

ZOO SCHOOL PROCEEDINGS

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Feline Behavior Problems & Psychopharmacology

Michele Gaspar, DVM, MA, LCPC

Wisconsin Veterinary Medical Association • Milwaukee Zoo • September 25, 2026

Introduction: The Presenting Complaint Is Not the Diagnosis

Cats are remarkably sensible animals when their behavior is understood in the context of feline ethology. Owners may describe a cat as spiteful, jealous, dominant, obsessive, anxious or mean, but these words are interpretations rather than behavioral observations. The clinician's first task is to describe what the cat is actually doing, determine when and where it occurs, identify antecedents and consequences, and then ask what medical, emotional and environmental factors may be driving the behavior.

A useful formulation for feline behavior cases is Medical → Emotional → Environmental → Learned. Could disease or pain be producing the behavior? What emotional state—fear, anxiety, frustration or hyperarousal—is present? What features of the environment maintain the problem? What has the cat learned from previous interactions? This framework is more useful than beginning with a drug. Psychoactive medication does not specifically eliminate house-soiling or aggression; it can reduce anxiety, arousal, reactivity or compulsive drive so that environmental change and learning become possible.

Behavior change should always prompt consideration of medical disease. Pain, lower urinary tract disease, chronic kidney disease, hyperthyroidism, diabetes mellitus, gastrointestinal disease, pruritus, neurologic disease and cognitive dysfunction can all alter behavior. Behavioral medicine requires diagnostic rigor, not fewer diagnostics.

Principles of Feline Psychopharmacology

Psychotropic drugs have two broad clinical jobs. Some modify the baseline emotional state and are administered daily for weeks to months; SSRIs, TCAs and buspirone fall primarily into this group. Others are used for predictable acute stressors or rapid reduction of arousal; gabapentin, pregabalin, trazodone and selected benzodiazepines are examples. Some patients benefit from both a maintenance medication and a situational medication.

The therapeutic endpoint should be defined before treatment. The goal is not simply sedation and certainly not personality suppression. A cat that is too ataxic to resist handling may still be terrified. Successful pharmacologic treatment should reduce fear, anxiety, pathologic arousal or compulsive drive while preserving normal feline behavior and improving the cat's capacity to learn and cope.

Selective Serotonin Reuptake Inhibitors

Fluoxetine is frequently a first-line maintenance medication for chronic feline anxiety, urine marking, compulsive behavior and selected cases involving impulsivity or hyperarousal. The 2024 AAFP Intercat Tension Guidelines list a suggested oral dose of 0.5–1.0 mg/kg every 24 hours and recommend allowing approximately 4–6 weeks to assess effect. Adverse effects may include decreased appetite, lethargy, occasional vomiting and urinary retention; appetite and urine and fecal output should be monitored, particularly early in treatment. Long-term therapy should generally be tapered rather than stopped abruptly.

Sertraline and paroxetine are alternatives, although feline data are less extensive. Selection among SSRIs should consider concurrent disease, other medications, formulation, palatability and the clinician's familiarity

with the drug. An SSRI should not be judged ineffective after several days; the delayed onset is fundamental to client counseling.

Tricyclic Antidepressants

Clomipramine may be useful for anxiety, urine marking and compulsive disorders. The 2024 AAFP guidelines list 0.25–0.5 mg/kg PO every 24 hours and similarly recommend allowing 4–6 weeks to assess response. Amitriptyline has a long history of feline use but has substantial anticholinergic and sedative effects; constipation, urinary retention, ataxia and cardiac arrhythmias are important considerations. Its bitter taste and sometimes profound sedation can also make it a poor practical choice. The fact that amitriptyline has traditionally been used for cats that urinate outside the box is not, by itself, a rationale for prescribing it.

Buspirone

Buspirone, a 5-HT_{1A} partial agonist, is particularly interesting in multicat households because it may reduce fear and increase social confidence. The AAFP guidelines list 0.5–1.0 mg/kg PO every 12–24 hours, with 2–4 weeks allowed to assess effect. Drug selection must follow behavioral formulation: increasing confidence in a timid cat that is repeatedly displaced may be useful, whereas increasing confidence in the cat already pursuing or blocking another cat may be counterproductive. The question is not simply, “Which drug treats aggression?” but, “Which cat is experiencing which emotional state?”

Gabapentin and Pregabalin

Gabapentin is widely used extra-label in cats for pre-visit anxiolysis, predictable stressful events, pain-associated behavioral problems and as an adjunct to chronic therapy. Sedation and ataxia are common dose-limiting effects. Renal elimination is clinically relevant, and dose reduction may be appropriate in cats with kidney disease.

Pregabalin is pharmacologically related to gabapentin but now has an important practical distinction: Bonqat® (pregabalin oral solution 50 mg/mL) is FDA approved for alleviation of acute anxiety and fear associated with transportation and veterinary visits in cats. The labeled dose is 5 mg/kg PO (0.1 mL/kg) approximately 1.5 hours before transportation or the veterinary visit; it may be administered on two consecutive days. Pregabalin is a Schedule V controlled substance. The FDA approval provides controlled field-study evidence for precisely the clinical situation in which gabapentin has traditionally been used extra-label. For chronic use in intercat tension, the 2024 AAFP guidelines list pregabalin at 1–2 mg/kg every 12 hours but note the lack of long-term feline safety information.

For both drugs, the therapeutic endpoint is reduced fear and improved coping—not simply immobility.

Trazodone and Benzodiazepines

Trazodone, a serotonin antagonist and reuptake inhibitor, is increasingly used for situational anxiolysis and as an adjunct, although the feline evidence base is smaller than its popularity might suggest. Benzodiazepines may provide rapid anxiolysis for selected acute situations but can produce sedation, ataxia, paradoxical excitation or behavioral disinhibition; tolerance and dependence are concerns with prolonged use. Oral diazepam is generally avoided in cats because of the rare but potentially fatal idiosyncratic acute hepatic necrosis reported with its use.

Polypharmacy requires deliberate attention to mechanism and interactions. Combining serotonergic drugs can increase the risk of serotonin toxicity, and appropriate washout periods may be necessary when changing classes. Start at the low end of an appropriate dose range, monitor carefully and resist the temptation to add medication merely because a maintenance drug has not yet had time to work.

Feline House-Soiling

“Inappropriate urination” is a presenting complaint, not a diagnosis. The first behavioral distinction is between toileting outside the litter box and urine marking. Toileting typically involves a larger volume of urine, squatting and a horizontal surface, whereas marking often involves smaller volumes, a standing posture with tail elevation and vertical surfaces. These are useful patterns rather than absolute rules.

Medical evaluation precedes a behavioral diagnosis. Lower urinary tract disease, urolithiasis, pain, arthritis, polyuria associated with renal disease or diabetes, hyperthyroidism and cognitive change should be considered according to signalment and history. A senior arthritic cat that abandons a high-sided box two flights downstairs may be making an entirely rational choice.

The litter-box history should be detailed: number, location, size, entry height, covered versus uncovered design, substrate, litter depth, cleaning frequency and, critically, access. The familiar “number of cats plus one” rule is useful only if boxes are distributed. Four boxes lined up together in the basement function more like one toileting location than four independent resources.

In multicat homes, the route to the litter box may matter as much as the box. Another cat can control a hallway, stairway or doorway through staring or blocking without ever fighting. The 2024 AAFP guidelines emphasize that subtle intercat tension may restrict access to resources and contribute to house-soiling. Treatment therefore includes medical therapy when indicated, litter-box optimization, distributed resources, reduction of social tension and medication only when a defined emotional target justifies it. Anti-anxiety medication tends to be more useful for urine marking than for house-soiling caused primarily by box aversion or poor environmental management.

Intercat Tension and Aggression

The term intercat tension is preferable to simply “aggression” because clinically important conflict is often quiet. In a large survey cited in the 2024 AAFP guidelines, 87.7% of multicat households reported signs of tension, and 73.3% of affected households reported onset associated with introduction of a new cat. Signs may include staring, blocking, stalking, displacement, avoidance, hiding, yielding resources and inhibition of normal behavior. Hissing, swatting, chasing and fighting represent only the more obvious end of the spectrum.

A simplistic linear dominance model is often misleading in domestic cats. Familiarity, affiliation, tolerance, resource availability and the ability to control proximity are more useful concepts. Cats sharing a household do not have to be friends. Successful coexistence may depend on the ability to avoid one another.

Environmental management is therefore treatment, not decoration. The modified Five Pillars framework emphasizes safe places; multiple and separated key resources; opportunities for play and predatory behavior; positive, predictable human interaction; and respect for feline sensory needs. Vertical territory, visual barriers, multiple escape routes and distributed food, water, resting and toileting sites increase choice and control.

At a zoo, enclosure design routinely considers retreat, distance, barriers, enrichment and resource distribution. The same principles apply in the home. Three food bowls lined up against one kitchen wall may look generous to a person but constitute a single contested feeding location to the cats.

Intercat relationships may deteriorate after introduction of a new cat, social maturation, illness or pain, a move, resource changes, exposure to an outdoor cat, redirected arousal or a veterinary visit. A cat returning from hospitalization may smell and behave differently enough to trigger aggression from a previously compatible housemate. Forced reunion should be avoided; separation, decompression and gradual reintroduction may be required.

When medication is considered, decide which cat—if any—needs it. The fearful cat that hides and yields resources may have a different pharmacologic target from the hyperaroused cat that stares, follows and chases. Sometimes both require treatment. Sometimes neither does: what they need is more space, safer access to resources and a carefully structured reintroduction. Medication is an adjunct to environmental and behavioral modification, not a substitute for them.

Pica and Compulsive Behaviors

Pica describes ingestion of non-food material; it does not identify the cause. Cats may ingest wool, fabric, plastic, rubber, paper, plants or other materials. Medical differentials should be pursued according to the individual patient and may include gastrointestinal disease, anemia, nutritional abnormalities, oral disease, endocrine or metabolic disease, neurologic disease and pain.

Once appropriate medical investigation has been completed, behavioral mechanisms may include oral exploratory behavior, early experience, genetic or breed predisposition, stress, frustration, reinforcement and a compulsive phenotype. Siamese and related breeds are classically associated with wool sucking and fabric chewing, but breed association does not eliminate the need for medical evaluation.

Treatment begins with safety: prevent access to material that may cause gastrointestinal obstruction or toxicity. Environmental enrichment, foraging and feeding strategies, play, opportunities for predatory behavior and reduction of social or environmental stress should follow. When the behavior is persistent, repetitive, difficult to interrupt and associated with an anxiety or compulsive phenotype, an SSRI or clomipramine may be considered as part of a broader treatment plan.

Overgrooming and the Problem With “Psychogenic Alopecia”

Overgrooming is another behavior that is easily converted prematurely into a psychiatric diagnosis. Fleas, food allergy, environmental allergy, ectoparasites, dermatophytosis, pain and neuropathic disease should be considered before concluding that grooming is anxiety-associated or compulsive. “Psychogenic alopecia” should be a conclusion reached after adequate dermatologic and medical assessment, not a label applied because lesions are self-induced.

When to Refer

Referral to a board-certified veterinary behaviorist (DACVB) should be considered for significant aggression or injury, human-directed aggression, complex multicat conflict, severe compulsive behavior, diagnostic uncertainty, cases requiring complex psychopharmacology or polypharmacy, failure of an appropriately implemented treatment plan, or situations in which feline or human welfare is substantially compromised. Referral is an extension of treatment, not therapeutic failure.

Clinical Take-Home Points

- Describe the behavior before interpreting it.
- Medical disease and pain remain part of every behavioral differential.
- Identify the emotional and environmental drivers before selecting a psychotropic medication.
- Sedation is not the same as anxiolysis.
- In multicat homes, staring, blocking and resource displacement may matter more than fighting.
- House-soiling requires attention to both the litter box and the route to the litter box.

- Pica and overgrooming are behaviors, not etiologic diagnoses.
- Environmental modification and psychopharmacology work best when they are integrated.

Selected References and Resources

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Monitoring Trilostane: A Decision-First Guide

Julia A. Bates, DVM, DACVIM (SAIM)

WVMA Zoo School 2026

THE BOTTOM LINE

- Treat the dog, not the lab report.
- WITHHOLD medication in a sick dog.
- Do not change a dose based on a single unexpected cortisol reading. Verify pill administration, meal timing, and owner adherence first..
- The 10-to-14-day recheck evaluates safety, not clinical efficacy.

The decision matrix

The dog	The cortisol	What you do
Doing great	Normal or unexpectedly high	Maintain current dose. Never increase trilostane based on isolated lab values.
Doing great	Surprisingly low	Confirm dosing time and food, check electrolytes, watch the trend. One low value in a well dog does not require intervention.
Still showing signs (PU/PD, panting, polyphagia, etc.)	Not low	Confirm the dog is actually getting the dose, with food, on schedule. Rule out other causes of the signs. Raise the dose only if it's truly Cushing's and further suppression looks safe.
Vomiting, not eating, weak, or collapsed	Any result	Discontinue trilostane immediately. Screen for iatrogenic hypoadrenocorticism, adrenal necrosis, and secondary illness.
Otherwise normal	One weird, unexpected value	Don't make a major dose change on a single number. Standardize the conditions and retest.

Pitfalls to avoid

- Raising the dose because of one cortisol result, without confirming the dog is actually undercontrolled.
- Treating the 10–14 day recheck as proof of clinical control. Its sole purpose is identifying acute over suppression early
- Continuing trilostane in a dog with new vomiting, diarrhea, lethargy, weakness, or collapse.
- Inconsistent sampling protocols. Keep the dose, meal size, and sample collection consistent across all visits.
- Assuming more drinking always means more drug is needed. Check for diabetes, kidney disease, a UTI, outside steroids, or an owner measuring water wrong.
- Relying exclusively on either the ACTH stimulation test or pre-pill cortisol alone. Neither test provides a complete clinical picture..

Owner Instructions

Give every owner this exact instruction, in writing if you can:

TELL EVERY OWNER

- *Skip your dog's dose and contact the clinic immediately if you notice:*
 - Decreased appetite or total refusal of food
 - Vomiting or severe diarrhea.
 - Marked lethargy, stumbling, or unusual weakness.
 - Collapse.

Testing Limitations

The goal of treatment is a comfortable dog. The tests we have only capture cortisol at one moment in time.

Trilostane creates a fluctuating suppression curve throughout the day. A single blood sample captures only a single moment, not total daily control. For this reason, post-pill tests and traditional ACTH stimulation protocols cannot gauge overall clinical stability across a 12- or 24-hour window.

What each test actually answers

Monitoring Tool	Clinical Utility	Limitations
Owner's description of symptoms	Are the target signs and quality of life better?	Doesn't tell you if the adrenal gland is being oversuppressed.
Exam, weight, body condition	Is the dog stable and hydrated?	Doesn't measure cortisol suppression directly.
Chemistry and electrolytes	Is it safe to keep treating right now?	Doesn't tell you whether clinical signs are controlled.
Pre-pill cortisol	Is trough cortisol reassuring in a dog that's doing well?	One value can mislead; not enough on its own in a sick dog.
Post-pill cortisol	What is cortisol during the window of peak drug effect?	Doesn't capture the rest of the day or quality of life.
ACTH stimulation test	Is adrenal reserve adequate, especially when oversuppression is suspected?	A poor stand-alone predictor of day-to-day clinical control.

A practical monitoring schedule

When	Main job	What to check
10–14 days	Safety check, not proof of efficacy	Owner history, appetite and energy, exam, weight, chemistry/electrolytes; cortisol testing read mainly for oversuppression risk.

When	Main job	What to check
4–6 weeks	Early efficacy and safety	Structured clinical history, exam/weight, chemistry/electrolytes, selected cortisol testing. Raise the dose only if signs persist and further suppression looks safe.
3 months, then every 3–6 months	Ongoing control and long-term safety	Clinical signs, exam/weight, chemistry/electrolytes, urine and blood pressure as needed, cortisol testing chosen for the actual clinical question.
Any time the dog is unwell	Rule out oversuppression and concurrent disease	Hold trilostane. Check electrolytes, renal values, glucose, hydration/perfusion, and run an ACTH stimulation test if indicated.

Dosing basics



- Label range: 2.2–6.7 mg/kg PO once daily, given with food.
- Most clinicians start closer to **1 mg/kg twice daily**. My recommendation.
- Before calling a dog a treatment failure, check: correct capsule strength, correct schedule, given with food, actually being administered, and when in the dosing interval the signs return.

Case Examples

Case 1 — Suppressed Post-Stimulation Cortisol in a Well Patient

- 11-year-old dog, drinking normally again, eating well, energy excellent.
- 3-hour ACTH stim: base 1.1, post 1.4 µg/dL (looks alarmingly suppressed).

What to do: Don't diagnose Addison's disease in a completely normal dog from one result. Cortisol can be profoundly suppressed at peak drug effect and recover later in the day. Interpret the test in the context of the whole dog, not in isolation.

Case 2 — Normal Lab Values with Persistent Clinical Signs

- 9-year-old dog, 10 weeks into once-daily trilostane.
- Pre-pill cortisol is 3.5 µg/dL. PU/PD comes back every evening.

What to do: The number looks fine, but the dog isn't controlled for the whole day. Split the total daily dose into twice-daily administration to cover the entire day rather than increasing the single morning dose.

Case 3 — Acute Illness in a Previously Controlled Patient

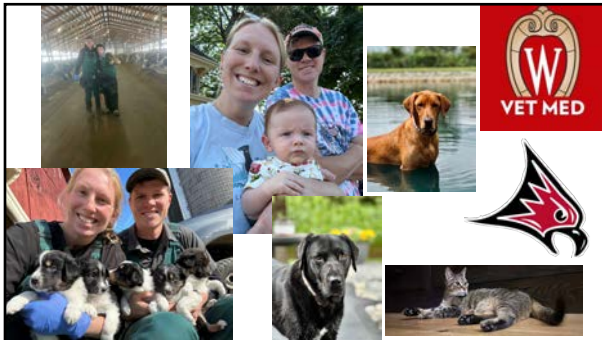
- 12-year-old dog, stable on trilostane twice daily for 3 months.
- Now lethargic, not eating, mild vomiting. Sodium 131, potassium 5.9.

What to do: Hold trilostane. Stabilize if the dog is unstable. Check adrenal function today (baseline cortisol ± ACTH stim). Look for another illness (GI, renal, pancreatic) hiding behind the electrolyte changes before blaming the drug alone.

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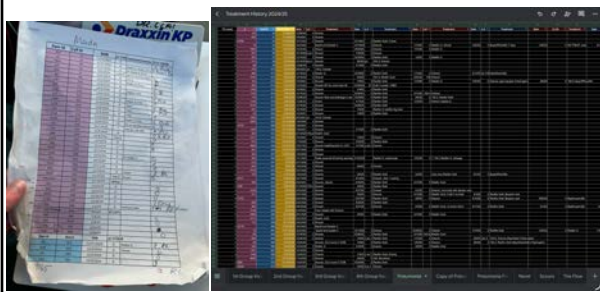




What am I doing?

- Weekly calf herd health with calf lung ultrasound (CLU) at a **beef farm**
 - All calves between 7 days and older are scanned, observed for scours, and navel checked
 - Treatments are made at time of scan based on lung score, past treatments, and temp
 - Scan up to 60 days of age
- Providing a framework for calving season records on google sheets
 - Treatment history
 - Valuable week to week and over time (post weaning, etc)
 - Identifying chronic cases
 - Protocol based antibiotic use
- Identifying risk factors in the environment

Records



Facilities to catch calves

These calves do not recognize you as food!!!



How does this benefit a beef operation?

- Disease surveillance in an environment of increased disease pressure
 - Confinement calving: farm employee, cow, calf, bull, show prep traffic that increases risk of disease
 - High value calves
- Forces routine to the farm
 - Looking at each animal intently once a week
- Consistent veterinarian presence
 - 3rd party of input that is not part of the family
- Created calf records
 - Prevalence of subclinical pneumonia
 - Treatment protocols
 - Analyzing treatment outcomes
- Early intervention treatment
 - Scours
 - Pneumonia
 - Navel infections
- Research on long term health effects on dairy calves when pneumonia is detected and treated early may translate to beef calves
- Chute training- Farm noticed that calves flow through the chute better later in life

2025 Calf Crop			
Heifers	70		
Bulls	72		
Died	4		
Total Calves	138		
	97% calf crop		
2024 Calf Crop			
Heifers	65		
Bulls	68		
Died	36 22 heifers 14 bulls		
Total Calves	97		
	73% calf crop		
	36 x 650lbs = 23400lbs x 2.80 = \$65,520		

Sum of Invoice per Season			
Category	2024 Calving	2025 Calving	Grand Total
Calf Charges	\$818.80	\$811.80	\$1,630.60
Catheterisation(s)	\$2,485.22	\$122.60	\$2,607.82
Fluids & Catheters	\$3,288.64	\$167.10	\$3,455.74
Lab Work	\$629.35	\$140.90	\$770.25
Lung Ultrasound		\$6,703.90	\$6,703.90
Treatments	\$5,298.98	\$4,047.61	\$9,346.59
Grand Total	\$12,496.99	\$12,098.91	\$24,595.90
	26 Dead Calves - 4 Dead Calves		
	36 x 650lbs = 23400lbs x 2.80 = \$65,520		
	4 x 650lbs = 2600 x 3.80 = \$9880		
	32 x 650 = 20800 x 3.80 = \$79,040 IN CALF SAVINGS		
Notes			
Second season calf charges are almost always split with more work (preg checking). Season one calf charges are almost always just for putting a calf on fluids.			
Did not count oxytetracycline, ampicillin, or crumbles towards treatment costs			
November to June			

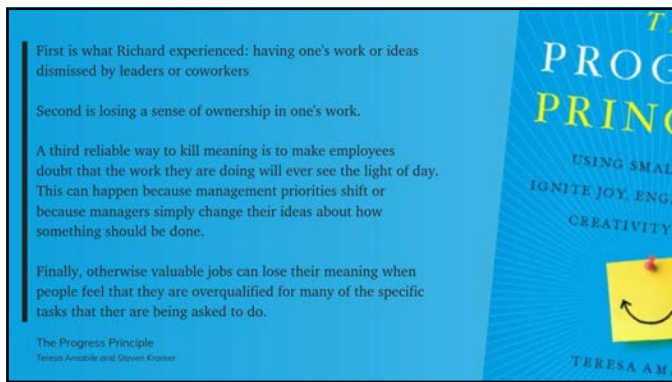
Where is the opportunity?

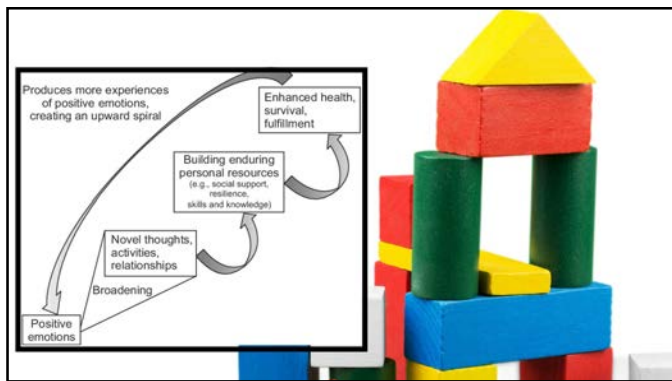
- Calving indoors in confinement
- Operations with high disease pressure
- Farms that are sick of just putting out fires, invest in preventative care
- High value animals



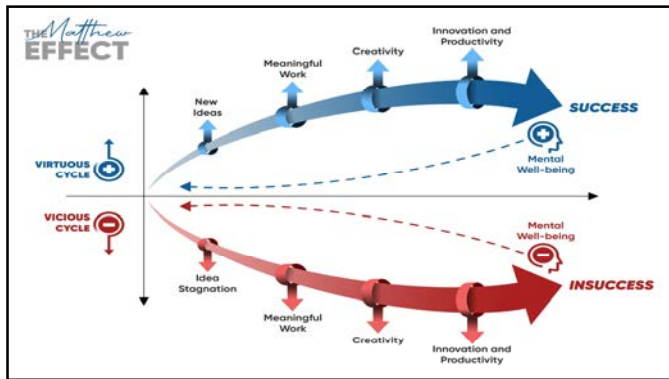












New Zealand Veterinary Journal

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What veterinarians need to know about communication to optimize their role as advisors on udder health in dairy herds

“Veterinarians, often act reactively, thinking that farmers are only interested if they ask for advice... Those veterinarians do not actively motivate farmers to improve animal health and results in them overlooking the possibility of actively approaching farmers with available services.”

