Revised 3rd Edition

ANESTHESIA

FOR THE PET PRACTITIONER

Banfield® PET HOSPITAL

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CONTRIBUTING AUTHORS

Karen Faunt, DVM, MS, DACVIM
Vice President
Medical Quality Advancement

Sharon Graham, DVM
Medical Advisor

Ashley Harris, DVM, DABVP
Medical Advisor

Robyn Hauser, DVM, DABVP
Medical Advisor

Michele King, DVM
Medical Advisor

Alison Marsh, DVM, JD
Medical Advisor

Deborah Miller, DVM, DABVP
Medical Advisor

Thomas Mohn, DVM, DABVP
Medical Advisor

Rachel Beck, CVT
Implementation Specialist
Medical Support

Loni Seebach, CVT
Implementation Specialist
Medical Support

Heather Stratton, CVT
Team Lead, Medical Support

Gary Goldstein, DVM, FAVD, DACVD
Associate Medical Director
University of Minnesota
Veterinary Medical Center

C. Lee Tyner, DVM
Professor, Director of Special Operations
College of Veterinary Medicine
Mississippi State University

EDITORIAL TEAM

Sharon DeBusk
Executive Editor

Nina Silberstein
Medical Writer/Copy Editor

Eric Jensen
Graphic Designer

Laurie O'Keefe
Medical Illustrator

PROJECT MANAGEMENT

Amy Walker, PMP
Project Manager

James Vatert, CPM, MBA
Project Manager

8000 N.E. Tillamook St.
Portland, OR 97213
800.838.6738
www.banfield.net

Banfield PET HOSPITAL

Dedication


Dr. Faunt

In the summer of 2009, we began the process of revising the 2nd Edition of *Anesthesia for the Pet Practitioner,* with the goals of improving the safety of anesthetic procedures and the quality of pain management for the pets in our care. We're proud to offer this resource, which includes a wealth of new information, from updated protocols and drug dosages to new sections on pain assessment, prevention and treatment. We've redesigned the algorithms and added section tabs to ease navigation through the manual.

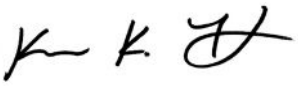
A number of individuals were instrumental throughout the process of creating this book. I'd like to extend my appreciation to the two anesthesiologists, Nora Matthews, DVM, ACVA, and Robert Meyers, DVM, ACVA, who volunteered to help us with this edition and whose input was invaluable in this review. Appreciation also goes to J. Jill Heatley, DVM, MS, DABVP (Avian), and Nigel Caulkett, DVM, MVetSc, ACVA, for their review of our section on Anesthetic Considerations for Small Exotic Pets. A special thank you to our medical advisors, who contributed their knowledge, experience and editing skills: Sharon Graham, DVM; Ashley Harris, DVM, DABVP; Robyn Hauser, DVM, DABVP; Michele King, DVM; Alison Marsh, DVM, JD; Deborah Miller, DVM, DABVP; and Thomas Mohn, DVM. I'd also like to thank Heather Stratton, CVT, team lead of Medical Support, Rachel Beck, CVT, Medical Support Implementation Specialist, and Loni Seebach, CVT, Medical Support Implementation Specialist, for their significant contributions, as well as Amy Walker, PMP, and James Vatert, CPM, MBA, project managers, for their efforts in coordinating workflow with everyone involved.

In addition, I'd like to thank the Publishing Team—Sharon DeBusk, Executive Editor, Nina Silberstein, Medical Writer/Copy Editor, and Eric Jensen, Graphic Designer—for their help in editing and designing this book and making it coherent and user-friendly.

I also want to thank David Clark, DVM, DABVP, and his entire team at our teaching hospital at Western University for trialing these new protocols and providing feedback for this Third Edition.

Finally, I want to acknowledge our medical directors and doctors who serve on our Peer Review Committee, Formulary Committee and Care Guidelines Committee. They provided the real-world experience and knowledge, which ensured that we learned from previous experiences and that our new processes would work in our hospitals.

It is my hope that the information within the pages of this manual will help us all in giving pets the same care we want for ourselves.



Karen K. Faunt, DVM, MS
Diplomate ACVIM Small Animal
Vice President, Medical Quality Advancement
Banfield Pet Hospital

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ANESTHESIA COMMITMENT DOCUMENT

As medical professionals, we are often driven by the dictum, "First, do no harm." Holding ourselves accountable to that guiding principle may require that we elect to not continue with a procedure due to the risk of injury or death to the pet. At Banfield, we expect doctors to make the best decision for the pet at all times. It takes knowledge, experience and courage to ensure that you do not allow outside forces such as scheduling, production value, client perception, or any other circumstance to influence you to proceed with an anesthetic procedure that is contraindicated based on any abnormal preanesthetic test or physical exam finding.

After years of performing peer reviews on cases with unexpected or poor outcomes, one of the most common threads among them, in hindsight, is poor decision-making. If even mild abnormalities exist in the preanesthetic blood work or physical examination findings, heed the warning. It makes no sense to do the test if you are not going to consider the results. If a cat or dog cannot be handled in a reasonable manner, or you have already lost control of the pet, STOP! If you have a gut feeling that you should not go forward, pay attention to that feeling. It's not just how much knowledge you have, but how you apply it that counts.

Throughout this manual, you will see the following red stop sign icon:

Each time you see it, remember to stop and make sure what you are about to do is the right course of action for the pet in your care.

AVOIDABLE SITUATIONS:

1. **Aggressive pet:** It is not worth risking injury to your team or the pet if it requires excessive restraint or you have a failed attempt at sedation. STOP! Start the process another day, if possible, with a different, better plan.

2. **Blocked cat:** Do not anesthetize a cat with urethral obstruction without first administering pain medication, performing cystocentesis, and stabilizing the patient with intravenous fluids and electrolyte abnormality correction. The blockage is not the emergency; renal failure and electrolyte imbalances are the problem. The heart stopping due to hyperkalemia may be life-ending long before the post-renal effects of physical obstruction on the patient are.

3. **Immobilization of brachycephalics (Persians, Bulldogs, Pugs, etc.):** Place an endotracheal tube in these patients and don't remove it until they are fully able to manage their own airway. These pets need constant monitoring to avoid airway compromise.

It is also important to remember that patients in your hospital that are receiving care from an outside surgeon or consultant are still your responsibility as it pertains to anesthesia protocol, monitoring guidelines and documentation. Remember: Stop. Think. Make a good decision.

SECTION 1:

Introduction to Anesthesia

SECTION 1

Introduction to Anesthesia

Welcome to the Revised 3rd Edition of *Anesthesia for the Pet Practitioner.* Our anesthesia manual is a living document–a work-in-progress that continues to evolve as we learn more about pain management and keeping anesthetized patients safe. Since publishing the 2nd Edition in 2008, Banfield has worked in close collaboration with respected veterinary medical professionals to gather the most up-to-date information for this edition as possible. We drew on the expertise of anesthesiologists and pain professionals, and reviewed the current literature. We also took into account learnings from the thousands of patients we anesthetize each year within our hospitals. All of this information and experience was used to determine the changes we made to our standards and protocols.

Our primary goals for this edition include improving both the safety of anesthetic procedures and the quality of pain management for our patients. It's important to remember that following the basics is still the best practice in anesthetic procedures: The preoperative exam, knowing how the drugs work, understanding the patient's physiology, knowing the equipment and monitoring the pet are all key factors in successful anesthetic outcomes.

You'll find a number of major medical changes in this edition of *Anesthesia for the Pet Practitioner.* The following partial list of changes reflects our decision to move forward to industry standards:

- Units of measurement: doses changed to mg/kg
- Premedications: all maximum mg doses eliminated except for acepromazine
- Replaced ketoprofen with meloxicam (Metacam®) for cats and carprofen (Rimadyl®) for dogs
- Added heating device to standard equipment requirements
- Fluids:
  - Reduced intravenous (IV) fluid rate
  - Changed standard fluid type to Lactated Ringer's Solution (LRS)
- Added hetastarch to emergency and CPR protocols

Other changes (also a partial list) include:

- Changed feline Fractious Pet Protocol to include dexmedetomidine (Dexdomitor®) in combination with ketamine and butorphanol (Torbugesic®) (DKT); removed Telazol® for fractious cats
- Added dexmedetomidine immobilization option for dogs
- Added fentanyl constant rate infusion (CRI) for postoperative pain control in orthopedic protocols
- Added pain assessment tool from Colorado State University
- Increased the utilization of local blocks

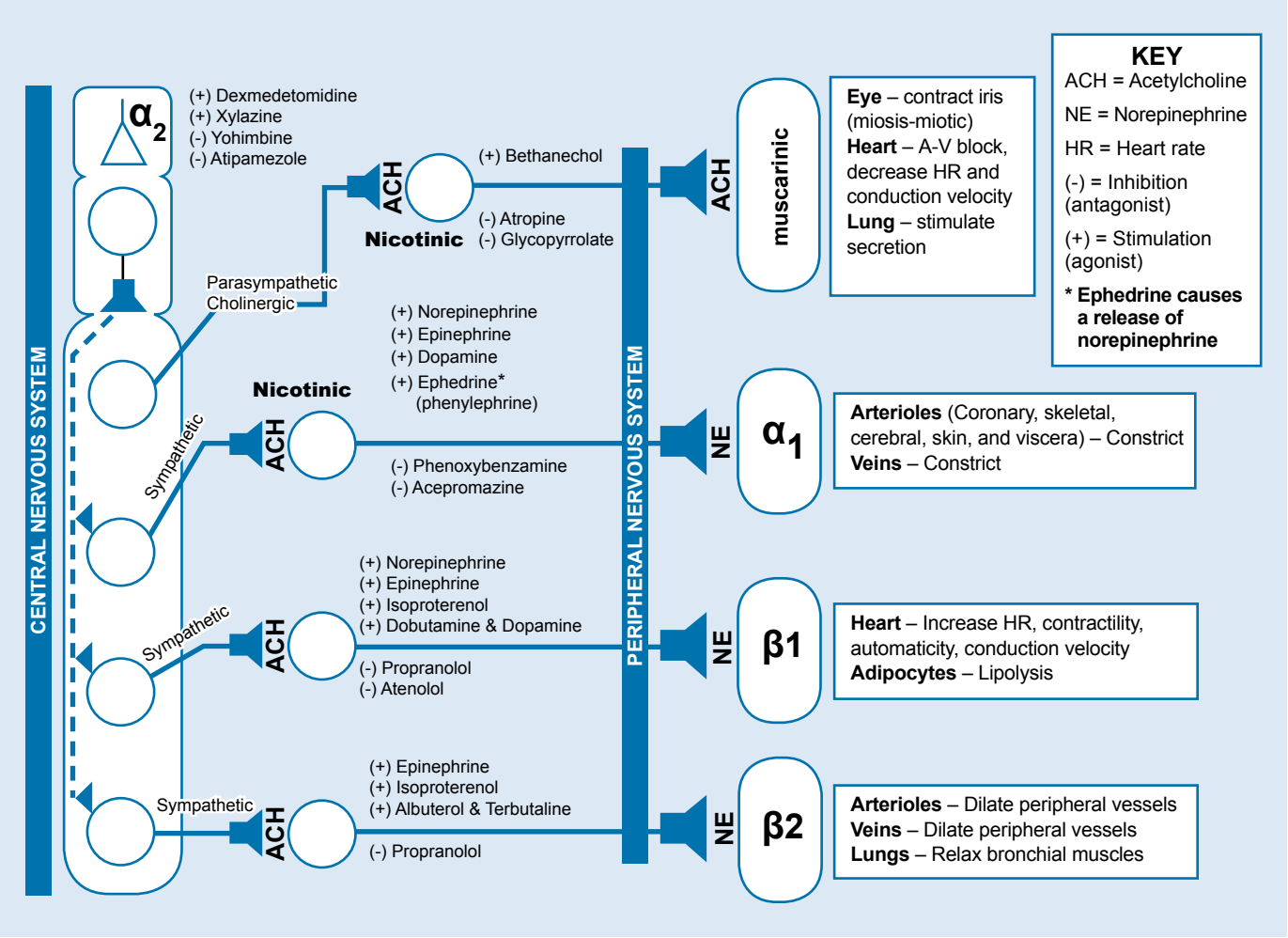
The largest philosophical change we are making is to embrace more rigor in basic preparation before beginning anesthetic procedures. We can take a lesson from human medicine, where mortality and complication rates are significantly reduced when clinicians use the now-popular World Health Organization (WHO) Surgical Safety Checklist.[1,2] The one-page checklist is intended to be read aloud in the operating room, similar to a pilot's checklist before takeoff and landing. The checklist reinforces accepted safety practices and ensures that all team members in the operating room communicate the most critical information during three key junctures: 1) Before induction; 2) Before the first incision, and 3) Before the patient leaves the operating room. The checklist is a simple, powerful tool for preventing human errors. After all, even the best, most conscientious practitioners can make mistakes. We are adapting this checklist for our practices and will include it in future versions of this manual once we have proven its utility in our hospitals.

We hope that the Revised 3rd Edition of *Anesthesia for the Pet Practitioner* serves as a useful guide in your hospital. As you put it to use, we are already gathering questions to consider for the next edition. Remember, in the end, that successful anesthesia depends not only on the leadership of the doctors, but every member of the hospital team doing the right thing for every pet, every single time.

Suggested reading:

1. http://www.who.int/patientsafety/safesurgery/en/
2. Gawande A. *The Checklist Manifesto–How to Get Things Right.* New York, N.Y. Henry Holt and Co. 2009.

Figure 1.1: Autonomic Nervous System: Drugs and Their Cardiovascular Effects



PHARMACOLOGIC INFLUENCE ON THE AUTONOMIC NERVOUS SYSTEM (ANS)

A review of the autonomic nervous system (ANS) will assist in developing an understanding of how drugs used during anesthesia affect both neurologic and cardiac function. Our primary goals in this discussion are: 1) Review the effect these drugs have on the central nervous system (CNS) in modulating consciousness and pain perception, and 2) Review how these drugs affect cardiac function and perfusion. The following are key drugs utilized in our anesthesia protocols that we will address in our review of anesthesia (*Figure 1.1*).

- Atropine, glycopyrrolate
- Midazolam, zolazepam, diazepam
- Lidocaine, bupivacaine
- Hydromorphone, fentanyl, buprenorphine, butorphanol (Torbugesic®), tramadol
- Dexmedetomidine (Dexdomitor®)
- Atipamezole (Antisedan®)
- Ephedrine
- Dobutamine
- Propofol
- Ketamine/tiletamine

The nervous system can be divided into two broad anatomic categories: central and peripheral (*Figure 1.2*, page 3). The CNS is composed of the brain itself (including the cranial nerves) and the spinal cord, while the peripheral nervous system (PNS) is composed of those nerves with their cell bodies located outside the spinal cord extending into the "periphery." Anesthesia will have effects on both of these systems in different ways, depending on the specific subset of receptor molecules associated with the nervous tissue in these different regions.

The CNS is further divided into the regions of the brain (telencephalon, diencephalon, mesencephalon, metencephalon, myelencephalon and spinal cord). These various sections of the brain are associated with different clusters of nervous tissue with unique functions. Anesthetic induction and maintenance agents affect these areas to cause the unconsciousness, hypnosis and amnesis

associated with anesthesia. Some agents also modulate the centrally mediated perception of pain.

The PNS includes the 12 pairs of cranial nerves that originate from various areas of the brain stem and 36 pairs of spinal nerves arising from the spinal cord. This section of the nervous system is involved with the control and sensation of the various effectors (muscles, sensory systems) outside of the brain and spinal cord. This system includes both autonomic and somatic subsystems (also called involuntary and voluntary, respectively). The involuntary or autonomic subsystem is further divided into the parasympathetic and sympathetic nervous system. Both of these functional systems of the ANS are acutely important in an understanding of anesthesia and the drugs that modulate anesthesia.

Sympathetic response and control is often described as a "fight or flight" response. Acute stimulation of this system causes rapid release of epinephrine from the chromaffin cells in the adrenal medulla, as well as acetylcholine at the preganglionic synapse and norepinephrine at the postganglionic synapse (*Figure 1.1*, page 2). This causes the classic "sympathetic" response—mydriasis, bronchodilation, increased heart rate (HR), increased cardiac contractility, and peripheral vasoconstriction leading to increased shunting of blood to the larger vessels and dilation of skeletal blood vessels. These effects are mediated through both alpha and beta adrenergic receptors. Alpha and beta adrenergic receptors are subclassified into alpha-1, alpha-2, beta-1 and beta-2 receptors, and are illustrated in *Table 1.1*, page 4.

Alpha-1 sympathetic pathway

- Systemic vasoconstriction: increased blood pressure (*Figure 1.3*, page 4)
- Important agonists: ephedrine, epinephrine
- Important antagonists: acepromazine
- Stimulation results in arteriole and venuole constriction leading to increase in blood pressure.
- Blockade results in arteriole dilation leading to decrease in blood pressure.
- For example, administering ephedrine, an alpha-1 agonist, induces vasoconstriction. Administration of acepromazine, an alpha-1 antagonist, blocks this pathway in a dose-dependent manner. Blockade of

Figure 1.2: The Nervous System

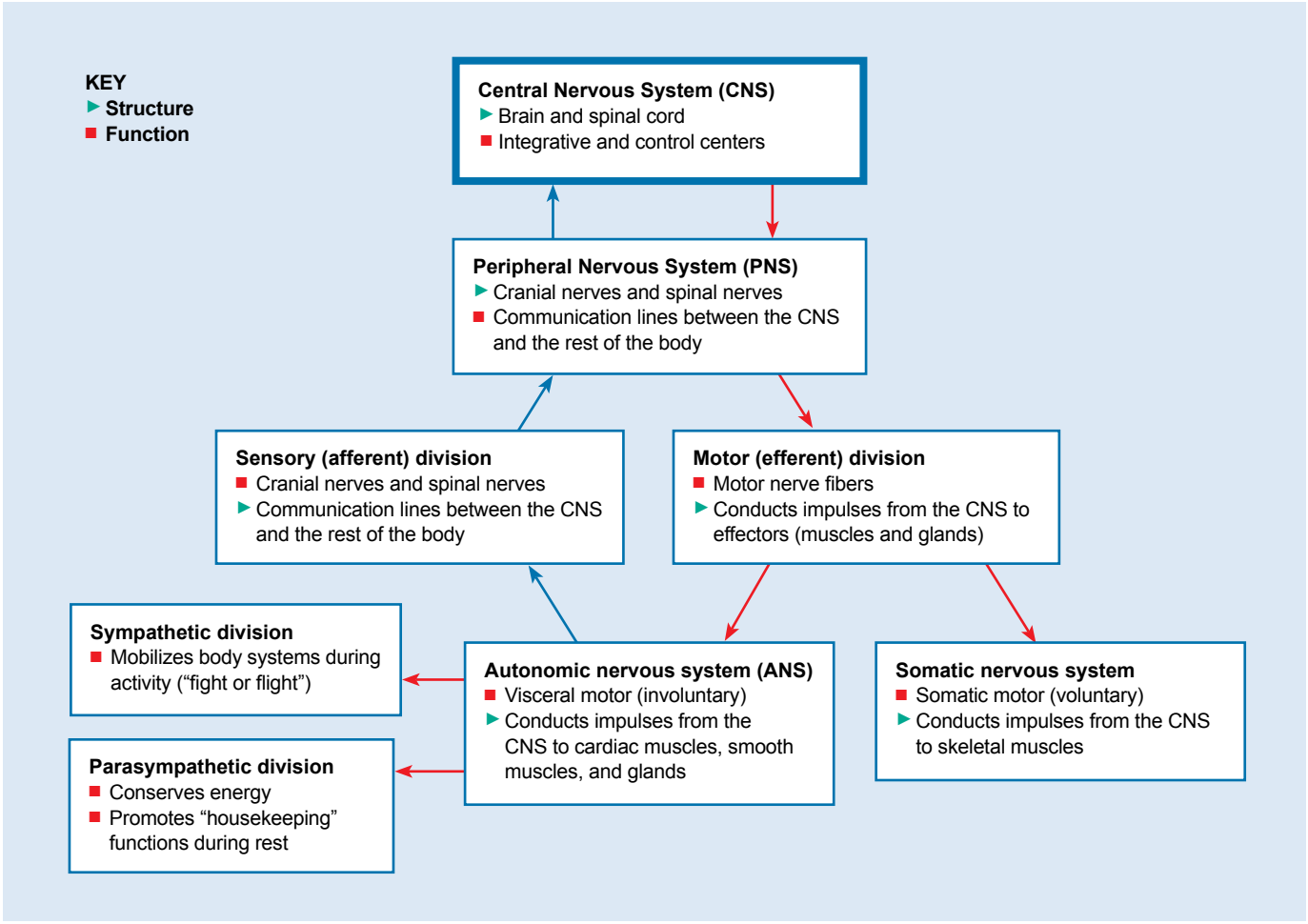


Table 1.1: Alpha and Beta Adrenergic Receptors

Receptor Type	Alpha-1	Alpha-2	Beta-1	Beta-2
Stimulation results in:	Peripheral vasoconstriction	CNS: sedation and mild analgesia PNS: peripheral vasoconstriction, transient hypertension reflex bradycardia	Cardiac effects prevail: increased HR, increased contractility	Respiratory effects prevail: bronchodilation and skeletal vasodilation
Agonists	Epinephrine, ephedrine	Dexmedetomidine	Epinephrine, ephedrine, dobutamine	Epinephrine, albuterol
Antagonists	Acepromazine	Atipamezole	Atenolol, propranolol	Propranolol
Comments	"Epinephrine-reversal" can occur when acepromazine is blocking alpha-1 receptors limiting reflex vasoconstriction, but epinephrine is stimulating beta receptors leading to vasodilation of the large vessels and increased cardiac output leading to peripheral pooling of blood.	Alpha-2 agonists are powerful sedatives with the potential for significant side effects. They must be used with caution. Atipamezole is a direct antagonist for dexmedetomidine and acts as a reversal agent.	Beta-1 effects are typically cardiac in nature. Atenolol is a relatively specific beta-1 antagonist.	Beta-2 effects are typically respiratory in nature. Albuterol is a relatively specific beta-2 agonist.

