy (cTTA) are also available. There are also variations of these methods as well with regards to suture size, implant design, and osteotomy methods. I would like to review the physical exam, radiographic evaluation, meniscal evaluation, and the most common surgical treatments. We will then review some of the current literature to help guide treatment recommendations.

Cranial cruciate ligament disease can be found in any size dog ranging from the Chihuahua to the giant Mastiff. It is uncommon in dogs less than one year of age but it can occur. Pets can have an acute onset of lameness or they may present with a several month history of lameness, reduced mobility, or “slowing down”. It has been reported to be bilateral in 30-50% of dogs. It is a multi-factorial disease and the cause remains elusive. It can be caused by a combination of conformation, increased tibial plateau angle, obesity, poor conditioning, and genetics.

Physical exam will vary depending on whether the cruciate ligament is partially or completely torn. The cranial cruciate ligament is composed of a larger caudolateral band and a smaller cranio medial band. The caudolateral band is taut in extension and the cranio medial band is taut in flexion and extension. The degree of stifle instability when testing with the cranial drawer test will depend on which portion of the ligament is torn and also on how much of the ligament is torn. Physical exam findings may include obvious or subtle lameness, muscle atrophy, joint effusion, decreased stifle flexion, pain with full stifle extension/flexion, stifle crepitation, stifle instability, and patellar luxation. Stifle effusion can be subtle enough that it is not easily detected on physical exam but it can be seen radiographically with cranial displacement of the infra-patellar fat pad. Muscle mass should be evaluated in both pelvic limbs and compared to the forelimb muscle mass. Dogs with chronic bilateral disease may not have pelvic limb muscle asymmetry but the muscle mass will be less than the forelimb muscle mass. Pain on exam is generally minimal unless the exam is performed soon after the cruciate has torn. Pain with the cranial drawer test is typically more severe than the tibial compression test. Crepitation can also be present due to stifle arthritis from other causes (previous fracture), meniscal tears, or referred from having severe coxofemoral arthritis. Patellar luxation (typically medial) can be a concurrent problem or it may be caused by severe stifle instability.
due to an acute cruciate tear. Patellar stability should be assessed with the stifle held in normal alignment (not in cranial drawer). At surgery you can also assess the trochlear groove depth and evidence for cartilage wear from a pre-existing patellar luxation.

Radiographs can be taken to rule out fractures of the femur, tibia (tibial tuberosity), and patella. They can be used to evaluate for subtle stifle effusion in cases of mild partial cruciate tears. The degree of arthritis should be evaluated which will be of prognostic significance. Osteophytes can be found at the distal patella, fabella, cranial and caudal tibial plateau, and along the femoral condyles. While two views are recommended the lateral view centered over the stifle will be the most useful. The AP view tends to be abnormal in patients with severe arthritis and isn't useful when evaluating effusion. Cranial tibial displacement can be evaluated radiographically and would only be present in cases with a full cranial cruciate ligament tear.

Treatment is best performed early in the course of the disease. There will be less arthritis and also less muscle atrophy. Therefore recovery can be faster and more complete. Dogs with partial tears also rarely have concurrent meniscal pathology which will be of prognostic value. The previous method of resting a partial tear dog for a few weeks to see if the ligament “heals” is not recommended if the owner would be willing to have surgery performed. While surgery can still be performed in cases with severe stifle arthritis the pet is much more likely to have continued lameness after getting up from rest or with vigorous activity and continued medical management may be needed.

Conservative management can be performed in small dogs and also in patients where the owners have financial limitations or the pet has pre-existing medical conditions that would make anesthesia and surgery more risky. Medical therapy would consist of controlled daily exercise, physical therapy (range of motion, treadmill, laser, ultrasound), joint supplements, weight management, pain medications, and other therapies such as acupuncture. The decision to pursue surgery should be thoroughly discussed with regards to potential complications, success rate, and post-operative care.