To cite this article: TJGM Lam, J Jansen, BHP van den Borne, RJ Rienes & H Hogveveen (2011) What veterinarians need to know about communication to optimise their role as advisors on udder health in dairy herds, New Zealand Veterinary Journal, 59:1, 8-15, DOI: 10.1080/00480169.2011.547162

It's Time to Tell a Story



XXXXXX 20/20				Feeding Regime				LOL AmpMax CMX 22/20			
DM (%)	% to Feed	% Dry Matter		DM (lb/1000lb)	DM (lb/1000lb)	DM (lb/1000lb)		DM (%)	% to Feed	% Dry Matter	
DM (%)	50%			Milk Feedings/Day	2			DM (%)	50%		
Crude Protein (%)	20	22.00		Quarantined Feeding (lb)	4			Crude Protein (%)	22	23.34	
Fat (%)	20	22.00		Pounds of Feeding (lb)	0.5			Fat (%)	20	22.00	
Lactone (%)	51	55.66		Pounds of DM/Day (lb)	0.00			Lactone (%)	40	55.58	
ash (%)	9	9.42		kg DM/Day (kg/d)	0.48			ash (%)	9	9.42	
Mcal/kg of DM = 4.896				Mcal/day = 2.12				Mcal/kg of DM = 4.930			
Energy per kilogram of milk replacer				Energy per day from milk replacer				Energy per kilogram of milk replacer			
ADG @ Birth				ADG @ 4 Days				ADG @ Birth			
Birth Weight (lb)	95			Days on Milk (days)	7			Birth Weight (lb)	95		
Birth Weight (kg)	38.64			Weight (kg)	40.35			Birth Weight (kg)	38.64		
Milk @ Birth (Mcal/d)	1.35			Milk @ 4 Days (Mcal/d)	1.40			Milk @ Birth (Mcal/d)	1.35		
Milk @ Birth (Mcal/d)	0.57			Milk @ 4 Days (Mcal/d)	0.52			Milk @ Birth (Mcal/d)	0.57		
ADG @ Birth	0.20			ADG @ 4 Days	0.20			ADG @ Birth	0.20		
ADG lbs/d @ Birth	0.54			ADG lbs/d @ 4 Days	0.49			ADG lbs/d @ Birth	1.99		
ME Required for Target ADG				ME Difference At - Target				ME Required for Target ADG			
Target ADG (lb/d)	2.00			ME for Target ADG (Mcal/d)	4.52			Target ADG (lb/d)	2.00		
Target ADG (kg/d)	0.91			ME for Target ADG (kg/d)	2.02			Target ADG (kg/d)	0.91		
ME (lb)	95			ME Required Difference (Mcal/d)	2.40			ME (lb)	95		
ME (kg)	38.64							ME (kg)	38.64		
Milk (Mcal/d)	1.35							Milk (Mcal/d)	1.35		
Milk (Mcal/d)	0.57							Milk (Mcal/d)	0.57		
ME for Target ADG (Mcal/d)	4.52							ME for Target ADG (Mcal/d)	4.52		
ME for Target ADG (kg/d)	2.02							ME for Target ADG (kg/d)	2.02		

Dairy Doctors

**Keep On "2.0Mcal/day for 200 lb animal (4 for 300)

Calf Check

Kendra Wells, DVM

WeanClean™



- Weaning – how many have pneumonia at the start of weaning? Goal: < 15%
- Start of treatment – how many score > 3 or < 2 at their first treatment? Goal: < 15%
- 7-10 d after treatment – how many score > 2 after their first treatment? Goal: < 15%
- 12x7 scans – starting at 7d of age, scan 12 at 7d intervals to find high-risk age group

Where To Start?



- Low hanging fruit AKA Auto-feeders
- Clients with a hunger to improve calf programs and are willing to make changes
- Progressive/cutting edge clients



How Do I Sell It?



- After herd check “for free” for 1 month
 - Utilize a client that is happy to talk about their satisfaction with the service
- Utilize ultrasound solely for pneumonia diagnosis in calves- get clients accustomed to it
- Meeting for clients to introduce new idea

How Do I Start?



- Client dependent
- 7x12 scans to find “hotspot” throughout all calves
- Scan calves treated within a day or two- are they being caught at a 2 or 3?
- Start at weaning and work back
- Want to be doing treatments on 2's or 3's not 4's and 5's – move to the group that shows that
- 100s of calves? Unideal housing? No help? Start with a proportion – 30

Routine



- Find your hotspot
- Scan there and treat your calves according to you and your farm's protocol
- If you can, recheck calves treated the prior week/2weeks
 - Are they improving or not?
- Record the info
- Report on the info- is there a pattern?

Reporting



SEN: OUEK #

LungScoresbyLungMonth

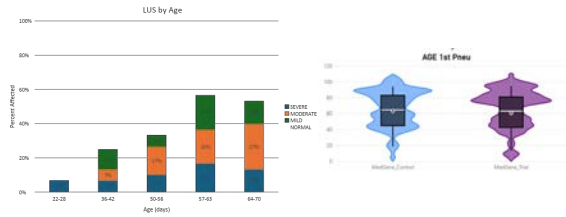
Count of ID

Column Labels

Row Labels

	SEVERE	MODERATE	MILD	NORMAL	Grand Total
10	13%	9%	16%	61%	100%
11	9%	16%	12%	63%	100%
12	10%	13%	14%	64%	100%
1	12%	12%	6%	70%	100%
2	15%	17%	10%	58%	100%
3	12%	13%	13%	62%	100%
4	15%	13%	14%	58%	100%
5	5%	6%	11%	77%	100%
6	2%	4%	9%	85%	100%
7	13%	18%	20%	50%	100%
8	12%	12%	9%	67%	100%
9	14%	12%	14%	60%	100%
Grand Total	11%	12%	12%	65%	100%

Compare to Treatment



Keep Going



- Money
- Sensitivity
- Calf raiser
- Can't change management

Questions



How to Perform Dental Nerve Blocks in the Horse for Dental Surgery

Jessica Hunt, DVM, DAVDC (Eq)

Midwest Veterinary Dental Services

Introduction

Regional nerve blocks are key to successfully performing dental surgery in the standing sedated horse. The maxillary and subsequent infraorbital nerve provides sensation to the maxillary dentition, which can be blocked with both maxillary and infraorbital nerve blocks. The mandibular nerve branches to the inferior alveolar nerve, which supplies sensation to the mandibular dentition. The inferior alveolar nerve can be anesthetized at two locations, depending on the target tooth/teeth. Anesthesia at the level of the mental foramen anesthetizes the ipsilateral canines and incisors, and anesthesia at the mental foramen will block the whole ipsilateral dental quadrant.^{1,2}

Patient Preparation and Protocols

Patient's should be heavily sedated to prevent sudden movements to minimize trauma to neurovasculature, injury to either the practitioner or the patient, and broken needles. Ideally, restraint in a standing stockade is recommended for longer or more complex dental procedures. If a stockage is not available, surgery should be performed in a quiet area with an anti-slip floor and good drainage. Placing an intravenous catheter to administer continuous rate infusion of sedation is recommended for procedures longer than 20 minutes. A veterinary assistant should be present to monitor sedation depth and restrain/ position the horse. The injection site is aseptically prepared to reduce the introduction of infection. All equipment needed for blocking should be

prepared and ready to use. The needle and/or extension line is to be flooded with injectant. A list of anesthetic drugs with varying time to onset and durations of action are listed in Table 1. The anesthetic agent should be chosen based on the duration of action desired for the dental procedure. Repeating the nerve block for postoperative pain management may be beneficial.¹

Table 1: Regional Anesthetic Drugs

Drug	Time to Onset	Duration of Action
Lidocaine	<2 minutes	1-2 hours
Mepivacaine	<2 minutes	1.5-3 hours
Bupivacaine	5-10 minutes	3-8 hours

Needles should be selected by using the smallest possible gauge needle that the practitioner is comfortable with, but still be sturdy enough to penetrate the skin and resist needle fracture.

Tuohy^a needles may be desired due to the tips being rounded bevel with the cutting edges offset to the side. This design makes it more likely to push the neurovascular structures away from the cutting edge making them safer compared to spinal or hypodermic needles.

Maxillary nerve block

The maxillary nerve block desensitizes all of the ipsilateral maxillary cheek teeth and gingiva, facial soft tissues rostral to the infraorbital foramen (lip, nostrils, and skin), and the nasal vestibule. The lacrimal, major and minor palatine, and caudal nasal nerves are in close proximity and may become anesthetized as well. Due to the potential of anesthetizing the lacrimal nerve; it is highly recommended to lubricate the ipsilateral eye every 30 minutes to prevent corneal desiccation and trauma.

Injection Technique

1. Locate the injection site by following the facial crest caudally, and drawing a caudal continuation of 2-3cm past the point of dorsal reflection into the zygomatic arch. This should be ventral to the lateral $\frac{1}{3}$ of the eye.
2. Aseptically prepare the area.
3. A 3.5" 20- or 22-gauge Tuohy needle is inserted perpendicular to the skin and advanced approximately 4.5-6 cm. A "pop" will be felt as the needle penetrates the fascial tissue between the masseter muscle and the extraperiorbital fat body. The needle should be advanced an additional 5mm after feeling the "pop."
4. Once in place, the style is removed and the syringe of injectant is attached. Aspirate to ensure the needle is not within a blood vessel.
5. Slowly inject 10mls of local anesthetic. Remove the needle and apply pressure to the injection site for 15 to 30 seconds.

Infraorbital nerve block

Blocking the infraorbital nerve desensitizes the ipsilateral maxillary premolars and gingiva, facial soft tissues rostral to the infraorbital foramen (lip, nostrils, and skin), and the nasal vestibule. If the needle can be seated deeper into the infraorbital canal, the ipsilateral molar teeth and gingiva can be desensitized.^{1,3} If the needle is being fed into the canal for desensitization of all ipsilateral teeth, the needle will be in close proximity to the nerve. This can be poorly tolerated by the patient, making proper sedation and restraint (such as a nose/ ear twitch and standing stockade) a necessity.²

Injection Technique

1. Palpate the nasoincisive notch and the rostral edge of the facial crest simultaneously with one hand. Without removing your fingers, dorsally displace the levator nasolabialis muscle and palpate the underlying infraorbital foramen. This is the injection site.
2. Aseptically prepare the area. A subcutaneous injection of 1ml lidocaine into the region of the foramen may increase patient compliance.
3. Dorsally displace the levator nasolabialis with the non-injecting hand. Starting approximately 0.5 to 1cm rostral to the foramen, slowly advance a 22- or 25-gauge 38-mm needle (or 3.5" Tuohy needle) 2-3cm into the ventral aspect of the infraorbital canal keeping the needle parallel to the facial crest.
4. Aspirate to ensure the needle is not placed within a blood vessel.
5. Slowly inject 3-5mls of injectant. Remove the needle and apply pressure to injection site for 15 to 30 seconds.

Inferior alveolar nerve block

The inferior alveolar nerve is a branch of the mandibular nerve that when blocked desensitizes the ipsilateral mandibular alveolar mucosa, teeth, and gingiva along the skin and labial mucosa rostral to the mental foramen. Due to the proximity of the lingual nerve, there is a risk of lingual trauma. There are two approaches, intraoral and extraoral. The use of a nerve locator may be helpful, but not necessary for the extraoral approach and will not be described in this paper.^{1, 2, 4, 5}

Injection Technique: Extraoral

1. Draw an imaginary line along the occlusal surface of the mandibular cheek teeth and a second line from the lateral canthus of the eye to the ventral mandible. This is the approximate location of the mandibular foramen on the medial aspect of the mandible.

2. Aseptically prepare the area.
3. Use a 20-gauge 6" Tuohy needle or 12.5cm spinal needle; hold the needle lateral to the skin in a vertical plane to determine the approximate depth, and grasp the needle at this point to prevent over-insertion.
4. Introduce the needle approximately 1 to 2cm medial to the ventromedial most aspect of the mandible to intersection of the determined lines (depth of the mandibular foramen), running the needle along the medial aspect of the ramus. Keep the needle constantly in contact with the bone while advancing.
5. Aspirate to ensure the needle is not placed within a blood vessel.
6. Inject 10mls of injectant slowly and remove the needle. Apply pressure to the injection site for 15 to 30 seconds.

Injection Technique: Intraoral

1. Adequately sedate the patient to prevent movement of the tongue. Cleanse the back of the mouth, by scrubbing the target area with betadine soaked gauze and rinse clean.
2. Grasp a 23-gauge 19- to 25-mm butterfly catheter with an alligator forceps. Introduce the needle into the oral mucosa overlying the rostral ramus just caudal to the mandibular third molar at the level of the occlusal surface. Advance the needle along the mesial aspect of the ramus.
3. Aspirate to ensure the needle is not placed within a blood vessel.
4. Slowly inject 10 to 12 ml of injectant.

Mental Foramen block (Rostral inferior alveolar nerve block)

Blocking at the level of the mental foramen desensitizes the rostral portion of the inferior alveolar nerve: ipsilateral alveolar mucosa, labial mucosa, skin, and gingiva rostral to the mental foramen and ipsilateral incisor and canine teeth; with possible anesthetize ipsilateral second and third premolar.¹ Intraoral and extraoral approaches are possible; however, the intraoral approach can be challenging due to restriction from the labial frenulum (this approach will not be described in the paper). Penetrating into the foramen is critical for providing anesthesia to the incisor and canine teeth. Infiltration around the foramen will anesthetize the skin and lip.² Due to the needle being placed in close proximity to the nerve, this block can be poorly tolerated. So adequate sedation and restraint (such as a nose/ ear twitch and standing stockade) are recommended.

Injection Technique

1. Dorsally displace the depressor labii inferioris muscle along the lateral rostral mandible. Palpate the mental foramen. This is the injection site.
2. Aseptically prepare the area. A subcutaneous injection of 1ml lidocaine into the region of the foramen may increase patient compliance.
3. Using a 25-gauge 25-mm needle or 3.5” 25-gauge Tuohy needle advance into the mental foramen.
4. Aspirate to ensure the needle is not placed within a blood vessel.
5. Slowly inject 3 to 5 mls into the mandibular canal, remove the needle. Apply pressure to the injection site for 15 to 30 seconds.

Intraligamental Anesthesia (ILA)

Injection of local anesthetic directly into the periodontal ligament has been observed to spread throughout the periodontal ligament and alveolar bone, resulting in desensitization of the target tooth.⁷ Utilizing a long-handled dental syringe^b is necessary. Due to the physical trauma of needle placement and possible ischemia after injecting local anesthetic with a vasopressor, the ILA-technique is not recommended for “tooth-saving” procedures. On a case by case basis, this may be sufficient as the only form of anesthesia.

Injection Technique

1. Using a long-handled dental syringe^b, 25G x 1” or 1-3/8” dental needle^c, and 1.8ml anesthetic (+/- vasopressor) solution cartridge^d.
2. Bend the needle about 90 degrees and insert along the tooth into the periodontal ligament until resistance is met, and inject 1 cartridge of anesthetic solution.
3. Repeat needle insertion and injection on the mesiobuccal, mesiolingual/-palatal, distobuccal, and distolingual/-palatal sides of the target tooth.
4. Additional injectant can be placed after molar spreader forcep use and more space is created if needed.

Discussion

Complications from regional anesthesia include hematoma formation, regional infection, neuropraxia, intravascular injection, facial trauma, and failure to desensitize (incidence being reported at 2.96%)⁶. Trauma to the vasculature and intravascular injection can be reduced by using Tuohy needles and aspiration prior to injection. Performing injections in a sterile manner helps reduce the risk of regional infection. Nerve damage and inadvertently anesthetizing close proximity nerves (such as the lacrimal and lingual nerves) can be reduced by using the smallest

effective volume of the injectant. Restricting feed or muzzling the patient for 4 to 6 hours post-injection reduces the risk of lingual and muzzle trauma.¹

The use of regional nerve blocks increases patient compliance, decreases procedural length, and provides a safer work environment during dental extractions. The combination of dental diagnostics, thorough knowledge of anatomy, and regional anesthesia many dental procedures (even advanced procedures) can be successfully performed under standing sedation.

Product and Equipment Names

^aTuohy Epidural Needle – GPC Medical Limited, New Delhi, India.

^bLong handled dental syringe: 40cm Extended Intra-Oral LA Syringe – Equine Blades Direct, Wedmore, United Kingdom or 30cm Equine Nerve Block 1.8ml Ampule Syringe – Equine Dental Instruments, Elmwood, Wisconsin

^cMonoject #401 25G long 1.375” or 1.00” Metal Hub Needles – Net32, Cary, North Carolina

^dLiocaine HCL2% with Epinephrine1:50,000 Cartridge 1.7mL – Net32, Cary, North Carolina

Acknowledgments

Declaration of Ethics

The author has adhered to the Principles of Veterinary Medical Ethics of the AVMA.

Conflicts of Interest

The author has no conflicts of interest.

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From Pugs to Persians to Pinschers: Custom Anesthesia for Different Breeds



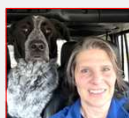
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Disclosures

- This lecture is not sanctioned by WVMA and does not reflect the opinion of the organizers or UW-Madison
- No financial disclosures
- No conflicts of interest

Introduction

- The Ohio State University: DVM (1993)
- University of Wisconsin
 - DACVAA & MS (1997)
 - PhD: Respiratory Neurophysiology (2002)
- Clinical Instructor (2003) → Full Professor (2019)
- Research Anesthesiologist (2020)
- CLINICIAN SCIENTIST





3 Takeaway Points

1. INDIVIDUALIZED MEDICINE
 - Tailor plans to individual patients – think outside the “protocol” box!
2. Breed-specific considerations DO exist in anesthetic/analgesic management
 - Pharmacogenomics
3. Nursing care is SOOO as important!
 - “Chill” protocols
 - Anti-nausea/anti-vomiting agents
 - Pre-oxygenation



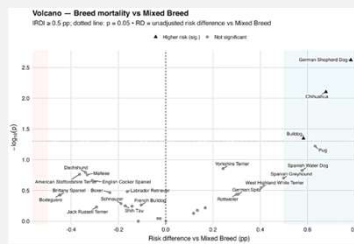
MY BREED is Sensitive to XXX!
You Cannot Use XXX in MY BREED!



Anesthetic-Related Mortality & Breed

Dogs (21 countries): Redondo et al 2025

- 54,542 dogs; pre-med to 48 h post
- Overall 0.69%; mixed breeds 0.68%
- MDR-1 breeds did not differ
- Unadjusted
 - German Shepherd 1.46%;
 - Chihuahua 1.35%; Bulldog 1.26%
 - Brachycephalics (0.82% vs 0.65%)
- After ASA adjustment
 - Brachycephalic effect attenuated
 - Chihuahua still different!



Genes Make a Difference ...



[ABOUT](#)
[CHIC PROGRAM](#)
[DISEASES](#)
[BROWSE BY BREED](#)
[APPLICATIONS](#)
[HEALTH CLINICS](#)
[ADVANCED SEARCH](#)

Recommended Tests/CHIC Program Requirements

The OFA, working with the breed's parent club, recommends the following basic health screening tests for all breeding stock. Dogs meeting these basic health screening requirements will be listed on the Canine Health Information Center (CHIC) numbers. For CHIC certification, all results do not need to be normal, but they must all be in the public domain so that responsible breeders can make more informed breeding decisions. For potential puppy buyers, CHIC certification is a good indicator the breeder responsibly factors good health into their selection criteria. The breed specific list below represents the basic health screening recommendations. It is not all encompassing. There may be other health screening tests appropriate for this breed. And, there may be other health concerns to which there is no currently accepted screening protocol available.

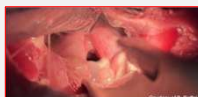
Screening	Testing options
Hip Dysplasia	One of the following: OFA Radiographic Hip Evaluation PennHIP Evaluation. Results registered with OFA. Federation Cynologique Internationale (FCI) AVA (Australian Veterinary Association) NPTB
Patellar Location	Veterinary Evaluation of Patellar Location. Results registered with OFA.
Heart	2 of the following: Basic Canine Exam. Results registered with OFA. Auscultatory Thoracic Evaluation from an approved Lab. Results registered with OFA. OFA Radiographic Elbow Evaluation B.A.P. (Breeders Association of Professionals) Results registered with OFA. OFA Radiographic Shoulder (SCS) Evaluation ACVO Eye Examination. Results registered with OFA. DNA-based Canine Multifactor Retinopathy (CMR) test from an approved laboratory. Results registered with OFA. First Generation Offspring of tested dogs eligible for Clear By Pedigree. DNA-based Canine's Thrombasthenia (BT) test from an approved laboratory. Results registered with OFA. First Generation Offspring of tested dogs eligible for Clear By Pedigree. Autosomal Canine Exam Basic Canine Exam DNA-based MDR1 test from an approved laboratory. Results registered with OFA. First Generation Offspring of tested dogs eligible for Clear By Pedigree.

WHAT ABOUT MIXED-BREDS??

Brachycephalic Breeds

An entire lecture!

- Pre-anesthetic evaluation
 - ASA III!
 - Good PE: airway, CV, GI, ocular, etc.
- Stress free & prepare
 - Consent form & patient work-up prior to procedure
 - "Chill Drugs": acepromazine, gabapentin, trazodone
 - "Goodie bag": "chill drugs", maropitant, cisapride, omeprazole
 - Airway tray/cart
 - Pre-oxygenation & flat probe pulse ox



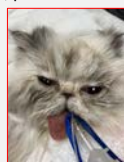
Brachycephalic Breeds

- Pre-meds
 - Dexmedetomidine + methadone
- Induction
 - Smooth & quick
 - Lidocaine IV
 - "Sandwich": propofol-ketamine-propofol
- Maintenance
 - MONITOR!!
 - Low dose inhalant
 - Local anesthetic techniques
 - Fascial plane blocks, maxillary n. blocks, infraorbital blocks, etc.



Brachycephalic Breeds

- Recovery
 - Low dose acepromazine (0.005 mg/kg IV, IM)
 - Sternal recumbency
 - Airway rack, tape roll, V-gel, etc.
 - Nebulize with epinephrine, pack with 7.5% NaCl, phenylephrine ...



- What about Persians?

- Canine Chiari-like Malformation
- Valvular Disease (MANY small dogs)



- Congenital, inherited: small skull → cerebellar herniation, compressed brainstem, syringomyelia (obstructed CSF)
- Symptomatic or asymptomatic: neck pain, sensitivity, "air scratching"

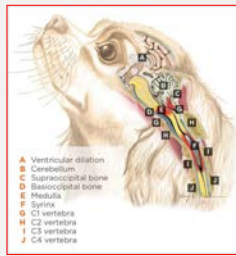
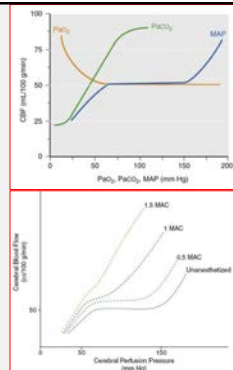


Figure 1. ... the caudal aspect of the cerebellum (shaded in red) is herniated through the foramen magnum and is compressing the medulla. The syringomyelia (syrinx) is notable between C2 and C3. Illustration: Wendy Chadbourne of Inky Mouse Studios

<https://todaysveterinarypractice.com/neurology/chair-like-malformation-an-overview/>

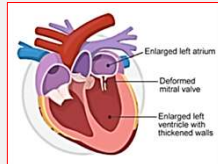
- Anesthetic plan: “neuroprotective”
 - ↓ nausea/vomiting: ondansetron, maropitant
 - ↓ cough: lidocaine (2 mg/kg); fentanyl (7 mcg/kg) IV
 - Avoid HIGH dose ketamine
 - Agents: midazolam, opioids, low dose dexmed
 - Pre-oxygenate
 - MAP: 60-160 mmHg
 - Mechanical ventilation: $\text{ETCO}_2 \sim 35 \text{ mmHg}$
 - LOW dose inhalants
 - PIVA
 - TIVA



<https://aneskey.com/anesethetic-effects-on-cerebral-blood-flow-and-metabolism/>

Cavalier King Charles Spaniel Myxomatous Mitral Valve Degeneration (MMVD)

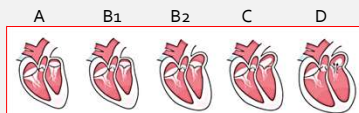
- ~30% of geriatric dogs; up to 90% of CKCS by age 10
- ~75% of dogs with heart disease (Lombard et al 2006; Rush 2002)
- Tricuspid valve affected in ~30% of cases
- Eccentric hypertrophy & annular dilation
- Left ventricular dilation
- Backflow during systole into left atrium → dilation
- Left holosystolic murmur



<https://simulhealth.boehringer-ingenheim.com/getacardio/product/therapeutics/vetmedin-ca>

ACVIM Classification of MMVD (Keene et al 2019)

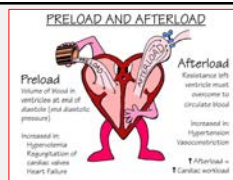
- Stage A: High risk for development, no murmur (breed disposition)
- Stage B: Structural heart disease, no failure
 - Stage B1: MMVD - no radiographic/echocardiographic changes
 - Stage B2: MMVD - radiographic/echocardiographic LA/LV changes
- Stage C: Previous or current clinical signs of CHF
- Stage D: End-stage MMVD, refractory to treatment



<https://improveternational.com/clinical-library/infectious-cardiac-disease>

Cavalier King Charles Spaniel

- MMVD anesthetic plan: “cardio-friendly”
- **FAST & LOOSE**
 - Preload: low - prone to fluid overload
 - ↓ fluid rate (~3 mL/kg/h IV)
 - Afterload: low (**LOOSE**) - encourage forward flow
 - Minimize vasoconstriction - which drugs vasoconstrict?
 - HR: avoid bradycardia (**FAST**) - smaller LV volumes so less regurgitation
- Stress free: catecholamines = vasoconstriction
- **SHORT** anesthetic time!