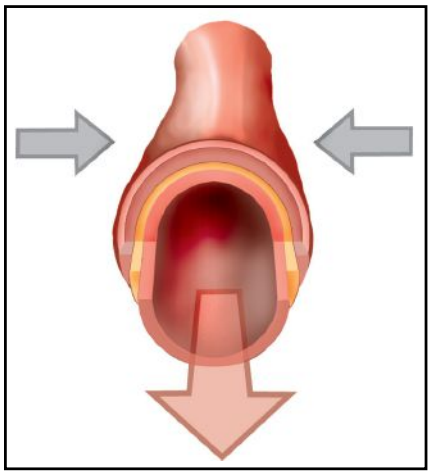
the pathway limits vasoconstriction and may result in lower blood pressure.

- Alpha-1 stimulation causes arteriole constriction.
- Alpha-1 blockade results in arteriole dilation.

Central/peripheral alpha-2 pathway

- CNS: sedation and analgesia
- PNS: transient peripheral vasoconstriction, reflex bradycardia

Figure 1.3: Alpha-1 Sympathetic Pathway



- Agonists: dexmedetomidine
- Antagonist to dexmedetomidine: atipamezole

Alpha-2 adrenergic receptor agonists have been used extensively to provide sedation and analgesia in veterinary patients. Alpha-2 receptors are located both pre-synaptically and post-synaptically. Analgesia appears to be mediated at both sites. Activation of alpha-2 receptors results in decreased release of norepinephrine; this decrease increases release of norepinephrine in adjacent nuclei. The final result is activation of spinal pre-synaptic and post-synaptic alpha-2 receptors to produce analgesia.

Alpha-2 agonists can be used as a component of total IV anesthesia; as a preanesthetic sedative-analgesic agent; as a constant rate infusion (CRI) supplement to inhalant anesthesia and in the postoperative period; in epidural and intrathecal injections; intra-articularly; and as a synergistic supplement to local anesthetics in regional nerve blocks. Banfield currently only employs them as premedications in the feline Fractious Pet Protocol and to immobilize non-fractious dogs.

Although powerful analgesics and sedatives, the alpha-2 agonists can have very significant clinical side effects. Of these, the most important are the cardiovascular effects. Alpha-2 agonists bind to post-synaptic alpha-2 receptors causing constriction of blood vessels. This results in a significant, yet transient hypertension. The body responds with a decrease in heart rate. Thus cardiac output is diminished by as much as 40% to 50%. Clinically, the peripheral vasoconstriction can cause significant blanching of the gums and, sometimes, decreased palpable pulse pressure. Use of dexmedetomidine in combination (usually with ketamine and butorphanol) helps to decrease the dose required and mitigates these effects. This is why Banfield uses this drug only in combinations and at a lower dose.

Because of these effects, alpha-2 agonists are not utilized in Banfield's healthy pet protocols nor are these agents utilized in fractious dogs, as fractious dogs can still be roused under the influence of an alpha-2 and as such the patients still pose a danger to the team. There is less chance of this happening with a dissociative, so Banfield continues to use Telazol® with fractious dogs. For these reasons, dexmedetomidine is included only in Banfield's non-fractious canine immobilization options and the feline Fractious Pet Protocol—and for fractious cats only when used in combination with a dissociative and/or opiate analgesic and at much lower than manufacturer recommended doses.

- Alpha-2 agonists significantly lower or eliminate the need for induction agents (up to 45%); therefore, induction doses of propofol may be as low as 1 mg/kg. Titrate propofol carefully. This is also true for minimum alveolar concentration of sevoflurane. Pets, therefore, require significantly less anesthetic gas.
- The alpha-2 agonist medetomidine has been shown to decrease the cardiac outflow obstruction associated with occult hypertrophic cardiomyopathy in cats, making this drug of potential great value in providing a safer alternative for sedation in this specific subset of our pets.
- Alpha-2 agonists can be reversed through the use of specific reversal agents. This can add to the safety of these agents.
- Xylazine, medetomidine and dexmedetomidine are examples of alpha-2 agonists. Tolazoline, yohimbine and atipamezole are alpha-2 receptor antagonists used to reverse the effect of the alpha-2 agonists.
- May cause vomiting in 20% to 30% of dogs and close to 90% of cats. This is not typically clinically significant except in situations of megaesophagus and the potential for aspiration.

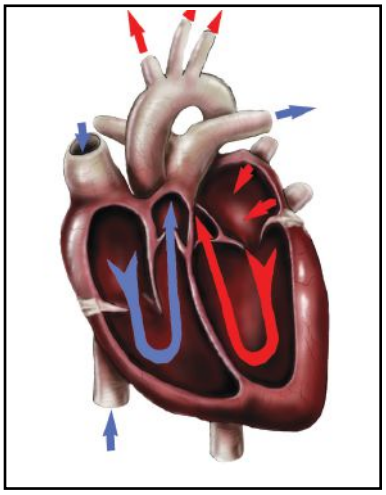
Beta-1 adrenergic pathway

- Cardiac effects predominate: increased heart rate, increased cardiac output (*Figure 1.4*)
- Agonists: epinephrine, ephedrine, dobutamine
- Antagonists: "beta-blockers" such as atenolol, propranolol

The beta adrenergic pathway is characterized by two primary receptor types, beta-1 and beta-2. Stimulation of beta-1 receptors located in the heart leads to increased heart rate and contractility, thus increasing cardiac output if all else remains normal.

- Dobutamine is an example of a beta-1 specific agonist.

Figure 1.4: Beta-1 Pathway



Beta-2 adrenergic pathway

- Respiratory effects predominate: bronchodilation, peripheral vasodilation
- Agonists: epinephrine, albuterol, terbutaline
- Antagonists: propranolol

Stimulation of the beta-2 receptors leads to vasodilation within the skeletal vasculature and bronchodilation due to relaxation of bronchiolar smooth muscle.

- Albuterol is an example of a beta-2 specific agonist.

Parasympathetic cholinergic pathway

- Cholinergic effects predominate: decreased heart rate; stimulated respiratory secretion; increased gastrointestinal motility
- Agonists: acetylcholine, bethanechol
- Antagonists: atropine, glycopyrrolate

The parasympathetic, cholinergic system is functionally and anatomically separate from the adrenergic pathway and is primarily responsible for effects essentially opposite of the sympathetic effects (decreased heart rate, increased secretion of gastric fluid and increased intestinal motility, increased respiratory secretions).

Tips for utilizing anticholinergics:

- Administration of an anticholinergic (glycopyrrolate or atropine) does not increase the heart rate above the basal rate but decreases vagal tone by blocking the effects of acetylcholine on the sinoatrial node. Heart rate may be elevated after administration of these drugs due to the presence of epinephrine in the system affecting the beta-1 pathways.
- The beta-1 pathway must be stimulated if the heart rate is to be increased above the basal rate, as seen with norepinephrine or epinephrine release/administration or dobutamine administration.
- Anticholinergic administration blocks the ability of the heart to slow in response to appropriate vagal stimulation. In Banfield's experience, this may result in unwanted tachycardia. Patients with a normal heart rate and blood pressure before anesthesia rarely benefit from pre-emptive anticholinergic administration. **This, however, is not the case with pediatric pets.**
- **Pediatric pets' cardiac output is much more dependent upon heart rate. Therefore, preventing bradycardia is very important in pediatric pets. For this reason, glycopyrrolate is included as a premedication in Banfield pediatric protocols.**
- Tachycardia after anticholinergic administration is difficult to manage. Supporting subsequent increased myocardial oxygen demand with supplemental oxygen, and administering IV fluids to support circulating volume, are helpful.
  - If tachycardia is present prior to anticholinergic administration, give supplemental oxygen and IV fluids and postpone induction of anesthesia until the heart rate normalizes or the primary cause is identified and treated.
- Due to the reasons noted above, Banfield protocols call for anticholinergic administration only when the pre-operative physical examination reveals bradycardia or if significant bradycardia associated with hypotension/poor perfusion develops during a procedure.

FRACTIOUS PET PHYSIOLOGY

Think. Make a good decision.

Fractious pets release a significant amount of catecholamines that lead to physiological effects such as tachycardia, hypertension, tachypnea, anxiety, muscle splinting, twitching, shivering, hyperthermia, salivation and mucus membrane color changes.

All these effects increase the risk of anesthesia in fractious pets. Close monitoring of the cardiovascular, respiratory and central nervous system is required to anticipate complications and prevent anesthetic accidents.

A fractious pet is defined as:

- Requiring more than one member of the hospital team to restrain
- Requiring more than one attempt at venipuncture because of aggression or demonstrating any signs of aggression
- Any and all overt displays of aggressive behavior

With feline patients, cardiomyopathy is often subclinical and not evident until the cat is challenged or the disease is very advanced. One study demonstrated cardiomyopathy in 15% of apparently normal cats.[1] Hypertrophic cardiomyopathy is the most common cardiac disease in cats; hypertrophic myocardial changes render patients more susceptible to myocardial hypoxia, ischemia and cardiac arrhythmias. During stressful episodes such as anesthesia and surgery, activation of the sympathetic nervous system leads to acceleration of the heart rate, decreased cardiac filling time and myocardial perfusion, and increased myocardial oxygen demand.

Acepromazine in fractious pets and epinephrine reversal:

- Epinephrine (natural catecholamine) is often released endogenously during stressful events, as with a fractious pet. Epinephrine stimulates both alpha and beta-1 and 2 receptors.
- When an alpha-1 antagonist, such as acepromazine, is given as a premedication, it blocks the effect of epinephrine on alpha-1 receptors, but not beta-1 and 2 receptors. As a result, arteriole constriction does not occur, although heart rate and contractility are increased. Vasodilation results in pooling of the circulatory volume in the vascular bed of skeletal muscle, which inhibits venous return and decreases cardiac output.

These cumulative effects may result in relative hypovolemic shock. As a result, it is imperative to avoid acepromazine in the fractious pet. The Fractious Pet Protocols do not include acepromazine.

Treatment of epinephrine reversal requires the administration of crystalloid fluids and/or colloids:

- Dogs: 20 mL/kg bolus (Repeat as needed up to 80 mL/kg)
- Cats: 5 mL/kg bolus (Repeat as needed up to 40 mL/kg)

Hetastarch may also be administered if needed:

- Dogs: 5 mL/kg bolus (Repeat as needed or begin CRI up to 20 mL/kg/day)
- Cats: 2.5 mL/kg bolus (Repeat as needed, or begin CRI up to 10 mL/kg/day)

References

1. Paige CF, Abbott JA, Elvinger F, Pyle RL. Prevalence of cardiomyopathy in apparently healthy cats. *JAVMA*. June 2009;234:11;1398-1403.

PERFUSION

Defining good perfusion (*Figure 1.5*, page 8)

- A state of adequate blood flow and volume to push red blood cells to the lungs, pick up oxygen and deliver it to the tissues. Or more simply, "nicely filled blood vessels," which means having adequate circulating blood volume, blood pressure, oncotic pressure and cardiac output (CO) to maintain normal perfusion.

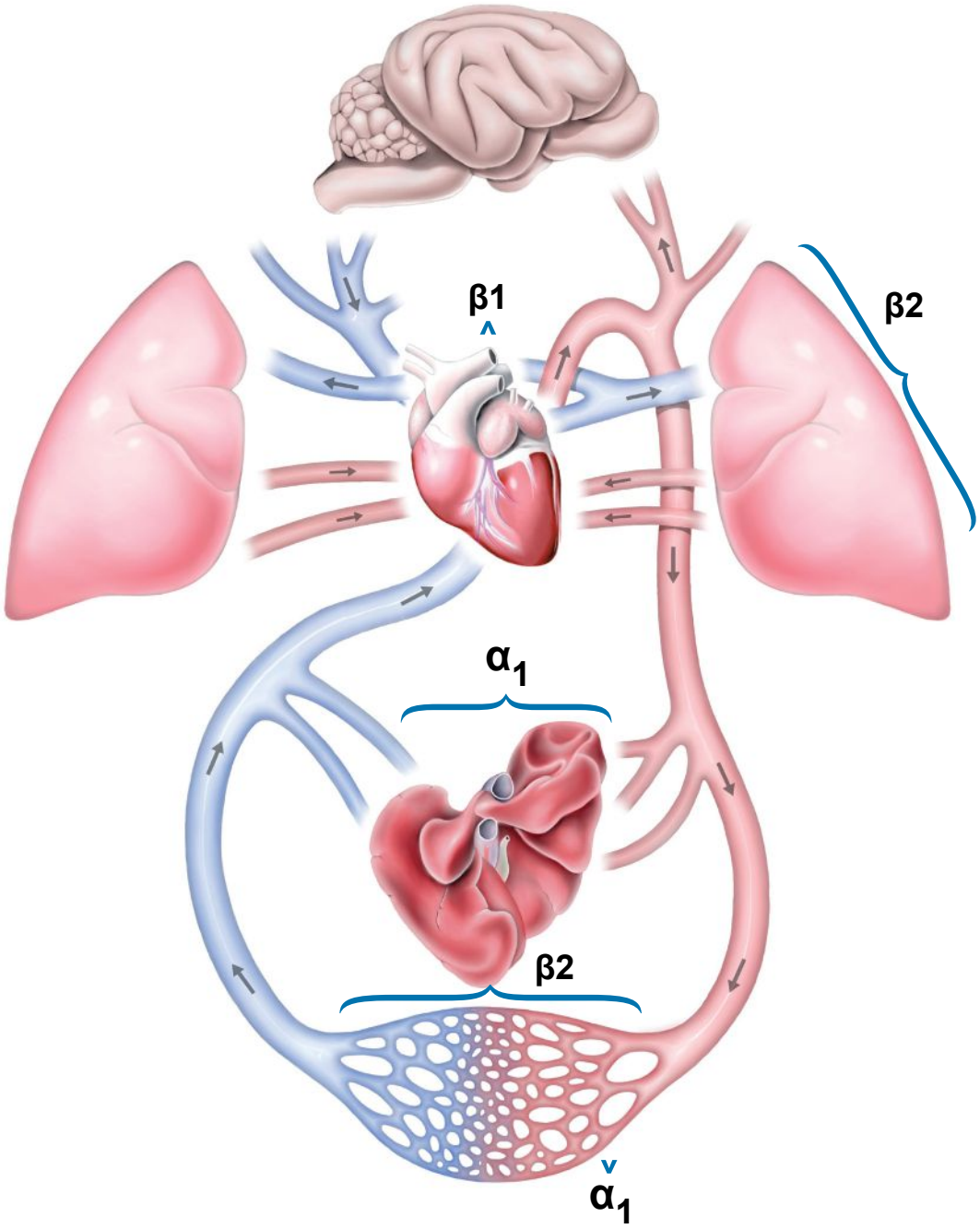
Anesthesia maintenance

- All anesthetic drugs affect perfusion to some extent. Most drug effects are dose dependent, therefore one must understand the mechanisms of how drugs alter perfusion during anesthesia. Understanding this is the first step toward maintaining perfusion during anesthesia.
- CO = heart rate (HR) x stroke volume (SV)
- Stroke volume is dependent on venous return (preload), total peripheral resistance (afterload) and cardiac contractility. The heart acts as a pump that pushes a certain volume of blood to the body. The amount depends on how much blood there is inside the pump before it is pushed out (preload); the mechanical power of the pump (contractility); and the resistance (afterload) the pump has to work against.
- It is important to note that preload (venous return) and afterload (peripheral resistance) affect cardiac output. In patients with systemic hypertension, resistance to left ventricular outflow (afterload) is increased and cardiac output can be decreased because the heart is pumping against higher pressures. Pets with hypotension often have reduced preload (filling) and therefore decreased cardiac output. These pets must be stabilized prior to anesthesia. These are all factors that can affect the outcome of anesthesia and must be considered prior to administration of anesthetic drugs.
- Cardiac output is fundamental to perfusion. Patients with excessively high heart rates or excessively small chamber sizes such as occurs in hypertrophic cardiomyopathy (HCM) may have stroke volumes so small that cardiac output is severely compromised. This is especially true in cats with occult feline HCM. These pets are often subclinical upon presentation and decompensate rapidly under anesthesia. Because of this, and knowing that we expect the heart rate to decrease after administration of premedications, it is very important to pay close attention to the pre-induction, post-premedication heart rate in cats. If the heart rate does not decrease after premedications, or if it is increased, then Banfield recommends stopping and re-evaluating whether anesthesia is appropriate.

- Circulating blood volume is critical to maintaining blood flow. Banfield protocols include IV fluids (colloids and crystalloids) to help maintain cardiovascular volume and tissue perfusion that could be compromised during anesthesia (See *Fluid Therapy*, page 39).

- Oncotic pressure also affects perfusion. If albumin and total protein levels are significantly below normal, pulmonary edema can result from fluid movement into the interstitium.

Figure 1.5: Good Perfusion and Receptor Sites



SECTION 2:

Requirements

SECTION 2

Banfield Requirements

GENERAL REQUIREMENTS FOR ANESTHESIA AND DEFINITIONS

General information

At all times, every medical team must comply with individual state practice acts. It is each doctor's responsibility to know and understand the requirements of his/her specific state, as well as Banfield's policies and procedures. Specifically, the doctor must ensure compliance with state regulations regarding the handling and administration of controlled substances, intubation of pets, anesthetic monitoring and drug administration documentation, and determine which hospital associates can legally perform dental prophylaxis and all other medical procedures.

The following are Banfield's standards which must be met in addition to all state regulations:

- All patients must be examined by the doctor prior to being sedated, immobilized or premedicated (fractious pets are the exception, but medications can only be given under the direction of the veterinarian in compliance with all state laws) and **again prior to induction of anesthesia.** The results of these examinations should be documented in the medical notes.
- When initially following new anesthesia protocols, the entire medical team should always monitor and closely observe the patient, from premedication administration through recovery from anesthesia. This close observation provides a greater understanding of how each drug affects the patient. Particularly close observation should occur for the first five anesthetic procedures in which a new protocol is employed. All anesthesia protocol information is based on the expectation that anesthetic delivery and monitoring equipment is in proper working order. **It is the responsibility of the attending doctor to ensure that the equipment is working correctly prior to proceeding with premedication and anesthesia.**
- Immobilization and general anesthesia protocols require a member of the hospital team to monitor the patient and document/record monitoring parameters from induction through recovery. This includes dental procedures in which one hospital associate should monitor anesthesia while another hospital associate performs the procedure, as allowed by individual state practice acts.
- Drugs affect individual patients differently. The attending doctor is responsible for knowing the patient's history, performing a complete physical exam, interpreting diagnostic tests and understanding Banfield's anesthetic system to appropriately choose protocols and determine specific drug dosages.
- Changes in drug dosages should be based first on the health status and second on the temperament of the patient. The doctor is responsible for defining the safe dosage for the individual patient. Do not exceed maximum dosages.
- When selecting a dosage, remember that minimal dose usually equals minimal risk, however it is important to keep in mind that the lower dose on pain medications will also mean less pain management. And, if a lower dose of tranquilizer in the premeds is used, a higher dose of induction agent and maintenance agent will be needed.
- It is best to avoid vaccinations in association with general anesthesia. If vaccines must be given, wait until the pet has been fully recovered for at least two hours.

Definitions and requirements

The requirements listed in the following pages are the minimum practice standards. If additional measures such as an IV catheter for an immobilized patient are prudent, please proceed accordingly.

TRANQUILIZATION/SEDATION

Definition:

The patient can walk.

- Use tranquilization/sedation for procedures such as blood collection and otoscopic exam, to assist in restraint for non-painful procedures, such as orogastric tube passage, and to help decrease anxiety.

Requirements:

- A complete and deliberate physical examination (PE)
- Monitoring of temperature, pulse, respiration (TPR) and pulse quality every 15 to 60 minutes depending on patient, with visual observation at all times
- Depth of tranquilization is such that endotracheal tube placement is **not** possible
- Electrocardiogram (ECG), pulse oximeter and blood pressure monitor to be used at the doctor's discretion
- IV catheter to be used for emergency venous access at the doctor's discretion; recommended for pets older than 5.

For tranquilizing a patient in the hospital:

- Butorphanol (Torbugesic®): 0.2 to 0.4 mg/kg SC, IM **AND** acepromazine: 0.05 mg/kg SC, IM (1.5 mg maximum dose)

OR

- Butorphanol: 0.2 to 0.4 mg/kg SC, IM

AND

- Midazolam: 0.2 to 0.4 mg/kg IM

OR

- Acepromazine or midazolam can be used alone, but will not provide analgesia.
- **Do not** use acepromazine on a fractious pet.

For air and ground travel:

- Inform owners that oral sedatives have variable effects on pets and are more effective when administered before the pet becomes anxious or excited. Owners will need to closely monitor their pet's reaction to the sedative and consult with the doctor for dosage adjustments. It is best to start with minimal doses.
- Recommend a "test" dose at least 24 hours in advance of travel to evaluate pet's response. This will help the owner determine the dose needed as well as ensure that the pet doesn't have an adverse response to the medication. Some pets experience hyperexcitability in response to alprazolam; in these cases, the dose may be halved, or another class of medication may be recommended.
- Pets should be acclimated to their carrier to decrease the stress that leads to barking, anxiety and hyper-excitability.
- Placing a favorite blanket in the carrier and feeding the pet or offering treats while in the carrier also helps. Dog Appeasing Pheromone (D.A.P.®) collars and diffusers and Feliway® spray can help reduce anxiety while acclimating the pet to the carrier as well as during travel. Clients should start acclimating their pet at least two weeks before their departure.