The three most common surgical methods (LFS, TTA, and TPLO) have variations of each method. Fabellar suture variations can be hand tied-vs-crimp clamp-vs-suture anchors. Suture type can also vary from monofilament nylon, Orthofiber, Fiberwire, and Fibertape. When the TPLO was first reported there was only one plate available from Slocum Enterprises. There are now numerous companies that produce TPLO plates with various sizes and designs. Both locking and non-locking screws can be used. The TTA has a similar history with the original implants being produced by Kyon. There are now multiple different types of implants (titanium and stainless steel) and variations in the surgery. These include TTA Rapid, fork or screw use for holding the plate in place, variations on the cage, and the modified Maquet technique (Etchepareborde et al, 2011).
So how do you decide what to do and what evidence is there in the literature to recommend one procedure over another. I will go over some of the current published literature and then discuss my own treatment recommendations.

The lateral fabellar suture technique was first reported in 1970 by DeAngelis and Lau and then later modified by Flo in 1975. It quickly became known as “The Flo Technique”. It is still one of the most widely performed orthopedic surgeries in dogs. The technique has undergone some changes with regards to suture size, suture type, and type of anchor (knot, crimp, or suture anchor). While it can be used on any size dog it is typically recommended for smaller dogs. Complications can include implant failure, infection, patellar luxation, and post-operative meniscal tears.

Slocum and Devine first published their results of 394 TPLO cases in 1993 in Veterinary Clinics of Small Animal Practice. It was previously discussed in “standing room only” lectures at various surgical conferences. The goal of the TPLO is to eliminate cranial tibial thrust instead of eliminating cranial drawer motion which was the previous surgical desire (the tibial compression test was first reported by Henderson and Milton in 1978 in JAAHA). The surgery aims to eliminate cranial tibial thrust by rotating the tibial plateau so that the plateau is perpendicular to the functional axis of the tibia. This was an entirely new technique which took many years to gain acceptance in the veterinary community. The fact that the procedure and equipment was patented also didn’t help it’s acceptance. It is now one of the most commonly performed surgeries in veterinary medicine and it’s my preferred treatment methods in dogs over approximately 30 pounds.

The TTA was first reported by Montavon, Demur, and Tepic in 2002 at the 1st World Veterinary Conference. They also proposed eliminating the tibiofemoral shear force but in a different way than the TPLO. They contended that the total joint force of the stifle is parallel to the patellar ligament, unlike Slocum, who maintains that it is parallel to the functional axis of the tibia. The principal concept of the TTA technique is to advance the tibial tuberosity to such an extent that the tibial plateau is perpendicular with the patellar ligament. This would reduce the tibiofemoral shear force to zero.

So how does a veterinarian decide what to do when they see a patient with lameness attributed to a torn cranial cruciate ligament? There are conflicting reports in the literature with regards to which of the common techniques are superior. Potential complications, cost, surgeon experience, and success rate all need to be taken into account. Unfortunately many of the studies have different methods for evaluating complications and also success. Case numbers tend to be small and statistical methods vary. Some procedures are also backed by the company that produces and sells the necessary equipment needed for the surgery. Radiographic and owner evaluations are inherently biased. Force plate evaluation is the most reliable method but it isn’t routinely done due to the need for specialized equipment and training.
Surgery is generally recommended in patients larger than 20-25 pounds, ones with concurrent meniscal injury, concurrent patellar luxation, and reduced mobility. There are of course many exceptions to these criteria.

So what does some of the literature tell us?

Vasseur in 1984 evaluated 772 dogs with cranial cruciate ligament tears from 1971-1981. Conservative management of dogs weighing less than 15kg appeared to be successful with 86% of dogs having normal or improved function. These dogs were managed with aspirin at 10 mg/kg BID to PRN. However it was noted that all dogs developed stifle arthritis. This paper from 35 years ago serves as our basis for recommending conservative management in small dogs.