<https://cards.merckvet.com/docs/ucv/preload-and-afterload/>

"Cardio-Friendly" Anesthetic Plan: MMVD

- ↓ stress/nausea/vomiting: gabapentin, ondansetron, maropitant
- Balanced anesthesia & multimodal analgesia
- Benzodiazepine + opioid pre-med
 - Midazolam (0.2-0.4 mg/kg) + methadone (0.2-0.5 mg/kg) IM/IV
- Propofol/alfaxalone/etomidate induction
 - Ketamine co-induction or propofol-ketamine-propofol sandwich
 - Propofol (1 mg/kg) - ketamine (0.25-0.5 mg/kg) - propofol (to effect) IV
- AVOID HIGH dose ketamine - CRI doses acceptable (2-10 mcg/kg/min IV)
- AVOID HIGH dose dexmedetomidine
- LOW inhalant - local techniques, opioids, low dose ketamine CRI
- MONITOR!!
 - ALL THE THINGS (ECG, SPO₂, BP, temp, ETCO₂)



Sighthounds (Greyhounds – Others?)

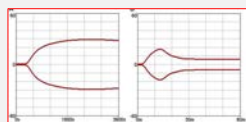
Robinson et al 1986; Zoran et al 1993; Pasloske et al 2009

- Genetic Groups
 1. Greyhound, Italian Greyhound, Whippet, Borzoi, Deerhound, Irish Wolfhound
 2. Saluki, Afghan Hound, Ibizan Hound, Pharaoh Hound



Sighthounds

- Nervous ... couch potatoes
- ↑ PCV (> 45%), creatinine, BUN, MAP
- ↓ platelets, WBCs, protein
- Mildly ↑ hearts/mild systolic physiologic murmurs - turbulence from ↑ SV
- High body surface-to-volume & low adipose (17% vs 35%): hypothermia
- Nonmalignant hyperthermia
- Hyperkalemia (Love 2019; <https://www.mynavas.org/post/anesthesia-associated-hyperkalemia>)
- Polymorphisms in CYP2B11 gene (Group 1) - slower metabolism
- Others ... Fibrinolytic Syndrome
 - Genetic test (DEPOHGEN: Deerhounds)



Sighthounds

- Thiobarbiturates & propofol & alfaxalone
 - Slightly longer recoveries vs mixed breed dogs
 - High muscle - low adipose
 - Metabolic deficiency through CYP2B11
 - If hepatic microsomal enzymes induced (phenobarbital) - thiopental response similar to mixed breeds
 - Propofol metabolism >3X lower vs Beagles, mixed breeds
 - Especially in Group 1
 - Greyhound, Italian Greyhound, Whippet, Borzoi, Deerhound, Wolfhound
 - Anecdotal reports in others ...



Sighthounds Anesthetic Plan

- “Stress-free, ✓ potassium, quick drugs”
- ↓ stress/nausea/vomiting: gabapentin, ondansetron, maropitant
- Balanced anesthesia - multimodal analgesia
 - SHORT anesthetic time (next slide)
 - Low-dose dexmedetomidine (1-3 mcg/kg IM, IV) - K⁺?
 - +/- Zenalpha® (medetomidine+vatinoxan; 1:1 – 2:1 IM)
 - Acepromazine (0.005-0.01 mg/kg IM, IV)
 - Propofol induction
 - LOW inhalant - local techniques, opioids!
 - Reversible or short acting drugs!

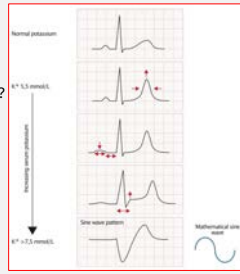


Sighthounds MONITOR!

- ALL THE THINGS (ECG, SPO₂, BP, temp, ETCO₂)
- Hyperkalemia
 - Check K⁺ (q 30 min) - duration is a risk factor (Love 2020)
 - Most (81%) occur at 2+ h of anesthesia
- Control ventilation/hypercapnia/acidosis
- If present:
 - Stop or continue procedure?
 - Reverse alpha-2 agonists?
 - IV fluid dilution
 - Further Tx

Hyperkalemia

- **10% Calcium gluconate**
 - 0.5-1.5 mL/kg; stabilize membranes - restore RMP???
 - Restored conduction, narrowed QRS
 - Ca^{++} -dependent impulse propagation (Piktel et al 2024)
- Regular insulin
 - 0.5-1 U/kg; shift intracellular
- Dextrose with insulin
 - 1-2 g/U insulin
- Terbutaline
 - 0.01 mg/kg SC; β receptor shift intracellular
- Inhaled salbutamol
 - 100 mcg actuation; β receptor shift intracellular
- Sodium bicarbonate
 - 1-2mEq/kg; shift intracellular

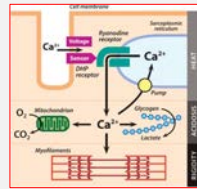


<https://ecgwaves.com/topics/cardiac-arrest-in-electrolyte-disturbances/>

Malignant Hyperthermia

Pharmacogenetic Disease (Roberts et al 2001)

- Border Collie, Springer Spaniel, Greyhound, Irish Wolfhound, Labrador Retriever
- Gene: autosomal dominant (dog) mutation in ryanodine receptor (RYR-1) on SR - $\uparrow \text{Ca}^{++}$ release
- Hypermetabolic state
- Trigger: halogenated anesthetics, stress



Malignant Hyperthermia

- Signs - after induction
 - $\uparrow \text{CO}_2$... $\uparrow$ temperature
 - Muscle fasciculations - rigidity
 - Metabolic (lactic) acidosis, myoglobinuria
- Treatment
 - Prevention vs treatment
 - Symptomatic (fluids, tx hyperkalemia, control ventilation, correct arrhythmias)
 - Dantrolene (RYR antagonist)



<https://prime.vetmed.wsu.edu/2021/10/19/breeds-commonly-affected-by-mdr1-mutation/>

- ## White feet – don't treat?



- 4 base pair deletion in MDR-1 gene → makes p-glycoprotein in BBB → efflux pump → drugs accumulate in brain (Mealey et al 2023)

[illegible]

Careful about anecdotal reports!

Case Report: Adverse reaction to butorphanol in a Collie homozygous for the ABCB1-2 (-) [MDR1] mutation

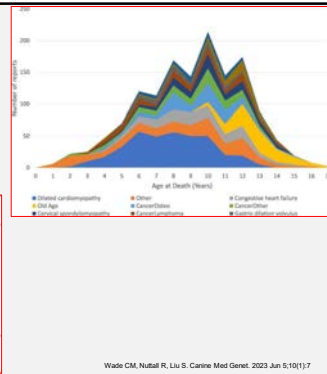
The Effect of the Canine *ADCB1-1Δ* Mutation on Sedation after Intravenous Administration of Acepromazine

Use drugs with high therapeutic index

Doberman Pinschers

- Get a good signalment & history!
- Von Willebrand Disease (vWD)
- Dilated Cardiomyopathy (DCM)

Locality/Purpose	Cardiac disease %	Osteosarcoma %	Lymphoma %	Hemangiosarcoma %	Cervical spondylomyelopathy %	Spondylitis %	Gastric dilation/volvulus %
Germany	20.5	25.5	3.5	5.5	15.5	10.5	5.5
Europe Show	38.97	7.4	4.27	0.97	1.97	4.9	2.97
US West/Show	24.9	2.5	2.9	0.9	0.9	3.9	0.9
Europe Working	36.47	4.47	7.97	0.97	0.97	3.5	5.47
Other	15.9	33.5	10.9	10.9	10.9	10.9	10.9
UK	22.0	0.0	10.9	10.9	10.9	10.9	10.9
US	32.0	4.4	3.9	3.5	3.5	3.5	3.7
Australia	29.0	29.0	5.5	5.9	0.9	2.9	2.9
American Pit	27.0	7.2	3.4	3.1	10.07	3.9	3.9
USDA Blood	29.3	0.7	5.2	0.1	0.2	7.2	10.9
Mean	28.3	4.8	5.1	3.8	5.7	5.7	4.0
Median	2.8	0.97	0.95	0.88	3.20	0.81	0.45
Q upper	32.80	8.30	4.20	3.21	8.05	4.99	4.88
Q lower	23.48	4.50	4.06	0.52	0.95	0.95	0.11



Wade CM, Nutall R, Liu S. Canine Med Genet. 2023 Jun 5;10(1):7

vWD

- Historical oral/nasal bleeding
- Diagnosis: vWF antigen assay (vWF:Ag%)
 - Normal 70-180%
 - Borderline 50-69%
 - Abnormal 0-49%
 - Most severely affected <25%

Classification	vWF concentration/structure	Clinical Severity	Affected Breeds
Type 1	low concentration/normal structure	variable	Airedale, Akita, Bernese Mountain Dog, Doberman Pinscher, German Shepherd, Golden Retriever, Greyhound, Irish Wolfhound, Mastiff, Boxer, Shetland Sheepdog, Shiba Inu, Shetland Sheepdog and others
Type 2	low concentration/abnormal structure	severe	German Shorthaired Pointer, German Wirehaired Pointer
Type 3	vWF markedly reduced or absent	severe	Pointers Chesapeake Bay Retriever, Dutch Kooiker, Scottish Terrier, Shetland Sheepdog Newfoundlands Blue Heeler, Border Collie, Bull Terrier, Cocker Spaniel, Labrador Retriever, mixed breed, Rottweiler and others

Von Willebrand Disease

Most common inherited bleeding disorder

Von Willebrand factor (vWF)

Area of damaged endothelium

vWF

- Important role in primary hemostasis
- Binds platelets
- Binds endothelial components
- Forms adhesive bridge between platelets and vascular subendothelial structures
- Contributes to fibrin clot formation (carries factor VIII)

Clinical

- Easy bruising
- Skin bleeding
- Prolonged bleeding from mucosal surfaces (epistaxis, GI, uterine)

Laboratory

- Normal platelet count (mild thrombocytopenia in type 2B)
- Normal PT/INR
- Normal aPTT (prolonged if very low factor VIII)

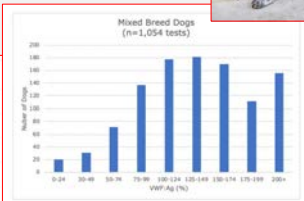
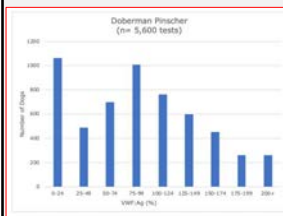
Treatment

- Desmopressin
- vWF concentrates

<https://www.mshvet.com/blog/step-by-step-von-willebrand-disease/>

vWD

- Desmopressin (1 mg/kg SC, IV)
- Cryoprecipitate (10 mL/kg IV)
- Fresh Frozen Plasma (FFP)
- Avoid acepromazine



German Shepherds, Golden Retrievers ...
<https://www.vet.com/animal-health-diagnostics/laboratory/comparative-coagulation/clinical-topics/von-willebrand-disease>

Genetic Cardiac Testing - NCSU

- Genetic ... but multifactorial

Cardiac

- Boxer Arrhythmogenic Right Ventricular Cardiomyopathy (ARVC)
- Doberman Dilated Cardiomyopathy (DCM)
- Golden Retriever Hypertrophic Cardiomyopathy (HCM)
- Maine Coon Hypertrophic Cardiomyopathy (HCM)
- Newfoundland/Subsidiary Aortic Stenosis (AS)
- Ragdoll Hypertrophic Cardiomyopathy (HCM)
- Rothman Ridgeback Inherited Ventricular Arrhythmias (IVA)
- Sphynx Hypertrophic Cardiomyopathy (HCM)

Neurological

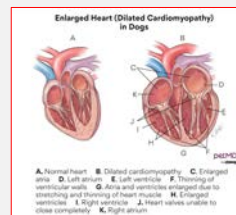
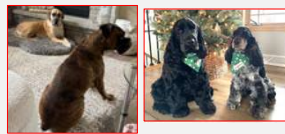
- American Staffordshire Terrier/Staffordshire Bull Terrier (NCT)
- Boxer Spontaneous Atrial Fibrillation (SAF)
- Cane Corso Degenerative Myelopathy (DM)
- Golden Retriever Cerebellar Degeneration (CD)
- Old English Sheepdog Cerebellar Degeneration (CD)
- Scottish Fold Syndrome

Pharmacogenetic

DCM (Doberman Pinscher)

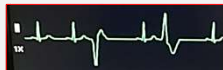
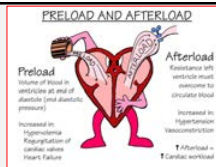
Genetic but ... multifactorial

- Dobermans, Great Danes, *Boxers* (carnitine def), Cocker Spaniels (taurine responsive)
- Diet: peas, chickpeas, lentils, potatoes ("grain free" diets)
- Systolic dysfunction
 - Dilation → mitral regurgitation, atrial fibrillation
 - Other dysrhythmias
 - Syncope, exercise intolerance, L or R CHF



DCM (Doberman Pinscher)

- Anesthetic plan: "cardio-friendly"
 - Preload: low - prone to fluid overload
 - ↓ fluid rate (~3 mL/kg/h IV)
 - Afterload: low - encourage forward flow
 - Minimize vasoconstriction - which drugs vasoconstrict?
 - Minimize stress - prehospital agents
 - Contractility: compromised → inotropic support
 - HR: keep "normal"
 - May present with atrial fibrillation/poor filling
 - ECG! VPCs common
 - May be on diuretics - ✓ K⁺

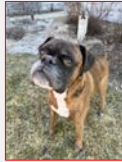
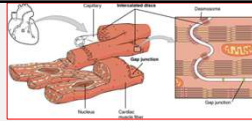


Talking About Boxers ...

DCM

Acepromazine

- “Well-known” sensitivity & collapse & bradycardia
- Related to Arrhythmogenic Right Ventricular Cardiomyopathy (ARVC)?
 - Mutation in striatin (desmosomal protein) → fibrofatty deposits in RV → sustained V-tach → syncope/death
- Enhanced vagal response - brachycephalic?
- Anesthetic plan:
 - Avoid acepromazine? OR
 - LOW dose (0.005 mg/kg)
 - Glycopyrrolate/atropine?



Version 5.25 from the Textbook of Veterinary Anatomy and Physiology Published May 18, 2016

Example Anesthetic Plan: DCM

- SHORT anesthetic time!
- ↓ stress/nausea/vomiting: gabapentin, ondansetron, maropitant
- Balanced anesthesia & multimodal analgesia
- Benzodiazepine + opioid pre-med
 - Midazolam (0.2-0.4 mg/kg) + methadone (0.2-0.5 mg/kg) IM/IV
- Propofol/alfaxalone/etomidate induction
 - Lidocaine co-induction or propofol-ketamine-propofol sandwich
 - Propofol (1 mg/kg) - ketamine (0.25-0.5 mg/kg) - propofol (to effect) IV
- AVOID HIGH dose ketamine - CRI doses acceptable (2-10 mcg/kg/min IV)
- AVOID HIGH dose dexmedetomidine – vasoconstriction
 - NAUGHTY? Use Zenalpha® (medetomidine + vatinoxan)?
- LOW inhalant - local techniques, opioids, low dose ketamine CRI!
- MONITOR!!
 - All the things (ECG, SPO₂, BP, temp, ETCO₂)

Hypertrophic Cardiomyopathy (HCM)

Maine Coons, Ragdolls, Sphinx, Persians, British Shorthairs, Bengals, Savannah Cats, Rex, etc. (Boeykens et al 2024)

- Most common feline cardiac disease (~15% of population)
- Dx: echo - proBNP not always reliable
- Mid-to-late life but 6 m -17 yr
- Dyspnea, lethargy, rear leg paralysis (clot), etc.
- Diastolic dysfunction → myocardial ischemia, LV outflow tract obstruction, thromboembolism



<https://www.vet.com.au>

Hypertrophic Cardiomyopathy (HCM)

Anesthetic Plan - "Cardio-Friendly"



- Preload: low - prone to fluid overload
 - ↓ fluid rate (~2 mL/kg/h IV)
- Afterload: low - encourage forward flow
 - Minimize vasoconstriction - which drugs vasoconstrict?
 - **Minimize stress - prehospital agents**
- Contractility/relaxation: compromised – inotropic/lusitropic support - dobutamine
- HR: keep "normal" - avoid tachycardia
- **SHORT anesthetic time!**
 - All protocols cause some cardiovascular compromise (Keating et al 2024)

Example Anesthetic Plan: HCM



- **SHORT anesthetic time!**
- ↓ stress/nausea/vomiting: gabapentin, ondansetron, maropitant
- Balanced anesthesia & multimodal analgesia
- Benzodiazepine + opioid ± alfaxalone pre-med IM (IV)
 - Midazolam (0.2-0.4 mg/kg) + methadone (0.2-0.5 mg/kg) ± alfaxalone (2 mg/kg)
- Propofol/alfaxalone/etomidate induction
 - Ketamine co-induction or propofol-ketamine-propofol sandwich
 - Propofol (1 mg/kg) - ketamine (0.25-0.5 mg/kg) - propofol (to effect) IV
- AVOID HIGH dose ketamine - CRI doses acceptable (2-10 mcg/kg/min IV)
- AVOID HIGH dose dexmedetomidine (**controversial** - ↓ LVOT obstruction; Lamont et al 2002)
- AVOID anticholinergics *if possible*
- LOW inhalant - local techniques, opioids, low dose ketamine CRI!
- **MONITOR!!**
 - All the things (**ECG**, SPO₂, **BP**, temp, ETCO₂)

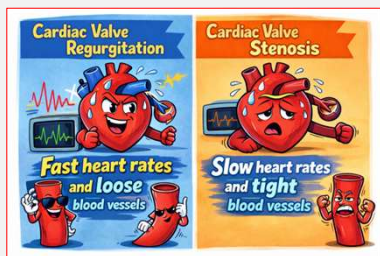
Subaortic Stenosis (SAS)

Bullmastiffs, Bouvier des Flandres, Dogues de Bordeaux, Golden Retrievers, Newfoundlands, Rottweilers (Ontiveros & Stern 2021)

- Anesthetic goals: **SLOW & TIGHT**
 - ↓ myocardial work (avoid tachycardia, minimize stress, maintain NSR)
 - β-adrenergic blockers
- Preload: normal
- Afterload: as "normal" as possible
- How? Minimize vasodilation & hypotension
- HR: low to normal - avoid tachycardia!
- **SHORT anesthetic time!**

Example Anesthetic Plan: SAS

- ↓ stress/nausea/vomiting: gabapentin, ondansetron, maropitant
- Balanced anesthesia & multimodal analgesia
- Alpha-2 agonist (low dose) + opioid
 - Dexmedetomidine (1-2 mcg/kg) + methadone (0.2-0.5 mg/kg) IM/IV
- Propofol/alfaxalone/etomidate induction
 - Lidocaine co-induction (1 mg/kg)
 - Propofol-ketamine-propofol sandwich
 - Propofol (1 mg/kg) - ketamine (0.1-0.2 mg/kg) - propofol (to effect) IV
- AVOID HIGH dose ketamine & dexmedetomidine
- AVOID acepromazine
- AVOID anticholinergics
- LOW inhalant - local techniques, opioids, low dose ketamine CRIs!
- MONITOR!!
 - ALL THE THINGS (ECG, SPO₂, BP, temp, ETCO₂)



Contraindicated During Anesthesia?

UW Veterinary Care
UNIVERSITY OF WISCONSIN - MADISON

UW Veterinary Care
Anesthesia Withheld
Drug
Recommendations
Updated 8/7/2023

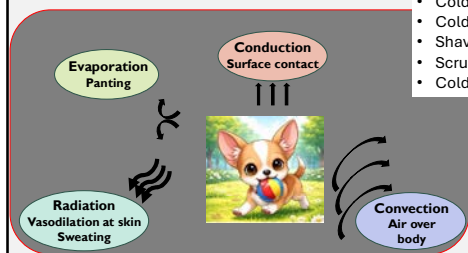
Class of Drug	Example	Withhold time
ACE inhibitors	Enalapril	1-2h
	Benazepril	1-2h
Angiotensin II Receptor Blockers	Losartan	24h
NSAIDs	Carpfen	Consult with anesthesia faculty
	Meloxicam	Consult with anesthesia faculty
Insulin	Insulin	Consult with anesthesia faculty
Partial mu-opioid receptor agonists	Buprenorphine	Consult with anesthesia faculty
Mu-opioid receptor antagonists	Butorphanol	Consult with anesthesia faculty
Platelet inhibitor	Clopidogrel	Consult with surgeon
Diuretic	Furosemide	Consult with anesthesia faculty
Sympathomimetic	Phenylpropanolamine	
PDE-3 inhibitor	Pimobendan	
Beta-adrenergic receptor blocker	Atenolol	
Calcium channel blockers	Diltiazem	

Toy Breeds

- Small size - low BMI
 - Dose on metabolic scaling?
 - Other factors considered (brain mass, hepatic metabolism, cardiac output, lung capacity, lipid solubility)
 - Use drugs with high therapeutic index!
- Accurate body weight - avoid overdosing (NSAIDs, fluids)
- Hypervolemia
- Hypothermia
- Hypoglycemia (Idowu & Heading 2018)
 - Minimal lipolysis as alternate fuel
 - Alanine deficiency → gluconeogenesis dysregulation if fasted



Thermoregulation



HYPOTHERMIA

- Anesthetic drugs
 - Alter blood flow patterns
 - Alter autonomic tone
 - Lose thermoregulation
- Cold fluids & gases
- Cold ambient temperature
- Shaving
- Scrubbing
- Cold surfaces

Consequences

- Left shift oxygen dissociation curve
- Shivering: ↑ O₂ consumption
- Prolonged recovery
- ↓ MAC
- Vasoconstriction
- Fluid shifts from IV space
- Diuresis
- Bradycardia - arrhythmias
- Platelet inhibition
- ↑ blood viscosity
- ↑ surgical site infections
- PONV

Tips to Treat

- Active warming
 - Forced air warmers
 - Most effective
 - Circulating water blankets
- Passive warming (blankets)
 - ↓ loss from all methods
 - Cannot replace heat
- Fluid warming, circuit warming
- NO DIRECT CONTACT with warm water bottles, warming devices, etc.



Warming Devices & Sphinx

- Others ... Rex, Mexican Hairless ...
- Care with skin!!
- Anesthesia vs awake?