For pets traveling by air:

- Recommend nonstop flights to minimize stress. Pets often get cold or hot while the plane is sitting on the ground.
  - Alprazolam:
    - Dogs: 0.025 to 0.1 mg/kg PO (maximum dose 2 mg), usually 0.25 mg to 2 mg total dose) q eight to 12 hours
    - Cats: 0.1 mg/kg PO usually 0.125 mg to 0.25 mg total dose q eight to 12 hours

OR

  - Diphenhydramine: 2 mg/kg PO (maximum dose 50 mg) q six to eight hours

- **Banfield will not give or prescribe acepromazine or other phenothiazine-type tranquilizers to pets traveling by air.** Phenothiazine derivatives, such as acepromazine, block alpha-1 adrenergic receptors in the circulatory system, resulting in vasodilation. This may create susceptibility to hypothermia and an inability to respond to changes in atmospheric pressure and temperature should a pet be in the cargo hold when something goes wrong. It is possible for pets to die during air transport as a result of phenothiazine tranquilization.

For pets traveling by ground:

- Oral agents that can be prescribed:
  - Alprazolam:
    - Dogs: 0.025 to 0.1 mg/kg PO (maximum dose 2 mg), usually 0.25 mg to 2 mg total dose q eight to 12 hours
    - Cats: 0.1 mg/kg PO usually 0.125 mg to 0.25 mg total dose q eight to12 hours

OR

  - Diphenhydramine: 2 mg/kg PO (maximum dose 50 mg) q six to eight hours

OR

  - Acepromazine: 0.25 to 1 mg/kg PO q eight to 12 hours. See precautionary notes in previous section on phenothiazine prior to prescribing.

IMMOBILIZATION

Definition:

The patient cannot walk, is experiencing a non-surgical plane of anesthesia, can be aroused with minimal effort, and maintains laryngeal and withdrawal reflexes.

- Use immobilization for procedures that can be completed in less than 10 minutes, are not painful and do not require general anesthesia, such as:
  - Clipping matted hair
  - Radiographs that do not require special positioning
  - Mild ear cleaning
  - Pedicure in aggressive patients
  - Minor wound care
- To enable handling of fractious pets requiring general anesthesia, see *Fractious Pet Protocol*, page 86.

Requirements:

- A complete and deliberate physical examination (PE) except for fractious pets (for fractious pets, complete the PE once immobilized)
- Depth of anesthesia is such that endotracheal tube placement is **not** possible. (If an endotracheal tube can be placed, the patient is considered to be experiencing general anesthesia, and all required supportive and monitoring measures noted in the *General Anesthesia Considerations for All Protocols*, pages 83, are necessary.) Even if an endotracheal tube cannot be placed, the proper endotracheal tubes should be readily available in case of an emergent need.
- Continual monitoring and observation of all vital functions. Record pulse, pulse quality, temperature, respiration and depth every five to 10 minutes until recovery.
- Pulse oximetry and blood pressure monitoring. Since a swallow reflex is still present, the pulse oximeter sensor will likely have to be used on alternative areas of the body–*i.e.*, ventral tail base, rectum, toe web, vulva, prepuce, ear, lip.
- An IV catheter can be placed for emergency access at the doctor's discretion for Telazol® or dexmedetomidine (Dexdomitor®) combinations.
- An IV catheter is required for propofol.
- Direct venous access for administration of fluids or drugs is highly recommended and decreases patient risk, especially for those of uncertain health status.
- If a pet is immobilized and the doctor finds the procedure is more extensive than anticipated and requires general anesthesia, then preanesthetic blood work, IV catheter insertion and appropriate preanesthetic medications MUST be completed prior to induction of general anesthesia.

The following agents are used to immobilize patients:

Dogs:

- Telazol®: 1 to 4 mg/kg IM **AND** butorphanol: 0.2 mg/kg IM. Use low doses, or avoid use in debilitated patients.

OR

- Propofol: 2 to 6 mg/kg slow IV to effect. Propofol alone does not provide analgesia.

OR

- Dexmedetomidine: 0.005 to 0.02 mg/kg IM **AND** butorphanol: 0.2 mg/kg IM. Use low doses, or avoid use in debilitated patients.

Cats:

- Propofol: 2 to 6 mg/kg slow IV to effect. Propofol alone does not provide analgesia.

OR

- Dexmedetomidine, ketamine and butorphanol (Torbugesic®) (DKT): 0.065 mL/kg IM of mixture. See preparation instructions for DKT mixture on page 36.

DO NOT immobilize brachycephalic dog or cat breeds.

- Because of the potential for apnea and/or airway obstruction resulting in hypoxemia and/or hypercarbia in apparently healthy brachycephalic breeds (*Figures 2.1 and 2.2,* page 12) during immobilization, Banfield recommends general anesthesia in all patients with potential for upper airway or pulmonary compromise. These include:
  - All brachycephalic breeds (dogs and cats)
  - Those with excessive pharyngeal folds, such as Shar Peis
  - Any pet with concern for abnormalities of the pharynx, larynx, trachea and esophagus, *i.e.*, trauma, mass lesions, etc.
- This allows for immediate maintenance of a patent airway with an endotracheal tube and ventilatory support with 100% oxygen. All general anesthesia prerequisites and monitoring procedures are necessary in these cases.
- The goal is preventing unnecessary deaths during immobilization in a high-risk group of patients.

Figure 2.1: Brachycephalic Breed (Bulldog)

Figure 2.2: Brachycephalic Breed (Persian)

GENERAL ANESTHESIA

Definition:

The patient cannot walk, has no gag reflex, is unconscious and has greatly diminished pain response.

- Use for radiographs requiring special positioning (hips, etc.), surgical procedures, invasive diagnostic procedures and painful procedures.

Patient evaluation:

- Perform preanesthetic physical exam and blood work as required. See *Canine/Feline Anesthesia Physical Examination Algorithm,* page 61, and *Preanesthetic Blood Work Evaluation Algorithm*, page 63.
- Address all abnormalities prior to proceeding with anesthesia.
- Review the patient's medical record completely.
- Confirm that medical team is aware of every procedure being performed on the patient.

Requirements:

- A complete and deliberate PE
- Food should be withheld for a minimum of two hours up to 12 hours. The attending doctor should determine the appropriate fasting time depending on pet and procedure; use shorter fasting periods for young patients who may be susceptible to hypoglycemia. Water should be withheld for a minimum of two hours prior to the procedure. There are separate guidelines for exotic patients. (See *Anesthetic Considerations for Small Exotic Pets*, starting on page 123).
- Complete blood count (CBC) and internal organ function screen (IOF) and electrolytes within 48 hours prior to anesthesia for pets over 2 years of age, or any ill patients or for nonelective procedures. CBC, preanesthetic IOF and electrolytes within 14 days prior to anesthesia for patients under 2 years of age for elective procedures.
- IV catheter
- Endotracheal tube placement
- ECG, pulse oximeter and blood pressure monitoring
- Continual monitoring and manual assessment—record in medical record every five minutes until recovery (See *Anesthesia Monitoring and Emergency Algorithm,* page 80).
- IV fluid support for procedures longer than 10 minutes

Use the following for general anesthesia:

- Premedications according to anesthesia protocols
- Induction according to anesthesia protocols
- Maintenance with oxygen and sevoflurane
- Monitor according to anesthesia flow chart and monitoring algorithms. Be sure to comply with all state regulations in addition to those listed in the monitoring algorithms.
- Supportive care, recovery monitoring and post-operative pain management according to anesthesia algorithms

PERIOPERATIVE ANTIBIOTICS

The Banfield Care Guidelines Committee continues to review published papers in human and veterinary medicine on the usage of perioperative antibiotics.

Historically, administration of perioperative antimicrobials has been an accepted practice for pets undergoing most surgical procedures including clean, elective procedures. However, the blanket use of perioperative antibiotics in clean, elective surgical procedures has become increasingly controversial. There is concern that prophylactic antimicrobial use may contribute to super-infections, colonization with resistant bacterial species or nosocomial infections.[1] In the American College of Veterinary Internal Medicine (ACVIM) consensus statement on Antimicrobial Drug Use in Veterinary Medicine, it was recommended that veterinarians should reserve prophylactic use for high-risk situations in which research or clinical experience has clearly shown that these applications provide measurable clinical benefit.[2] In one prospective report, no significant association between administration of antimicrobial prophylaxis and the surgical site infection rate was identified.[3] Another study indicated a significantly lower infection rate if prophylactic antibiotics were administered and surgical duration exceeded 90 minutes, but not for a shorter surgical time.[3]

Following the guidance of ACVIM, Banfield no longer recommends perioperative antibiotic administration in clean, elective procedures including canine and feline ovariohysterectomies and castrations. It is not necessary to use antimicrobial drugs in all surgical cases to prevent infections. It is possible to effectively minimize the likelihood of postoperative infections by vigorously promoting aseptic technique, minimizing surgical time and minimizing tissue manipulation.[2] Following is a list of risk factors that studies have determined increase the likelihood of postoperative infection.

- Surgical time (risk of infection may double every 70 minutes)
- Experience of the surgeon
- Wound contamination level presurgery
- Obesity
- The number of paraprofessionals in the surgical room
- Patient debilitation (need for ICU care)
- Presence of foreign material such as a drain

As such, we continue to recommend the usage of **preoperative** prophylactic antibiotics in circumstances that would qualify under the risk factors stated above. However, at all times the practitioner's clinical judgment should prevail.

Perioperative antibiotics are in no way intended to reduce the need for proper patient preparation, sterile surgical practices, proper tissue handling or proper postoperative care.

Non-elective or elective complicated procedures

Banfield continues to recommend the use of prophylactic antimicrobial use in all non-elective or elective complicated procedures. Research continues to suggest that prophylactic antimicrobial treatment is useful in preventing development of postoperative infections in pets undergoing surgical procedures associated with high risk of infection. The selection and timing of prophylactic antibiotics is important.

Administration must occur prior to surgery or at the time of incision to be effective. The type of surgery and the type of preoperative contamination are factors in determining which antibiotic is most appropriate.

Soft tissue surgery: To reduce the chances of protein-binding interferences with the anesthetic agents, ampicillin should be administered at least one hour pre-induction. Two hours would be more ideal so pets can be observed for any potential anaphylactic reactions. Ampicillin can be useful for complicated sterilization surgeries and other soft tissue surgeries. However, ampicillin has been shown to be of no benefit in bacteremia associated with dental scaling. It has excellent efficacy against beta-hemolytic *Streptococci, Enterococcus faecalis*, obligate anaerobes and *Pasteurella multocida*. Ampicillin should be dosed at 10 mg/kg IM and repeated at six to eight hour intervals if necessary.

Dental procedures: The use of systemic clindamycin and topical chlorhexidine is associated with the highest levels of reduction in oral bacterial levels.[4] Clindamycin ideally should be started **two to three** days prior to the dental procedure, but the oral absorption rate is very rapid and it could be administered in the hospital setting a **minimum of two hours** prior to anesthesia. Clindamycin does have an intrinsic neuromuscular blocking activity and should be used cautiously with other neuromuscular blocking agents. It is also highly protein-bound. The recommended oral dosage is 5.5 to 11 mg/kg PO. Clindamycin should be continued for a minimum of five days post-cleaning if there is evidence that the pet needs the benefit of extended antibiotic therapy. Chlorhexidine oral rinse solution should be applied to the teeth and gums as soon as proper endotracheal tube placement has

occurred to ensure that aspiration of the product does not occur. It has the most benefit if allowed to stay in place for 10 minutes before proceeding with the dental cleaning.

Orthopedic procedures (including declaws): Cefazolin is a first generation cephalosporin and has excellent efficacy against *Staph intermedius*, beta-hemolytic *Streptococci* and *Pasteurella multocida*.[5] It has good efficacy against *E. coli, Klebsiella pneumoniae* and most obligate anaerobes.[6] Cefazolin is the most appropriate antibiotic for orthopedic procedures or patients with infected skin. Cefazolin can be administered as a **slow** intravenous (IV) injection at any time during the preoperative or intraoperative period because it is not protein bound. **It is most effective when given just prior to the skin incision being made.** Cefazolin should be re-dosed if the surgery is longer than 90 minutes.[7] The recommended dosage is 22 mg/kg slow IV.

Miscellaneous procedures: For applications not listed above, it is recommended that the veterinarian research which bacteria are most likely to be present at the surgical site on the pet and select the antibiotic most appropriate for the application based on sensitivities. Caution should be used with highly protein-bound drugs, and the possibility of any interactions with medications used for anesthesia should be researched.

Additional notes

We recommend keeping the number of paraprofessionals present in the surgical suite to the minimum number needed for anesthetic monitoring and proper pet care.

References

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PRACTICE STANDARDS FOR MULTIPLE PROCEDURE ANESTHESIA

The purpose of this section is to define and communicate the benefits and risks of performing multiple concurrent procedures requiring anesthesia, elective or non-elective.

There are several reasons risk increases with the number of procedures being performed:

- Extra anesthesia time
  - Increased risk of hypothermia.
- Increased risk of hypoperfusion.
- Cross contamination of tissue.
  - Aerosolized bacteria from dental prophylaxis in surgical incisions.
  - Contamination of spay or neuter site from non-sterile secondary surgery sites.
- Transient bacteremia from dental prophylaxis hematogenously spread to surgical sites.

Elective procedures should not be performed on sick and, therefore, inherently unstable patients.

- Elective anesthesia is anesthesia performed on a healthy or stable pet in order to perform a surgical procedure which is not vital to the immediate diagnosis or treatment of an underlying disease.
- Elective anesthesia procedures include spay, neuter, canine prophylactic gastropexy, feline declaw, and true dental prophylaxis (no periodontal disease present).

Elective anesthesia procedures should be performed on pets that are healthy or have non-life-threatening or stable conditions. Determination should be done on a case by case basis. Examples of non-elective procedures:

- Orthopedic repair, wound repair, abscess flush, mass removal, pyometra, aural hematoma, cystotomy, gastrointestinal surgery, periodontal treatment, etc.

Multiple surgical procedures may be performed at the same time if:

- There is little or no risk of additional contamination. *i.e.,* oral mass removal and dental prophylaxis.
- The pet is stable and there is no reason to be concerned about the total length of anesthesia anticipated. *i.e.,* combination spay, stenotic nares, and soft palate resection.
- All procedures are necessary to preserve the pet's immediate health, *i.e.,* concurrent repair of traumatic fracture, laceration, and hernia.
- The pet is so aggressive that achieving anesthesia is the most traumatic part of the procedures.

SECTION 3:

Pain Management, Drugs and Fluid Therapy

SECTION 3

Pain Management, Drugs and Fluid Therapy

PAIN MANAGEMENT

Appropriate pain management is a significant and important part of any anesthetic procedure that causes pain or inflammation in the pet. It is not appropriate to forego appropriate pain management for any reason. It is the attending doctor's responsibility to ensure that appropriate pain management is employed through the procedure and through recovery (See *Anesthesia Task Pain Chart*, pages 18-19).

- **Appropriate pain management is paramount to a successful anesthetic procedure. Premedication with pain medications and postoperative anti-inflammatories is just the beginning of managing pain associated with anesthetic procedures. Depending on the duration and extent of the procedure, it is important to recognize the signs of intraoperative pain such as increased heart rate, blood pressure, or respiratory rate that may need to be treated with a repeated dosage of butorphanol versus increasing the sevoflurane concentration. Butorphanol can typically be administered safely every one to four hours.**
- Multimodal pain management provides the best results. It begins prior to anesthesia and continues until all inflammation and pain has resolved.
  - Multimodal pain management simply means addressing pain management in more than one manner and/or at more than one level in the pain pathway.
  - The use of local blocks, nonsteroidal anti-inflammatory agents (NSAIDs), narcotics and dissociatives are all examples of pain medications that can be used together in various combinations to address pain management.
  - The use of local blocks should be strongly considered, as there is good evidence to show that if transmission of pain can be prevented, the patient will experience less pain from the procedure even after the local anesthetic wears off.
  - Local blocks are now standard level of care and should be part of every feline declaw procedure.
  - Banfield strongly encourages the use of local blocks for the following procedures:
    - Neuters—intratesticular blocks
    - Ovariohysterectomy (OHE)—line block for incision
    - Dental extractions
    - Epidurals for hind limb orthopedic procedures
  - See *Techniques for Local and Regional Anesthesia*, page 30, for performing relevant blocks for these procedures.
- Banfield's recommended premedications are designed to work with the practice's postoperative pain management drugs in a multimodal fashion.
- See the *Banfield Protocols,* starting on page 83, for specific postoperative pain management recommendations.
- **Postoperative pain monitoring:** It is very important to provide adequate pain management in the postoperative period. Remember that each patient is individual and will have varying reactions to pain and varying responses to medications. Postoperative pain management must be tailored to each individual's needs. In an effort to assist postoperative monitoring, acute pain scales have been developed for the dog and the cat. These scales are meant to be a tool to help the practitioner facilitate patient pain management (See *Colorado State University Canine and Feline Acute Pain Scales*, pages 16-17). Remember to provide additional pain management when a score of 2 or higher is noted during assessment of the patient.

Figure 3.1: Colorado State University Canine Acute Pain Scale

CANINE ACUTE PAIN SCALE

Colorado State University Veterinary Teaching Hospital

PAIN SCORE FOR DOGS	PSYCHOLOGICAL & BEHAVIORAL	RESPONSE TO PALPATION	BODY TENSION
0 	☐ **Comfortable** when resting ☐ **Happy, content** ☐ Not bothering wound or surgery site ☐ Interested in or curious about surroundings	☐ **Nontender** to palpation of wound or surgery site, or to palpation elsewhere	MINIMAL
1 	☐ **Content to slightly unsettled** or restless ☐ **Distracted easily** by surroundings	☐ **Reacts to palpation** of wound, surgery site, or other body part by looking around, flinching, or whimpering	MILD
2 	☐ Looks **uncomfortable** when resting ☐ May **whimper or cry** and may **lick or rub wound** or surgery site when unattended ☐ Droopy ears, **worried facial expression** (arched eye brows, darting eyes) ☐ **Reluctant to respond** when beckoned ☐ **Not eager to interact** with people or surroundings but will look around to see what is going on	☐ Flinches, whimpers cries, or guards/pulls away	MODERATE Reassess analgesic plan
3 	☐ **Unsettled, crying, groaning, biting or chewing** wound when unattended ☐ **Guards or protects wound** or surgery site by altering weight distribution (i.e., limping, shifting body position) ☐ **May be unwilling to move** all or part of body	☐ May be **subtle** (shifting eyes or increased respiratory rate) if dog is too painful to move or is stoic ☐ May be **dramatic**, such as a sharp cry, growl, bite or bite threat, and/or pulling away	MODERATE Reassess analgesic plan
4 	☐ **Constantly groaning or screaming** when unattended ☐ May bite or chew at wound, but unlikely to move ☐ **Potentially unresponsive** to surroundings ☐ **Difficult to distract** from pain	☐ Cries at non-painful palpation (may be experiencing allodynia, wind-up, or fearful that pain could be made worse) ☐ May react aggressively to palpation	MODERATE TO SEVERE May be rigid to avoid painful movement Reassess analgesic plan

REASSESS PAIN MANGAEMENT IF PET FALLS WITHIN THIS RANGE

If the pet can't be aroused to be evaluated for pain, check vital signs, assess therapy, and rescore when awake.
Evaluate for acute pain based on the above scale. Patients may exhibit features from multiple pain levels.
Determine the final pain score based on the relative distribution of findings and overall clinical impression.

Banfield PET HOSPITAL

Colorado State University

#505583

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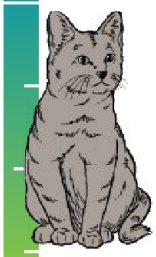
Figure 3.2: Colorado State University Feline Acute Pain Scale

FELINE ACUTE PAIN SCALE

Colorado State University Veterinary Teaching Hospital

PAIN SCORE FOR CATS	PSYCHOLOGICAL & BEHAVIORAL	RESPONSE TO PALPATION	BODY TENSION
0 	☐ **Content and quiet** when unattended ☐ Comfortable when resting ☐ Interested in or curious about surroundings	☐ **Not bothered** by palpation of wound or surgery site, or to palpation elsewhere	MINIMAL
1 	☐ **Signs are often subtle and not easily detected in the hospital setting**; more likely to be detected by the owner(s) at home ☐ Earliest signs at home may be **withdrawal from surroundings or change in normal routine** In the hospital, may be content or slightly unsettled ☐ **Less interested** in surroundings but will look around to see what is going on	☐ May or may not react to palpation of wound or surgery site	MILD
2 	☐ Decreased responsiveness, **seeks solitude** ☐ **Quiet**, loss of brightness in eyes ☐ **Lays curled up or sits tucked up** (all four feet under body, shoulders hunched, head held slightly lower than shoulders, tail curled tightly around body) with eyes partially or mostly closed ☐ **Hair coat appears rough** or fluffed up ☐ May intensively groom an area that is painful or irritating ☐ Decreased appetite, **not interested in food**	☐ **Responds aggressively or tries to escape** if painful area is palpated or approached ☐ **Tolerates attention**, may even perk up when petted as long as painful area is avoided	MODERATE Reassess analgesic plan
3 	☐ Constantly **yowling, growling, or hissing** when unattended ☐ May bite or chew at wound, but unlikely to move if left alone	☐ **Growls or hisses at non-painful palpation** (may be experiencing allodynia, wind-up, or fearful that pain could be made worse) ☐ **Reacts aggressively** to palpation, adamantly pulls away to avoid any contact	MODERATE Reassess analgesic plan
4 	☐ Prostrate ☐ Potentially **unresponsive** to or unaware of surroundings, difficult to distract from pain ☐ Receptive to care (even mean or wild cats will be **more tolerant of contact**)	☐ **May not respond** to palpation ☐ **May be rigid to avoid painful movement**	MODERATE TO SEVERE May be rigid to avoid painful movement Reassess analgesic plan

REASSESS PAIN MANGAEMENT IF PET FALLS WITHIN THIS RANGE

If the pet can't be aroused to be evaluated for pain, check vital signs, assess therapy, and rescore when awake.
Evaluate for acute pain based on the above scale. Patients may exhibit features from multiple pain levels.
Determine the final pain score based on the relative distribution of findings and overall clinical impression.