Lazar et al (Veterinary Surgery), in 2005 published a study evaluating the Long-Term Radiographic Comparison of TPLO versus extracapsular stabilization (ECR). They used a radiographic osteoarthritis scoring system to compare 27 ECR stifles to 52 TPLO stifles with a minimum follow up of greater than 12 months. They found that dogs with larger OA score differences were 5.78 times more likely to have had ECR than TPLO.

Conzemius et al (JAVMA), in 2005 published a study evaluating the Effect of Surgical Technique on Limb Function After Surgery for Rupture of the Cranial Cruciate Ligament. They evaluated 131 Labrador Retrievers with unilateral RCCL and injury to the medial meniscus and compared them to 17 clinically normal dogs. Surgical techniques compared were the LFS, intracapsular stabilization (ICS), and TPLO. They used force plate data before and at 2 and 6 months after surgery. They found that LFS and TPLO were superior to ICS but that the majority of dogs failed to achieve normal function by 6 months.

Randy J. Boudrieau published an excellent review in Veterinary Surgery (2009) that was titled, “Tibial Plateau Leveling Osteotomy or Tibial Tuberosity Advancement?”. It discussed the proposed mechanism of action of each technique, theoretical advantage of TPLO vs TTA, surgical technique, outcome, and complications. It is an excellent review for those wishing to go deeper into the science behind each method. The conclusion was that “it remains to be fully elucidated if either procedure is superior and under what conditions”. Both methods at that time appeared to have similar success, complications, and were both validated in experimental models.

Au et al (Veterinary Surgery), in 2010 Compared Short and Long-term Function and Radiographic Osteoarthritis in Dogs After Postoperative Physical Rehabilitation and TPLO or LFS. The study only had 35 LFS and 30 TPLO cases. All dogs had significant increases in OA scores 24 months after surgery. Both groups of dogs had statistically similar force plate data and neither technique appeared superior.

Christopher and Cook (Veterinary Surgery) in 2013 published a study Comparing Long-Term Outcomes Associated With TPLO (65), TTA (18), and TightRope (79). They used subjective client and DVM assessments. They found that the TTA had
higher rates of complications than either TR or TPLO, that TPLO and TR had more cases that reached full function, and that TR had the highest safety-to-efficacy ratio. Dr. Cook is a patent holder for the TightRope procedure.

Nelson et al (Veterinary Surgery) in 2013 published a study Comparing Functional Outcome of TPLO versus Extracapsular Repair with 15 TPLO cases and 23 ECS cases. They evaluated force plate data up to one year after surgery. They concluded that normal limb loading was achieved faster with TPLO and that TPLO dogs had function that was indistinguishable from the control population by 1 year postoperatively.

Gordon-Evans et al (JAVMA) in 2013 published a Comparison of LFS and TPLO with 40 dogs in each group. They followed dogs for at least 1 year and used physical exam, owner survey, and force plate data. They found that peak vertical force for the TPLO dogs was 5-11% higher that LFS dogs and owner satisfaction was higher (93% vs 75%) for the TPLO patients.

Krotscheck et al (Veterinary Surgery) in 2016 published the Long-Term Functional Outcome of TTA versus TPLO and Extracapsular Repair (ECR). Case numbers were: TTA (14), TPLO (15), and ECR (23). They evaluated force plate data up to a year after surgery. They concluded that at the walk, TTA achieves normal function by 12 months; however, at a trot TTA in indistinguishable from ECR. TPLO resulted in operated limb function that was similar to control population by 6-12 months postoperatively at the walk and trot.

Heidorn et al (JAVMA) in 2018 published Rate of Return to Agility Competition for Dogs with CCLR Treated with TPLO. They evaluated 31 dogs from 2007 to 2013 and used owner survey assessment. They found that 65% of dogs returned to agility and that 80% of those did so within 9 months after surgery. However some owners may have elected to not have their pets return to agility due to the concern for re-injury or possible tearing of the opposite CCL.