<https://www.courtesyimg.com/stockphoto/hairedog/hairless-dog-breeds/>

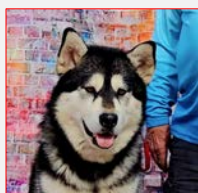
Giant Breeds

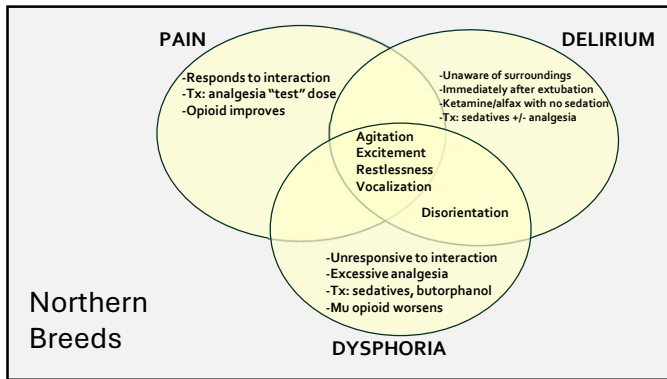
- Genetic issues previously discussed ... DCM
 - Atrial fibrillation! Irregularly irregular!
- Difficulties in dosing - get accurate body weight
 - Expense (methadone, Nocita®)
- Difficult to handle
- GV 20
 - ↑ dexmed sedation dogs (vs IM) & cats (off site SC; same IM) (Pons et al 2017; Solash et al 2025)
 - ↑ hydro analgesia in dogs at 1/10 dose (vs IM; Scallan et al 2021)
 - ↑ bird sedation (ket/midaz vs IM; Monteiro et al 2022)
 - Due to ↑ heat/blood flow (Solash et al 2025)
 - ↓ dose ~25% if profound sedation not needed!



Northern Breeds

- Gene variant (C-15A) in OPRM1 gene = increased dysphoria with opioids
 - Huskies, Alaskan Malamutes, Labrador Retrievers (Wagner et al 2002; Hofmeister et al 2006; Hawley & Wetmore 2010; Kongara 2017)





End With a Fun Fact ...

- Dachshunds
 - Lower HR (~8 beats/min) vs others during MRI (Harrison et al 2012)
 - ↑ in ETCO₂ of 1 mmHg → ↑ HR 0.9 beats/min
 - Not related to body mass, temperature



Key Takeaway Points

- Airway matters first!
 - Brachycephalic breeds (Bulldogs, Pugs, Persian cats)
 - Preoxygenation, rapid intubation, careful recovery monitoring
- Watch the heart
 - Boxers, Dobermans, HCM cats, Great Danes, Newfoundlands, etc.
- Drug responses differ with genetics
 - e.g., sight hounds, MDR-1 mutation in herding breeds, etc.
- Other breed physiologically-related issues ...
 - **Bottom Line: Breed matters!**
 - **Anticipate risks → adjust plan → improve anesthetic safety!**

Thank You! Questions?

Rebecca.johnson@wisc.edu



Managing Chronic Kidney Disease

What actually improves outcomes in dogs and cats

Julia Bates, DVM, DACVIM (SAIM)

WVMA Zoo School 2026

1 Confirm CKD before treating CKD

CKD requires a persistent functional or structural kidney abnormality. Do not stage a dehydrated, obstructed or otherwise unstable patient. A single increased creatinine or SDMA is not enough when prerenal and postrenal causes remain plausible. Conversely, normal creatinine does not exclude early CKD in a poorly muscled patient.

Initial Diagnostics

- **History:** Focus on changes in appetite, diet, water intake, urine volume, vomiting frequency, stool quality, medications, supplements, toxin exposures, prior urinary tract issues, weight, and activity level.
- **Physical examination:** Document body weight, body condition score (BCS), muscle condition score (MCS), hydration status, oral health, thyroid palpation (in cats), retinal and fundic findings, abdominal palpation, and systolic blood pressure (SBP).
- **Laboratory profile:** CBC; serum chemistry covering creatinine, blood urea nitrogen (BUN), phosphorus, potassium, calcium, and albumin; SDMA when additional functional assessment is warranted; and a complete urinalysis including urine specific gravity (USG) and sediment exam. Add a urine protein-to-creatinine ratio (UPC) if the sediment is inactive. Request a urine culture when systemic illness, active sediment, or pyelonephritis is plausible.
- **Diagnostic imaging:** Use ultrasound or radiographs to evaluate structural changes, nephrolithiasis, ureteral obstruction, neoplasia, congenital anomalies, or acute concurrent disease. Chronic sonographic renal changes support a CKD diagnosis, but they do not prove that an acute illness is caused entirely by renal decompensation.

Repeat creatinine and SDMA after two to four weeks in stable feline patients following an initial diagnosis. The first three months help differentiate stable disease from a progressive trajectory. Recheck sooner if the patient is symptomatic, laboratory markers are shifting rapidly, or medications are being adjusted.

2 Staging and Substaging

IRIS stage	Dogs creatinine mg/dL	Cats creatinine mg/dL	Clinical use
1	<1.4	<1.6	Nonazotemic CKD requires another renal abnormality: inappropriate USG, persistent renal proteinuria, imaging abnormality, renal biopsy lesion or persistent SDMA increase.
2	1.4–2.8	1.6–2.8	Mild azotemia. Clinical signs may be absent or subtle. Progression control and complication screening dominate.
3	2.9–5.0	2.9–5.0	Moderate azotemia. Symptom control, nutrition and hydration carry more weight. Individual variation is large.
4	>5.0	>5.0	Severe azotemia. Comfort, intake and proportional care take priority; reversible decompensation still warrants evaluation.

Use fasting creatinine where practical and interpret it with muscle mass and trend. SDMA can move a poorly muscled patient into a more advanced stage, but discordant results should be repeated in 2–4 weeks. If discordance persists, IRIS supports assigning the higher stage. Stage does not explain every clinical sign and should not be used as a treatment checklist by itself. [1,20]

Substage	Dog UPC	Cat UPC	What to do
Nonproteinuric	<0.2	<0.2	Monitor according to stage and trend.
Borderline proteinuric	0.2–0.5	0.2–0.4	Confirm persistence; control hypertension and address inflammatory/postrenal causes. Drug treatment is individualized because outcome evidence is limited.
Proteinuric	>0.5	>0.4	Confirm renal origin and persistence. Treat with renal diet and RAAS inhibition when hydrated, stable and not hypotensive.

SBP mmHg	IRIS risk	Intervention
<140	Normotensive	No antihypertensive treatment.
140–159	Prehypertensive	Repeat and monitor; consider treatment when target-organ injury or compelling risk is present.
160–179	Hypertensive	Confirm persistent hypertension unless target-organ injury requires immediate treatment; then treat.
≥180	Severely hypertensive	Treat promptly. If ocular or neurologic target-organ injury is present, do not delay for repeated visits.

3 Species Differences

Issue	Cats	Dogs
Primary guidance	Use the 2026 iCatCare consensus plus current IRIS staging and treatment guidance.	Use current IRIS guidance and canine clinical trials; do not import feline drug approvals or feline-specific algorithms.
UPC threshold	Proteinuric >0.4; borderline 0.2–0.4.	Proteinuric >0.5; borderline 0.2–0.5.
Hypertension	Amlodipine is often effective first-line. Telmisartan 2 mg/kg q24h is an alternative; significant proteinuria may influence selection.	RAAS blockade is commonly used when proteinuria is present. Amlodipine may be added for inadequate BP control and is often needed for marked hypertension.
Appetite/weight	Mirtazapine has CKD-specific evidence. Capromorelin 2 mg/kg q24h is approved for feline CKD-associated unintended weight loss.	Capromorelin is approved for appetite stimulation in dogs, but canine CKD-specific outcome evidence is limited. Diagnose the cause of anorexia rather than reflexively layering drugs.
Anemia	Darbepoetin may be used. Molidustat is conditionally approved for nonregenerative anemia associated with CKD in cats.	Molidustat is not a canine CKD treatment. Darbepoetin is the usual ESA when intervention is justified.
Hypercalcemia	Ionized hypercalcemia is an important diet-limiting complication. Diet calcium and Ca:P ratio may need active review.	Hypercalcemia is less characteristic of routine CKD management and should prompt evaluation for another cause when present.
Home SQ fluids	Sometimes useful for persistent dehydration, but not routine and not supported by controlled survival data. Burden and tolerance matter.	May be used selectively, dose must reflect size, losses, cardiac status and response.
Feeding tube	Esophagostomy tubes are often practical for sustained nutrition, water and medication in cats.	Esophagostomy or gastrostomy tubes may be considered depending on anticipated duration and concurrent disease.

4 The first 90 days

Initial visits establish whether renal function is stable, progressively declining, or suffering from acute decompensation. Starting multiple interventions simultaneously in a stable animal complicates toxicity tracking and contributes to caregiver burnout. Stagger interventions sequentially

Time	Clinical questions	Suggested data	Decision
Day 0	Is CKD confirmed? Is the patient stable and hydrated? Is there target-organ injury or a reversible cause?	Weight, BCS, MCS, hydration, BP and fundic exam; CBC, chemistry, USG/sediment, UPC when valid; culture/imaging as indicated.	Hospitalize if decompensated or unable to maintain intake/hydration. Otherwise choose the highest-priority intervention.
1–2 weeks	Was a new drug tolerated? Is BP safe? Did kidney function or potassium worsen?	After RAAS blockade: clinical status, BP, creatinine, potassium. After antihypertensive change: BP in 5–14 days; sooner with severe hypertension or target-organ injury.	Review dose or hydration if symptomatic hypotension, hyperkalemia, clinical decline or creatinine increases >25–30% after RAAS inhibition.
2–4 weeks	Stable or progressive? Better, unchanged or worse clinically?	Repeat creatinine/SDMA after new diagnosis; weight, intake, vomiting, stool, hydration and home observations.	Shorten follow-up and search for active disease if progression is confirmed.
4–6 weeks	Did diet or binder achieve its phosphorus goal without compromising intake or calcium?	Phosphorus, total calcium and preferably ionized calcium; weight and diet history.	Intensify phosphate restriction only if intake remains adequate and targets are not met; reduce restriction if ionized hypercalcemia develops.
About 4 weeks	Did antiproteinuric treatment reduce UPC?	UPC, BP and clinical status.	Titrate cautiously if benefit is inadequate and safety parameters permit.
By 3 months	What is the trajectory and sustainable plan?	Trend creatinine/SDMA, phosphorus, weight/MCS, BP, UPC when relevant and caregiver diary.	Set the next interval based on progression, complications and burden rather than stage

Time	Clinical questions	Suggested data	Decision
			alone.

5 Nutrition and adequate intake

Therapeutic renal diets reduce uremic episodes and renal-related mortality in dogs and cats. These diets modify phosphorus, dietary protein, energy density, sodium, potassium, acid-base buffering, and omega-3 fatty acids simultaneously. Clinical trial outcomes reflect the collective dietary formulation, not isolated protein restriction

When to intervene

- **Cats:** Recommend renal diets for all azotemic patients. For stage 1 or borderline stage 2 cats, evaluate phosphorus exposure, FGF23 levels (if available), and serum calcium. Avoid strict, unpalatable protein restriction in early-stage cats with low muscle mass.
- **Dogs:** Consider a renal diet at IRIS stage 2. Consider earlier initiation if persistent proteinuria or hyperphosphatemia is present. Adjust protein levels and caloric density to maintain muscle condition and body weight.
- **Transition guidelines:** Resolve nausea, dehydration, oral pain, and constipation before changing foods. Transition slowly over one to two weeks. Never introduce a novel diet during hospitalization or periods of acute illness..

Monitoring and Adjustments

- Record exact diet, amount offered and amount eaten. Ideally goal is to try to estimate actual calories being eaten.
- Monitor body weight, BCS and MCS at every recheck. Home weights can reduce travel burden and catch decline earlier.
- If the patient refuses all renal diets, feed a complete diet it will eat, then manage phosphorus separately if needed. Partial renal-diet intake may still be useful.
- Escalate nutritional support when intake remains inadequate despite treating reversible causes, weight or MCS continues to fall, or medication and hydration needs are driving repeated restraint. Discuss a feeding tube before the patient is unstable.

6 Phosphorus and CKD mineral bone disorder

IRIS stage	Target serum phosphorus mg/dL
2	2.5–4.5
3	2.5–5.0
4	2.5–6.0

Dietary restriction is the primary tool for lowering phosphorus. Recheck phosphorus and calcium after four to six weeks on a renal diet. Add an enteric phosphate binder only if serum phosphorus remains above the target range despite consistent consumption of the restricted diet. Binders must be mixed directly into every phosphorus-containing meal to be effective. Titrate the binder dose according to serum phosphorus, calcium concentrations, appetite, and stool consistency.

2026 iCatCare Consensus on Feline Phosphorus Management

- **Early-stage cats:** In IRIS stage 1 or 2 cats with serum phosphorus under 4.5 mg/dL, measuring FGF23 helps determine whether dietary phosphate restriction is warranted. Values >400 pg/mL support restriction; 300–400 pg/mL warrants monitoring; <300 pg/mL does not indicate additional dietary changes.
- **Advanced disease:** In azotemic cats whose serum phosphorus already meets stage targets, persistent FGF23 levels >700 pg/mL can justify further dietary phosphate restriction. Recheck every 6 to 12 weeks while adjusting.
- **Testing context:** FGF23 is not a screening test for CKD; its utility lies in guiding phosphate restriction when serum phosphorus falls within normal limits.
- **Hypercalcemia:** If ionized calcium rises, assess the diet before increasing phosphate binders or restriction. For hypercalcemic cats or those prone to calcium oxalate uroliths, select diets containing no more than 200 mg calcium per 100 kcal with a Ca:P ratio below 1.4:1.

7 Proteinuria

Confirm that proteinuria is persistent on at least two samples taken two or more weeks apart. Rule out postrenal sources such as active urine sediment, hemorrhage, or lower urinary tract infection, as well as prerenal dysproteinemias. Correct dehydration and treat systemic hypertension before evaluating antiproteinuric therapy.

Step	Cats	Dogs	Monitoring or change rule
Treat threshold	Persistent UPC >0.4. Consider borderline 0.2–0.4 individually; benefit is unproven.	Persistent UPC >0.5. Borderline 0.2–0.5 warrants investigation and trend assessment.	Treat only when stable, hydrated and not hypotensive.
Initial drug	Telmisartan 1 mg/kg PO q24h or an ACE inhibitor such as benazepril.	ACE inhibitor or ARB; telmisartan has canine antiproteinuric data. Choice depends on BP, potassium, kidney function and availability.	Check clinical status, BP, creatinine and potassium at 1–2 weeks.
Efficacy	Recheck UPC about 4 weeks after starting or changing dose.	Recheck UPC about 2–4 weeks after starting or changing dose.	Aim for a meaningful UPC reduction while avoiding hypotension, hyperkalemia and worsening azotemia.
Long term	Clinical status, SBP and UPC about every 3 months when stable.	Individualize, often every 1–3 months initially and every 3–6 months once stable.	A creatinine increase >25–30% after RAAS inhibition warrants review of hydration, BP, dose and concurrent disease.
Combination blockade	Routine ACE inhibitor plus ARB therapy is not recommended.	Routine dual RAAS blockade is generally avoided.	Reassess the plan if lower UPC is accompanied by worsening kidney function, hyperkalemia, reduced appetite, or poorer quality of life.

8 Hypertension

Obtain blood pressure readings in a quiet environment using an appropriately sized cuff and a consistent anatomical site. Record the technique and cuff size in the medical record to ensure consistency across follow-ups.

Situation	Intervention	Recheck	Change rule
SBP 160–179 without target-organ injury	Confirm persistence, then treat.	Usually 1–2 weeks after starting or changing treatment.	Titrate if still ≥ 160 ; reduce if hypotensive or clinically weak.
SBP ≥ 180 or retinal/neurologic injury	Treat promptly. Cats often receive oral amlodipine; dogs may need RAAS blockade plus amlodipine depending on proteinuria and severity.	As soon as 24–72 hours with severe target-organ injury; otherwise about 5–7 days.	Avoid an abrupt fall that produces hypotension. Continue close checks until controlled.
Stable control	Goal ideally <140, otherwise <160 without hypotension.	Every 1–3 months initially, then with routine CKD monitoring.	Recheck sooner after illness, dehydration, weight change or medication changes.

Feline doses under iCatCare guidelines list amlodipine at 0.125–0.25 mg/kg PO q24h and telmisartan at 2 mg/kg PO q24h as single-agent therapies. If combining telmisartan with amlodipine, start telmisartan at ≤ 1 mg/kg PO q24h. Note that 1 mg/kg q24h is the labeled feline antiproteinuric dose, not the higher antihypertensive monotherapy dose. Do not apply feline blood pressure doses to dogs.

9 Gastrointestinal Signs, Poor Intake, and Weight Loss

Poor intake requires immediate intervention. Waiting for a cat or dog to become cachectic before addressing appetite worsens outcome. Try to determine whether the decline stems from nausea, constipation, dehydration, uremic toxicity, dental pain, aversion to oral medications, or an unrelated systemic disorder..

Problem	Cats	Dogs	What counts as failure
Nausea/vomiting	Maropitant can reduce vomiting; ondansetron is reasonable for suspected nausea. Mirtazapine can improve appetite, vomiting and weight in feline CKD.	Maropitant or ondansetron may be used based on the clinical problem; CKD-specific outcome data are limited.	Ongoing vomiting, food aversion, dehydration or inadequate caloric intake despite 24–72 hours of outpatient support.
Unintended weight loss	Capromorelin 2 mg/kg PO q24h is approved for CKD-associated weight loss. Benefit is weight gain, not proven survival or muscle gain.	Capromorelin is labeled for appetite stimulation in dogs. It does not replace diagnosis or nutrition planning.	Continued weight or muscle loss, inadequate intake or treatment distress.
Acid suppression	Azotemia alone is not an omeprazole indication.	Same principle.	No defined acid-related indication or no clinical

Problem	Cats	Dogs	What counts as failure
	Reserve for reflux, esophagitis or suspected/documentated ulceration.		response.
Feeding tube	Discuss an esophagostomy tube early when nutrition, water or medications remain inadequate.	Choose esophagostomy or gastrostomy access according to duration and disease.	Do not persist with stressful syringe feeding or repeated forced medication when a tube better fits goals.

10 Hydration and fluid therapy

Target fluid administration to documented clinical dehydration. Polyuria alone is not an automatic indication for subcutaneous fluids, and lowering serum creatinine via hemodilution does not represent a meaningful clinical improvement.

Clinical state	Reasonable action	Reassessment
Stable, hydrated and eating	Increase water access and moisture in food. No routine SQ fluids.	Home intake, weight, urination, stool quality and routine examinations.
Mild recurrent dehydration but otherwise stable	Address nausea, constipation, environment and water access first. Consider a monitored SQ-fluid trial if deficits persist and the patient tolerates it.	Define the intended benefit before starting: appetite, activity, hydration or stool quality. Stop if no observable benefit.
Acute decompensation, repeated vomiting, inability to maintain hydration, severe electrolyte/acid-base disorder, oliguria/anuria or suspected pyelonephritis/obstruction	Hospital assessment and IV therapy are usually more appropriate than escalating home SQ fluids.	Serial weight, urine output when relevant, perfusion/hydration, electrolytes, acid-base status, creatinine and clinical response.
Cardiac disease, hypertension, oliguria or fluid intolerance risk	Use smaller, individualized amounts or avoid empiric fluids.	Stop or reduce for weight gain, edema, tachypnea, increased respiratory effort, worsening hypertension or lack of benefit.

For cats, the 2026 iCatCare guidelines describe 75–100 mL per cat every one to three days as a typical starting range for those needing home fluids, but the guideline advises against routine use for every patient. Calculate canine fluid volumes based on the individual dog's body weight, cardiac status, and measured losses; do not extrapolate feline volume ranges to dogs.

11 Electrolytes, Acid-Base, and Constipation

Abnormality	When to intervene	Monitor and modify
Hypokalemia	Supplement documented deficiency and look for inadequate intake, GI loss, renal loss or drug effects.	Recheck potassium after starting or changing supplementation. Reduce if potassium normalizes or RAAS therapy raises it.
Metabolic acidosis	Treat persistent metabolic acidosis after hydration and diet are addressed.	Recheck total CO ₂ /bicarbonate and potassium. Dose to correction without overshoot.
Constipation	Treat dehydration and hypokalemia, improve litter access and consider fiber or an osmotic laxative such as PEG 3350.	Track defecation frequency and stool consistency at home. Less frequent, dry stool may be an early sign of poor hydration in cats.
Hyperkalemia	Confirm the result and evaluate obstruction, oligoanuria, acidosis, RAAS drugs and supplements.	Hold or reduce contributors when clinically appropriate and recheck promptly according to severity.

12 Nonregenerative Anemia

Evaluate for chronic gastrointestinal blood loss, iron deficiency, systemic inflammation, hemolysis, primary bone marrow disease, infection, and excessive diagnostic blood sampling before attributing anemia solely to reduced renal erythropoietin production. Base the decision to treat on the patient's clinical signs, such as lethargy, hyporexia, weakness, and tachycardia, rather than relying on a single packed cell volume (PCV) cutoff.

Intervention	Cats	Dogs	Monitoring
Transfusion	For severe symptomatic anemia or when immediate	Same.	PCV/hematocrit and clinical response; monitor

Intervention	Cats	Dogs	Monitoring
	oxygen-carrying support is needed.		transfusion complications.
Darbepoetin	Common ESA option. Assess iron availability and BP.	Common ESA option when CKD-associated anemia is clinically important.	PCV weekly during induction, then space once stable; monitor BP, iron status, response and loss of response.
Molidustat	Conditionally approved in the US for nonregenerative anemia associated with CKD: 5 mg/kg PO q24h for 28 days, followed by at least a 7-day pause before another course when needed.	Not available for dogs.	Follow the current label. Monitor PCV/CBC, BP, physical examination and adverse effects. Avoid polycythemia.
Treatment goal	Improve clinical function and maintain PCV in a safe target range; iCatCare's darbepoetin algorithm uses 30–40%.	Improve clinical function without overshoot.	Failure to respond should trigger reassessment of iron, inflammation, bleeding, diagnosis, administration and antibodies with ESA therapy.

13 Urinary Tract Infections

Subclinical bacteriuria does not warrant antibiotic treatment. Reserve antimicrobial therapy for patients with clinical evidence of a urinary tract infection. Collect a cystocentesis sample for quantitative culture and sensitivity testing before administering antibiotics if pyelonephritis is suspected, and screen for urinary calculi or anatomical obstructions. Fever, renal pain on palpation, an inflammatory leukogram, active sediment, worsening azotemia, or new systemic illness support active infection; a vague clinical decline alone does not establish pyelonephritis

14 Managing Acute Clinical Decline

Outpatient care may fit when	Hospitalization is more likely to help when	Escalate diagnostics when
Patient is bright enough to eat or can maintain intake with modest support; dehydration is mild; vomiting is controlled; urine production is adequate; vital signs and electrolytes are safe; caregiver can monitor and return promptly.	Persistent vomiting or anorexia, moderate/severe dehydration, marked weakness, severe electrolyte or acid-base disturbance, oliguria/anuria, suspected obstruction or pyelonephritis, uncontrolled hypertension, severe anemia, or failure of outpatient care.	The decline is disproportionate to prior stable CKD, there is pain or fever, urine output changes, values rise rapidly, response to fluids is poor, or repeated “uremic episodes” lack an explanation.

A fluid trial serves to determine if azotemia has a reversible prerenal component. Clear improvements in hydration, attitude, appetite, and serum creatinine point to volume depletion. If clinical parameters fail to improve despite restored hydration, reassess for infection, ureteral obstruction, drug nephrotoxicity, pancreatitis, or end-stage loss of renal mass. Do not prolong hospitalization simply because serum creatinine fails to reach reference ranges if the patient is otherwise clinically stable and no further inpatient treatments will change the trajectory.

15 Monitoring that changes management

Patient	Suggested interval	Core monitoring	Why sooner
Newly diagnosed cat	Every 2–4 weeks initially, with closer checks according to stage and signs; use the first 3 months to monitor trends.	Caregiver report, weight/BCS/MCS, hydration, BP, targeted exam, creatinine/SDMA trend, phosphorus, potassium, calcium, albumin, PCV; UPC if relevant.	Clinical decline, falling weight, rising kidney values/phosphorus, new hypertension/proteinuria or treatment change.
Stable cat	Every 3–6 months, individualized to patient and caregiver.	Detailed history and exam, BP, weight/BCS/MCS; focused renal panel. Periodic CBC, urinalysis and T4 as indicated.	New anorexia, vomiting, constipation, reduced urination/marked PU, vision/neurologic signs, weakness or caregiver concern.
Stable dog	Usually every 3–6 months; shorten with higher stage, progression or active complications.	History, exam, weight/BCS/MCS, hydration, BP, CBC/chemistry and urinalysis; UPC when proteinuric/borderline or after treatment.	Same clinical triggers, plus rapid UPC change or complications of RAAS therapy.
After a treatment change	Drug-specific: BP 5–14 days; RAAS safety 1–2 weeks; UPC about 2–4 weeks; diet/binder chemistry 4–6 weeks.	Measure the variable the treatment was intended to change and the variables it could harm.	Any adverse clinical change. Do not wait for the scheduled visit when the patient is worse.