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Table 3.1

Anesthesia Task Pain Chart

Expected Level of Pain	Surgical Procedure or Disease Process	Recommended Analgesic(s) (In addition to local or regional nerve blocks when appropriate)
Severe to Excruciating This level of pain can kill.	■ Neurotic pain/central nervous system (CNS): nerve entrapment, cervical intervertebral disk disease (IVDD), herniations, severe inflammation, meningitis, CNS infarcts/tumors ■ Multiple fractures or fracture repair with extensive soft tissue injury, pathological fractures ■ Extensive inflammation: peritonitis, fasciitis, severe cellulitis ■ Postsurgical pain after extensive tissue injury or inflammation ■ Necrotizing pancreatitis ■ Necrotizing cholecystitis ■ Bone neoplasia	Multimodal pain control including opioids (hydromorphone, fentanyl) and nonsteroidal anti-inflammatory drugs (NSAIDs), where appropriate
Moderate to Severe (Varies with degree of illness, tissue manipulation or injury)	■ Musculoskeletal: osteoarthritis; acute polyarthritis; some intra-articular surgical procedures (*i.e.*, large dogs, extensive manipulation); fracture repair; hypertrophic osteodystrophy; panosteitis; some dental extractions (multiple rooted teeth, some canine teeth, extensive handling or difficult removal, extensive soft tissue involvement); onychectomy ■ Soft tissue surgery: total ear canal ablation; post-laparotomy (extensive tissue handling or inflammation); post-thoracotomy; traumatic diaphragmatic hernia repair (associated with organ or extensive tissue injury); extensive mass removals; extensive soft tissue injury repair (extensive laceration repair, etc.) ■ Peritonitis (*i.e.*, bacterial, urine, bile, pancreatic) ■ Early or resolving stages of soft tissue injuries/ inflammation/disease ■ Capsular pain due to organomegaly (*i.e.,* pyelonephritis, hepatitis, splenitis, splenic torsion) ■ Mesenteric, gastric, testicular, or other torsions, hollow organ distention ■ Pleuritis; trauma (*i.e.*, orthopedic, extensive soft tissue, head); thoracolumbar disk disease; rewarming after accidental hypothermia; frostbite; cancer pain; mucositis; thrombosis/ ischemia (arterial or venous); aortic saddle thrombosis; ocular: corneal abrasion/ ulceration, glaucoma, uveitis; reproductive tract: whelping/queening, mastitis.	Multimodal control including opioids (hydromorphone, fentanyl for severe pain, butorphanol, tramadol, buprenorphine for moderate pain) and NSAIDs (where appropriate)

Anesthesia Task Pain Chart (cont'd)

Expected Level of Pain	Surgical Procedure or Disease Process	Recommended Analgesic(s) (In addition to local or regional nerve blocks when appropriate)
Moderate	■ Minimally invasive orthopedic procedures: extracapsular cruciate repair; external fixator placement for fracture repair; tail amputation; simple dental extractions (incisors, some small pre-molars, uncomplicated removal). ■ Soft tissue surgery: laparotomy (short, minimal tissue manipulation or inflammation); uncomplicated inguinal hernia repair; diaphragmatic hernia repair (acute, simple, no organ injury); some external mass removals/ laceration repairs (less extensive than noted above); **ovariohysterectomy/castration (older or obese patients, or extensive tissue handling)**, enucleation. ■ **Some dental procedures (simple gingival flaps);** some soft tissue injuries (less extensive than noted above); urethral obstruction; resolving pancreatitis, early or resolving surgical procedure; illness; injury	Multimodal pain control including opioids (butorphanol, tramadol, buprenorphine) and NSAIDs (where appropriate)
Mild to Moderate (Varies with degree of illness or tissue manipulation/injury)	■ Soft tissue surgery: ovariohysterectomy/ castration (young animals); some lacerations; small mass removals; chest drains ■ Some dental procedures ■ Cystitis ■ Otitis ■ Early or resolving surgical procedure, illness, injury	For **moderate** pain: multimodal pain control including opioids (butorphanol, tramadol, buprenorphine) and NSAIDs (where appropriate) For **mild** pain: butorphanol, buprenorphine or NSAIDs
Mild	■ Early, resolving, or simple involvement of surgical procedure, illness, or injury	Butorphanol, tramadol, buprenorphine (low end dose) or NSAIDs

Banfield's most commonly used drugs for pain management

OPIOIDS

Buprenorphine

- A partial opiate agonist/antagonist
- Partial mu agonist and antagonist on the kappa receptor
- Onset of action within 30 to 60 minutes; dependent on route of administration
- Duration of approximately six to 12 hours
- Highly bound to plasma proteins (96%)
- Metabolized in the liver and eliminated mainly in the feces (70%), with 30% excreted in the urine
- Efficacious for moderate to severe pain
- Analgesic effect created by the binding of opiate receptors in the central nervous system (CNS)
- Dogs: 0.005 to 0.02 mg/kg IM, IV, SC q six to 12 hours (transmucosal absorption in the dog is still under question and review)
- Cats: 0.005 to 0.01 mg/kg IM, IV, SC, transmucosal q six to 12 hours

Butorphanol injectable

- Mixed agonist/antagonist. Primary agonist at the kappa receptor and antagonist at the mu receptor.
- May interfere with or reverse effects of pure mu opioids
- Efficacious for mild to moderate pain
- Well-tolerated by cats
- Produces less respiratory depression than does morphine or oxymorphone
- No histamine release
- Duration of action:
  - Dogs: 30 minutes to one hour
  - Cats: one to three hours
- **Can be repeated as needed every one to four hours**
- Dogs: 0.2 to 0.4 mg/kg IM, SC
- Cats: 0.2 to 0.4 mg/kg IM, SC
- Time to effect: 15 to 30 minutes
- Metabolized in the liver and excreted in the urine and feces

Source

1. Hellyer PW, Gaynor JS. Acute postsurgical pain in dogs and cats. *Comp Cont Educ Pract Vet.* Feb 1998;20(2) 140-153.

Fentanyl

- Class II controlled substance
- Metabolized in the liver
- Protein-bound
- Pure mu agonist
- Duration of effect is 30 to 45 minutes.
- For postoperative pain management in orthopedic or ear surgery. Loading dose is given if no other opiate has already been given.
- Fentanyl injectable: Dogs and cats: Loading dose: 0.003 mg/kg IV; use only as a loading dose prior to starting a fentanyl constant rate infusion (CRI).
- Fentanyl CRI: 0.02-0.06 µg/kg/min. See *Orthopedic Protocol*, page 102; *Ear Surgery Protocol*, page 103; and *Fentanyl CRI Recipe*, page 21.

Hydromorphone

- Partial mu agonist
- Injectable opiate sedative/restraining agent, analgesic and preanesthetic
- Onset of action within 15 to 30 minutes depending on route of administration
- Bradycardia commonly seen after administration
- May cause vomiting; do not use as premedication for suspected cases of gastric dilatation volvulus or intestinal obstruction.
- Duration of effect is four to six hours
- IV use is not associated with histamine release.
- Provides management for moderate to severe pain control
- Metabolized in the liver, primarily by glucuronidation. Because cats are deficient in this metabolic pathway, half-lives may be prolonged. Metabolite excreted by the kidney.
- Dogs: 0.05 to 0.2 mg/kg IM, IV, SC q two to six hours
- Cats: 0.05 to 0.1 mg/kg IM, IV, SC q two to six hours
- May cause hyperthermia in cats. See page 84 for further discussion.
- Epidural: 0.03 to 0.04 mg/kg q eight to 24 hours

Tramadol oral

- Synthetic opiate agonist analgesic (not a federally scheduled drug)
- Onset of action is within 60 minutes
- Mild to moderate pain relief
- Moderate duration of action
- Metabolized in the liver and excreted in the urine
- Tolerated by dogs and cats
- Synthetic mu-receptor opiate agonist and inhibitor of reuptake for both serotonin and norepinephrine
- Use with caution with other CNS depressants and in patients with history of seizures.
- Dose may need to be reduced in patients with hepatic or renal disease
- Dogs and cats: 2 to 4 mg/kg PO q eight hours (dogs),

q 12 hours (cats), for five to seven days
- Can be used in conjunction with NSAIDs or corticosteroids

NONSTEROIDAL ANTI-INFLAMMATORY DRUGS (NSAIDS)

Because hypotensive or hypovolemic episodes may occur during anesthetic procedures, do not give nonsteroidal anti-inflammatory drugs (NSAIDs) preoperatively to decrease risk of renal injury from decreased perfusion.

CARPROFEN (RIMADYL®) ORAL AND INJECTABLE (DOGS ONLY)

- Anti-inflammatory analgesic
  - Peak effect: one to three hours
  - Long duration
  - Metabolized in the liver, with the majority (70% to 80%) eliminated in the feces and remainder eliminated in the urine
  - Mild to moderate pain relief
- Potent inhibitor of cyclooxygenase, phospholipase A2 and prostaglandin synthesis
- **Do not use in the presence of renal disease or liver disease.**

Table 3.2

Fentanyl Constant Rate Infusion (CRI)* Recipe

1. Remove 24 mLs of 0.9% NaCl from the 1 L bag of 0.9% NaCl.

2. Invert and add 24 mL of fentanyl (50 µg/mL) into this 1 L bag of 0.9% NaCl = 1.2 µg/mL.

3. Mix well.

4. Deliver at a rate of 1 mL/kg/hr with an IV-infusion pump.
- This equals a CRI of 0.02 µg/kg/min or 0.0012 mg/kg/hr.
- This is an appropriate dose for both dogs and cats.

5. For dogs, the fluid rate can be increased, if clinical signs warrant up to 3 mL/kg/hr.
- This would equate to a fentanyl CRI of 0.06 µg/kg/minute or 0.0036 mg/kg/hr.

6. LABEL THE CRI BAG APPROPRIATELY WITH THE FOLLOWING INFORMATION:
- Drug name
- Concentration
- Type of base solution: NaCl
- Rate of infusion
- Date of reconstitution
- 24 hour expiration
- Name of associate making the CRI

Considerations for fentanyl CRIs

- If no previous mu agonist has been given (morphine or hydromorphone), administer 0.003 mg/kg of fentanyl IM or IV to rapidly achieve initial therapeutic blood levels. If morphine or hydromorphone was given as a premedication less than two hours previously, then no loading dose is typically needed.
- Fentanyl's duration of effect is about 30 minutes. Undesirable effects will not linger as long as when morphine, hydromorphone, or oxymorphone are used.
- 30 minutes prior to the discontinuation of the fentanyl CRI, administration of a final dose of hydromorphone (0.2 mg/kg IM, IV, SC) will allow for a smoother transition onto oral tramadol and NSAID.
- As with any CRI of an opiate, give special consideration to:
  - Heart rate: Significant bradycardia can occur. If associated with hypotension, or if severe, then recommend anticholinergic (glycopyrrolate, 0.01 mg/kg IV, IM) administration.
  - Respiration: Significant decreased respiratory rate, recommend administering preanesthetic dose of buprenorphine or butorphanol as a partial antagonist. If severe, then administer naloxone and discontinue the CRI.
  - Body temperature: If hypothermic, provide active heating and decrease CRI.
  - Level of pain: Adjust CRI based on pain level not to exceed 3 mLs/kg/hr in dogs and 1 mL/kg/hr in cats.

*** CRIs <u>DO NOT</u> GO HOME WITH THE OWNER. IF PET IS TRANSFERRED TO AN EMERGENCY/SPECIALTY FACILITY, THE CRI BAG CAN BE SENT WITH THE PET *IF* THE BAG IS APPROPRIATELY LABELED WITH DRUG, DOSE, FLUID RATE AND DATE OF RECONSTITUTION.**

- **Do not use with other NSAIDs or corticosteroids, or in patients with risk of bleeding.**
- Injectable: 4 mg/kg SC **once**, then switch to oral dosing
- Oral 4 mg/kg PO in dogs once daily or divided into two equal doses for three to seven days

Deracoxib (Deramaxx®) (dogs only)

- COX-2 selective NSAID
- Reaches peak plasma concentration within two hours following administration
- Highly protein bound (90%)
- Metabolized into four metabolites in the liver and eliminated with the feces
- Inhibits prostaglandins that contribute to pain and inflammation by inhibiting COX-2
- Provides management of postoperative pain and treatment of pain associated with osteoarthritis
- 0.90 to 1.8 mg/kg PO once daily to manage pain associated with osteoarthritis
- 2.6 to 3.6 mg/kg PO once daily for postoperative pain management

Meloxicam (Metacam®) oral

- COX-2 preferential NSAID
- Honey-flavored base in two strengths:
  - 0.5 mg/mL 15 mL (equivalent to 0.016 mg per drop); 1.5 mg/mL 10 mL (equivalent to 0.05 mg per drop)
- Dogs: Meloxicam is well-absorbed by dogs after oral administration and can be administered directly into the mouth or mixed with food. Food does not alter absorption. Recommended initial dose is 0.18 mg/kg PO the first day of treatment, and then subsequent doses of 0.09 mg/kg PO once per day.
- Cats: Meloxicam can also be used orally in cats, but it is considered off-label use of the product due to lack of efficacy and safety studies in the United States. Use the 0.5 mg/ml solution. Dosage schemes for cats for osteoarthritis and inflammation or chronic pain are as follows: The initial dose given should be 0.1 to 0.2 mg/kg PO depending on the severity of the pain. This can then be followed by a daily dose of 0.05 mg/kg PO for a maximum of two to three days. Due to the potential for NSAID toxicity in cats, prolonged use should be evaluated carefully for each patient.
- Reaches peak plasma levels at seven to eight hours post-administration
- Duration of 24 hours
- Highly protein bound (97%)
- Metabolized in the liver, mainly eliminated in the feces
- Inhibits cyclooxygenase, phospholipase A2 and prostaglandin synthesis by preferentially inhibiting COX-2
- Provides analgesic, anti-inflammatory and antipyretic effects similar to other NSAIDs
- Provides control of pain and inflammation associated with osteoarthritis

Meloxicam (Metacam®) injectable

- Cats: 0.2 mg/kg SC. Used as a single, postoperative injection in healthy, well-hydrated patients.
- Dogs: 0.2 mg/kg SC. Used to initiate osteoarthritis therapy prior to continuation with oral dosing.

Robenacoxib (Onsior®)

- Unlike meloxicam, robenacoxib (Onsior®) can be administered for a maximum of three days and does not carry an FDA "black box" warning.
- Robenacoxib is also a unique NSAID because of its short blood and long tissue half-lives, which theoretically minimize renal, GI and other adverse effects that arise from those tissues being exposed to the drug.
- Robenacoxib provides 24 hours of pain relief with once-a-day administration and reaches maximum concentration in the blood within 30 minutes.
- Tablets are to be given whole; do not break tablets.
- If cat is 2.5 to 6.0 kg (5.5-13.2 pounds), use one whole tablet.
- If cat is greater than 6.0 kg (13.3+ pounds), use two whole tablets.
- Reaches maximum concentration in the blood within 30 minutes of administration.
- Banfield recommends post-operative administration in the hospital after cat is sternal and swallowing:
  - To avoid perioperative hypotension and potential renal disease.
  - The remaining two tablets should be sent home for administration over the next two days.
- Can be used in conjunction with an opioid injection
- **Do not use longer than three days total, including day of surgery.**
- **Not labeled for cats under 4 months of age**
- Do not use concurrently with other NSAIDs or corticosteroids.
  - If cat received a meloxicam injection, then do not use robenacoxib as "go home" medication.

CLEARANCE OF NSAIDS

Think. Make a good decision.

- There may be situations where you need to switch from one NSAID to another in an attempt to improve anti-inflammatory and analgesic efficacy. It is important to take into consideration how long the period of time following one NSAID administration is, before the administration of a different NSAID.
- Clinicians have empirically recommended various washout periods, ranging from 24 hours to seven days after use of an NSAID and before administration of another NSAID or a glucocorticoid.
- Although analysis of serum half-lives of the NSAIDs indicates that they would be cleared within eight to 12 hours, there is a prolonged clinical effect for many of these medications.
- Therefore, a rule of thumb for washout is five to 10 half-lives following the first NSAID (*Table 3.3*).
- For robenacoxib (Onsior®), we recommend a seven-day washout period.

Table 3.3

NSAIDS Washout Chart for Dogs[1]

Product	Est. serum half-life (hours)	5X half-lives (days)	10X half-lives (days)
Aspirin	7.5 - 12	10 - 14 recommended	10 - 14 recommended (aspirin triggering lipoxin)
Carprofen (Rimadyl®)	5 - 8 (oral) 22 - 23 (injectable)	2 (oral) 5 (injectable)	4 (oral) 10 (injectable)
Deracoxib (Deramaxx®)	3	Next day	2
Etodolac (EtoGesic®)	9.7 - 14.4	3	6
Flunixin (Banamine®)	3.7	Next day	2
Ketoprofen (Ketofen®)	4 - 5	Next day	2
Meloxicam (Metacam®)	20 - 30	7	14
Phenylbutazone	2.5	Next day	2
Piroxicam (Feldene®)	40	9	18
Tepoxaline (Zubrin®)	2 - 3	Next day	2

This table is a guideline for washout based on NSAID half-lives. Wait at least five to 10 half-lives between NSAIDs.

Reference

1. Papich MG. An update on nonsteroidal anti-inflammatory drugs (NSAIDs) in small animals. *Vet Clin North Am Small Anim Pract.* 2008;(38):1243-1266.

DENTAL NERVE BLOCKS

Why use local dental blocks

- Oral procedures are painful.
- Analgesia should be a part of every anesthetic protocol because it is good medicine, humane and decreases anesthetic maintenance drug dosages.

When to use local dental blocks

- Dental extractions
- Painful oral surgery (*e.g.*, oronasal fistula repair)
- Tumor removal
- Fracture repair

How to use local blocks

- As part of balanced analgesia—it enhances pre-emptive and multimodal pain control.
- Local anesthetics block painful impulses to the spinal cord and decrease wind-up.
- Local anesthetics will wear off; therefore, the concurrent use of other agents is required to provide long-term multimodal pain management.