There are numerous other studies comparing complication rates and success as well. So what do we do with this information? Many of these studies have small sample sizes and various methods of defining success so they aren’t ideal.

It appears that all dogs are improved regardless of surgical technique. Just removing a torn caudal medial meniscus will improve the dog’s lameness. Some studies have shown the TPLO to be superior but others have found it to be similar to the TR and ECR. Complications for the TTA and TPLO can certainly be more severe than for the ECR as well. Suture failure and subsequent meniscal injury is less of an issue than plate failure and fracture of the tibia. It also appears that post-operative physical therapy will help all dogs regain function faster.

My own personal opinion is that I favor the TPLO in the majority of dogs compared to other techniques. The TTA is generally not recommended if the tibial plateau is greater than 27-30 degrees while there isn’t a cut off for the TPLO. Concurrent patellar luxation can be addressed with either procedure. For small dogs I will
perform a lateral fabellar suture and have primarily changed from monofilament nylon to Orthofiber due to its superior strength. It is a braided suture but I haven’t seen any increased rates of infection. However suture failure can still occur. I will perform a TTA if the owner chooses it, the plateau is less than 27 degrees, and I feel that they are a good candidate for the procedure (based on radiographs). I have performed three TPLO’s on two of my own pets and have performed over 2000 TPLO’s to date. I have entirely switched to locking plates for all of my TPLO cases. They have been shown to reduce the infection rate in giant breeds of dogs and osteotomy alignment is better maintained. They may also allow for improved vascular ingrowth under the plate since the plate isn’t compressed to the bone.

I feel that dogs with early partial tears, minimal arthritis, and normal menisci will perform better than other cases. I will perform a meniscectomy if the meniscus is torn but I don’t perform meniscal releases. It has been shown that the meniscus is an important stabilizer of the stifle. It has effects on load bearing, load distribution, shock absorption, and joint stability. There is an increased rate of arthritis progression if there is a need for a complete caudal medial meniscectomy or if a meniscal release has been performed. Meniscal tears can occur in 30-50% of dogs with a complete cruciate tear and there is also a 5-10% rate of post-operative meniscal damage. These are both greatly reduced in dogs with early partial tears.

I warn owners of a less than 1% risk for implant loosening/failure, 1-2% rate of the need for implant removal, and a 5% rate of post-operative meniscal tears. I have performed single session bilateral TPLO’s but it would be very rare. I will operate the second side 4 weeks after the first side since that is the time frame that we would typically see infection and implant loosening/osteotomy movement. I don’t allow any outside off leash activity for at least 12 weeks and strongly recommend controlled leash walking to encourage recovery of muscle mass. Controlled physical therapy with a canine rehabilitation specialist will certainly speed their recovery. Weight control is also critically important for long-term success.

If you have other questions regarding cruciate disease or other surgical questions I can be contacted at:

**Sean Gallivan, DVM, MS, DACVS**
VCA Veterinary Care Animal Hospital and Referral Center
9901 Montgomery Blvd, NE
Albuquerque, NM 87111
(505) 296-2982
sean.gallivan@vca.com
In Part 1 of Synergistic Veterinary Practices, Values, Vision, Mission were discussed, as well the difference between management and leadership. Culture was touched on – but this session will focus on the specifics of culture, and how it can be used to create conditions of trust and respect.

**Culture**

Culture is the workplace environment leaders create for their teams. It is the sum of leadership, beliefs, values, behaviors and attitudes that contribute to the emotional and relational environment of your practice.

Culture is an intangible asset with far-reaching effects. In fact, culture is often what attracts people to a workplace, but is also one of the main reasons people leave. Culture is fragile and must be revered and protected, as ultimately, this affects your profitability, and the practice goodwill. Five topics shape culture:

- Expression of practice goals (Values, Vision and Mission)
- Clear Expectations
- Environment of Trust
- Employee Engagement
- Change Management

You can’t successfully lead and influence others until the above elements have been established.