Monitoring can be reduced to the minimum information that will change the plan. In a stressed cat, caregiver reports, home weight, appetite and stool/urine logs may be more valuable than a blood panel that prevents future visits. A home-collected urine sample may be adequate for USG or UPC when collection method is documented and sediment interpretation is appropriate. Ideally, culture should have a sterile sample.

16 Caregiver Burden and Treatment Adherence

Complex regimens can strain the caregiver-patient relationship through forced administration of pills, unpalatable foods, fluid restraint, and financial costs. The 2026 iCatCare guidelines emphasize caregiver capacity when constructing a treatment protocol.

Ask directly	What the answer changes
Which part of care is hardest: food, pills, fluids, visits, cost or uncertainty?	Remove or reformulate the highest-burden low-value item first.
What improvement can the caregiver actually see?	Continue treatments that improve appetite, comfort, hydration, activity or another defined outcome. Stop trials with no observable benefit.
How many handling events can this patient tolerate each day?	Combine compatible medications, choose lower-frequency options, use a feeding tube when appropriate, or accept a less intensive plan.
Can the caregiver obtain home weights or keep a short appetite/vomiting/stool diary?	Use home data to lengthen time between clinic visits and shorten follow-up when deterioration appears.
What are the financial and time limits?	Choose testing that answers the next decision rather than a MDB, UC, BP, and UPC.
What would make today a bad day for this patient?	Define quality-of-life triggers and a palliative plan before a crisis.

Practical Adjustments

- Have the caregiver demonstrate medication administration during the appointment. Switch formulations (e.g., from pills to flavored liquids or transdermal preparations where validated) based on where the process breaks down.
- Do not hide unpalatable medications in the animal's primary food. This causes food aversion and undermines dietary management.
- Involve veterinary technicians to demonstrate fluid administration, coach through diet transitions, and run blood pressure rechecks.
- Deprescribe at every visit. Confirm that every medication has a clear indication, an active target, and an observable benefit.

17 Stage-oriented priorities

Stage	Dogs	Cats
1	Confirm renal disease and cause; monitor trend, BP and UPC. Treat persistent proteinuria or hypertension. Avoid automatic protein restriction.	Confirm renal disease and cause; monitor trend, BP and UPC. Consider phosphate exposure and selective FGF23 use. Treat hypertension/target-organ injury and persistent proteinuria.
2	Therapeutic renal diet; phosphorus target; treat persistent proteinuria and hypertension; monitor nutrition and hydration.	Therapeutic renal diet with careful transition; phosphorus/calcium strategy; treat persistent proteinuria and hypertension; address early intake, weight and constipation changes.
3	All stage 2 priorities plus active control of nausea, vomiting, dehydration, acidosis, potassium abnormalities and anemia when present. Discuss feeding access before crisis.	Same priorities, with stronger emphasis on intake, weight/MCS, constipation, hydration and caregiver burden. Consider SQ fluids only when a monitored trial has a reason.
4	Comfort and reversible problems first. Hospitalize when likely to restore a clinically useful baseline. Offer feeding support, anemia care and palliative options proportionately.	Comfort, calories, hydration and symptom control take precedence over progression-focused interventions. Avoid forced feeding and repeated prolonged hospitalization without a defined benefit.

18 Treatments with Unproven or Limited Evidence

Intervention	Evidence problem	Practical position
Additional omega-3	Renal diets often already contain omega-3 fatty acids; added outcome benefit beyond a complete renal diet is unproven.	Review the full diet before adding.
Azodyl	A small blinded feline study did not improve azotemia when capsules were opened and sprinkled on food.	Do not use routinely.

Intervention	Evidence problem	Practical position
Porus One / Renaltec	Small studies focus on uremic toxins or laboratory endpoints; patient-centered outcomes remain unproven.	Low priority; discuss cost and uncertainty.
AminAvast	Small, under-enrolled study with laboratory endpoints.	Insufficient evidence for routine use.
Stem cells	A small randomized feline trial did not show useful kidney benefit.	Clinical trials only.
SGLT2 inhibitors / AIM-directed therapy	Human or preclinical rationale without adequate canine/feline clinical outcome trials.	Not current standard care.
Routine acid suppression	CKD does not reliably cause gastric acid hypersecretion or ulceration.	Use only for a defined acid-related indication.
Treating SDMA	SDMA is a marker, not a therapeutic target.	Use SDMA to interpret kidney function and address the identified complication.

19 Give each prescription an exit strategy

Treatment	Goal	Early recheck	Stop or modify when
Renal diet	Adequate calories with stage-appropriate phosphorus control.	Weight/intake within 1–2 weeks; chemistry in 4–6 weeks.	Food aversion, inadequate calories, weight/MCS loss or hypercalcemia.
Phosphate binder	Phosphorus within stage target.	Phosphorus/calcium in 4–6 weeks.	Hypercalcemia, constipation, poor intake, inability to mix with food or no biochemical benefit.
RAAS inhibitor	Meaningful UPC reduction without harm.	BP, creatinine, potassium in 1–2 weeks; UPC about 4 weeks.	Symptomatic hypotension, hyperkalemia, clinical decline or concerning creatinine increase.
Antihypertensive	SBP ideally <140, otherwise <160, and prevent/reverse target-organ injury.	5–14 days; sooner when severe.	Hypotension, weakness or inadequate response requiring titration/add-on therapy.
Antiemetic/appetite drug	Improved intake, vomiting and weight trajectory.	24–72 hours by caregiver report; weight within 1–2 weeks.	No benefit, adverse effect, or ongoing inadequate intake requiring escalation.
SQ fluids	Observable improvement in hydration, intake, stool or activity.	After several administrations or sooner if risk.	No benefit, distress, weight gain, edema, tachypnea or increased respiratory effort.
Anemia therapy	Improved clinical function and safe PCV target.	Per drug protocol; often weekly PCV initially for ESA.	Overshoot, hypertension, adverse effect, no response or another cause identified.

20 What to treat first

Usually first	Only when indicated	Usually last or never
Adequate calories and an accepted renal diet; clinically important dehydration; vomiting/nausea; constipation; persistent hypertension; phosphorus above target; persistent renal proteinuria.	Phosphate binders; potassium or alkali; appetite stimulant; feeding tube; SQ fluids; anemia treatment; acid suppression for a defined indication.	Antibiotics for bacteriuria alone; unproven supplements ahead of effective care; treating SDMA itself; a long medication list with no monitored benefit.

In early CKD, slowing progression and preventing target-organ injury are primary goals. In late CKD, comfort, calories, hydration, and the ability to remain at home may take priority.

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Pella Bibs have Seven Pockets

Pella bibs have seven pockets. Make sure all the pockets are empty prior to placing them in the laundry. Sharps, gloves, pens, Paintstiks, etc. Anything that can make a mess of the laundry or anyone working with the laundry (or laundry equipment) should be removed. This includes a simple “dry wipe” of manure covered bibs.

Paintstik is a particular problem. It usually survives with little damage in the washing machine, but the hot tumbling environment of the dryer is where the fun starts. That stuff spreads all over the clothes in the laundry and in the dryer itself. WD-40 with some elbow grease will remove the paint from the interior of the dryer (WD-40 trick is from an old client, Randy Acker). Use plenty of paper towels. As for paint-stained bibs, spray with WD-40 and scrub with a small wire brush. It may take a couple of washes spot treated with a stain remover (Spray ‘N Wash, Shout, etc.) to remove the WD-40. I don’t think I need to go into the problem of needles and other sharps.

Left displaced abomasums were much more common when I started practice. In the fall of 1992, the corn dried rapidly and created feeding issues throughout that winter. Some clients were still component feeding while others were learning how to manage TMRs. Milk fever, ketosis, and retained placentae were common. In March and April of 1993, we (Waunakee Veterinary Service) saw about 60 DAs per week by four veterinarians (maybe double of what we’d normally see). Not all those 60 DAs had surgery. It was a remarkable time. The DAs would be found anywhere from a day before freshening to a day after freshening.

Our surgical procedure was a right flank omentopexy. Omentopexy tends to elongate and stretch and thus would sometimes create a recurrence of DA. During the not quite two years of practice prior to the spring of 1993 I became frustrated with repeat DAs. My omentopexies were included in the first layer closure of the abdomen (peritoneum and transversus abdominis muscle) via a simple continuous suture. Around the spring/summer of 1993 I adjusted that suture to include two or three bites of the pyloric end of the abomasum then continued with the omentopexy to finish that suture. This addition of the abomasal sutures drastically reduced the number of repeat DAs I saw. (A nice reference on DA surgery is S. Earnest, “LDA surgery tips and aftercare for recent grads” in Proceedings of the Fourth Recent Graduate Conference. American Association of Bovine Practitioners. February 12-13, 2021. St. Louis, MO. Pages 24-27.)

Early in my career I developed an interest in bovine lameness out of need within our practice. Hoof trimmers were just getting started and the smaller dairies I served left that hoof care work to me. I dealt with sole abscesses, sole ulcers, foot rot, etc. as best I could. In 1994 I attended the International Conference on Bovine Lameness in Banff, Canada and met a local hoof trimmer, Karl Burgi. Karl over time taught me better procedures for hoof care and eventually introduced me to the “street nail treatment” (“The Solear Approach to Draining the Pedal Joint”, page 261 in Bovine Laminitis and Lameness, A hands-on approach. Paul R. Greenough, 2007, Saunders Elsevier) for complicated sole ulcers or more correctly septic distal interphalangeal joint (DIP joint aka coffin joint). These animals are non-weight bearing and show swelling at the coronary band. Prior to that time, we would amputate the affected claw, removing the severely infected coffin joint but cows with just one toe were lucky to have one more lactation (See R. C. Bicalho, et al, Journal of Dairy Science 89:2596-2602, 2006). There are several other surgical procedures to rectify this problem and maintain both claws (see R. Breuer, “Stable feet before a night out: Bovine arthrodesis”, AABP Recent Graduate Conference Proceedings, Vol. 56, No. 1, pages 71-73, February 2023.). The “street nail technique” is quick, technically easy to perform, and maintains both claws in the bovine foot which greatly enhances her survival.

Cold feet. As I started practice, it was common to go from stanchion barns to free stall barns in uninsulated bibs. Dressing for the weather was interesting at best. My feet were cold many times in the winter. Then a client asked if my socks were wet at the end of the day. I said yes. He told me he had the same problem and his doctor suggested Mitchum roll on anti-perspirant. I’m not saying my feet never get cold but they have stayed warmer since.

203: Lessons Learned Beyond Veterinary School: A Food Animal Panel Discussion

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Tidbits for Difficult Calvings

5 Important pieces to every calving

1. Upper body strength
2. The Farmer
3. Binder Twine
4. Change of clothes
5. Escape route



Upper Body Strength

- Hand strength
- Arm Strength
- Stamina
- Mental toughness

The Farmer/Farmhand

- Fresh arms
- Strength
- Knowledge of this situation
- Experience

Binder Twine

- Versatility
- Easy to get into tight spaces
- Less traumatizing
- Use other than to get the calf out

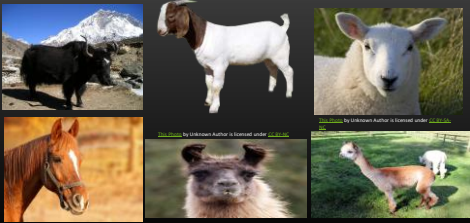
Change of Clothes

- Sweat
- Urine
- Miscellaneous fluids
- Feces
- Mud

Escape Route

- Consider the weather conditions
- Consider the cows health or will you learn something new!
- Materials you have on you or near you
- What does it entail to get to safety
- Restraint

Multiple Species/Multiple Cases



Kon Yak

- Vaccines are important
- Age of the client/purpose for the animal
- Being the youngest Dr. on staff
- Zero facilities for handling
- THEY STILL GET SICK so what do I treat them with!!!!

Ewe with Tetanus

- Midazolam
 - 0.1-0.5mg/kg up to 1mg/kg for better sedation.
- Tetanus antitoxin (Colorado Serum Company)
 - 3000-15000 Units IV
 - Repeat in 7 days 1500 Units SQ
- Penicillin
 - 20,000 to 44,000 IU/kg IM for 5-7 days.
- Treatment is wild!

Goat v. Saint Bernard (Greta)

- Instant conversion of a Nigerian Dwarf to a LaMancha
 - Midazolam
 - Flow by Isoflurane
 - Diapers-honey bandage
 - Antibiotics
 - Call you resident friends from 4th year!!!!!!!

Take home Messages

- Put the Midazolam in the truck!
- Diapers don't just catch crap!
- Tie over bandages are incredible in the field.
- Milwaukee Packouts save steps as does the Top-off!

Thank You

The best way to find yourself is to lose yourself in the service of others.

-Mahatma Gandhi

203: Lessons Learned Beyond Veterinary School: A Food Animal Panel Discussion

Dr. Meg Mueller
Osseo-Augusta Veterinary Clinic



- 2010 UW-SVM grad
- Mixed animal 4 doctor practice
- Ownership 2021
- NWWVMA/WVMA



Today's topics:

- Communication and Honesty
- Mentorship and Resources
- Boundaries
- Creativity

Communication and Honesty

- Transparency
- It's ok to not know
- Include the client
- Mistakes happen



Mentorship and Resources

- Generational differences
- Tailor to individual
- Share/"Circle the wagons"
- Facebook groups
- Professional organizations
- Cheat sheets
- Phone a friend



Boundaries

- YOU decide
- Train your clients
- No is a complete sentence
- Prioritize your non negotiables
- Safety-physical and psychological



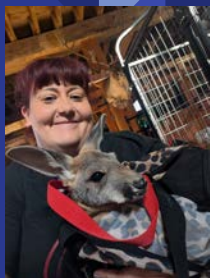
Creativity

- Use your clients, learn from them
- You DO have the knowledge
- Jump in with both feet
- Be open minded
- Time limits for successes



Let's talk!

Dr. Meg Mueller
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Incisor and Canine Extractions

Jessica Hunt, DVM, DAVDC-EQ

Midwest Veterinary Dental Services

Diagnosis of Incisor and Canine Pathology

A thorough oral exam is the foundation of diagnosis and should evaluate for present of pulp exposure, tooth fracture, tooth mobility, and tooth resorption. Radiograph is often required to confirm and stage disease.

Traumatic injury is the most common cause of incisor and canine pathology in young horses. Both the tooth itself and the surrounding bone are assessed for fracture. If tooth fracture is present. The fracture is assessed to be acute or chronic, complicated (pulp exposure) or uncomplicated (no pulp exposure), and if the tooth remains vital. Acutely fractured, but still vital teeth may be candidates for vital pulp therapy. Chronic fractures and non-vital teeth are assessed for endodontic/restorative therapy (root canal) or exodontia (extraction).

Equine Odontoclastic Tooth Resorption and Hypercementosis (EOTRH) is the most common cause of exodontia in adult/senior horses. EOTRH typically is diagnosed in horses over the age of 15 years. Radiographs are necessary for disease staging and progression. There are two concurrent processes seen on radiographs: inflammatory tooth resorption and hypercementosis (excess cementum deposition). See the chart below for resorption staging. Extraction is recommended for stage 3 and above lesions due to pulp involvement.

Tooth Resorption (TR) Clinical Staging System and Stage Description	
TR1	Mild dental hard tissue loss (cementum, or cementum and enamel).
TR2	Mild dental hard tissue loss (cementum, or cementum and enamel) with loss of dentin that does not extend to the pulp cavity.
TR3	Deep dental hard tissue loss with dentin loss that extends to the pulp cavity; most of the tooth still retains its integrity.
TR4A	Extensive hard tissue loss extending to the pulp cavity; most of the tooth has lost integrity; crown and root are equally affected.
TR4B	Same extensive loss as 4A, but the crown is more severely affected than the root.
TR4C	Same extensive loss as 4A, but the root is more severely affected than the crown.
TR5	End-stage — remnants of dental hard tissue are visible only as irregular opacities on radiographs, and the gingiva has fully covered over the site.

Preparation of the Patient

Before any extraction, a thorough physical exam is performed to assess if the patient is a good candidate for sedation. The patient is heavily sedated to prevent sudden movements to minimize injury to either the patient or practitioner. The patient should be restrained in a standing stockade or in a quiet area with an anti-slip floor, good drainage, and monitored/restrained by a capable assistant. A full oral exam should be performed and any cheek teeth pathology addressed prior to removal of all incisors (if possible), due to procedures being more challenging and uncomfortable for the patient after incisors are removed. Regional anesthesia and local anesthesia is performed prior to the extraction process.

Incisor Extractions

Instrumentation includes the following: Basic surgery pack, Luxators (sizes 3S, 3C, 5S, 5C), Elevators — winged and milk tooth types, Incisor spreader, Incisor forceps, Rongeurs, and Suture: 2-0 Monocryl.

Technique

- 1) Sulcular incision made around the tooth to begin soft-tissue release.
- 2) Luxation vs. elevation — luxators sever the periodontal ligament with a rocking/twisting sharp-edged action, while elevators lever the tooth out; both are used in combination to loosen the tooth before extraction.
- 3) Tooth is then delivered from the socket with forceps once adequately mobile is achieved.
- 4) Post extraction radiographs are obtained to confirm full tooth removal, including the root. Take care to assess that there are no retained root fragments or separated islands of dental material.
- 5) 2-0 Monocryl is used to suture the oral mucosa if possible in a simple interrupted or cruciate suture pattern.
 - a) Goal is to minimize tension on the suture line.
 - b) Extraction sites almost always dehisce, regardless of closure technique, but generally heal without incident.
- 6) Postoperative feeding instructions recommend feeding a softened diet for 1-2 weeks (mash, dry pellets, pasture grass, and soft hay are acceptable). Avoid using slow feed hay nets for 4 weeks.
- 7) Medications include an antimicrobial for 7 to 10 days and an anti-inflammatory for 3 to 5 days.

- 8) Exercise restriction is recommended: no riding with a bit for 3 to 4 weeks.
- 9) Recheck surgical site in 4 to 6 weeks. Assess for gingival healing and abnormal tissue (mass/tumor formation).

Canine Extractions

Patient preparation and instrumentation is similar to incisor extractions. Additional equipment includes a periosteal elevator, dental unit, and high-speed handpiece; alternatives include osteotomes or Dremel tool (with copious water irrigation)

Technique

- 1) A sulcular incision is made followed by a mucogingival flap over the canine.
- 2) The mucogingival flap is raised using periosteal elevators.
- 3) Buccal bone is removed with a high-speed surgical bur to expose the root (generally ~65% of the tooth is recommended to be exposed prior to luxation and manipulation of the tooth).
- 4) Luxation and elevation of the tooth is made.
- 5) Gentle manipulation and rotation with forceps is made to facilitate delivery of the tooth.
- 6) Alveoloplasty (smoothing/recontouring) the vacated alveolar socket is performed using a high-speed drill with a diamond bur, rongeurs, and curettes.
- 7) The mucogingival flap is thinned prior to closure to reduce suture line tension and subsequent risk of dehiscence.
- 8) Closure of the mucogingival flap is made with 2-0 or 3-0 monocril in a simple interrupted pattern with sutures spaced ~3mm apart.
- 9) Postoperative instructions are similar to incisor extraction. Recommend no riding with a bridle for 4 weeks to avoid bit pressure on healing extraction sites.

APPROVED

...Sort Of?

Understanding Conditionally Approved Drugs in Small Animal Medicine

Danielle Mayc, DVM - Clinical Pharmacology Resident, Kansas State University

WVMA Zoo School September 2026 - 1.2 scientific credits



About me



**EDUCATION**
DVM— University of Wisconsin School of Veterinary Medicine

**PRACTICE**
Six years in small animal general practice

**CURRENTLY**
PhD in Physiology
Residency in Veterinary Clinical Pharmacology

**RESEARCH FOCUS**
Pain models and the pharmacokinetics / pharmacodynamics of NSAIDs in small ruminants and calves

Disclaimer: AI was utilized for creation of this presentation | No conflicts of interest

Learning objectives

1

Define conditional approval

Explain what it means and how it differs from full FDA approval.

2

How do we use CA drugs

Describe how conditionally approved products may — and may not — be used in practice.

3

What's out there?

Identify the conditionally approved medications available to small animal practitioners.

4

Implementing in practice

Incorporate these products appropriately into patient care.



What is an animal drug?

Article intended for the diagnosis, cure, mitigation, treatment, or prevention of a disease

AND

Article other than food, intended to affect the structure or any function of the body

Federal Food, Drug, and Cosmetic Act (FDCA)

It's all about intended use...

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Regulatory Entities



FDA — CVM
Animal drugs, devices

**Food and Drug
Administration
Center for Veterinary
Medicine**



USDA
Biologics — vaccines and related products

**US Department of
Agriculture**



EPA
Topical parasiticides and premise
products.

**Environmental
Protection Agency**

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Four paths to market



Full approval

NADA / ANADA — most rigorous



Conditional approval

Faster; effectiveness bar is lower



Indexing

Minor species, non-food only, unapproved but legal market status



Emergency Use Authorization

*Most expedient; **emergencies only***

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Components of New Animal Drug Applications (NADA)

	Target animal safety	Safe for the treated species at the labeled dose
	Effectiveness	Substantial evidence from adequate, well-controlled studies
	Human food safety	Withdrawal time established for food-producing animals
	Chemistry, manufacturing & controls	Consistent identity, strength, quality, and purity
	Environmental impact	Assessment of effects from the product's use
	All other information	Any additional data bearing on safety or effectiveness
	Labeling	Directions for safe, effective use as approved

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ANIMAL MEDICINAL DRUG USE CLARIFICATION ACT - 1994

AMDUCA - ELDU

WHAT IT ALLOWS

Veterinarians may use certain approved animal drugs and approved human drugs in an **extra-label** manner — differently than the approved label directs.

Why it matters: there isn't an approved drug for every animal, every disease, and every condition.

EXTRA-LABEL USE IS LIMITED — KEY REQUIREMENTS

A valid VCPR
A valid veterinarian–client–patient relationship must be in place.

Food-animal safeguards
Additional requirements apply in food-producing animals to protect the human food supply.

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MINOR USE AND MINOR SPECIES ANIMAL HEALTH ACT - 2004

The MUMS Act

Minor species

Any animal that is not a major species.
Major species: horse, dog, cat, cattle, pig, chicken, turkey.

Minor use

A drug for a major species, used to treat a rare, uncommon disease.
Conditions for which few or no approved drugs exist.

Why it matters: a full NADA is cost-prohibitive for these small markets, so MUMS modifies the FFDCA to provide for **conditional approval**.

NEW - JUNE 2025

MUMS Blueprint for Success: 2026–2028
A three-year FDA / CVM strategic plan to expand the MUMS program and improve drug development and availability for underserved animal populations.

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One solution: conditional approval

Legally market a drug **before proving full effectiveness** — once it is shown to be **safe** and to have a **reasonable expectation of effectiveness**.

 Same safety standard

 Same human-food-safety

 Same manufacturing / quality

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It's all about the evidence....

FULL APPROVAL

Substantial evidence

Adequate, well-controlled studies

CONDITIONAL APPROVAL

Reasonable expectation

Pilot studies or published literature

EUA

Reasonable belief of benefit

Risk-benefit

MORE effectiveness evidence

LESS effectiveness evidence

Effectiveness efficacy varies. Safety, human-food-safety, and manufacturing standards do not.

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The clock: 1 + 4 = 5 years

Valid 1 year, renewable annually up to 4 times. Each renewal requires active progress toward substantial evidence.

0

1

2

3

4

5

Conditional approval

Renew

Renew

Renew

Renew

STOP or FULL

This is the "conditional" in conditional approval — not a permanent status.

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The clock, live: Canalevia-CA1

 Conditional through Dec 21, 2026. By year-end it either converts to full approval or comes off the market.

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CATION: don't build a chronic protocol around a product that may not convert; have a plan B.