Commonly used local blocks for oral pain

- Infraorbital
- Caudal maxillary
- Middle mental
- Inferior alveolar

Local anesthetic agents

Bupivacaine (0.5%)—Most commonly used for dental nerve blocks due to longer duration of action

- Fairly slow onset: 10 to 15 minutes.
- Long duration of action: approximately three to eight hours
- Maximum dose is 2 mg/kg for dogs and 1 mg/kg for cats
- Typical volume per injection site is 0.5 to 1 mL for dogs and 0.2 to 0.3 mL for cats
- Highly protein bound (95%)
- Metabolized in the liver and excreted through the urine
- Blocks the generation and conduction of nerve impulses
- Should not be administered intravenously
- More toxic to the heart than lidocaine

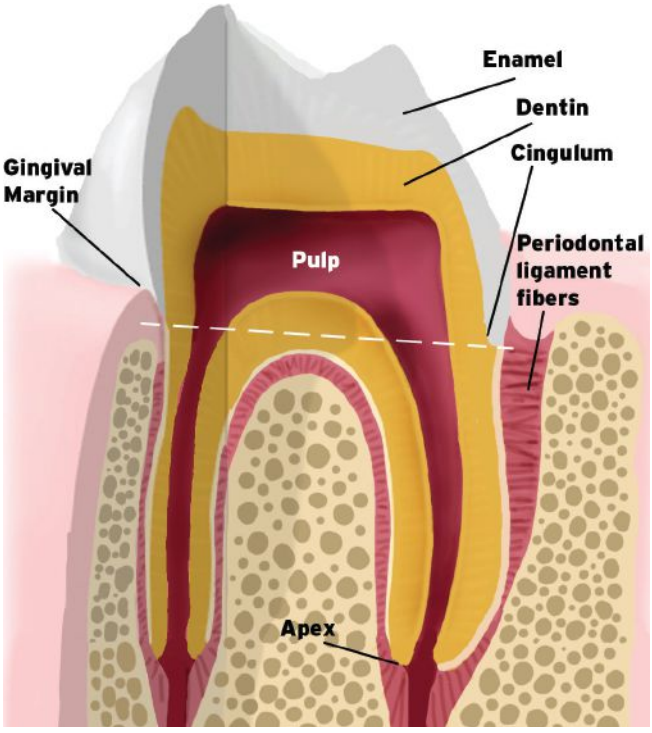
Dental nerve block techniques

Most dental procedures produce strong sensory stimuli that affect general anesthesia requirements and postoperative recovery. Dental nerve blocks interrupt these sensory stimuli locally and should be a component of overall pain management. Regional dental nerve blocks can decrease the concentration of inhalant anesthesia required, which reduces adverse side effects, such as hypotension, bradycardia and hypoventilation.[1] In addition, dental nerve blocks ease the patient's recovery from anesthesia because adverse side effects, such as hypertension, tachycardia and tachypnea, are also minimized postoperatively because of decreased oral pain.[2]

Local anesthetics completely block sensory nerve transmission and prevent secondary (central) pain sensitization. For this reason, local blocks are often used in conjunction with other injectable and systemic pain medications.[3]

Perioperative pain management is required for tissue injury resulting from noxious stimuli and a subsequent decreased pain threshold at the surgical site. Analgesics given preoperatively and intraoperatively are often insufficient because of the ongoing postoperative inflammatory reaction involving the injured hard and soft tissue. The resultant inflammatory mediator release can cause peripheral and central sensitization.[4] Practitioners should consider a multimodal pain management approach to prevent pain hypersensitivity.[4]

Figure 3.3: Anatomy of a tooth



The benefits of implementing multimodal pain management for dental and oral surgery, specifically dental blocks, include:

- Owners expect effective pain management.
- Pets often are discharged the same day after dental procedures, and owners want their pets to be as alert and pain free as possible.
- Pets recover faster and with fewer complications.[5]
- The minimum alveolar concentration required for inhalant anesthetics is decreased, therefore reducing anesthesia complications and improving safety.[1]
- They eliminate the pain perception, decrease anesthesia levels and result in a smoother anesthesia experience.[6]
- Local blocks continue to provide analgesia in the postoperative period, keeping the pet comfortable while using fewer systemic pain medications.[7,8]
- Signs of pain after dental procedures, such as rough recoveries, vocalization, restlessness, pawing at the mouth, behavior changes, inappetence and depression, are minimized when regional oral nerve blocks are used.[9]

Many dental surgical procedures produce strong stimulation, and pets undergoing them often manifest variable depths of general anesthesia due to poor or inadequate analgesic administration.[10]

Common dental and oral surgical procedures for which dental nerve blocks are indicated include:

- Surgical and nonsurgical extractions
- Advanced periodontal treatments, such as root planing, periodontal debridement and periodontal flap surgery
- Oral trauma that involves lacerations of the lips, gums and tongue; foreign bodies; and jaw fractures that require soft and hard tissue surgical intervention
- Incisional and excisional biopsies
- Soft- and hard-tissue oral surgery, such as oronasal fistula repair, palatal surgery, maxillectomies, mandibulectomies and reconstruction surgery

Anatomy of oral nerves

Sensory innervation to the oral structures arises from the trigeminal nerve. In the maxilla, the upper teeth, soft and hard tissue and palate are innervated by the maxillary nerve that enters the maxillary foramen and infraorbital canal from the sphenopalatine fossa. The maxillary nerve branches into the infraorbital nerve, which in turn branches into the caudal, middle and rostral superior alveolar nerves. In the mandible, the lower teeth and soft and hard tissues are innervated by the mandibular nerve. The mandibular nerve branches into the lingual nerve just before it enters the mandibular foramen and provides sensory innervation to the tongue and the inferior alveolar nerve; this nerve branches into the rostral, middle and caudal mental nerves, which provide sensory innervation to the lower molars, premolars, canines, incisors and soft and hard tissues of the rostral mandible.

The infraorbital, caudal maxillary, middle mental foramen and inferior alveolar (mandibular) blocks are the most common regional dental nerve blocks used in veterinary medicine. There are several variations on the technique, including intraoral and extraoral positioning of the needle. Gentle insertion of the needle into the soft tissue or foramen will minimize tissue trauma. Once inserted in the proper location, aspirate to ensure that there is no vascular access and then inject slowly. If aspiration yields blood, remove the needle and syringe and start over with a clean needle and syringe. This section will emphasize only intraoral techniques.

Administration of nerve blocks

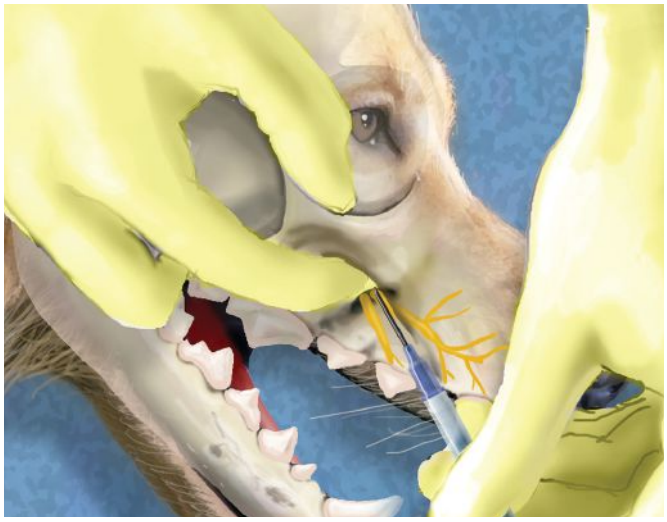
Materials and equipment needed for dental nerve blocks are minimal and include bupivacaine (0.5%); 1 mL syringes; 25-gauge, 5/8-inch needles; surgical scrub; and a dog and cat skull to help you locate the foramina.

Bupivacaine (0.5%) is the agent of choice for these procedures. Its onset of action is 10 to 15 minutes, and the duration of action is three to eight hours.[1,2] It offers a higher degree of sensory block than other injectable agents, such as lidocaine (which is ideal for sensory nerves of the head) with less tissue irritation.[9] Bupivacaine is more toxic than lidocaine to the heart, so the lowest possible dose is used (*i.e.*, do not exceed 2 mg/kg for a total cumulative dose in dogs and 1 mg/kg for a total cumulative dose in cats during any given procedure).[1,2,4] Generally, the dose per site is 0.5 to 1 mL in dogs and 0.2 to 0.3 mL in cats. Keep in mind that in a small dog (*e.g.*, 3 kg), you will need to reduce the recommended dose of 0.5 mL per site so you don't exceed the total cumulative dose.

Infraorbital nerve block

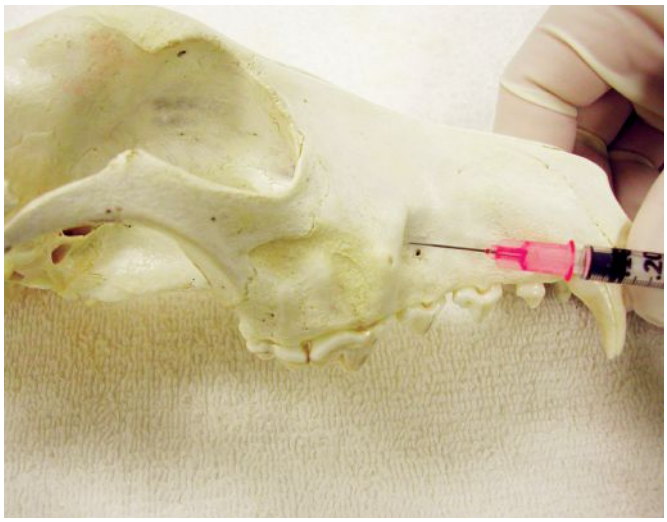
Infraorbital nerve blocks affect the maxillary incisors; canines; and the first, second and third premolars as well as the soft and hard tissues rostral to the upper fourth premolars. The nerve can be palpated as an indentation at the bony ridge in the maxilla dorsal to the distal root of the third maxillary premolar in dogs. It is halfway between a line drawn from the apex of the canine tooth to the dorsal border of the zygomatic arch. In cats, the infraorbital foramen is palpated as a bony ridge dorsal to the second premolar just ventral to the eye, where the

Figure 3.4



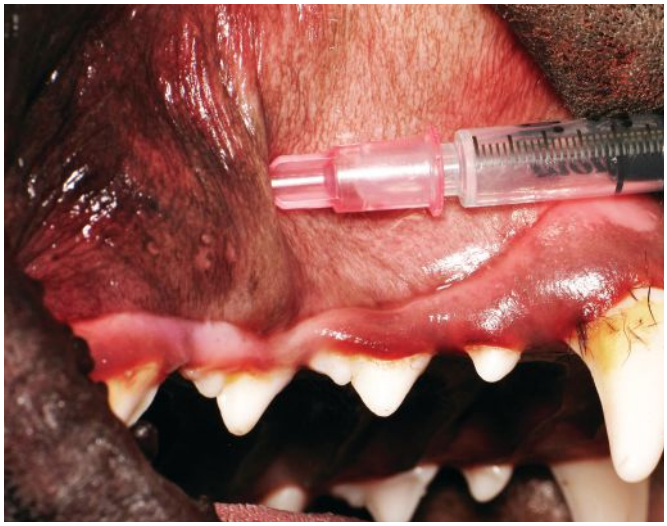
Location of the infraorbital nerve block.

Figure 3.5



Infraorbital nerve block on a dog skull.

Figure 3.6



Infraorbital nerve block in a dog.

zygomatic arch meets the maxilla. In cats, the infraorbital block affects all the teeth on the ipsilateral side where the block is done.

Once the location is identified, clean the area with surgical scrub and palpate the infraorbital foramen. Insert the needle to the hub through the buccal mucosa in a caudal direction parallel to the dental arcade, into the entrance of the foramen. Aspirate and then inject slowly (*Figures 3.4-3.8*, pages 26-27).

Caudal maxillary nerve block

This block affects the maxillary fourth premolar, upper molars and the soft and hard tissue caudal to the maxillary fourth premolars, including the hard and soft palate. This block mimics a splash block–you are not actually entering a foramen as you do with the infraorbital block, but you rely on anatomical direction to affect the maxillary nerve by injecting in the area where the nerve branches around the upper molars and fourth premolar. **This block is only used in dogs.**

Clean the area with surgical scrub and insert the needle to the hub into the area of soft tissue just caudal to the last molar at a 30 to 45 degree angle with the dental arcade. Aspirate and then inject slowly (*Figures 3.9-3.10*, page 27).

Middle mental nerve block

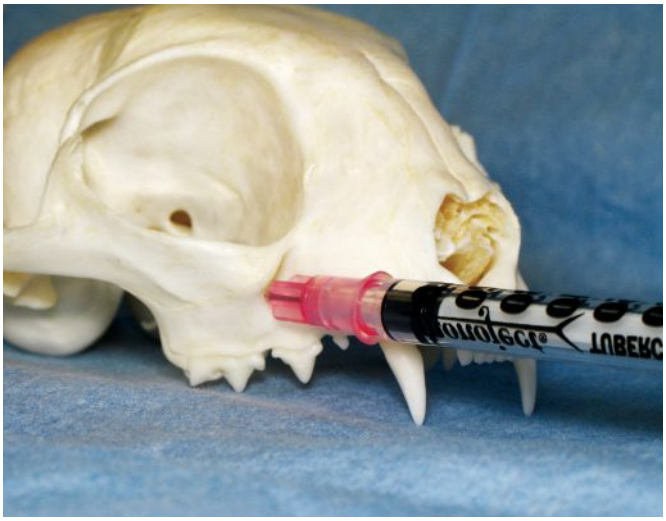
The middle mental block affects primarily the mandibular incisors and surrounding soft tissue.[11,12] The middle mental foramen is the largest of the three mental foramina and is the one used most often. It is located and can be palpated ventral to the mesial root of the lower second premolar, just caudal to the mandibular labial frenulum. **In cats and small-breed dogs, the middle mental foramen is difficult to palpate; therefore, the inferior alveolar nerve block is used in those cases.**

Once identified, clean the area with surgical scrub, insert the needle into the submucosa in a rostral to caudal direction and advance it into the middle mental foramen. Aspirate and inject slowly. In most dogs, the needle will not penetrate completely to the hub as it does with the infraorbital dental block (*Figures 3.11-3.13* pages 27-28).

Inferior alveolar nerve block

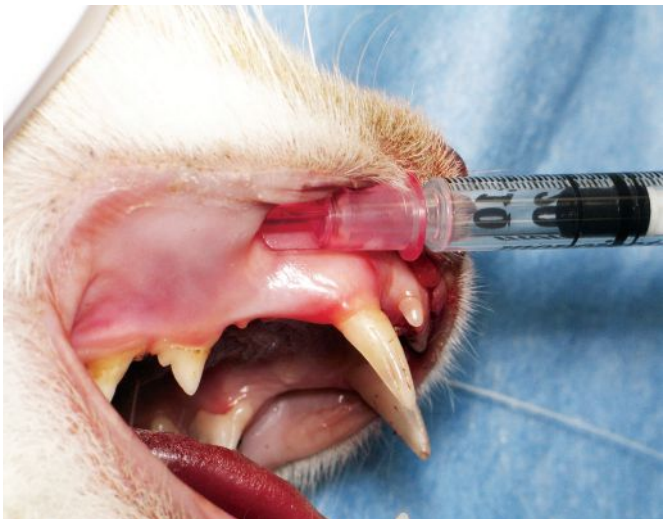
The inferior alveolar, or mandibular block, affects all the teeth in the mandible, including the soft and hard tissues. If the local anesthetic infiltrates in a more lingual caudal direction, the tongue may be affected; therefore, it is important to make sure the needle is directed toward the caudal ramus of the mandible when inserting to prevent

Figure 3.7



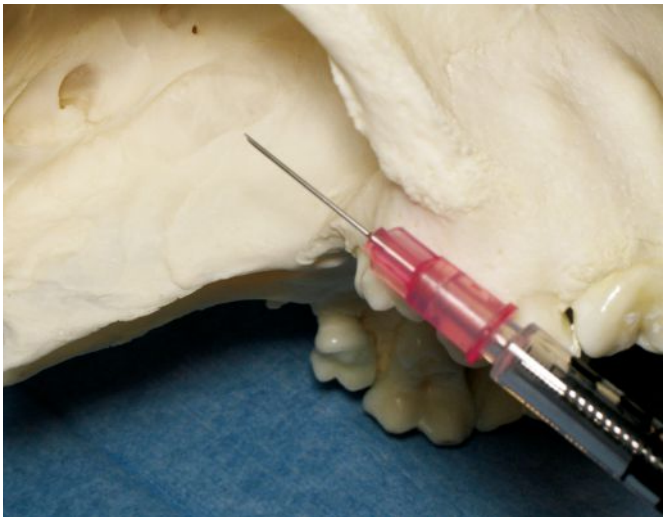
Infraorbital nerve block on a cat skull.

Figure 3.8



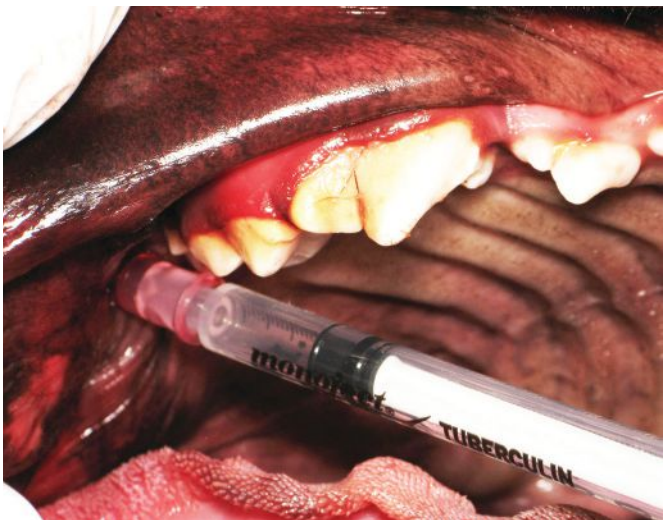
Infraorbital nerve block in a cat.

Figure 3.9



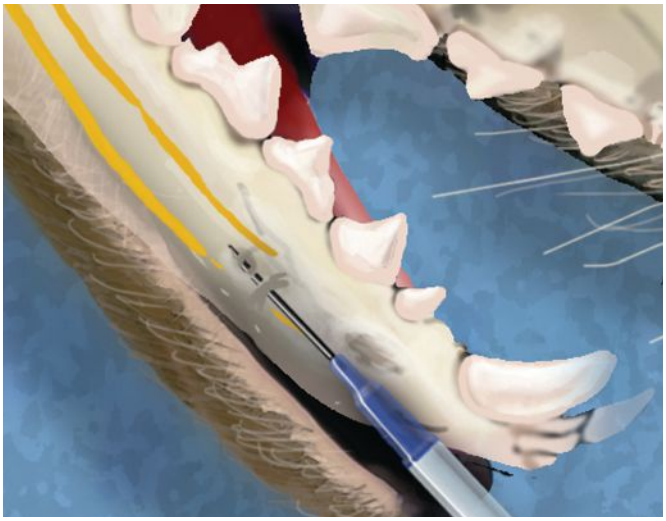
Caudal maxillary nerve block on a dog skull.

Figure 3.10



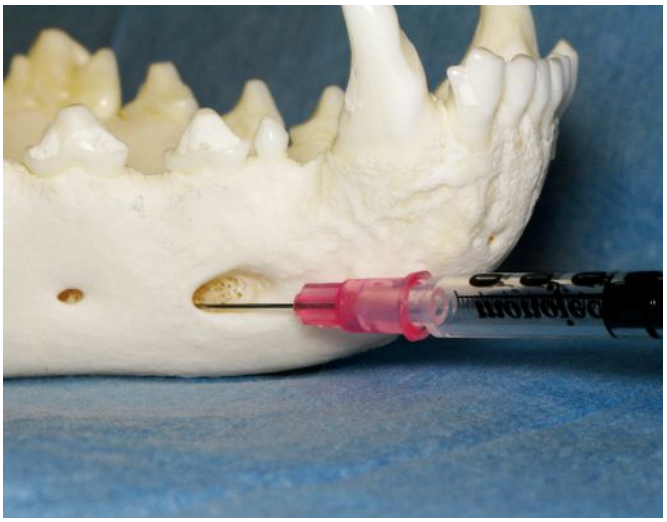
Caudal maxillary nerve block in a dog.

Figure 3.11



Location of the middle mental nerve block.

Figure 3.12



Middle mental nerve block on a dog skull.

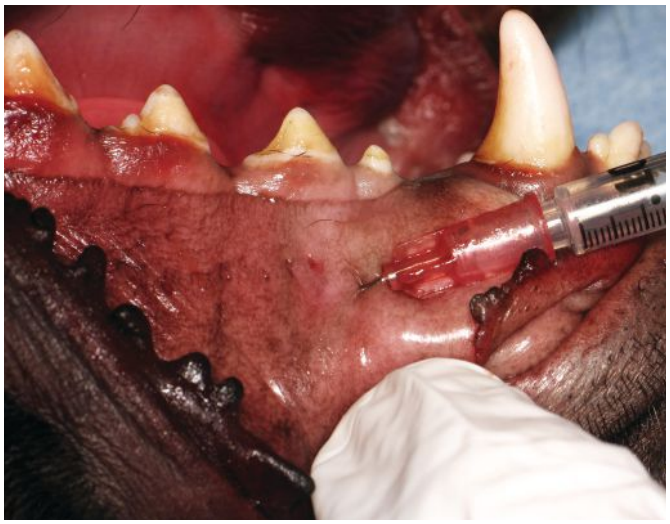
the bupivacaine from anesthetizing the tongue.
The mandibular foramen is located two-thirds of the distance from the last molar to the angular process. The foramen is one-half to one inch from the ventral surface of the mandible in dogs and one-quarter inch from the ventral surface of the mandible in cats. Palpate the angular process extraorally (as the most caudal and ventral projection of the mandible) and the mandibular foramen intraorally with a forefinger. Insert the needle just caudal to the last molar in a direction toward the angular process, and advance the needle along the lingual surface of the mandible adjacent to the mandibular foramen. Aspirate and inject slowly (*Figures 3.14-3.18,* pages 28-29).

Discussion

Regional dental nerve blocks are relatively safe when used correctly. Complications resulting from oral nerve blocks have been described in human dentistry; however, the incidence is extremely low.[13] Toxic doses of bupivacaine have been reported to cause cardiovascular toxicity and death in people, although this is also very rare.[14]

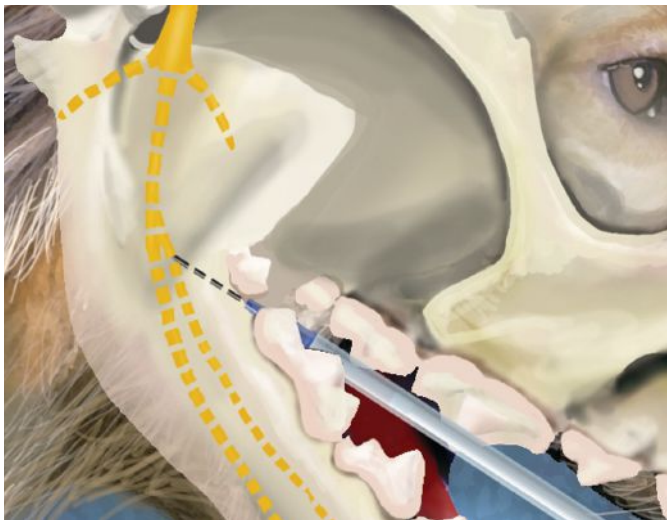
Even though these complications are uncommon in pets, practitioners still need to ensure correct dosing, choose an appropriate needle size and length, identify appropriate locations, insert and advance the needle gently to avoid unnecessary soft tissue trauma and aspirate before injecting the bupivacaine. With practice and proper training, dental nerve blocks are inexpensive to perform and easy to learn. They will significantly improve pet care and be a valuable addition to your pain management armamentarium for your dental and oral surgical procedures.