**Successfully Leading and Influencing Others**

Every person on the team leads and influences others; leading and influencing is not defined by position. Leadership is defined as the process of social influence in which others are enlisted in order to accomplish a common goal. Now consider how culture contributes to leading others. If trust is absent in the practice, no one, not even the leader can influence others. Rather – a “do as I say” mentality takes over. Leading others by ‘giving orders’ is exhausting, frustrating and causes people to quit. On the flip side, leading others through influence produces harmony and self-satisfaction, as the true description of team work begins to unfold.

If leadership influences others to accomplish a common goal and you have good leadership, then why would it be essential to “motivate” people?

The most effective leaders understand that people are motivated to fulfill basic needs before moving on to other, more advanced needs.

Team members must have their basic needs met (food, water,
warming, rest, security and safety), before progressing to the next level. People can’t fully engage or be energized by the direction of a veterinary practice when they’re worried about how they’ll pay for their next meal, for example. Second, the psychological needs (belonging to the team, feeling valued and accomplished and having a positive relationship with leadership) must be met. Third, a team member has self-fulfillment needs as well, such as achieving one’s fullest potential or contributing creativity to the success of the organization. Do you know what your team member’s individual self-fulfillment needs are? Reflect on the ability of the practice to contribute to the team member’s motivation. Is every team member leveraged appropriately for the skills they possess? If not, why? What resources do they need to help achieve the third level of Maslow’s Hierarchy of Needs? Understanding and implementing Maslow’s Hierarchy further contributes to the practice culture, employee engagement and retention.

Change Management
Change can be difficult in the practice, especially when positive cultures, practice goals, and trust have not been established. Even if those elements have been established, it can be difficult to change protocols or procedures that have become habits. Great leaders understand the three contributors of change resistance and implement practices to overcome the small hurdles.

Informational resistance is defined as team members not knowing why a problem exists, how it affects the business or organization, and where potential change could occur.
Personal resistance is due to loss of familiar patterns, or relationships with fellow team members.
Cultural resistance includes a personal opinion that change is not possible within the organization, or leadership is not capable of carrying out the change.

Manage change with the values, vision and mission in mind - and always follow through. Great leaders inspire others through cheerleading and a positive “we can” attitude.

Everyone dreams of having a great workplace – and hopefully you have (or will be) creating this environment in your practice. What’s even more critical to the team and the owner at the end of the day is protecting the practice goodwill.

Protection of Goodwill
Goodwill is defined as the non-tangible value of the practice. Therefore, subtract the equipment, inventory or cash on hand from the value of the practice. You are left with the culture, brand, clientele, and compliance to name a few. These are things that can be hard to place a specific dollar value on, but they increase the profitability and sale price of the practice (when it is time to sell). Take a look at the following graphic. It compares three practices ranging from great culture to poor culture, and look at the effect on employee turnover, employee engagement, client compliance, and at the end of the column, the amount of money left over for reinvestment.
The culture of the practice has a significant effect on the bottom line. Positive cultures have more engaged team members, lower employee turnover and greater compliance. Doesn’t it make sense that happy employees make happy clients? If employees are happy, they stay at the practice long-term and establish bonds and relationships with clients.

The key to remember, it doesn’t matter what role a person has in the practice. Everyone contributes to the culture of the practice by modeling behaviors that have been established by the values. So, if a team member is not “fitting in” and they are disrupting the culture, is it time to let that person go? If you are hiring a warm body but they don’t naturally embody the values that have been established, is it the right decision to hire them?

And the most important take away: before you point fingers at others for inappropriate behaviors, evaluate yourself. The best leaders model values in everything they do. **Actions speak louder than words.**
Thank you for your ongoing support of the Four Corners Veterinary Symposium.

Proceeds from your registration fees were donated to The Animal Connection.

the animal connection

ANIMAL PROTECTION OF NEW MEXICO