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U.S. Department of Health & Human Services

U.S. FOOD & DRUG

ADMINISTRATION

Animal Drop

FDA

FDA Center for Veterinary Medicine

FDA Center for Veterinary Medicine

Home

Search Results

Search Results

Search Criteria (Search Results: 1/25)

View # of Records: 25

Export to:

Excel

CSV

PDF

Application #	Sponsor Name	Program/Device Name	Ingredients	Application Status
141-007	Elanco LLC	REXIDIN 100 G/41	Sulfonamides	Withdrawn
141-002	Algalene Animal Health	CALDEX F/ANALG	Chondroline	Approved
141-007	Elanco Strategic Products, LLC	PROQUINOLONE	Fluoroquinolone	Approved
141-074	Pharmacia Inc.	Veterinex 300 G/41	Antibiotics	Approved
141-007	Veterinex-USA, Inc.	PROQUINOLONE	Fluoroquinolone	Approved
141-076	Genex Laboratories Inc.	FEDQUINOLONE	Fluoroquinolone	Approved
141-008	Trovanex	Neurokin 401	Antibiotics	Approved
141-008	Trovanex	LIAMVIR 401	Progestins	Approved
141-026	Zentis Inc.	DEXTRORISACIN	Dexamethasone	Approved
141-023	LABORATORY	EquiVet 1000 G/41	Fluoridines	Approved
141-029	Elanco LLC Inc.	Combiex 500mg 30 G/41	Lidocaine Propofol Propofol/Sevoflurane	Approved

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Reading the label



CA1

Conditionally Approved, 1st application

App

Identifies the product

STRICT Usage Statement

"other than as directed in the labeling"

Approved, Jan 07 - Conditionally Approved Drug in Small Animal Medicine

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#1 RULE



No extra-label use of a conditionally approved drug.

AMDUCA permits extra-label use of fully approved animal and human drugs — it does not extend to conditional, indexed, or EUA products.

Use only the labeled species, indication, dose, and route.

Approved, Jan 07 - Conditionally Approved Drug in Small Animal Medicine

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The four pathways, compared

	Full approval	Conditional	Indexing	EUA
Evidence	Substantial evidence	Reasonable expectation	Expert-panel review	Reasonable belief
Safety standard	Yes	Yes (same)	Yes	Risk-benefit
Eligible drugs	Any	MUMS + expanded	Non-food minor species	Declared emergency
Duration	No limit	5 years max (1+4)	Ongoing (listed)	Length of emergency
Extra-label use?	Yes (AMDUCA)	No	No	No
Marketing allowed	Yes	Yes	Yes	Per authorization

Approved, Jan 07 - Conditionally Approved Drug in Small Animal Medicine

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QUICK GUIDE: FDA pathways for new animal drugs

FDA route	What it means	Evidence standard	Excluded use allowed?	Timeline of approval/authorization	Other considerations
Approved	FDA has reviewed and approved all 7 technical sections of the drug sponsor's application. The drug is fully approved for use in the target species, including all claims, routes, and/or for food-producing species and/or both.	Full demonstration of safety and safety as well as substantial evidence of effectiveness required by 21 CFR Part 314	Yes , under ANDAC and 21 CFR Part 315, unless prohibited in 21 CFR Sec 315.41	No time limit	• Good standard for routine use • Includes both animal and human data • For food-producing animals, the FDA reviews both animal and food safety data
Conditional approval	FDA has reviewed and approved all 7 technical sections of the drug sponsor's application. The remaining section pertains to substantial evidence of effectiveness.	Full demonstration of safety and safety as well as reasonable evidence of effectiveness required by 21 CFR Part 314	No , unless the drug also has full approval for another indication	Temporary approval for up to 3 years to collect substantial evidence of effectiveness; data and/or studies not approved for use until full approval is granted	• Drug must be intended to address unmet needs to treat a disease that either: • Affects a small population of animals • Affects a few major species (dogs, cats, horses, cows, pigs, chickens, and others) • Focus on animal species only species other than the major species • Same food safety evaluation for food-producing animals as for full approval
Expanded conditional approval	FDA has reviewed and approved all 7 technical sections of the drug sponsor's application. The remaining section pertains to substantial evidence of effectiveness.	Full demonstration of safety and safety as well as reasonable evidence of effectiveness required by 21 CFR Part 314	No , unless the drug also has full approval for another indication	Same as for conditional approval	• Drug must be intended to treat a disease or life-threatening disease or condition or an animal disease or human health need • Pathway addresses situations when demonstrating effectiveness would require complex or particularly difficult studies • Same food safety evaluation for food-producing animals as for full approval
Relaxed	Drugs listed in the FDA's Index of Legally Marketed Unapproved New Animal Drugs for Other Species	Expert panel's unanimous conclusion that the benefits outweigh risks for the listed use as required by 21 CFR Part 315	No	Indefinite—will bring the sponsor's application for full approval	• Data submitted for the specific minor species and indications • Not permitted for major species or food-producing animals
Emergency use authorization	Drug temporarily authorized for use during an emergency declared by the Secretary of Health and Human Services to address serious or life-threatening conditions	Best scientific judgment based on available data resulting in reasonable belief that the known or potential benefits outweigh the risks when used as authorized	No , unless the drug also has full approval for another indication	Authorization ends only as long as the emergency declaration	• Use is limited to the specific nature of authorization, which authorizations are subject to end to ensure compliance • Food safety evaluation to ensure products from treated animals are safe for human consumption

ANDAC = Animal Medical Drug Use Classification Act of 2014 (CMA) • Code of Federal Regulations (CFR) • U.S. Food and Drug Administration
 FDA Center for Veterinary Medicine determines the safety data for new animal drugs as well as the quality (QTC) prescription or emergency food directive (EFD).
 The list of relaxed drug conditions includes some products with prescription or QTC marketing data. VFD marketing data also is an marketing option.
 To request: Because the FDA pathway is conditionally approved and conditionally approved new animal drugs do not require demonstration of substantial evidence of effectiveness, but participants are not able to file for approval. Relaxed or emergency use authorization are generally considered over time pathway.
 Visit www.fda.gov/oc/animal-drug-pathways for more information on FDA animal drug pathways, ANDAC, and relaxed drug use.



<https://www.avma.org/resources/health/animal-health-and-welfare/future-health/understanding-the-animal-drug>



Report problems — help determine the future

Report ALL drug problems

- Lack of effectiveness
- Side effects — animal and human exposure
- Medication errors
- Product defects



During the conditional window, your reports feed FDA's decision on whether the drug converts to full approval.

Use FDA's "How to Report Animal Drug Side Effects and Product Problems."

Approved, Sust OTC - Conditionally Approved Drug in Small Animal Medicine

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Talking to clients

"This is an FDA product — reviewed, found safe, with early (not yet complete) effectiveness data."

"We must use it exactly as labeled."

"It may become fully approved — or be withdrawn if studies aren't completed."

"Let's talk through cost, availability, and monitoring."

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PART TWO

Current CA drugs for Companion Animal

Cardiology

Neuro / Pain

GI

Nephrology

Parasitology

Approved: Sept 2021 - Conditionally Approved Drugs in Small Animal Medicine22

Current product list

Product (CA1)	Ingredient	Sp.	Indication	App #	Since
Canalevia-CA1	crofelemer	Dog	Chemotherapy induced diarrhea	141-552	Dec 2021*
Panacell-CA1	fungisulfib	Dog	Acute onset pancreatitis	141-567	Nov 2022
Varenzio-CA1	molidustat	Cat	Nonregenerative anemia of CKD	141-571	2023
Fidoquel-CA1	phenobarbital	Dog	Seizures — idiopathic epilepsy	141-578	Sep 2023
UpCard-CA1	torsamide	Dog	Pulmonary edema in MMVD/CHF	141-577	May 2024
felycin-CA1	sotalolol	Cat	Subclinical HCM	141-604	Mar 2025
Livium-CA1	pregabalin	Dog	Chiari-like malformation/SM	141-606	May 2026
Credelio Quattro-CA1	lotilaner/praziquantel	Dog	New World screwworm	141-619	Dec 2025

*Canalevia is in its fifth and final year — conditional through Dec 21, 2026.

Approved: Sept 2021 - Conditionally Approved Drugs in Small Animal Medicine

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CARDIOLOGY - CONDITIONALLY APPROVED

felycin-CA1
sotalolol - delayed-release tablets

CA1 - CONDITIONAL
141-604 - since Mar 2025

INDICATION

Management of ventricular hypertrophy in cats with subclinical HCM.

DOSE & ADMINISTRATION

0.3 mg/kg PO once weekly.

SPECIES & SIGNALMENT

Cats. Not for breeding cats. Contraindicated with pre-existing liver disease, diabetes.

MECHANISM OF ACTION

β1TOR inhibitor (sotalolol) — antiproliferative; slows myocardial hypertrophy and fibrosis.

SPECIAL NOTES

- Do NOT substitute compounded sotalolol or human Sotalolol.
- Screen chemistry for liver disease first; monitor ALT/AST.
- Handling: pregnant / breastfeeding women should avoid contact.

DIAGNOSTICS / MONITORING

Echocardiogram to diagnose end-diastolic LV wall thickness ≥16 mm (20/16 mm/16 mm, no CHF/AE, Add BP, T4 & chemistry to rule out hypertension and hyperthyroidism.

Approved: Sept 2021 - Conditionally Approved Drugs in Small Animal Medicine25

CARDIOLOGY · CONDITIONALLY APPROVED



UpCard-CA1

torsemide - oral solution (2 mg/mL)

CA1 · CONDITIONAL
141.577 · since May 2024

INDICATION

Pulmonary edema in dogs with CHF caused by MMVD — used as an adjunct.

DOSE & ADMINISTRATION

0.11–0.44 mg/kg (0.05–0.2 mg/lb) PO once daily; max 0.44 mg/kg/day, $\pm$ food.

SPECIES & SIGNALMENT

Dogs. Must already be on pimobendan + spironolactone + an ACE inhibitor.

MECHANISM OF ACTION

Loop diuretic (pyridyl-sulfonylurea); blocks Na⁺/K⁺/2Cl⁻ in the loop of Henle — more potent, longer-acting than furosemide.

SPECIAL NOTES

- Give only WITH pimobendan + spironolactone + an ACE inhibitor.
- Avoid in renal failure, anuria, dehydration, hypotension, hypotension.
- Ensure free access to water; wash hands after handling.

DIAGNOSTICS / MONITORING

Titrate to severity of pulmonary edema, exam, hydration and renal values (BUN); monitor electrolytes and renal function.

Approved, Sort 071 · Conditionally Approved Drugs in Small Animal Medicine

23

NEUROLOGY & PAIN · CONDITIONALLY APPROVED



Fidoquel-CA1

phenobarbital - tablets

CA1 · CONDITIONAL
141.578 · since Sep 2023

INDICATION

Control of seizures associated with idiopathic epilepsy in dogs.

DOSE & ADMINISTRATION

2.5 mg/kg PO BID (min) → titrate to effect to max 5 mg/kg BID (5–10 mg/kg/day). Give with food.

SPECIES & SIGNALMENT

Dogs, 6 months of age and older.

MECHANISM OF ACTION

Barbiturate anticonvulsant; potentiates GABA-A-mediated inhibition and raises the seizure threshold.

SPECIAL NOTES

- Schedule IV controlled substance — records & secure storage.
- Liver is the target organ — monitor chemistry/CBC; $\uparrow$ ALP/ALT/GGT, $\downarrow$ T4.
- Handling: pregnant women should administer with caution.

DIAGNOSTICS / MONITORING

Monitor serum phenobarbital (VET target 2.5–35 μ g/mL) plus biochem & hematology; titrate on clinical response. Split tablets used within 90 days.

Approved, Sort 071 · Conditionally Approved Drugs in Small Animal Medicine

23

NEUROLOGY & PAIN · CONDITIONALLY APPROVED



Liavium-CA1

pregabalin - chewable tablets (30 / 90 / 180 mg)

CA1 · CONDITIONAL
141.656 · since May 2026

INDICATION

Management of pain and clinical signs of Chiari-like malformation and syringomyelia in dogs.

DOSE & ADMINISTRATION

5–10 mg/kg PO twice daily, with food.

SPECIES & SIGNALMENT

Dogs; cannot be dosed accurately under 2 kg ($\approx$ 4.5 lb).

MECHANISM OF ACTION

α 2 δ ligand — binds the α 2 δ subunit of voltage-gated Ca²⁺ channels, reducing excitatory neurotransmitter release (neuropathic pain).

SPECIAL NOTES

- Schedule IV controlled substance — handle/store per DEA & state rules.
- May be given concurrently with an NSAID.
- Human exposure: dizziness, drowsiness, balance / vision changes.

DIAGNOSTICS / MONITORING

Veterinary diagnosis of CSM (typically advanced imaging / MRI) confirms the labeled indication. The 90 mg tablet is scored; 30 & 180 mg are not.

Approved, Sort 071 · Conditionally Approved Drugs in Small Animal Medicine

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GASTROENTEROLOGY · CONDITIONALLY APPROVED



Panoquell-CA1

fusapiradio sodium - lyophilized powder for IV injection

CA1 · CONDITIONAL
141-527 · since Nov 2022

INDICATION

Management of clinical signs associated with acute onset of pancreatitis in dogs.

DOSE & ADMINISTRATION

0.4 mg/kg (0.1 mL/kg) IV once daily × 3 days; slow IV bolus over 15 s-1 min.

SPECIES & SIGNALMENT

Dogs. IV use only. Safety not established in cardiac / hepatic / renal disease, pregnancy, or <6 months.

MECHANISM OF ACTION

Selective LPA-1 activation inhibitor — blocks neutrophil adhesion and extravasation into inflamed pancreatic tissue.

SPECIAL NOTES

- Reconstitute only with the supplied bacteriostatic water (benzyl alcohol).
- Refrigerate reconstituted product; stable 28 days.
- Highly protein-bound — caution with NSAIDs & other protein-bound drugs.

DIAGNOSTICS / MONITORING

In-hospital adjunct to standard care (fluids, analgesia, anti-emetics — no NSAIDs). Contraindicated with known hypersensitivity.

Approved, Sub-OT · Conditionally Approved Drugs in Small Animal Medicine

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GASTROENTEROLOGY · CONDITIONALLY APPROVED



Canalevia-CA1

crofelemer - 125 mg delayed-release tablet

CA1 · CONDITIONAL
141-532 · final year → Dec 31, 2026

INDICATION

Treatment of chemotherapy-induced diarrhea in dogs.

DOSE & ADMINISTRATION

≤140 lb: 1 tablet PO BID × 3 days. >140 lb: 2 tablets PO BID × 3 days. Do not break/crush/chew; s food.

SPECIES & SIGNALMENT

Dogs (oral). Safety not evaluated in pregnancy, lactation, or breeding.

MECHANISM OF ACTION

Botanical/antisecretory (from Croton tiglium); locally inhibits intestinal Cl⁻ channels (CFTR + CaCl₂) → less Cl⁻ and water secretion.

SPECIAL NOTES

- Enteric-coated — swallow whole.

DIAGNOSTICS / MONITORING

Rule out infectious causes of diarrhea first — treating an infectious cause with Canalevia may delay appropriate therapy.

Approved, Sub-OT · Conditionally Approved Drugs in Small Animal Medicine

23

NEPHROLOGY & HEMATOLOGY · CONDITIONALLY APPROVED



Varenzin-CA1

molidustat - oral suspension

CA1 · CONDITIONAL
141-571 · since 2023

INDICATION

Nonregenerative anemia associated with chronic kidney disease in cats.

DOSE & ADMINISTRATION

5 mg/kg (2.3 mg/lb) PO once daily up to 28 days, then x7-day pause; repeat up to 4 cycles. Shake well.

SPECIES & SIGNALMENT

Cats ≥1 year. Contraindicated in pregnant / lactating / breeding cats.

MECHANISM OF ACTION

HIF-prolyl-hydroxylase inhibitor — stabilizes HIF to raise the cat's own erythropoietin.

SPECIAL NOTES

- Caution: sodium history or thromboembolic predisposition.
- Stagger x2 h from phosphate binders, iron & multivalent cations.
- Handling: women who are / may become pregnant use caution.

DIAGNOSTICS / MONITORING

Monitor HCT/PCV — weekly from *day 14 of each cycle STOP if it exceeds the upper reference limit (polycythemia). Restart a cycle when it falls below the lower limit.

Approved, Sub-OT · Conditionally Approved Drugs in Small Animal Medicine

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PARASITOLOGY · CONDITIONALLY APPROVED



Credelio Quattro-CA1

lotilaner + moxidectin + praziquantel + pyrantel - chewable

CA1 · CONDITIONAL
141-619 · since Dec 2025

INDICATION

Treatment of New World screwworm (*Cochliomyia hominivorax*) larvae / myiasis in dogs.

DOSE & ADMINISTRATION

Min 20 mg/kg lotilaner + 0.02 mg/kg moxidectin + 5 mg/kg praziquantel + 5 mg/kg pyrantel, chewable with food. Re-dose if vomiting <1 h.

SPECIES & SIGNALMENT

Dogs & puppies ≥8 weeks and ≥3.3 lb.

MECHANISM OF ACTION

Lotilaner (isoxanzoline, GABA/Glu-gated Cl⁻ channel blocker) is the active vs. screwworms, moxidectin, praziquantel & pyrantel add broad parasite coverage.

SPECIAL NOTES

- Separate application from full Credelio Quattro — no AMDUCA / extra-label rights.
- Isosuxinone class — tremor / ataxia / seizure potential; caution with seizure history.
- Reportable foreign animal disease — report suspected screwworm cases.

DIAGNOSTICS / MONITORING

One molecule, two label statuses on a single package — match the application number (141-619) to the screwworm indication.

Approved, Sub-DOT · Conditionally Approved Drug in Small Animal Medicine

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Some “conditional” drugs have graduated



Laverdia

verdinexar · dog

Canine lymphoma
Full approval Dec 2025

(was Laverdia-CA1)



KBroVet

potassium bromide · dog

Idiopathic epilepsy
Full approval Jan 2026

(the textbook expanded conditional example)

Once full, they gain AMDUCA extra-label eligibility. Always stay updated with status!

Approved, Sub-DOT · Conditionally Approved Drug in Small Animal Medicine

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Take-home messages

1

Conditional approval lowers the effectiveness bar — not safety, quality, or manufacturing.

2

Up to 5 years as CA product → full approval or come off the market.

3

No extra-label use — ever — of a conditionally approved product. Match the application number.

4

Currently eight CA products for small animal — consider using!

5

Report problems and lack of effectiveness — you help decide whether these drugs survive.

6

Verify status in the Green Book; it changes constantly.

Approved, Sub-DOT · Conditionally Approved Drug in Small Animal Medicine

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Questions & discussion

Resources

- FDA CVM — Conditional Approval Explained: A Resource for Veterinarians
- AVMA — Understanding FDA Pathways for Animal Drugs (printable clinic chart)
- FDA — Green Book / Recent Animal Drug Approvals · Animal Drugs @ FDA
- Product FOI Summaries & labels for each CA1 product (application numbers on the menu slide)



Exotic Pet Euthanasia: Practical Approaches to a Good Death

Alyssa Scagnelli, DVM DACZM (Zoological companion animal)

LEARNING OBJECTIVES

Identify *acceptable methods* of euthanasia

- Small mammals
- Birds
- Reptiles and amphibians
- Fish

Species-specific challenges: *determining death*

New evidence: *improving welfare and reliability*

BONUS material: *euthanasia protocols*



WHAT IS A "GOOD DEATH" ?

- Minimizes fear, anxiety, pain and distress
- Produces rapid and reliable unconsciousness
- Progresses to irreversible loss of brain function and death
- Minimizes owner distress
- Is practical and predictable for the veterinary team

Euthanasia:
Eu = good
thanatos = death

✦ *Death is an endpoint. Euthanasia is a process.*

EXOTIC PETS: LESS STRAIGHT FORWARD

Anatomy

Tiny vessels
Difficult access

Physiology

Diving reflex/breath-holding
Hypoxia tolerance
Ectothermy
Persistent cardiac activity

Behavior

Stress from restraint
Aversion to face mask/chamber
Prey species

Human Factors

Clinician/staff unfamiliarity
Owner presence during euthanasia
Setting owner expectations

COMMUNICATION AT THE END OF LIFE

👉 Exotic animal bonds are no less meaningful than domestic species

👉 Owners should have the option of being present for some or all of the procedure

Set expectations:

- What will they see?
- How long should euthanasia take?
- Are any secondary steps required/recommended?

Offer keepsakes (feathers, fur clippings, foot/tail/skull prints)



APPROACH TO EXOTIC ANIMAL EUTHANASIA

PLAN ➡ SEDATE/ANESTHETIZE ➡ EUTHANIZE ➡ CONFIRM

Plan:

- Species, condition, drugs, dose, route, owner presence, back up plan, histopathology

Sedate/anesthetize:

- Minimal physical restraint, +/- unconsciousness

Euthanize:

- Euthanasia agent, timeframe, 1 or 2 steps

Confirm:

- Heart beat, apnea, reflexes, other



WHEN SEDATION ISN'T ENOUGH

A mini soap box(🧼🧼)...

AVMA Guidelines
for the Euthanasia of Animals:
2020 Edition*



Methods of euthanasia that require general anesthesia at a deep surgical plane

- Intracardiac administration of a barbiturate
- Placement of IO catheter for euthanasia
- Cervical dislocation w/ minimal training
- IV potassium or magnesium chloride

Sedation ≠ Anesthesia

SMALL MAMMALS



AVMA GUIDELINES FOR SMALL MAMMALS

Preferred when feasible:

- Sedation → IV barbiturate overdose
- Anesthesia → IC (intra-cardiac) barbiturate overdose

Other methods:

- Species- and circumstance-dependent



VASCULAR ACCESS SITES

Rabbits:

1. Marginal ear (24-26G)
2. Cephalic (24-26G)
3. Lateral saphenous - 25G butterfly



VASCULAR ACCESS SITES

Guinea Pigs:

1. Lateral saphenous
Butterfly (25G) or IV catheter (26G)



Reich et al., J Mu Exp, 2014

VASCULAR ACCESS SITES

Others:

1. Chinchillas/rat: dorsal pedal (26G)
2. Ferret/hedgehog: cephalic (24-26G)



Alvarado et al., Lab Animal, 2012

No vein? No problem.



SMALL MAMMALS: INTRA-ORGAN INJECTION

Intra-hepatic

- Acceptable with conditions
- Mammals and birds (anesthetized), cats (awake)
- *Not assessed in exotic small mammals*

Intra-renal

- Acceptable with conditions
- Anesthetized
- 2025 study in New Zealand White rabbits

★ Intra-cardiac

- Must be anesthetized



2020 AVMA Guidelines, p114

SMALL MAMMALS: INTRA-PERITONEAL INJECTION

Acceptable with conditions:

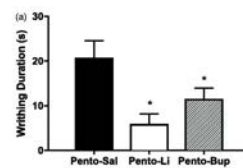
- Non-irritating barbiturate
- Not quick ⚠

Clinical recommendation:

- Heavy sedation + IP barbiturate

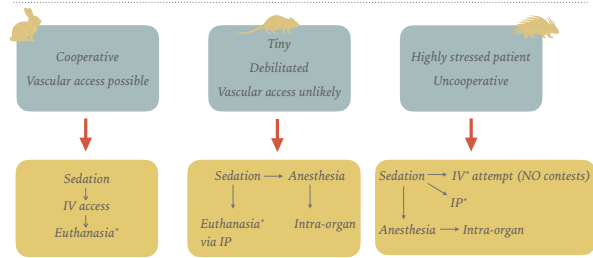
Alternative:

- Lidocaine/bupivacaine + barbiturate (rats)
 - Euthasol® diluted to 162.5 mg/ml
 - Lidocaine (10 mg/ml)
 - Bupivacaine (2.5 mg/ml)



Khan et al., Laboratory Animals, 2018

SMALL MAMMALS: SUMMARY



*Euthanasia via overdose of barbiturate

SMALL MAMMALS: MASKING AND INDUCTION CHAMBERS

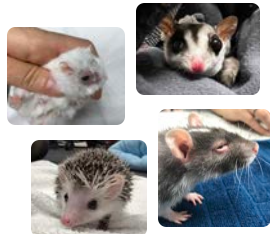
Using inhaled agents as initial sedation:

1. Production of unconscious state is not rapid (worse w/ pulmonary disease 🚑)
2. Distress due to properties of agent
3. Distress due to "trapped" feeling
4. Staff (+/- owner) exposure



SMALL MAMMALS: MASKING AND INDUCTION CHAMBERS

Possible exceptions:



Best Practices

- Induction chamber
- Pre-oxygenate (gets used to gas flow)
- Start vaporizer low, gradual increases
- Dark environment
- Consider substrate material from home environment

BIRDS



AVMA GUIDELINES FOR BIRDS

Preferred when feasible:

- Sedation → IV barbiturate overdose
- Anesthesia → IC (intra-cardiac), ICe (intra-coelomic), IO (intra-osseous)

Acceptable with conditions:

- Sole inhaled agents
- Cervical dislocation (<200g, highly trained)
- Others



AVIAN SEDATION

Injectable:

- Intra-muscular injection (pectoral muscles) ✨



Intra-nasal:

- Good option for birds w/ decreased body condition
- Watch for sneezing!
- Species and sedative-dependent effects



Waters, Journal of Clinical Avian Medicine, 2014

VASCULAR ACCESS SITES

Small Birds (<250g):

1. Jugular: 27-25G needle

Large Birds:

1. Jugular: 23-25G needle
2. Ulnar/basilic: 25G needle or butterfly
3. Medial metatarsal: 25G needle or butterfly



Do I need to place an IV Catheter?