Figure 3.13



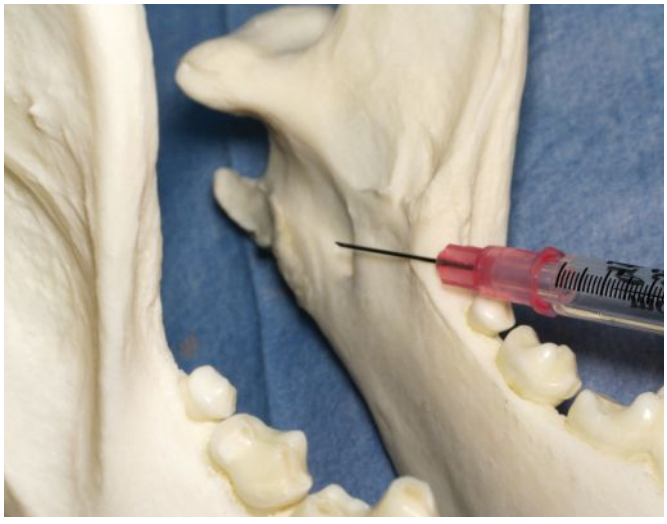
Middle mental nerve block in a dog.

Figure 3.14



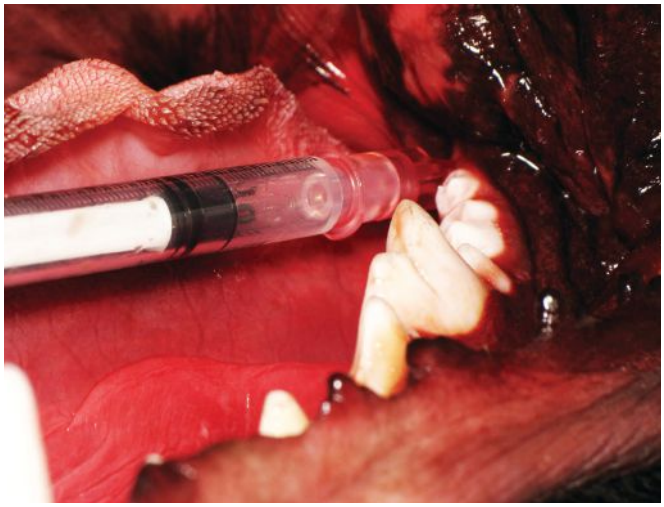
Location of the inferior alveolar nerve block.

Figure 3.15



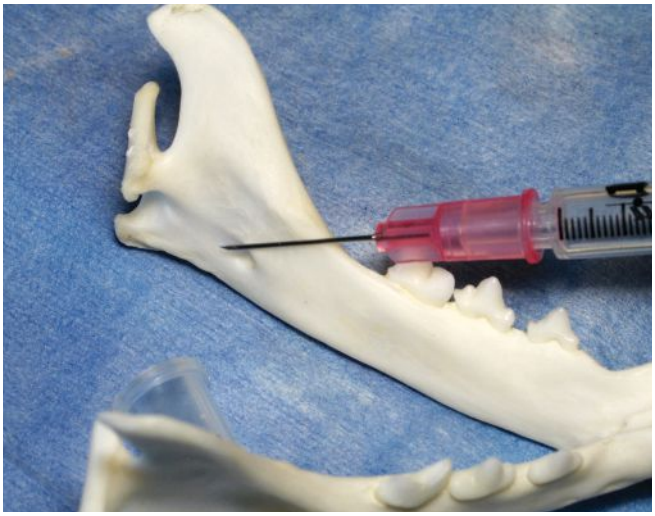
Inferior alveolar nerve block on a dog skull.

Figure 3.16



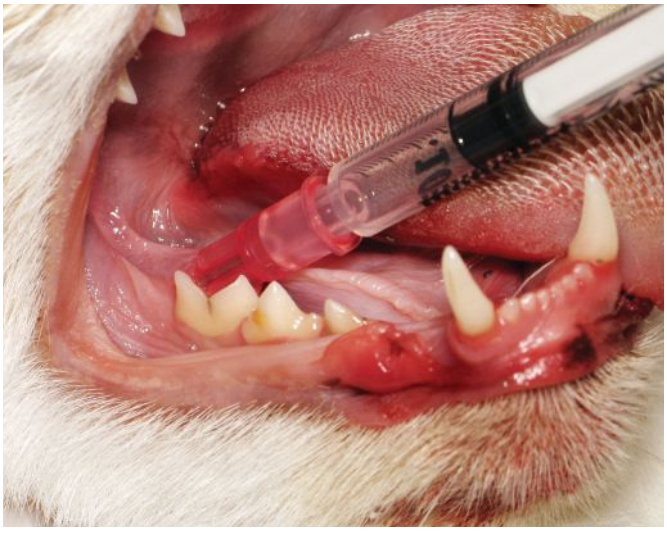
Inferior alveolar nerve block in a dog.

Figure 3.17



Inferior alveolar nerve block on a cat skull.

Figure 3.18



Inferior alveolar nerve block in a cat.

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TECHNIQUES FOR LOCAL AND REGIONAL ANESTHESIA

Local Anesthetic Agents

Lidocaine: Dose 1 to 2 mg/kg in dogs and cats. Cats are very sensitive to the side effects of lidocaine so use lower end of dose when possible. Dogs can tolerate lidocaine doses up to 4 mg/kg if absolutely necessary, unless the injection is given in an area of high vascular absorption, such as the intercostal region or inflamed areas.

Bupivacaine: Dose 2 mg/kg in dogs and 1 mg/kg in cats. **Always aspirate to ensure intravenous injection is not occurring.** The closer an injection of bupivacaine occurs to the nerve, the quicker the onset of action. For example, dental nerve blocks or intracostal nerve blocks take effect quicker than a skin block for a mass removal. A good working knowledge of anatomy allows injections near the nerve, which results in a much quicker onset of action. While bupivacaine may take 15 to 20 minutes to take full effect, it usually is providing effective analgesia within one to two minutes when properly applied. In areas where the skin, and not a particular nerve, is being blocked, onset of action may take the full 15 to 20 minutes total.

It is not recommended to mix lidocaine and bupivacaine, as mixing increases the time of onset and decreases the duration of either product when used individually. When using both products in one patient at separate sites, remember the doses are cumulative, do not exceed 1 to 2 mg/kg either lidocaine and/or bupivacaine total. Signs of local anesthetic toxicity can include central nervous system (CNS) symptoms such as twitching, tremoring and seizures in awake patients, or cardiac depression in anesthetized patients. Bupivacaine can cause a fatal cardiac toxicity if injected intravenously. Treatment for local anesthetic toxicity involves discontinuing the drug, or reducing the dosage, and providing supportive care. Diazepam can be used to help manage seizures if needed.

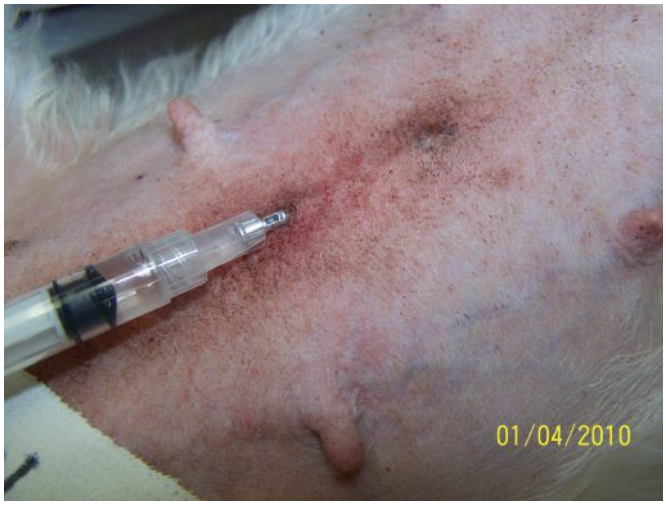
Local Anesthetic Techniques

Splash blocks are generally considered inconsistent and ineffective and should not be relied upon to provide analgesia in patients.

Line blocks (*Figure 3.19*) can be very effective in situations such as cesarean sections and abdominal surgeries or in any patient that could benefit from lower doses of inhalant maintenance agents. Local infiltration is performed with 0.3 to 0.5 mL per site. Do not exceed maximum doses; if further volume is required, dilute 50:50 with sterile saline. Lidocaine has a very quick onset of action and will prevent the body's reaction to surgical pain, which can result in dorsal horn windup and make postoperative pain more difficult to manage. In cases where significant postoperative pain is anticipated, the use of bupivacaine can provide a more prolonged duration of analgesia. **Remember to decrease the dose of local anesthetics by 50% to 75% in pregnant patients.**

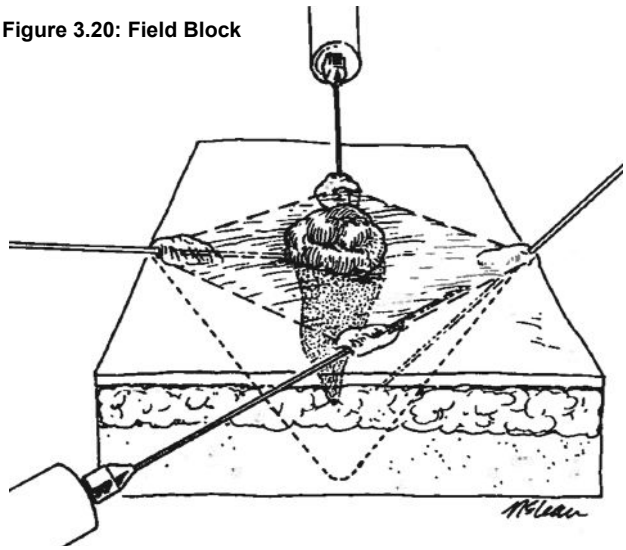
Field blocks (*Figure 3.20*) are an excellent technique to provide analgesia for small and/or superficial mass removals. They can also be helpful with larger mass removals under general anesthesia, but be careful not to

Figure 3.19: Line Block



Used with permission from Mark E. Epstein, DVM, DABVP (C/F).

Figure 3.20: Field Block



The production of walls of anesthesia enclosing the surgical field.

Thurman JC, Tranquilli WJ, Benson GJ. *Essentials of Small Animal Anesthesia and Analgesia.* ©1999. Wiley-Blackwell. Reproduced with permission of John Wiley + Sons, Inc.

exceed the maximum dosage of local anesthetic agents; if a large area is involved, dilute the maximum dose 50:50 with sterile saline to provide a larger volume for injection. Bupivacaine is the local anesthetic agent of choice for this type of block, especially since it will provide a more prolonged analgesia postoperatively. Ideally, the block should be performed post premedication and pre-induction to allow for 10 or 15 minutes for full effect.

Peripheral/ring blocks are most often employed during feline declaw procedures, but can also be useful for canine dewclaw removal, digital mass removals or digital amputations. Bupivacaine is the local anesthetic of choice for these procedures. The block should be performed post premedication and pre-induction to allow for full effect. When appropriately applied for a feline declaw procedure, ring blocks with bupivacaine can begin providing effective analgesia within three to five minutes (See *Feline Declaw Protocol*, page 89).

Intratesticular blocks (*Figure 3.21*) have routinely been employed in canine and feline neuters and can greatly decrease the amount of general anesthesia required for maintenance as well as provide significant analgesia during clamping of the spermatic cord during castration.

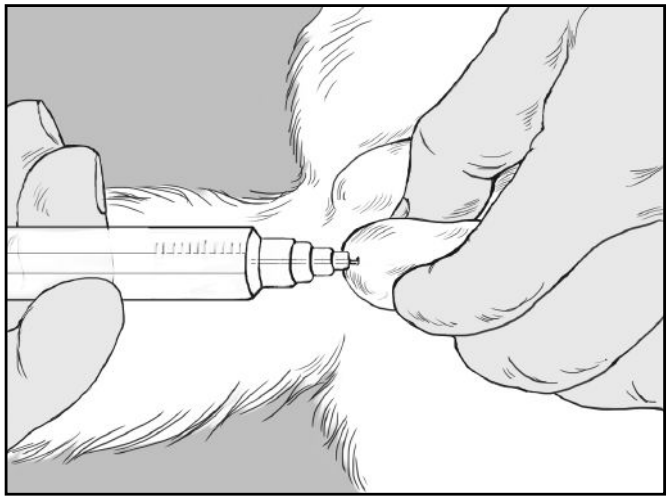
Following induction and prior to surgical preparation: 2 mg/kg lidocaine is injected via a 22-gauge 1 to 1 1/2-inch needle (medium to large dogs), or 1 to 2 mg/kg lidocaine is injected via a 25- gauge 5/8-inch needle (cats and small dogs).

- Insert needle into the caudal pole and advance to the center of the testicle.
- Aspirate to ensure inadvertent intravascular injection does not occur.
- Slowly inject one-third to one-half of the volume of lidocaine, expect backpressure, until the testicle palpates turgid. Repeat with the second testicle.
- Perform surgical site preparation.
- Onset of action occurs within one to two minutes.

Intra-articular blocks can be performed with lidocaine prior to arthrotomy, and/or bupivacaine can be placed into the joint prior to closure. If using more than one local anesthetic, remember that doses are cumulative; do not exceed 2 mg/kg total dose. Bupivacaine typically provides four to six hours local analgesia postoperatively.

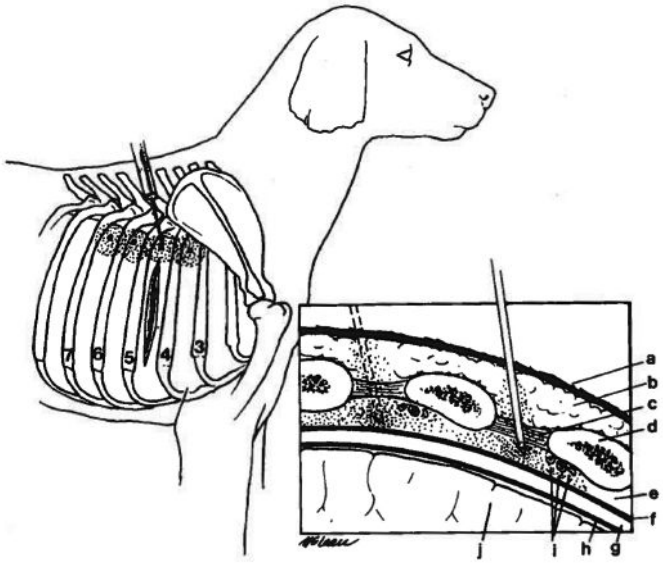
Intercostal blocks (*Figure 3.22*) are an excellent technique to provide comfort and analgesia for broken ribs, chest tube placement or postoperative thoracotomy. Bupivacaine is the local anesthetic of choice and should be injected two spaces ahead of and two spaces behind the area of concern. A minimum of three consecutive ribs should be blocked. This is a highly vascular area and has a high level of systemic absorption, so calculate maximum doses very carefully. This block can be repeated every eight hours as needed. Monitor closely for any signs of local anesthetic overdose, such as tachycardia, tremoring, etc., and decrease doses as needed. The injection should be given at the proximal, caudal border of each rib. Always aspirate to ensure that an intravascular injection is not occurring.

Figure 3.21: Intratesticular Block



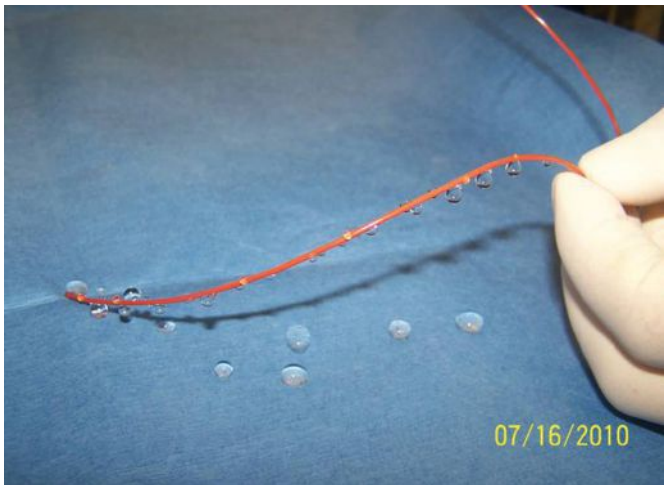
Medical illustration by Laurie O'Keefe

Figure 3.22: Intercostal Block



Needle placement for inducing intercostal nerve block. a, skin; b, subcutaneous tissue; c, intercostal muscles; d, rib; e, subcostal space; f, pleura costalis and fascia; g, interpleural space; h, pleura pulmonalis; i, intercostal artery, vein and nerve; j, lung.

Figure 3.23: Soaker Catheter



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Soaker catheters (*Figure 3.23*) can be placed intra-operatively for procedures such as limb amputation, large mass removals and total ear canal ablation (TECA) surgeries, where significant postoperative pain is expected. A red rubber tube can be fenestrated using a surgical scalpel blade and then sutured into the surgical area, very similar to the placement of a Penrose drain. Fixation to the skin can be accomplished using butterfly tape or a Chinese finger snare suture. A male adapter plug should be used to cap the open end of the tube which should be easily accessible. The dose of bupivacaine should be calculated, diluted 50:50 with sterile saline and injected into the tube, followed by 1 to 2 mL of sterile saline for flushing. This can be repeated every eight to 12 hours as needed. Monitor the patient closely for any signs of toxicity and decrease the dose of bupivacaine if needed. A soaker catheter can remain in place for up to five days with careful attention to cleanliness; removal rarely requires sedation.

Epidural blocks (See *Techniques for Epidural Anesthesia*).

TECHNIQUES FOR EPIDURAL ANALGESIA

For epidural analgesia, patients are typically sedated or anesthetized and placed in sternal or lateral recumbency. Sternal recumbency facilitates the hanging drop technique whereas lateral recumbency facilitates positioning of patients with fractures. Next, the cranial edges of the wings of the ilia are palpated (*Figures 3.24-3.25*). A line connecting these two points typically overlies the vertebral body of L7. Just caudal to this line, an indentation can be felt which corresponds to the lumbosacral junction. Location can be verified by palpating the dorsal spinous process of the seventh lumbar vertebra rostral to this indentation. Once located, a 10 cm by 10 cm area of hair directly over the lumbosacral junction is clipped and the skin is surgically prepared.

Needle insertion is made directly over the depression formed by the lumbosacral junction with the needle initially positioned perpendicular to the skin (*Figures 3.26-3.27,* page 33). It is important the stylet is correctly positioned

Figure 3.24

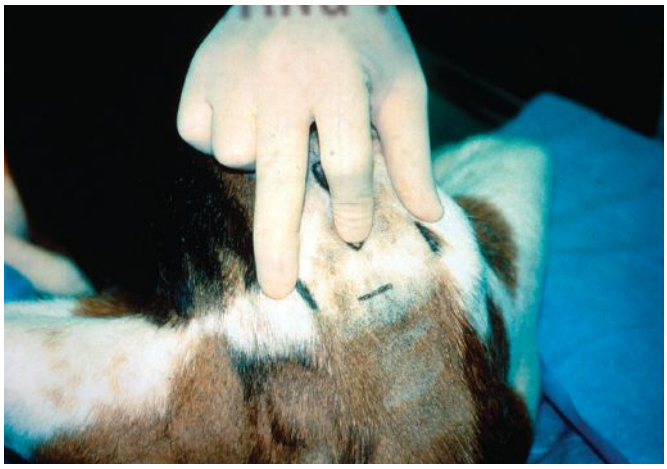


Figure 3.25

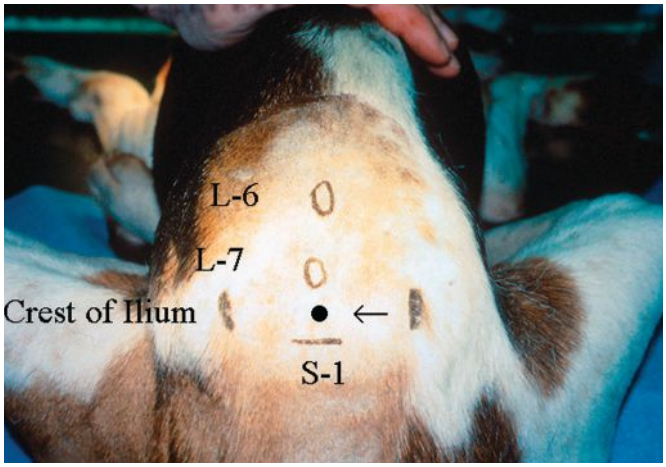
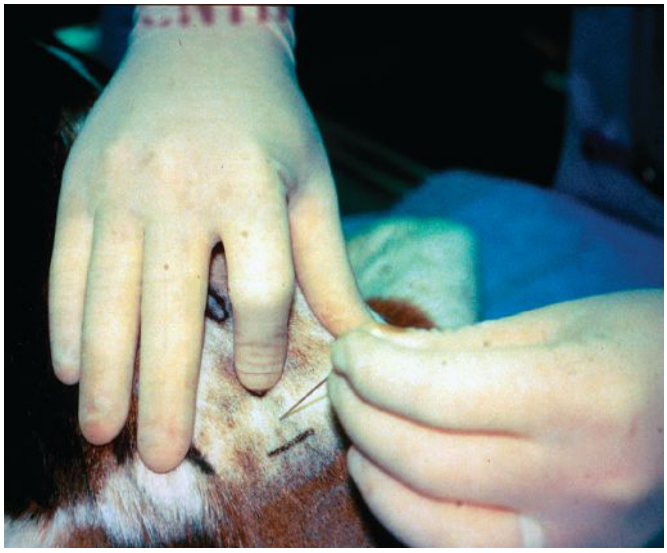


Figure 3.26



within the needle to prevent transplantation of skin into the epidural space. When using the hanging drop technique, the stylet is removed after penetrating the skin and placed on a sterile area (typically the sterile paper glove liner).