Probably not

TO MASK DOWN OR NOT MASK DOWN . . .

Avian Respiratory Physiology

- Unidirectional air flow
- Gas exchange on inhale and exhale
- Greater surface area for gas exchange

➡ Inhalant effects are FAST



...THAT IS THE QUESTION

MASKING DOWN: WATERFOWL

The Dive Response

- Trigeminal n. stimulation from face mask:
 - Apnea
 - Bradycardia

- A "roomy" mask is key
- Injectable sedation ideal ☆



Long Beach Animal Hospital, 2020

No vein?



Options exist

AVIAN EUTHANASIA: NON IV ROUTES

Intra-coelomic (ICe)

- Intra-hepatic?
- Anesthesia required
- **Caution:** air sac system
- Enter coelom at caudal keel

Intra-cardiac

- Challenging, anesthesia required

Intra-osseous

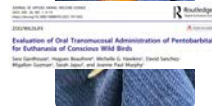
- NOT femur or humerus
- Anesthesia required



AVIAN EUTHANASIA: NON IV ROUTES

Oral pentobarbital (390 mg/ml) administration

- Wildlife technique
 - Dose: 602 mg/kg (~1.5 ml/kg) PO
 - Successful in >95% of birds
 - Loss of heart beat ~ 4 min
 - Adverse events - no different than IV route
- Not currently recommended per AVMA guidelines



Useful for small
birds or specific
circumstances?

AVIAN EUTHANASIA: POINTERS

A few noteworthy items...

- Vocalization, wing flapping
- Effects worse in poultry
- Consider wrapping in towel
- Anesthetize if you have the option ☆



REPTILES & AMPHIBIANS



ECTOTHERMS CHANGE THE RULES

- ⚠ Apnea - EXPECT IT!
- ⚠ What is cardiac shunting? And why is it in this talk?
- ⚠ Temperature is everything
- ⚠ Cardiac arrest is not immediate
- ⚠ Cardiac arrest ≠ death



COMPLICATING EUTHANASIA: PHYSIOLOGY

Reptiles can hold their breath for hours

- Aquatic species > terrestrial species
- Chelonians > snakes/lizards

- ★ Apnea ≠ death
- ★ Inhalants - less effective

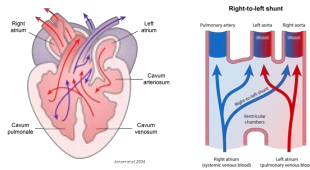


COMPLICATING EUTHANASIA: PHYSIOLOGY

Aquatic reptiles have a dive response

- Cardiac shunting
 - Turtles, crocodilians
 - Tortoises? Other reptiles?

- ★ Inhalants - less effective



COMPLICATING EUTHANASIA: PHYSIOLOGY

The Preferred Optimum Temperature Zone (POTZ)

- Metabolic activity
 - Drug metabolism
 - Cellular metabolism
 - Perfusion

- ★ Reptiles need to be at POTZ prior to and during euthanasia
- ★ Cardiac arrest may not be immediate if below POTZ



COMPLICATING EUTHANASIA: PHYSIOLOGY

Reptiles/amphibians readily utilize anaerobic metabolism

- Breath holding and shunting = extreme hypoxia tolerance



- ★ Brain function can persist without oxygen
- ★ Myocardium contracts without perfusion/O₂

REPTILES/AMPHIBIANS: DEATH VERIFICATION

Unreliable:

- Breathing
- Heart beat
- Reflexes



REPTILES/AMPHIBIANS: DEATH VERIFICATION

Alright, but what can be done?

- Doppler (>2 min)
- Palpebral/corneal reflex
- Apnea
- Hold for few hours/overnight
- Colors/mucus membranes
- Orbit appearance



In chelonians, aim
crystal midline and
ventral



What is recommended?

- 



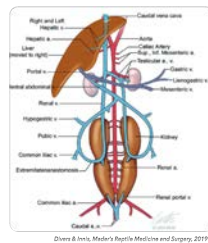
Preferred when feasible (AVMA):

-

My recommendation:

Injectable:

-



VASCULAR ACCESS SITES

Lizards & Snakes

Ventral coccygeal vein

- Ventral midline approach easiest
- At least 8-10 scales caudal to vent
- Insert needle between scales 60-90° to spine
- Negative pressure after entering
- Advance to bone, slowly back off
- 22-25G (lizards)
- 25-29G (snakes)



⚠ Geckos, skinks, anoles

VASCULAR ACCESS SITES

Chelonians

Jugular vein (22-25G, needle/butterfly)

- Right side larger
- Often blind
- Hold in lateral, injector grabs head
- Draw imaginary line between dorsal tympanum and shoulder
- Sight negative pressure after entering
- Superficial
- Hold off after



VASCULAR ACCESS SITES

Chelonians

Brachial venous sinus (22-29G, needle/butterfly)

- Larger tortoises easier
- Extend arm, approach from caudal aspect
- Palpate prominent biceps brachii tendon
- Insert needle 90° to arm above tendon
- Direct just caudal to elbow
- Maintain slight negative pressure



VASCULAR ACCESS SITES

Chelonians

Dorsal occipital sinus (25G)

- Deep sedation/anesthesia
- Palpate occipital protuberance
- Flex head ventrally - opens space between skull and C1
- Insert needle midline just caudal to protuberance
- Slight negative pressure after entering, advance ventrally
- Flash obtained - stabilize with non-dominant hand, inject slowly



REPTILE & AMPHIBIAN EUTHANASIA: NON IV ROUTES

Intra-coelomic (ICe)

Lizards & Amphibians: dorsal recumbency or upright; inject caudally off midline

Snakes: dorsal recumbency or upright; inject caudal third

Chelonians: dorsal/lateral recumbency; inject where bridge meets plastron



REPTILE & AMPHIBIAN EUTHANASIA: NON IV ROUTES

Intra-cardiac (IC)

Lizards & Amphibians

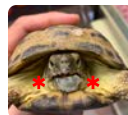
- Pectoral girdle
- Approach via xyphoid or axillary window

Snakes

- Cranial third, look for movement
- Approach via ventrum

Chelonians

- Pectoral meets abdominal scute
- Approach via cervical fossa



✖ The heart is more caudal in monitor lizards

REPTILE & AMPHIBIAN EUTHANASIA: NON IV ROUTES



AJVR

AVMA

Transmucosal pentobarbital is a successful euthanasia method in pond slider turtles (*Trachemys scripta*)

Summary

- 100 mg/kg pentobarbital PO or per-cloacal
- Successful euthanasia by 24 h
 - Respiratory arrest, 15 min
 - Loss corneal reflex, 45 min
- Will leak from cloaca ⚠
- Oral recommended



AJVR

AVMA

Transmucosal administration of pentobarbital and phenylephrine solution induces euthanasia in bearded dragons (*Pogona vitticeps*)

Summary

- 100 mg/kg initial pentobarbital dose
- 400 mg/kg follow-up dose (20 min later)
- Successful euthanasia by 5 h
 - Respiratory arrest, 30 min
 - Loss deep pain, 30 min
- Adverse reactions ⚠
- Heavy sedation recommended

FISH



PET FISH EUTHANASIA CONSIDERATIONS

Immersion agents

- Use home tank water
- Supplement O₂
- Supplement heat
- +/- buffer (e.g., MS-222, benzocaine)
- Dispose of water appropriately



APPROVED IMMERSION METHODS

1-step method

- MS-222, clove oil (eugenol oil), benzocaine, CO₂, others

2-step method

- Immersion anesthetic + physical method
 - Pithing
 - Decapitation
 - Exsanguination
- Immersion anesthetic + injection of euthanasia agent

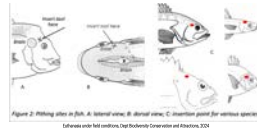


Figure 2: Pithing sites in fish. A: Ventral view, B: Dorsal view, C: Ventral view of the head. The diagrams show the location of the pithing site relative to the fish's body and head.

APPROVED INJECTABLE METHODS

1-step method

- Pentobarbital IM, IV, ICE

2-step method

- Sedative/anesthesia + pentobarbital
- Anesthesia + KCl



UPDATES IN EUTHANASIA GUIDELINES

**AVMA Guidelines
for the Euthanasia of Animals:
2020 Edition***



Immersion agents

Most fish

- x30 minutes beyond loss of opercular movement

Hypoxia tolerant fish

- 2-step method

BUT WAIT!

USE OF TRICLAINE METHANESULFONATE, CLOVE OIL AND 2-PHENOXYETHANOL FOR IMMERSION EUTHANASIA OF TANGA CICHLIDS (*SAROTHERIODON LUNELLII*)

Sherry S. Branstetter¹, Linda H. Heston¹, Jennifer L. Smith²

COMPARISON OF THREE CONCENTRATIONS OF AQUA-SED™ FOR IMMERSION EUTHANASIA OF BUTTERFLY SPLITTEN (*AMEGA SPLENDENS*)

Sherry S. Branstetter¹, Linda H. Heston¹, Jennifer L. Smith²

EUTHANASIA BY CONTINUOUS TOPICAL DELIVERY OF CLOVE OIL OVER THE GILLS RESULTS IN DELAYED CARDIAC ARREST IN COMPARISON TO IMMERSION BATH IN JUVENILE RED HEAD TAPAJOS KATFISHES (*PROPHAGUS PYROCEPHALUS*)

Linda H. Heston¹, Sherry S. Branstetter¹, Jennifer L. Smith²

Conclusions:

- Two-step method REQUIRED for most fish, regardless of immersion agent used
- 2020 guidelines debunked !!!

WHAT ABOUT INJECTABLE KCL?

EVALUATION OF POTASSIUM CHLORIDE ADMINISTERED VIA THREE ROUTES FOR EUTHANASIA OF ANESTHETIZED KOI (*CYPRINUS CARPIO*)

Stephanie M. Lutz¹, Kristin L. Heston¹, Jennifer L. Smith², Linda H. Heston¹, Sherry S. Branstetter¹, Linda H. Heston¹

POTASSIUM CHLORIDE ADMINISTERED VIA FOUR ROUTES FOR EUTHANASIA OF ANESTHETIZED GOLDFISH (*CARASSIUS AURATUS*)

Stephanie M. Lutz¹, Linda H. Heston¹

Study:

- Compared delivery of KCl via different routes to anesthetized koi and goldfish

Conclusions:

- Koi: Utilize IC route (10 mEq/kg)
- ICe and topical not reliable
- Goldfish: all routes effective, ICe easiest!

PET FISH EUTHANASIA SUMMARY

Do NOT trust immersion alone!

Utilize a 2-step method

Step 1: Immersion (anesthesia)

Step 2 options:

- IV or intra-cardiac pentobarbital or KCL
- ICe pentobarbital
- Pith



QUESTIONS?



Euthanasia Protocols: Small Mammals

	Ferrets	Rabbits	Guinea Pigs	Chinchillas	Rats/Mice/ Hamsters	Hedgehogs	Sugar gliders
Favorite protocol/ owner wants to be present	0.5 mg/kg xylazine + 0.5 mg/kg butorphanol induction (for IV catheter) 0.1 mL/kg isoflurane rebreath (200 mg/mL) and midazolam (5 mg/mL) (induction) Propofol to effect (induction) Pentobarbital IV standard dose (euthanasia)	Midazolam (0.5-1 mg/kg), ketamine (2 mg/kg), xylazine (0.5 mg/kg) (induction for IV catheter) Ketamine (1-3 mg/kg IV) until or propofol to effect or alfentanil (0.5-3 mg/kg IV) (induction) Pentobarbital IV standard dose (euthanasia)	40 mg/kg desmedetomidine + 1 mg/kg midazolam (deep sedation) Ketamine 1-3 mg/kg IV or propofol to effect via exposure buccally (induction) Pentobarbital IV standard dose (euthanasia)	15 mg/kg desmedetomidine + 4 mg/kg ketamine (deep sedation) Ketamine 1-3 mg/kg IV or propofol to effect via dorsal pedal artery (induction) Pentobarbital IV standard dose (euthanasia)	Desmedetomidine 40-60 mg/kg + Midazolam 1 mg/kg (Mediators to deep sedation, rats) ISO/SEVO via face mask after sedation followed by IV pentobarbital injection (standard dose) (euthanasia)	Midazolam 1 mg/kg + Alfentanil 2-3 mg/kg (low BSA/SC, never before mouse (light doses near neck) (Midazolam to deep sedation) ISO/SEVO via face mask after sedation followed by IV pentobarbital injection (standard dose) (euthanasia)	Injectable protocols have not been well studied Midazolam + 1 mg/kg butorphanol IV (induction) ISO/SEVO via face mask after sedation followed by IV pentobarbital injection (standard dose) (euthanasia)
Alternatives	ISO/SEVO via face mask after sedation followed by IC pentobarbital injection (standard doses)	ISO/SEVO via face mask after sedation followed by IC pentobarbital injection (standard doses)	ISO/SEVO via face mask after sedation followed by IC pentobarbital injection (standard doses)	ISO/SEVO via face mask after sedation followed by IC pentobarbital injection (standard doses)	Consider IC injection if sedating mask reduces Consider induction chamber if handling stress requires stress of chamber	Ketamine may replace alfentanil at 30 mg/kg Consider induction chamber if handling stress requires stress of chamber	Consider induction chamber if handling stress requires stress of chamber
Comments	Most protocols for dogs/rats are effective	Rarely can vocalize with anesthesia or midazolam (any protocol) Consider SC injection for sedation if poorly muscled	"Prepares" and "padding" can occur with low doses and other agents Consider SC injection for sedation if poorly muscled	Consider SC injection for sedation if poorly muscled	Requires very high doses of ketamine to be effective - not recommended due to seizure and sting of agent	May require gas if severely obese	Inject SC in between shoulder blades, not near wing pasterns (prior absorption)

Euthanasia Protocols: Birds

	Parrots	Passerines	Chickens	Water fowl
Favorite protocol/ owner wants to be present	2-4 mg/kg midazolam + 2-4 mg/kg butorphanol IM (Mild/moderate sedation; low and fast for larger birds, higher and for smaller birds) ISO/SEVO via face mask (induction) Pentobarbital IV (0.2-1 mL/kg) off the needle, jugular vein (Euthanasia)	Most injectable agents require dilution due to small patient size - an arbitrary 0.01 mL of 2-3 agents (each) IM may produce sedation ISO/SEVO via face mask (induction) Pentobarbital IV (0.2-1 mL/kg) off the needle, jugular vein (Euthanasia)	Desmedetomidine 40 mg/kg + Midazolam 2-3 mg/kg IM (Sedation) ISO/SEVO via face mask (induction) Pentobarbital IV (0.2-1 mL/kg) off the needle or butterfly jugular or medial recurrent vein (Euthanasia)	Desmedetomidine 40 mg/kg + Midazolam 2-3 mg/kg IM (Sedation) ISO/SEVO via face mask (induction) Pentobarbital IV (0.2-1 mL/kg) off the needle or butterfly medial recurrent vein (Euthanasia)
Alternatives	Pentobarbital (0.2-1 mL/kg) ICs after anesthesia induction (not appropriate for kites/parrots)	Pentobarbital (0.2-1 mL/kg) ICs after anesthesia induction (not appropriate for kites/parrots)	Pentobarbital (0.2-1 mL/kg) ICs after anesthesia induction (not appropriate for kites/parrots)	Pentobarbital (0.2-1 mL/kg) ICs after anesthesia induction (not appropriate for kites/parrots)
Comments	Wing flapping and vocalizing can occur, but less likely when under anesthesia	Keep in mind relative volume of IM injection to keel muscle - large volumes not recommended due to pain/pressure on injection. If poorly muscled, an induction chamber may be the most humane.	Wing flapping and vocalizing can occur, but less likely when under anesthesia	Can breath hold with inhalants, injectable preferred prior to induction Wing flapping and vocalizing can occur, but less likely when under anesthesia

Euthanasia Protocols: Reptiles/Amphibians

	Lizards	Snakes	Chelonians	Amphibians
Favorite protocol/ owner wants to be present	Demoxadol/0.3 mg/kg (NOTED DOSE) + etomidate 2 mg/kg + ketamine 20 mg/kg SC (Other drug sedates but species dependent) Alfaxalone 5 mg/kg IV bolus Alfaxalone 10-20 mg/kg SC (Induction) *This may not be needed pending success of Step 1* Pentobarbital (100-100 mg/kg) IV via ventral tail vein (Euthanasia) Follow with adjunctive method path	Demoxadol/0.3 mg/kg (NOTED DOSE) + etomidate 2 mg/kg + ketamine 20 mg/kg SC (Other drug sedates but species dependent) Alfaxalone 10-20 mg/kg SC (Induction) *This may not be needed pending success of Step 1* Pentobarbital (100-100 mg/kg) IV via ventral tail vein or SC (Euthanasia) Follow with adjunctive method path	Demoxadol/0.3 mg/kg (NOTED DOSE) + etomidate 2 mg/kg + ketamine 20 mg/kg SC (Other drug sedates but species dependent) Alfaxalone 20-30 mg/kg SC (Induction) *This may not be needed pending success of Step 1* Pentobarbital (100-100 mg/kg) IV via jugular or brachial vein; dorsal occipital area site is less challenging, but less favorable if owner present (Euthanasia) Follow with adjunctive method path	Frings/baths: Sedation via induction chamber - will need 1%, can take a while (Initial sedation → anesthesia) Anesthetic: 5 mg/L alfaxalone bath (induction) Can drop drops over gills for maintenance Pentobarbital (100-100 mg/kg) SC (Euthanasia) Follow with adjunctive method path
Alternatives	Some small species (e.g. geckos, anoles) - can sedate and anesthetize via inhalant induction chamber Pentobarbital(100 mg/kg) ICe after anesthesia induction (not appropriate for histopathology)	Small species/terrestrials - can anesthetize via sedate/inhalant induction chamber Pentobarbital(100 mg/kg) ICe after anesthesia induction (not appropriate)	Pentobarbital(100 mg/kg) ICe after anesthesia induction (not appropriate for histopathology)	Pentobarbital(100 mg/kg) ICe after anesthesia induction (not appropriate for histopathology)
Comments	Maintain POTZ SC injection favored due to relatively small limb muscles, most patients Inject sedatives in cranial half Avoid tail site: geckos, skinks, anoles	Maintain POTZ Inject sedatives in cranial half	Inject sedatives in cranial half Will breath hold, inhalants not recommended	Injectable protocols not well-studied, too much species variation Frings can occasionally over their stomach, following sedatives/inhalants, but this has typically been associated with injectable protocols

Euthanasia Protocols: Fish

	Fish
Favorite protocol/ owner wants to be present	500-1,000 mg/L MS-222 (buffered with equal weight baking soda) x 30 minutes (anesthesia) Up to 100 mg/L clove oil (dosed to effect) x 30 minutes (anesthesia) Pentobarbital(100 mg/kg) IC after anesthesia induction (not appropriate for histopathology)
Alternatives	Pentobarbital(100 mg/kg) ICe after anesthesia induction (not appropriate for histopathology or ice fish)
Comments	Use home aquarium water, maintain temperature When using MS-222, prepare buffered solution <u>before</u> placing fish in bath (wear eye and skin protection when preparing, dispose responsibly) Clove oil not approved for food fish species After final injection, consider placing back into anesthesia water to ensure full effect

Euthanasia Protocols: Small Mammals

	Ferrets	Rabbits	Guinea Pigs	Chinchillas	Rats/Mice/ Hamsters	Hedgehogs	Sugar gliders
Favorite protocol/ owner wants to be present	0.5 mg/kg midazolam +0.5 mg/kg butorphanol (sedation for IV catheter) 0.1 ml/kg (equal volumes ketamine [100 mg/ml] and midazolam [5 mg/ml]) (induction) or Propofol to effect (induction) Pentobarbital IV, standard doses (euthanasia)	Midazolam (0.5-1 mg/kg), ketamine (5 mg/kg), buprenorphine (0.05 mg/kg) (sedation for IV catheter) Ketamine (1-3mg/kg IV bolus) or propofol to effect or alfaxalone (1-3 mg/kg IV) (induction) Pentobarbital IV, standard doses (euthanasia)	40 mcg/ kg dexmedetomidine + 1 mg/kg midazolam (deep sedation) Ketamine 1-3 mg/kg IV or propofol to effect via saphenous butterfly (induction) Pentobarbital IV, standard doses (euthanasia)	15 mcg/kg dexmedetomidine + 4 mg/kg ketamine (deep sedation) Ketamine 1-3 mg/kg IV or propofol to effect via dorsal pedal butterfly (induction) Pentobarbital IV, standard doses (euthanasia)	Dexmedetomidine 40-80 mcg/kg + Midazolam 1 mg/kg (Moderate to deep sedation, rats) ISO/SEVO via face mask after sedation followed by IC pentobarbital injection (standard doses) (euthanasia)	Midazolam 1 mg/kg + Alfaxalone 3-5 mg/kg into <u>deep SC</u> tissue below mantle (spiny dorsum near neck) (Moderate to deep sedation) ISO/SEVO via face mask after sedation followed by IC pentobarbital injection (standard doses) (euthanasia)	Injectable protocols have not been well-studied Consider 1 mg/kg midazolam + 1 mg/kg butorphanol SC (sedation) ISO/SEVO via face mask after sedation followed by IC pentobarbital injection (standard doses) (euthanasia)
Alternatives	ISO/SEVO via face mask after sedation followed by IC pentobarbital injection (standard doses)	ISO/SEVO via face mask after sedation followed by IC pentobarbital injection (standard doses)	ISO/SEVO via face mask after sedation followed by IC pentobarbital injection (standard doses)	ISO/SEVO via face mask after sedation followed by IC pentobarbital injection (standard doses)	Consider SC injection if sedating small rodents Consider induction chamber if handling stress surpasses stress of chamber	Ketamine may replace alfaxalone at 30 mg/kg Consider induction chamber if handling stress surpasses stress of chamber	Consider induction chamber if handling stress surpasses stress of chamber
Comments	Most protocols for dogs/cats are effective	Rarely, can vocalize with anesthesia or euthanasia (any protocol)	“Popcorning” and “paddling” can occur with low doses and other agents Consider SC injection for sedation if poorly muscled	Consider SC injection for sedation if poorly muscled	Require very high doses of ketamine to be effective - not recommended due to volume and sting of agent	May regurgitate if recently eaten	Inject SC in between shoulder blades, not near wing patagium (poor absorption)

Euthanasia Protocols: Birds

	Parrots	Passerines	Chickens	Water fowl
Favorite protocol/ owner wants to be present	2-6 mg/kg midazolam + 2-6 mg/kg butorphanol IM (Mild/moderate sedation: low end for larger birds, higher end for smaller birds) ISO/SEVO via face mask (induction) Pentobarbital IV (0.2-1 ml/kg) off the needle, jugular vein (Euthanasia)	Most injectable agents require dilution due to small patient size - an arbitrary 0.01 ml of 2-3 agents (each) IM may produce sedation ISO/SEVO via face mask (induction) Pentobarbital IV (0.2-1 ml/kg) off the needle, jugular vein (Euthanasia)	Dexmedetomidine 40 mcg/kg + Midazolam 2-3 mg/kg IM (Sedation) ISO/SEVO via face mask (induction) Pentobarbital IV (0.2-1 ml/kg) off the needle or butterfly, jugular or medial metatarsal vein (Euthanasia)	Dexmedetomidine 40 mcg/kg + Midazolam 2-3 mg/kg IM (Sedation) ISO/SEVO via face mask (induction) Pentobarbital IV (0.2-1 ml/kg) off the needle or butterfly, medial metatarsal vein (Euthanasia)
Alternatives	Pentobarbital(0.2-1 ml/kg) ICe after anesthesia induction (not appropriate for histopathology)	Pentobarbital(0.2-1 ml/kg) ICe after anesthesia induction (not appropriate for histopathology)	Pentobarbital(0.2-1 ml/kg) ICe after anesthesia induction (not appropriate for histopathology)	Pentobarbital(0.2-1 ml/kg) ICe after anesthesia induction (not appropriate for histopathology)
Comments	Wing flapping and vocalizing can occur, but less likely when under anesthesia	Keep in mind relative volume of IM injection to keel muscle - large volumes not recommended due to pain/pressure on injection. If poorly muscled, an induction chamber may be the most humane.	Wing flapping and vocalizing can occur, but less likely when under anesthesia	Can breath hold with inhalants, injectables preferred prior to induction Wing flapping and vocalizing can occur, but less likely when under anesthesia