Then, a few drops of sterile solution are placed in the hub of the needle until a meniscus is formed. The needle is slowly advanced until it encounters bone or punctures the ligamentum flavum. If bone is struck, the needle is withdrawn to the subcutaneous tissue and redirected. If the ligamentum flavum is punctured and the needle tip enters the epidural space, fluid will typically flow from the hub of the needle into the space (*Figures 3.28-3.29*).

If the epidural is being performed while the pet is in lateral recumbency, the stylet is left in the needle until a characteristic pop is felt as the ligamentum flavum is punctured.

Figure 3.27

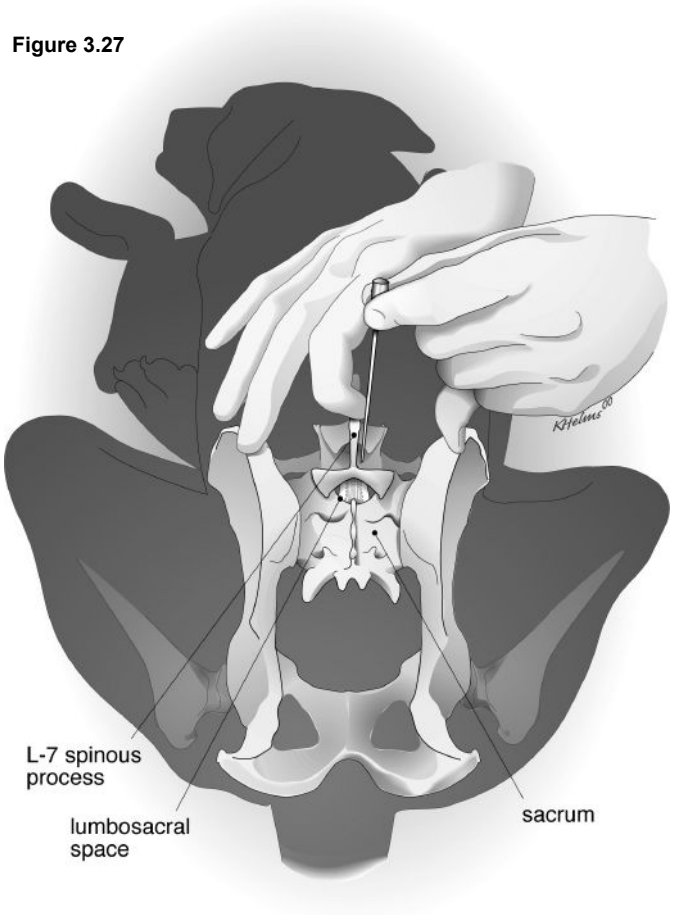


Figure 3.28

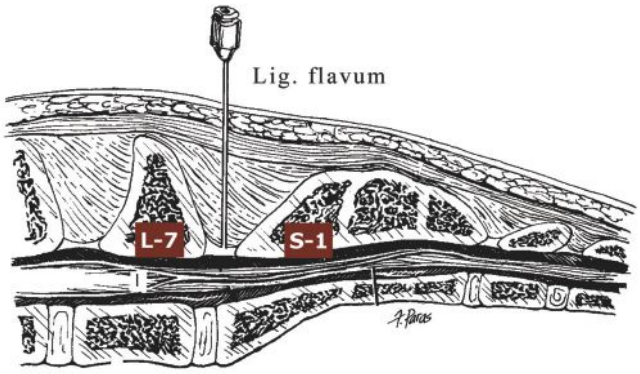
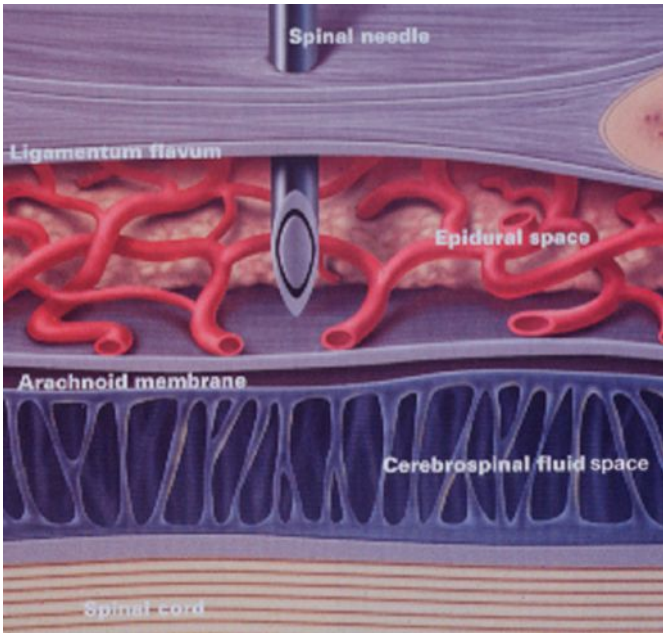


Figure 3.29



With both techniques, following insertion and removal of the stylet, the needle is observed for flow of cerebral spinal fluid or blood. Once the tip of the needle is confirmed to be in the epidural space, the syringe is attached to the hub of the epidural needle and a slow injection of the analgesic agent is begun (*Figure 3.30*).

Observation of the lack of compression of a small (1 mL) air bubble in the syringe helps to ensure that there is no resistance to injection. Following injection, the needle is withdrawn and the surgical site is placed ventrally in order to facilitate the movement of analgesic drug to the correct side of the spinal cord. Other signs indicating correct needle placement may include twitching of the tail muscles and a change of respiratory pattern during injection. If blood flows out of the needle, it can be withdrawn and flushed, then reinserted (with the stylet in place).

Materials Needed

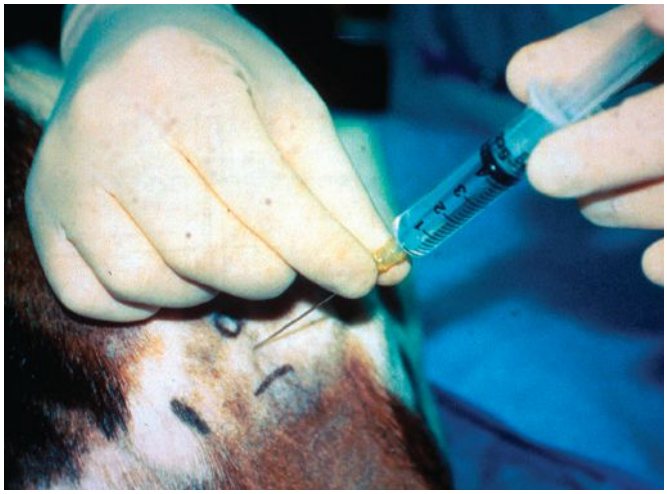
- Spinal needle: 22- to 20-gauge, 2.5 to 3.5 inches long
- Sterile gloves

Drugs and Dosages

- Hydromorphone 0.03 to 0.04 mg/kg
- Dilute with sterile water to a volume of 1 mL/4.5 kg. Maximum volume 6 mLs.
- Duration: eight to 24 hours
- Minimal systemic effects; bradycardia can occur. Monitor for urinary retention in the immediate postoperative period and provide bladder expression or catheterization as needed.

For further information on epidurals, epidural medications and dosages, please call your medical director.

Figure 3.30



PREMEDICATIONS

Purpose

1. Calm the patient and reduce stress.
2. Decrease dose of induction and maintenance drugs.
3. Improve induction and recovery quality.
4. Provide initial aspects of multimodal pain management.

Note: Do not rely on premedications alone to facilitate venipuncture or catheter placement in fractious pets. Move directly to *Fractious Pet Protocol*, page 86.

This section includes information on drugs used for premedications and pain management, including the time to effect, duration of action, where it is metabolized and how it is excreted. There is also information about the protein-binding property of each drug. Protein-binding is important as it is the property of the drug that limits distribution and availability in the bloodstream. Only the unbound portion of the drug exhibits the pharmacologic effects and is available for metabolism and excretion. If a drug overdose occurs, the protein-binding capacity may be exceeded, which leads to excess amounts of free drug in the bloodstream that must be accounted for when attempting to reverse an overdose.

Acepromazine

- A phenothiazine sedative/tranquilizer
- Onset is fairly slow. Peak effects are seen 30 to 60 minutes post administration.
- Duration of approximately six to eight hours
- 99% protein-bound
- Metabolized in the liver, with conjugated and unconjugated metabolites excreted in the urine
- An alpha-1 antagonist:
  - Results in vasodilation of arterioles
  - Action is dose-dependent, so low doses result in slight vasodilation, and a large dose can result in a relative hypovolemic shock.
  - Helps counteract the hypertension often seen in stressed patients
  - Should predilute to 1 mg/mL to allow for proper and more precise drug measurement (*Table 3.4*, page 35).
  - Protects against some arrhythmias including ventricular premature complex (VPC) and ventricular fibrillation associated with epinephrine release
  - Provides anti-emetic action
  - Provides no pain control
  - **Reminder: Anything Ace does, fluids can fix.**
  - **Avoid using in fractious pets as it can cause epinephrine reversal syndrome.**

Maximum total dose of acepromazine for any pet is 1.5 mg. Acepromazine may be used with caution or at half the calculated dose in Boxer breeds or sighthound breeds. However, keep in mind, when premedication doses are reduced, the amount of induction medication and inhalation anesthetic required are often increased, which can have adverse effects on the pet as well.

Table 3.4

Directions for Dilution of Acepromazine
Order sterile water for injection and 30 mL empty sterile vials through BanfieldDirect or other medical supply source.
Draw up 27 mL of sterile water with a sterile syringe and add it to the empty sterile vial.
Draw up 3 mL of 10 mg/mL acepromazine and add to the same vial—this results in a 1 mg/mL solution.
Vial with diluted Ace should be labeled and dated.
The solution is light-sensitive; therefore, the vial should be completely wrapped with opaque tape or CoFlex® (or a similar product). If protected from light, the solution is stable at room temperature.
Do not keep the 10 mg/mL acepromazine in an area where it could be easily accessed by mistake.

Butorphanol

- Partial opiate agonist/antagonist
- Onset begins within a few minutes post IV administration, and within 15 minutes after IM administration.
- Generally lasts one to two hours
- Highly protein-bound
- Metabolized in the liver. Metabolites excreted in the urine (86% to 89%) and feces (11% to 14%).
- Antagonist to mu receptors and can be used as a reversal agent for pure opioids whose analgesic action is mediated through mu receptors, *i.e.*, hydromorphone
- Provides pain management through effects on kappa and sigma receptors
- Provides good visceral analgesia by acting at the subcortical and spinal levels
- Has little to no respiratory depression
- Butorphanol administered subcutaneously (SC) in cats is less painful, but absorption may be delayed. Consider the timing and extent of the procedure to be performed when deciding whether to administer SC or intramuscularly (IM).

IM administration in the epaxial or caudal thigh muscles helps to ensure absorption, especially with a low-volume dosage.

- Butorphanol is a mixed agonist/antagonist; therefore, a ceiling is reached on its analgesic properties—higher doses do not proportionally equal more pain management. As higher doses are given, the likelihood of adverse effects developing increases (*i.e.*, dysphoria). May need to be re-dosed every one to two hours to maintain pain control.
- Class IV controlled substance. Follow Drug Enforcement Administration (DEA) regulations regarding storage, usage and documentation.

Recommended reading

The following articles discuss the effects of butorphanol and other analgesics:

1. Lascelles BDX, Roberston SA. Use of thermal threshold response to evaluate the antinociceptive effects of butorphanol in cats. *Am J Vet Res.* 2004;65:1085-1089.
2. Ko JCH, Lange DN, Mandsager RE, Payton ME, Bowen C, Kamata A, et al. Effects of butorphanol and carprofen on the minimal alveolar concentration of isoflurane in dogs. *JAVMA.* 2000;217:1025-1028.
3. Romans CW, Gordon WJ, Robinson DA, Evans R, Conzemius MG. Effect of postoperative analgesic protocol on limb function following onychectomy in cats. *JAVMA.* 2005;227:89-93.
4. Gellasch KL, Kruse-Elliot KT, Osmond CS, Shih ANC, Bjorling DE. Comparison of transdermal administration of fentanyl versus intramuscular administration of butorphanol for analgesia after onychectomy in cats. *JAVMA.* 2002;220:1020-1024.
5. Ilkiw JE, Pascoe PJ, Tripp LD. Effects of morphine, butorphanol, buprenorphine and U50488H on the minimum alveolar concentration of isoflurane in cats. *Am J Vet Res.* 2002;63:1198-1202.

Dexmedetomidine (Dexdomitor®)

- Alpha-2 agonist
- Alpha-2 agonists have good analgesic properties, however, they are not appropriate as sole analgesic agents. Therefore, they are combined with opiate analgesics in our protocols.
- Effects on the higher centers in the CNS

- Will cause a transient peripheral vasoconstriction and reflex bradycardia that is significant. Cardiac output can be decreased up to 40%.
- For these reasons, dexmedetomidine is only used in combination with a dissociative and/or opiate analgesic and at much lower than manufacturer recommended doses (1 to 3 µg/kg).
- **Dexmedetomidine, ketamine, butorphanol (Torbugesic®) combination (DKT) is made by adding 1 mL of dexmedetomidine, 1 mL of ketamine and 1 mL of butorphanol into a sterile vial. The mixture is stable for up to two months at room temperature. Be sure to label the container appropriately as DKT and include the date it was mixed.**
- Alpha-2 agonists significantly lower the need for induction agents (up to 45%); therefore induction doses of propofol may be as low as 1 mg/kg. Titrate propofol dose carefully. This is also true for minimum alveolar concentration (MAC) of sevoflurane. Pets, therefore, require significantly less anesthetic gas.
- The alpha-2 agonist, medetomidine, has been shown to decrease the cardiac outflow obstruction associated with occult hypertrophic cardiomyopathy in cats making this drug of potential great value in providing a safer alternative for sedation in this specific subset of our pets.[1] Therefore, dexmedetomidine is included in the feline *Fractious Pet Protocol*, page 86.
- Pets under the influence of an alpha-2 can still be roused; this is why Banfield is not recommending its use as an immobilization agent in fractious dogs.
- Alpha-2 agonists can be reversed through the use of specific reversal agents. This can add to the safety of these agents.
- Practitioners can expect to see a significant bradycardia (usually up to 50% of the resting heart rate), blanching or paleness of the mucus membranes and decreased respiratory rate. Pulse oximetry readings can be lower as well if peripheral vasoconstriction is profound.
- Xylazine, medetomidine and dexmedetomidine are examples of alpha-2 agonists. Tolazoline, yohimbine and atipamezole are alpha-2 receptor antagonists used to reverse the effect of the alpha-2 agonists. Atipamezole will be used to reverse dexmedetomidine when needed.

Source

1. Lamont LA, Bulmer BJ, Sisson DD, Grimm KA, Tranquilli WJ. Doppler echocardiographic effects of medetomidine on dynamic left ventricular outflow tract obstruction in cats. *JAVMA*. 2002; Nov. 1;221(9):1276-81.

Diphenhydramine

- An H1-antihistamine
- Rapid onset of action
- Duration of approximately six to eight hours
- Highly protein-bound
- Metabolized in the liver and mostly excreted as metabolites in the urine
- Competitively antagonizes histamine at H1 receptor sites
- Used to help prevent transfusion reactions, when a patient has received or is anticipated to receive a transfusion
- Used when a patient is undergoing surgery for a mast cell tumor
- Has a high first-pass effect when given orally. Only 40% to 60% will reach the systemic circulation, thus injections are more effective.

Hydromorphone

- An opiate agonist
- Good analgesic properties
- Onset of action occurs within 15 to 30 minutes
- Duration of approximately two to six hours; absorbed rapidly after injected; concentrates in the kidney, liver and lungs; lower levels are found in the CNS. The maximum effect is reached four hours after administration.
- Only 30% to 40% protein-bound
- Metabolized in the liver, primarily by glucuronidation, so half-life in cats may be prolonged. Metabolites excreted by kidneys.
- Agonist at mu and kappa opioid receptors
- Less likely to cause histamine release or vomiting
- Hydromorphone may cause hyperthermia in cats (See page 84 for further discussion).
- Vomiting and defecation can occur after dosing
- Used in the Orthopedic, Ear and Declaw Protocols
- Class II controlled substance. Follow DEA regulations regarding storage, usage and documentation.

Midazolam

- A benzodiazepine
- Rapid onset of action
- Duration of approximately six to eight hours
- Highly protein-bound
- Metabolized in the liver to active metabolites that are excreted in the urine
- Potentiates action of gamma-aminobutyric acid (GABA) resulting in neural and CNS depression.
- A sedative
- A muscle relaxant
- Anticonvulsant—of great benefit in the *CNS & Eye/Globe Protocol*, page 105, as it will help to prevent

seizures in higher risk patients, such as the stabilized epileptic requiring a surgical procedure.
- Class IV controlled substance. Follow DEA regulations regarding storage, usage and documentation.
- **Note:** Diazepam is substituted for midazolam when it is unavailable–the diazepam dose is 0.2 mg/kg SC or IM.

Telazol®

See the following *Induction Agents* section for complete information.

- Used as a premed in fractious dogs in conjunction with butorphanol
- Dose is 1 to 4 mg/kg IM. Use low doses with debilitated or ill pets.
- Wait a full 30 minutes before deciding the first dose has been ineffective before administering more Telazol® to achieve desired effect. Some pets take up to 30 minutes to succumb to the effects.
- See page 38 for more information on Telazol as an induction agent.

INDUCTION AGENTS

- Prior to anesthetizing the patient, verify that pre-anesthesia blood tests were completed within two weeks prior to induction for healthy patients less than 2 years of age (elective procedures) or 48 hours prior to induction for all others. Address any abnormalities found. If abnormalities are noted and anesthesia is necessary, choose the appropriate protocol. See *Preanesthetic Evaluation*, page 55, for more information.

Think. Make a good decision.

- Make sure premeds have had 30 minutes to take effect. If insufficient time is given, a much higher dose of induction agent will be required.
- Re-evaluate cardiovascular system after premeds have taken effect.
- Induction agents are used to facilitate intubation.
- Induction doses are administered carefully and to effect.
- Induction methods should provide a smooth and calm transition to unconsciousness.
- The induction phase is one of the two most common times when adverse anesthesia events occur, recovery being the other.
- It is important to monitor patients carefully during the induction phase to prevent occurrence of adverse events.
- See individual anesthesia protocols for appropriate induction agents.
- Mask induction is highly stressful and causes catecholamine release and tachycardia. Mask induction should only be used when specifically instructed by the protocol.
- Tank induction has special Occupational Safety and Health Administration (OSHA) restrictions in addition to being stressful for the pet, so it is prohibited at Banfield.

Ketamine

- Used as an induction agent for some exotic species (See *Anesthetic Considerations for Small Exotic Pets*, page 123).
- Also a part of the premedication combination (dexmedetomidine/butorphanol/ketamine) used in fractious cats (See *Fractious Pet Protocol*, page 86).

Propofol

- A hypnotic sedative
- An alkylphenol derivative

- Insoluble in water
- Formulated as an emulsion. The emulsion components of soybean oil, ovolecithin and glycerol are media that allow bacterial growth; therefore, the product has limited shelf life after opening.
- Highly protein-bound
- Metabolized in the liver to inactive metabolites that are excreted in the urine
- Propofol has three main uses: (in the hospital, it is used primarily for induction and immobilization, and rarely for anesthetic maintenance. If you need it for other uses, please contact a medical director or advisor for further information).
  1. Induction agent
     - Prior to inhalant gas maintenance
     - Given at least 30 minutes after premeds
  2. Immobilization/chemical restraint for short (less than 10 minutes) procedures
     - Minimally painful examinations or diagnostic procedures
     - Radiology positioning in minimally painful, stable pets
     - Must "convert" to general anesthesia if procedure is going to require more than 10 minutes
     - Must provide appropriate analgesia (given an adequate amount of time PRIOR to immobilization) for painful procedures. See *Immobilization*, page 11, for more information.
  3. Anesthetic maintenance
     - When intubation is not possible (*i.e.*, tracheoscopy or bronchoscopy)
     - Status epilepticus that is refractory to diazepam/midazolam or phenobarbital injections
     - Constant rate infusion: 0.2 to 0.5 mg/kg/min
- Duration: Five to 10 minutes. It is redistributed to adipose tissue fairly quickly after injection.
- Analgesia: **Only** during unconsciousness. **Appropriate preanesthetic analgesia is required.**
- Side effects: apnea (especially when administered too quickly), cyanosis, hypotension, bradycardia (rate and dose dependent).
- Extravasation outside the vein causes little tissue irritation.
- It is recommended to give one-quarter to one-third of the calculated dose as a slow IV bolus, assess patient, and give the rest as needed to allow for intubation.
- After induction, keep any remaining propofol in the syringe for the same patient. If the patient needs a small dose of agent during the transition from propofol to sevoflurane, it will be readily available.
- **Proper handling of propofol:** Adherence to the highest sterile practices when handling propofol can minimize the postoperative infection rate. This involves disinfecting the top of the vial with isopropyl alcohol prior to inserting the needle; drawing up the propofol as close to injection time as possible; and allowing the product to remain in predrawn syringes no longer than six hours. PropoFlo™ 28 contains benzyl alcohol as a preservative. This addition increases the shelf life of the broached or opened bottle to 28 days. Clearly write the "Opened" date with a permanent marker on the bottle once the seal is broken. Store opened bottles of Propoflo 28 at room temperature for 28 days.

Think. Make a good decision.

Propofol administration

- "Slowly" means over 60 to 90 seconds as follows:
  1) Give 1/4 of dose at a time.
  2) While giving each 1/4 dose, count to 15 as you give it and don't finish giving the 1/4 dose until you count 15 seconds.
- Give "to effect" means check jaw tone and intubate if possible; if not, then repeat with the second 1/4 of the calculated propofol dose.