Euthanasia Protocols: Reptiles/Amphibians

	Lizards	Snakes	Chelonians	Amphibians
Favorite protocol/ owner wants to be present	Dexmedetomidine 0.3 mg/kg (NOTE DOSE!) + midazolam 2 mg/kg + ketamine 20 mg/kg SC (Often deep sedation but species dependent) Alfaxalone 5 mg/kg IV bolus Alfaxalone 10-20 mg/kg SC (Induction) *This step may not be needed pending success of Step 1* Pentobarbital (60-100 mg/kg) IV via ventral tail vein (Euthanasia) Follow with adjunctive method: pith	Dexmedetomidine 0.3 mg/kg (NOTE DOSE!) + midazolam 1-2 mg/kg + ketamine 10 mg/kg IM (Often deep sedation but species dependent) Alfaxalone 10-20 mg/kg SC (Induction) *This step may not be needed pending success of Step 1* Pentobarbital (60-100 mg/kg) IV via ventral tail vein or IC (Euthanasia) Follow with adjunctive method: pith	Dexmedetomidine 0.3 mg/kg (NOTE DOSE!) + midazolam 1-2 mg/kg + ketamine 30 mg/kg IM (Often deep sedation but species dependent) Alfaxalone 20-30 mg/kg SC (Induction) *This step may not be needed pending success of Step 1* Pentobarbital (60-100 mg/kg) IV via jugular or brachial vein; dorsal occipital sinus site is less challenging, but less favorable if owner present (Euthanasia) Follow with adjunctive method: pith	Frogs/toads: Isoflurane via induction chamber - will need 5%, can take a while (Initial sedation —> anesthesia) Axolotls: 5 mg/L alfaxalone bath (induction) Can drip drops over gills for maintenance Pentobarbital (60-100 mg/kg) IC (Euthanasia) Follow with adjunctive method: pith
Alternatives	Some small species (e.g. geckos, anoles) - can sedate and anesthetize via inhalant induction chamber Pentobarbital(100 mg/kg) ICe after anesthesia induction (not appropriate for histopathology)	Small species/juveniles - can anesthetize via sedate/inhalant induction chamber Pentobarbital(100 mg/kg) ICe after anesthesia induction (not appropriate)	Pentobarbital(100 mg/kg) ICe after anesthesia induction (not appropriate for histopathology)	Pentobarbital(100 mg/kg) ICe after anesthesia induction (not appropriate for histopathology)
Comments	Maintain POTZ SC injection favored due to relatively small limb muscles, most patients Inject sedatives in cranial half Avoid tail use: geckos, skinks, anoles	Maintain POTZ Inject sedatives in cranial half	Maintain POTZ Inject sedatives in cranial half Will breath hold, inhalants not recommended	Injectable protocols not well-studied, too much species variation Frogs can occasionally evert their stomach following sedation/anesthesia, but this has typically been associated with injectable protocols

Euthanasia Protocols: Fish

	Fish
Favorite protocol/ owner wants to be present	500-1,000 mg/L MS-222 (buffered with equal <u>weight</u> baking soda) x 30 minutes (anesthesia) Up to 100 mg/L clove oil (dosed to effect) x 30 minutes (anesthesia) Pentobarbital(100 mg/kg) IC after anesthesia induction (not appropriate for histopathology)
Alternatives	Pentobarbital(100 mg/kg) ICe after anesthesia induction (not appropriate for histopathology or koi fish)
Comments	Use home aquarium water, maintain temperature When using MS-222, prepare buffered solution <u>before</u> placing fish in bath (wear eye and skin protection when preparing, dispose responsibly) Clove oil not approved for food fish species After final injection, consider placing back into anesthesia water to ensure full effect



The Highlights....

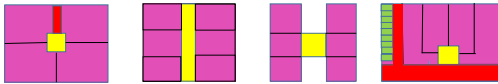
- Facilities Design
- Backgrounding
- Stocking Density
- Ventilation
- Disease Identification
- Pen Rules
- Using Feeder Data

Facilities Design

- Building Structure
 - Peaked roof, covered chimney/ridge cap
 - Monoslope
 - Flat, insulated ceiling
 - Greenhouse/hoop building
- Curtains
 - Insulated (quilted or standard thermal layers)
 - Breathable screen curtains
 - Poly (Polyethylene) curtains
 - PVC-coated vinyl curtains

Barn Design

- Feeding station location
 - Central
 - Minimize hose length
- Accessibility to feeder, water tank, calf starter
- Avoid long, narrow pen
 - Can challenge calves to access feeder
 - Animal traffic can decrease nesting scores with trampling of bedding



Facilities Design

- Lighting
 - Goal 16 hours of "daylight"
 - > 80 lux
- Minimize temperature stress (< 5F, >77F)
- Feeder platform
 - Tend to be wet area
 - Surface should be smooth for hygiene reasons, often need to add lime, sand, salt
 - Daily cleaning-rubber scraper, remove debris

Facilities Design

- Determine number of calves to expect annually
 - 1000 cow dairy, 425 heifer calves born annually
 - 425/12=35-36 calves monthly
 - plan for 20% over flow in months of increase birth rates -esp. summer months
- Is the dairy in expansion mode
- Will there be expansion in the future
- What is the breeding strategy and how does that effect calf facilities
 - Does the dairy retain ownership of beef-on-dairy(BOD) calves or genomics culls

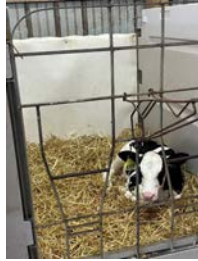
Backgrounding

- Newborn pen considerations

- Age moved from individual to groups
 - Minimum of 7 days of age prior to group housing
 - Incidence of disease greatest 8-14 days
 - Recommendation to transfer to group housing at 14 days of age

- Individual Pen arrangement

- Within the group pen
- Individual pen with move to group pen
- Pair pens with move to group together



Stocking Density

- 30-50 sq. ft. per calf
- Less than 14 days of age gap in pen population
- 15-20 calves per pen
 - often feeder manufacturers recommend up to 25

Remember, most often this is an all in-all out system
need to be able to clean and sanitize pens between groups



Stocking Density

Feeding stations

- each feeder can usually cover to 2 stations at 20 calves each
- Can add a secondary pump
 - Helps allow multiple calves consuming at the same time
- Station height matters- what is calf size when introduced to feeder



Ventilation

- Positive Pressure Ventilation Tubes
 - Need 4-5 air exchanges per hour
 - Air movement of less than 0.5 mph at calf level
- Heat stress
 - Basket fans
 - Tunnel ventilation in summer
- Cold Stress
 - Calf coats are a must
 - Calves grow, must evaluate size weekly
 - Frequent pen bedding to achieve nesting scores 3-4

Feeding Schedules

- 2-3 L per meal
 - Smaller meals will cause calves to “crowd” the feeding station, prevent other calves access
- Limited vs unlimited
 - Step up schedule
 - 10-14 L per day
- Training calves
 - Should be trained in less than 60 hrs
 - Letting them figure it out

Automated Feeder Management

- Inspect and clean powder and additive outlets
- Calibration of powder and additive delivery
- Monitor and refill cleaning solutions
- Water supply
- Inspect delivery hoses and nipples, clean and replace on a schedule
- Monitor and follow-up on feeder data
- Pasteurizer function when using waste/whole milk
 - Pre pasteurize
 - Post pasteurize
 - Nipple level

Automated Feeder Management

- Feeder Nipple selection
 - Length of nipple
 - Short vs long
 - Opening diameter
- Nipple selection can impact health events
 - Longer nipple length and large bore hole allows for too much milk, too fast and in proximity to Eustachian tube openings allowing milk to back up into the ears
 - Calves that have repeated flooding of the Eustachian tubes are prone to ear infections and aspiration pneumonia
- Regular cleaning of holding tank if using pasteurized whole milk

* Hand out

Health Monitoring

- Feeder based information vs health monitoring platform
 - Feeder based information
 - Drinking speed
 - Volume consumed
 - Aborted visits
 - Number of visits
 - Delayed time between visits
 - Tag Based systems (SenseHub by Merck, CowManager by Select Sires)
 - Calf activity
 - Feeding time
 - Temperature

Health monitoring

- Milk intake – may begin decreasing up to 5 days prior to illness
- Drinking speed- decrease 4 days prior
- Aborted visits-increase 3 days prior
- Lung Ultrasound at 2 weeks, 4 weeks, and preweaning can be helpful

• *J Morrison, et al 2022

Colostrum Monitoring

- Establish Goals with each farm
- SMART goals
 - 85% of herd >6.2
 - How often is report made
- Colostrum replacer use will make this difficult
- High FPT, low performance
- Monitor weekly, analyze monthly and quarterly

1043	7.5	8/10/2024	8/10/2024
1044	6.8	8/10/2024	8/10/2024
1045	6.9	8/10/2024	8/10/2024
1046	7	8/10/2024	8/10/2024
1047	6.5	8/10/2024	8/10/2024
1048	7.0	8/10/2024	8/10/2024
1049	7.0	8/10/2024	8/10/2024
1050	6	8/10/2024	8/10/2024
1051	7.8	8/10/2024	8/10/2024
1052	7	8/10/2024	8/10/2024
1053	6.8	8/10/2024	8/10/2024
1054	7.5	8/10/2024	8/10/2024
1055	7.5	8/10/2024	8/10/2024
1056	7.0	8/10/2024	8/10/2024
1057	7.0	8/10/2024	8/10/2024
1058	6.5	8/10/2024	8/10/2024
1059	7.0	8/10/2024	8/10/2024
1060	7	8/10/2024	8/10/2024
1061	6.6	8/10/2024	8/10/2024
1062	6.8	8/10/2024	8/10/2024
1063	7	8/10/2024	8/10/2024
1064	7.0	8/10/2024	8/10/2024
1065	6.5	8/10/2024	8/10/2024
1066	7.0	8/10/2024	8/10/2024
1067	7.0	8/10/2024	8/10/2024



Performance Data

- Birth Weight
- Birth Height
- Total Serum Protein Concentration
- Treatments
- Volume of milk
- Volume/amount of additives
- Calculated cost per pound of gain (range \$1.54-\$2.30)

[illegible]

2018-2019	
1st Year	10%
2nd Year	10%
Final 3 years	
3rd Year	10%

Day	Vial Color	Date of		Total					Bacteria	Antibiotic ²
		Sample	Sample Source	Solids	Protein	Butterfat	SCC ³			
1	Lt Orange	11/25/2025	Post-P AM	11.2%	3.53%	1.59%	120,000			
2	Lime Green	11/26/2025	Post-P PM	13.3%	3.47%	0.403%	834,000			
3	Pink	12/1/2025	Post-P AM	13.6%	3.41%	4.41%	441,000			
4	Pink Blue	11/28/2025	Post-P PM	13.3%	3.49%	4.01%	700,000			
5	Green	11/29/2025	Post-P AM	13.3%	3.82%	2.26%	275,000			
6	Turquoise	11/29/2025	Post-P PM	13.6%	3.59%	4.10%	1,100,000			
7a	Gold	12/1/2025	Pre-P AM	12.8%	3.43%	3.53%	790,000	8,000	Not Found	
7b	Gold	12/1/2025	Post-P AM	12.2%	3.6%	2.7%	160,000	1,000	Not Found	
7c	Gold	12/1/2025	Last CalP AM	13.0%	3.4%	3.7%	1,000,000	2,000,000	Not Found	

- Wean by age
 - Most common
 - Start the “step down” in feeding program
 - Decrease by 2L every 2-3 days
 - Wean at 60 days of age
- Wean by growth
 - Goal is to double birth weight (Triple for jerseys)
 - 4 inches of height (best measure of growth)
 - Need to customize feeding program to each calf

Transitioning

- Intake of 3# of calf starter daily
 - Hard to know individual calf intakes
 - Need to have high quality calf starter
- Stress-
 - Minimize as much as possible
 - Only ONE change at a time
 - Weaning
 - Calf starter
 - Housing/Pen moves
 - Commingling

Common Challenges

- Expecting to decrease labor costs
 - Team will spend less time on remedial task, more on data management
 - Huts/individual pens can require 10 min/calf/day
 - Auto systems 1-4 minutes/calf/day but more on data input and analysis
- Poor ventilation/climate control
- Underestimating surges
 - Overstocking
 - Maternity pen challenges
 - Time of year

Common Challenges

- You cannot vaccinate your way out of disease challenges
 - Vaccines are a tool, not a Band-Aid
 - Scours-is your scours vaccine providing protection for the pathogens on site
 - Regular monitoring for changes in pathogens
 - Respiratory disease
 - Cause may vary by age
 - Pre and post mortem diagnostics can be helpful
- Fly management
 - Summer air speed
 - Fly predators/fly bait
 - Perimeter management
- Cross sucking

Key Components of Successful Automatic Feeders

- Colostrum (adequate quantity, quality, and timely delivery) & individual newborn care for 12-14 days
- Plentiful, well bedded resting space with
- Appropriate ventilation for good air quality and control of respiratory diseases
- Management: focus on calf care, automated feeder monitoring and maintenance
- Cleanliness is next to godliness

To build or not to build

Management

Labor

Fresh cow pen management

Facility

Ventilation

Hygiene

What is the goal of the automated feeding system?

Questions??

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Cheek Teeth Extractions

Jessica Hunt, DVM, DAVDC-EQ

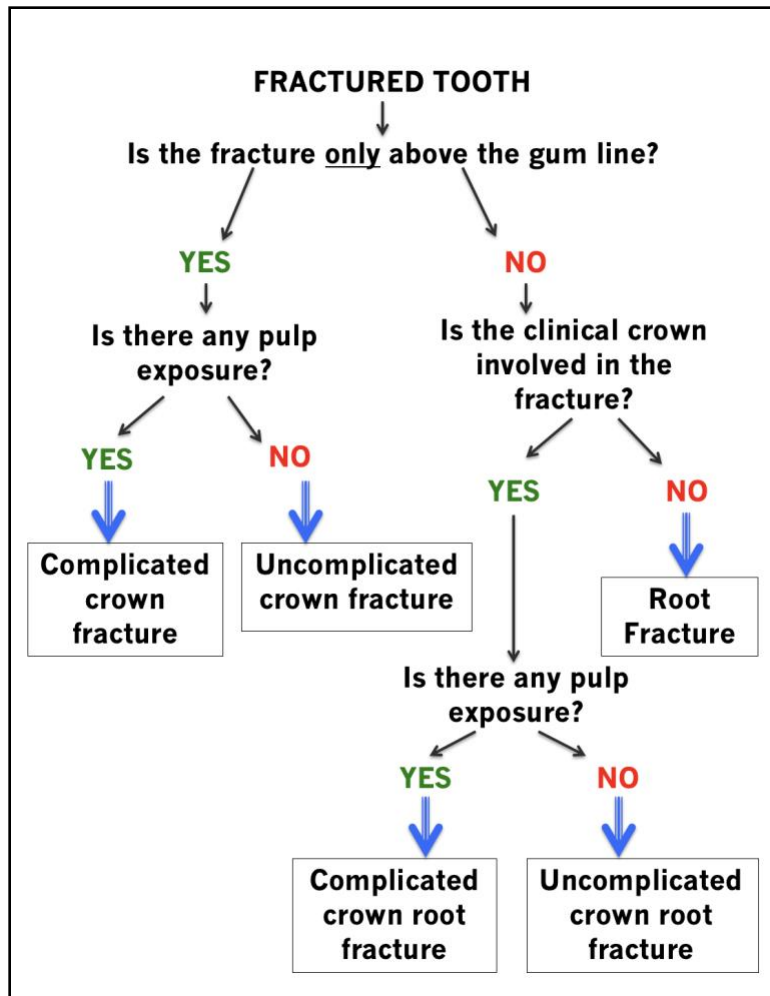
Midwest Veterinary Dental Services

Diagnosis of Cheek Teeth Pathology

A thorough oral exam, aided by a full-mouth speculum and adequate light, is the foundation of diagnosis and should evaluate for periodontal disease and diastemata, pulp exposure, tooth fracture, tooth mobility, and infundibular caries. Presenting signs may include quidding, feed packing in the cheeks, halitosis, weight loss, headshaking, nasal discharge, or facial swelling. Radiographs (intraoral and extraoral, including oblique views) are required to confirm and stage disease; computed tomography is increasingly used for complex or overlapping pathology given the anatomic complexity of the cheek teeth and their proximity to the paranasal sinuses.

Periodontal disease secondary to diastemata is the most common indication for cheek tooth extraction in adult and senior horses. Feed material packs between teeth, driving progressive attachment loss, pocket formation, and eventual periodontal ligament failure. Infundibular caries is a second common finding, in which enamel and cementum defects within the infundibulum progress to dentin and, if untreated, can lead to complicated crown fracture. Apical (root) infection—whether idiopathic or secondary to fracture, caries, or disrupted eruption—is a further common indication and may present as mandibular swelling with a draining tract (mandibular cheek teeth) or sinusitis with unilateral nasal discharge (maxillary cheek teeth 108–111/208–211, due to their close apical relationship with the paranasal sinuses). See the chart below for periodontal disease staging. Extraction is generally recommended for PD3 and above, or for any tooth with a non-vital pulp or complicated crown/crown-root fractures.

Periodontal Disease (PD) Staging System and Stage Description	
PD1	Gingivitis, but no attachment loss
PD2	Mild attachment loss (<25%); periodontal pocket present, food packing common between adjacent teeth.
PD3	Moderate attachment loss (25-50%); deeper periodontal pocketing, gingival recession, and periodontal ligament compromise.
PD4	Severe attachment loss (>50%); pocket often communicates with the apex/pulp, marked tooth mobility, and secondary apical infection is common.



Preparation of the Patient

Before any extraction, a thorough physical exam is performed to assess if the patient is a good candidate for sedation. The patient is heavily sedated to prevent sudden movements and minimize injury to either the patient or practitioner. The patient should be restrained in a standing stockade or a quiet area with an anti-slip floor, good drainage, and monitored/restrained by a capable assistant. A full-mouth speculum is placed and a complete oral exam of all incisors, canines, and cheek teeth is performed, as pathology elsewhere in the mouth can affect anesthetic and extraction planning. Regional anesthesia (maxillary or infraorbital nerve block for upper cheek teeth; inferior alveolar nerve block for lower cheek teeth) and local anesthesia or intraligament anesthesia are performed prior to the extraction process. Most cheek tooth extractions are completed standing; general anesthesia is reserved for cases requiring a surgical (buccotomy) approach or for fractious or otherwise unsuitable standing candidates.

Standing Oral Cheek Tooth Extraction

Instrumentation includes the following: Full-mouth speculum and head stand/stabilization, mouth mirror, dental picks and explorers, gingival elevators, long luxators, molar spreaders, cheek tooth extraction forceps, fragment/root-tip forceps, curettes, saline for lavage, and alveolar packing material.

Technique

- 1) Full-mouth speculum and regional nerve block are placed; the tooth and surrounding gingiva are assessed for mobility and periodontal pocketing.
- 2) A gingival elevator or luxator is advanced circumferentially within the periodontal space to progressively sever the periodontal ligament, working both the buccal and lingual/palatal aspects of the tooth before any traction is applied.
- 3) Molar/cheek tooth spreaders are carefully placed in the interproximal space on mesial and distal aspect of the target tooth.
- 4) Occlusal reduction or purposeful sectioning of the crown with a motorized bur is performed when needed to improve forceps.
- 5) Gentle manipulation is made with cheek teeth extraction forceps by applying steady rotation forces.
- 6) The tooth is delivered from the alveolus with cheek tooth extraction forceps +/- fulcrums to apply steady traction along the long axis of the tooth once adequate mobility is achieved; excessive lateral force is avoided to reduce the risk of alveolar or mandibular fracture.
- 7) Post-extraction radiographs are obtained to confirm full tooth removal, including the root(s). Take care to assess for retained root fragments or separated islands of dental material, and to evaluate for oroantral or oronasal communication in maxillary extractions.
- 8) The socket is packed (e.g., dental wax, polyvinylsiloxane, betadine soaked gauze, or an equivalent packing agent) to exclude feed material while the alveolus heals by granulation. Shorter alveoli (as in advanced aged horses) can be left to heal by second intention.
- 9) Depending on the case and alveolar packing type. Recommendations for alveolar packing to be checked and replaced approximately every 1–2 weeks until the socket has adequately filled with granulation tissue may be made. Full healing may take several weeks to months depending on tooth size and location. Most straight forward extractions with dental wax packing or healing by second intention are recommended to be rechecked in 4 to 6 weeks.
- 10) Postoperative feeding instructions recommend a softened diet if they do not readily eat their normal diet (soaked pellets or mash, soft hay, pasture grass etc) for 1–2 weeks, followed by gradual reintroduction of normal forage; avoid stemmy long-stem hay that can pack into an open alveolus.

- 11) Medications include an antimicrobial for 5 to 14 days and an anti-inflammatory for 3 to 5 days. A sinus lavage is added when sinusitis accompanies a maxillary extraction.
- 12) Recheck surgical site in 4 to 6 weeks with oral exam and radiographs; assess for alveolar fill-in, resolution of any sinus involvement, and abnormal tissue (mass/tumor formation).
- 13) Routine oral examination with occlusal surface odontoplasty should be recommended every 6 months to manage dentition opposing the vacated alveolus.

Surgical Approaches for Complicated Extractions

A minority of cases cannot be completed by the standing oral approach—typically severely curved or ankylosed roots, extensive periapical infection, or a tooth that is otherwise inaccessible by mouth. These cases require advanced dental techniques or a surgical approach.

Partial Coronectomy

When traditional tooth spreading and manipulation would be detrimental to crown integrity, such as a severely fractured or structurally compromised crown, partial crown removal techniques are usually elected. A cutting bur is used to remove approximately 3mm from the clinical and reserve crown of the tooth being extracted at either to distal or mesial (or both) aspect of the tooth. Partial crown removal is made to the level of the crestal bone to allow for release of the crown interlock. Mobility of the tooth in a mesial to distal direction is improved with minimal force on the clinical crown and adjacent cheek teeth.¹

Minimally Invasive Transbuccal Approach and Intradental Screw Placement (MITSE)

If there is a lack of clinical crown or separation of apex or roots occurs, a minimally invasive buccotomy may be elected for direct line access to the reserve crown or retained apex/root(s) of the tooth. After aseptic preparation of the skin is made and the parotid salivary duct is identified, a stab incision is made through the skin with a #15 scalpel blade and a cannulated trocar is passed through the cheek to provide straight line access to the apex of the alveolus. Luxation and gentle manipulation can be made with specialized instruments or an extraction rod can be placed into the retained dental material allowing orally delivery with a slotted hammer.²

Lateral buccotomy

A direct surgical approach through the skin, lateral aspect of the alveolus, and musculature (if present) overlying the affected tooth. The tooth is exposed and elevated under direct visualization, allowing controlled removal of teeth that cannot be safely delivered by mouth. The incision is closed in layers, with a drain placed if indicated. This approach carries a lower risk of iatrogenic fracture than repulsion but still requires general anesthesia and a longer recovery than standing extraction.³

Repulsion

A historical technique in which the tooth is driven into the oral cavity using a punch placed against the tooth from a trephine site over the reserve crown/apex, most often through the sinus for maxillary cheek teeth. Repulsion carries a comparatively high complication rate (iatrogenic fracture of adjacent teeth or bone, sinus/nasal damage) and has been largely replaced by standing extraction and buccotomy; it is now reserved for select cases where other approaches are not feasible.⁴

Postoperative Complications to Monitor

Oroantral or oronasal fistula formation (maxillary extractions), sinusitis, alveolar sequestrum formation, feed impaction within an inadequately packed socket, damage to adjacent teeth, and iatrogenic mandibular or maxillary fracture are the principal complications following cheek tooth extraction. Routine rechecks with oral exam and radiography allow these to be identified and addressed early.

References:

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4. Coomer RPC, Fowke GS, and McKane S. Repulsion of maxillary and mandibular cheek teeth in standing horses. *Vet Surg*. 2010. DOI: 10.1111/j.1532-950X.2011.00819.x