Telazol® (Zolazepam and Tiletamine)

- Similar to diazepam/midazolam and ketamine but with greater synergism.
- This drug is NOT an analgesic and provides little to no effective analgesia; therefore, appropriate analgesics must be administered concurrently.
- Major uses include:
  - Canine immobilization–routine cases
  - Canine Fractious Pet Protocol
  - Induction for the Ear Surgery Protocol if no other health problems. Provides better immobilization during anesthesia.
- Zolazepam is similar to diazepam, which is a minor tranquilizer. Duration of action: one to two hours, dogs; three to four hours, cats.
- Tiletamine is a dissociative like ketamine. Duration of action: two to three hours, dogs; one and a half to two hours, cats.
- In cats, zolazepam is metabolized slower than in dogs; therefore, cats experience a much smoother recovery from Telazol® anesthesia than dogs. Dogs having a rough recovery from Telazol® may benefit from an additional dose of midazolam 0.05 to 0.1 mg kg IM, IV.
- Not an ideal choice for pets with known cardiac disease
- Pharmacokinetic data is limited. Ketamine, a similar drug, is only 50% protein-bound.
- See Premedications, page 34.

FLUID THERAPY IN PETS

Introduction

Most anesthetic drugs affect the circulatory system and renal function, thus fluid administration for patients under general anesthesia is Banfield's practice standard. IV fluid therapy also maintains venous access and enables the management of fluid and electrolyte disturbances. The patient's current health status, underlying disease, and fluid and electrolyte status were taken into consideration when our anesthesia protocols were in development. Please refer to the individual protocols for the specific fluid type, volume and rate of fluid administration. The following is a general overview of fluid therapy considerations surrounding anesthesia.

Types of fluids

The broad types of fluids that can be administered intravenously are crystalloids, colloids and oxygen-carrying fluids. The only oxygen-carrying fluids available to the veterinary market now are fresh whole blood transfusions or packed red cell transfusions, since Oxyglobin® (a bovine hemoglobin-based oxygen carrier), is off the veterinary market. More comprehensive and vitally important details regarding administration of oxygen-carrying colloids and accomplishing blood transfusions are beyond the scope of this book, but can be found in other references.

Crystalloids are aqueous solutions that contain electrolytes and non-electrolyte solutes which can pass easily through capillary membranes. The crystalloid solutions currently used in the Banfield practice are:

- 0.9% sodium chloride (0.9% NaCl)
- 0.45% sodium chloride with 2.5% dextrose (2.5% dextrose/0.45% NaCl)
- Lactated Ringer's Solution (LRS)
- Normosol®-R

Colloids are aqueous solutions that contain both small and large molecules that are often too large to filter through capillary membranes and thus stay in the intravascular space.[1] Colloids are divided into natural and synthetic forms. Natural colloids consist of plasma, packed red blood cells and whole blood preparations. Synthetic colloids available include hetastarch, which Banfield currently carries.

Crystalloids

Crystalloids are used primarily for interstitial volume replacement and maintenance fluids. The composition of isotonic replacement solutions, such as LRS or Normosol®-R are considered balanced crystalloid solutions if they closely resemble the composition of extracellular components (*Table 3.5*, page 40). LRS and Normosol®-R provide electrolytes and buffers in concentrations similar to normal plasma. These solutions may be administered without inducing changes in electrolyte composition of the patient. **It is important to remember that even though LRS and Normosol®-R are balanced and contain potassium typical of normal plasma levels, they will not prevent ongoing potassium loss or correct hypokalemia.** Normal saline (0.9% NaCl) can be used as a replacement fluid even though it is not a balanced solution, as it only provides sodium and chloride. In a normal patient, 75% to 80% of the isotonic crystalloids administered IV moves to the extravascular space within two hours and serves primarily as a replacement of extracellular fluid (ECF). In most anesthetic procedures, rehydration and resuscitation with crystalloids is best accomplished by using an isotonic, balanced electrolyte solution such as LRS or Normosol®-R. Both 0.9% NaCl and 2.5% dextrose/0.45 % NaCl solutions are also isotonic and can be used as replacement fluids in select situations where Normosol®-R or LRS are not appropriate, such as hyperkalemia or alkalosis. In many situations, potassium supplementation may be necessary. Fluids that have been supplemented with potassium chloride should not be used where rapid infusion of large volumes may occur, as this can induce cardiac abnormalities.

The goal of fluid therapy in anesthetized patients is to maintain a normal physiologic state or return it to close to normal before anesthesia. The most common changes during anesthesia are related to volume or composition of the extracellular fluid. Selection of the appropriate fluid type and fluid rate for a patient, should be based on the needs of the patient and it is important to evaluate the patient before, during and after anesthesia to determine if the fluid rate and type are meeting the patient's needs.

For hypovolemic states, crystalloid fluids such as 0.9% NaCl, LRS or Normosol®-R should be used initially. Volumes one and a half to three times the calculated blood volume of the pet (blood volume of the dog is 80 to 90 mL/kg; blood volume of the cat is 45 mL/kg) may be required to restore cardiovascular values to acceptable levels.

- Dogs: 20 mL/kg bolus (up to 80 mL/kg). Cats: 5 mL/kg bolus (up to 40 mL/kg)
- Two or three large-gauge intravenous catheters may be required to achieve these fluid volume rates.

Table 3.5

Electrolyte Composition of Commercially Available Fluids

Fluid	Glucose (g/L)	Na+ (mEq/L)	Cl- (mEq/L)	K+ (mEq/L)	Ca2+ (mEq/L)	Mg2+ (mEq/L)	Buffer† (mEq/L)	Osmolarity (mOsm/L)	Cal/L	pH
Dextrose and Electrolyte Solution Composition										
2.5% dextrose in 0.45% NaCl	25	77	77	0	0	0	0	280	85	4.5
0.9% NaCl	0	154	154	0	0	0	0	308	0	5.0
Lactated Ringer's Solution	0	130	109	4	3	0	28 (L)	272	9	6.5
Normosol®-M in 5% dextrose‡	50	40	40	13	0	3	16 (A)	364	175	5.5
Normosol®-R‡	0	140	98	5	0	3	27 (A)	296	18	6.4
Plasma-Lyte§	0	140	103	10	5	3	47 (A)	312	17	5.5
50% dextrose	500	0	0	0	0	0	0	2780	1700	4.2

Source: DiBartola SP, Bateman S. Introduction to fluid therapy. *Fluid, Electrolyte, and Acid-Base Disorders in Small Animal Practice*. 3rd ed. St. Louis, Mo. Saunders. 2006;333.

† Buffers used: A, acetate; B, bicarbonate; G, gluconate; L, lactate
‡ CEVA Laboratories. Overland Park, Kan.
§ Travenol Laboratories, Deerfield, Ill.

Colloids

Colloids are primarily intravascular volume-replacing fluids. Colloids may be used in hypovolemic patients and in those with severe hypoalbuminemia (serum albumin levels are less than 2 g/dL). The benefits of colloid therapy are more rapid and provide longer-lasting support of hypovolemia. Resuscitation of perfusion deficits associated with hypovolemia requires rapid intravascular volume expansion by IV or interosseous (IO) routes of administration. Colloids and crystalloids are equally effective in expanding the plasma compartment; however, two and a half to three times more crystalloid solution must be given compared with a colloid solution. Large volumes of crystalloids rapidly administered IV can lead to extravasation into the interstitium and, potentially, the development of peripheral edema. Colloids are needed to support oncotic pressure. Hetastarch can be used to increase central oncotic pressure and avoid the problems encountered with rapid natural colloid infusion. They can also be used in conjunction with whole blood or plasma. They are not, however, to be considered a substitute for blood products when albumin, red blood cells or coagulation proteins are needed.

- Synthetic colloids should be used with caution and at reduced dosage rates in patients with congestive heart failure and in those with renal disease.
- Hetastarch can be used for resolution of volume depletion (due to hypovolemia, shock, blood loss). It can be used in combination with plasma or whole blood for ongoing hemorrhage from traumatic loss, or disseminated intravascular coagulation (DIC).
  - Dogs: 5 mL/kg bolus (up to 20 mL/kg/day)
  - Cats: 2.5 mL/kg bolus (up to 10 mL/kg/day)
  - Evaluate ECG.
  - Hetastarch has a moderate colloid effect for approximately 24 hours.
- Fresh whole blood contains red blood cells, coagulation factors, platelets, albumin, fibrinogen, globulins, white blood cells and antithrombin. A starting dosage is 10 to 22 mL/kg.
- Packed red blood cells contain red blood cells only. Starting dose is 10 mL/kg.
- Fresh frozen plasma (FFP) contains coagulation factors, albumin, fibrinogen, globulins and antithrombin. Starting dosage for FFP is 6 to 10 mL/kg.

- Blood products should always be administered warm (never exceed 99°F) with an in-line blood filter.
- Cross-matching should be performed for patients receiving blood products containing red blood cells.
- In normovolemic patients, the recommended infusion rate for whole blood or plasma products is 6 to 22 mL/kg/day. In hypovolemic patients, the rate should not exceed 22 mL/kg/hr.
- For patients with compromised cardiac function, the rate should not exceed 4 mL/kg/hr.

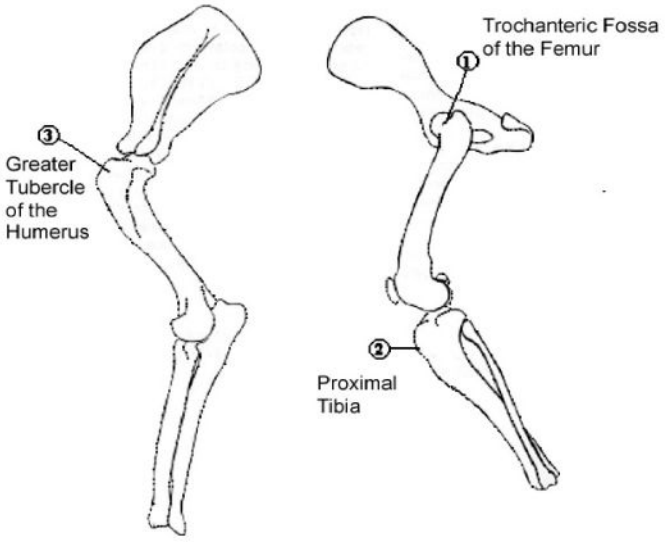
Intraosseous route (IO) for fluid therapy

It is often very difficult or impossible to deliver fluid therapy intravenously to pediatric patients, other small exotics and pets in shock. In these cases, where peripheral veins are small and collapsed, it is very important to supply the patient with fluids. Placement of an intraosseous catheter is a simple and lifesaving procedure.

Materials:

- IV fluids
- IV drip set
- 22-, 20- or 18-gauge short spinal needle is preferred to prevent bone plugs, however syringe needles of the appropriate gauge can be used
- Surgical gloves
- Most critically ill pets will not need to be sedated for IO catheter placement. If sedation is necessary, use midazolam 0.2 mg/kg plus butorphanol 0.2 mg/kg IM for both dogs and cats. (For exotic patients, please refer to the *Anesthetic Considerations for Small Exotic Pets*, starting on page 123, and proceed with the steps for the particular species or class).
- Shave and perform a surgical prep of the area over the insertion site. See *Figure 3.31* for recommended sites.
- After surgical prep, a sterile paper glove liner can be used to create a clean field over the insertion site.
- Block the skin over the site and the deep tissues, including the periosteum, with lidocaine. Calculate the lidocaine dose carefully to avoid toxicity due to overdose. The maximum lidocaine dose for a local block is 2 mg/kg.
- If the site cannot be easily palpated because of fat/muscle tissue or tough skin, make a small stab incision to facilitate insertion of the needle into the bone. Note: Difficult insertion can result in a bent/dulled needle or tissue trauma.
- Insert the needle, with the stylet in place (See *Figure 3.31* for location and orientation of the needle), into the trochanteric fossa of the femur, greater tubercle of the humerus or proximal tibia. Use moderate direct pressure or, if necessary, a back-and-forth screwing motion through the cortex. Puppies and kittens have very soft bones, and very little pressure is needed.
- Once the needle is in the marrow cavity there should be no resistance. If there is resistance, the needle is cortical bone and may need to be withdrawn partway and redirected. Continue through the cortical bone to reach the marrow cavity or withdraw the needle a few millimeters to see if the needle is hitting the cortical bone on the opposite side of the marrow cavity.
- To confirm correct placement, remove the stylet, attach a sterile 3 mL syringe and aspirate. A small amount of marrow should be visible in the hub. Marrow is not always retrieved, especially in exotics. If the needle is well-seated you should be able to move the limb by moving the hub of the needle and sterile fluid should flow easily into the needle with no subcutaneous build-up of fluid.
- Secure the hub of the needle with tape and/or suture. E-collars are highly recommended to prevent patient aggravation of the site.
- Attach IV fluids. Anything that can be administered IV (with the exception of chemotherapeutic agents), can also be administered via IO catheter. Follow the same dose and fluid rate as used for IV.
- If fluids are not to be continuous, a catheter male adaptor plug may be inserted and the site padded with gauze and vet-wrapped to protect the hub.
- IO catheters may be left in place for up to 72 hours in a critically ill patient. The IO catheter must be pulled if the patient becomes active and bends the needle.

Figure 3.31: Placement Sites for Interosseous Catheter



Possible complications

- **Infection resulting in cellulites, subcutaneous abscess or osteomyelitis.** Proper sterilization and prep of area before catheter placement will greatly reduce the chance of infection.
- **Extravasation of fluid around the puncture site**. This will be absorbed once fluids are stopped.
- **Needle breaks off in the bone.** As long as there is no infection or tissue irritation, this is unlikely to be a problem. If a portion of the needle is in the subcutaneous space, then you can attempt retrieval with a cut-down.

Possible reasons for therapeutic failure

- Misplacement, bending or clogging of the needle
- Puncture through the bone
- Replacement of the marrow cavity with fat or fibrous tissue

Complications of fluid therapy

Fluid overload can be a major complication of IV fluid therapy. Patients with underlying cardiac, renal or pulmonary dysfunction are particularly susceptible to fluid overload. Symptoms of fluid overload include serous nasal discharge, coughing, restlessness, dyspnea, pulmonary crackles, chemosis, ascites, diarrhea and fluid extravasation from the catheter site. These clinical signs can resolve when IV fluids are discontinued. Cats are more susceptible to fluid overload and should be monitored closely whenever fluids are being administered. Other complications that should be monitored include catheter site complications, hypoproteinemia and/or hypoalbuminemia and electrolyte disturbances.

Reference

1. Chan DL, Rozanski EA, Freeman LM, Rush JE. Colloid osmotic pressure in heath and disease. *Compendium.* 2001;23(10):896-904.

SECTION 4:

Equipment

SECTION 4

Equipment

ANESTHESIA EQUIPMENT

This section reviews specific recommendations for various anesthetic-related items. While other members of the hospital team can select and prepare equipment, it is the responsibility of the attending doctor to ensure that the proper anesthetic equipment is chosen for each pet and that the equipment is in good working order prior to induction (See *Anesthesia System Flow Chart*, page 50).

Intravenous (IV) catheters

Table 4.1

Recommended IV Catheter Size	
Wt. (kg)	**Catheter Size**
> 16 kg	18-gauge
9 to 16 kg	20- 18-gauge
2 to 8.9 kg	22- 20-gauge
< 2 kg	24- 20-gauge

When selecting catheter sizes (*Figure 4.1*), the largest catheter that will not traumatize the vein should be used. This allows for the rapid administration of fluids and drugs if needed in an emergency situation. The ranges listed above can be used as a guideline to aid in selecting catheters, and should be used in conjunction with evaluating the patient's size and condition. Normal saline should be used to flush catheters. Heparinized saline is not recommended due to risk of inducing coagulation defects in small pets with repeated use or accidental mixture of too strong of a solution.

Figure 4.1

IV catheters

Laryngoscopes

A laryngoscope should always be used to aid in intubation. This is especially important when intubating cats and brachycephalic dogs. Using a laryngoscope to visualize the trachea reduces the risks of complications during intubation. Test the laryngoscope prior to inducing anesthesia. The small blade is typically used for cats and small dogs, and the large blade is typically used for medium and large dogs.

Endotracheal tube selection

Figure 4.2

Endotracheal tubes

- Selecting the correct tube size will depend on the breed and body condition of the patient (*Figure 4.2*). Selecting tubes based on patient weight can lead to the wrong tube size being used; this is especially true in overweight or brachycephalic patients.
- The largest tube that will fit easily and not irritate or traumatize the trachea is recommended.
- There are two methods to assist in selecting an endotracheal tube:
  - The endotracheal tube size should be as close as possible to the diameter of the trachea. Digitally palpating the patient's trachea will often help to indicate optimal tube size.
  - The distal end (end going into the patient) of the endotracheal tube can be measured against

Figure 4.3

The distal end of the ET tube can be measured against the width of the patient's nasal septum.

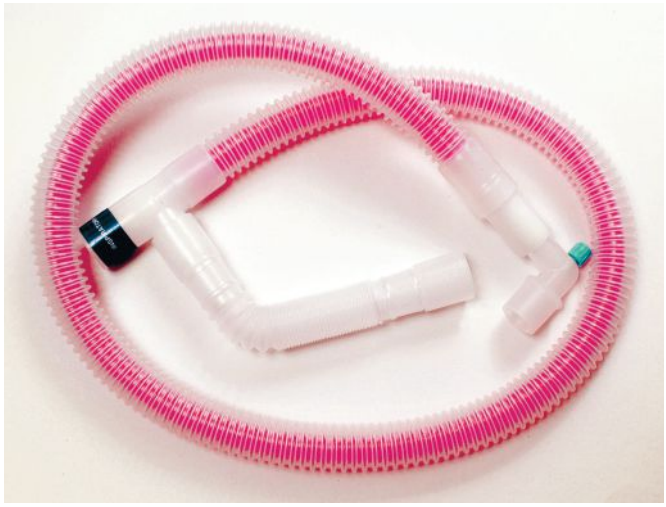
the width of the patient's nasal septum. While this method is effective, there is the possibility of selecting a size too small (*Figure 4.3*).

- It is recommended to have three endotracheal tubes ready prior to intubation—the tube intended for use, along with one larger and one smaller in diameter. This will ensure that additional tubes are at hand if the tracheal diameter is over- or underestimated.
- Cuffs should be tested for integrity before use. When checking the cuff for leaks, do not over-inflate the cuff as this will destroy the cuff (See *Induction and Intubation,* page 65, for additional information).
- Tubes must be clean and in good condition.
  - Endotracheal tubes should be rinsed after every use with a mild detergent or antiseptic (antibacterial hand soap or dilute chlorhexidine).
  - The tubes can soak in plain water when necessary to aid in removing mucus or other debris.
  - Always ensure the cuff is inflated during the washing process to remove any debris on the cuff.
  - Endotracheal cleaning brushes MUST be used to clean the internal surfaces of the tube to remove any mechanical obstruction within the tube.
  - ALL cleaning residue MUST be rinsed completely with water. Residual chlorhexidine has been associated with epithelial ulceration and chemical burns in the oral cavity and trachea of cats exposed to it. Be careful and thoroughly remove any detergent residue.
  - After cleaning, deflate the cuff and hang to dry.

Breathing circuit guidelines

- 2 to 10 kgs use pediatric (pink) rebreathing circuit (*Figure 4.4*)
- 0 to 2 kgs use non-rebreathing circuit (*Figure 4.5*)
- > 10 kgs use adult (blue) rebreathing circuit
- Breathing circuit selection should be based on the patient's ideal body weight. A patient's ideal body weight may be different from actual body weight. Using what the patient *should* weigh is important as lung size and breathing capacity do not change with weight gain.

Figure 4.4

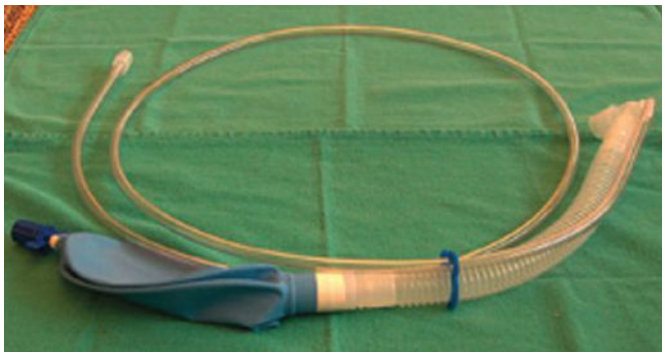


Universal F circuit: rebreathing circuit

Non-rebreathing circuit

The non-rebreathing (Bain, Jackson-Rees) circuit should be utilized on pets that are 2 kgs or less (*Figure 4.5*). It is important to remember that the non-rebreathing circuit is a semi-closed system and does not utilize the CO_2 absorbent. In order to prevent rebreathing of CO_2, the flow rate of oxygen must be higher than the patient's respiratory volume. Therefore, the oxygen flow rate should never be below 2 L per minute when using a non-rebreathing system.

Figure 4.5



Non-rebreathing circuit

Tips for connecting the non-rebreathing circuit:

- The patient end is the portion of the breathing circuit that is connected to the endotracheal tube or mask on the patient. (Banfield only recommends the use of masks for exotic or pocket pets.)

- The quick-disconnect connects to the anesthesia machine by inserting it into the female end of the tubing that comes out of the vaporizer.
- The exhalation limb on the non-rebreathing circuit should be inserted into the scavenger hose that is a part of the hospital's anesthesia scavenger system. **Always verify that the pop-off valves on the non-rebreathing circuit are open before connecting to the scavenger system.**
- Always trace the flow of gas through the anesthesia machine to ensure that the non-rebreathing circuit has been set up properly.

Care and cleaning of circuits

Breathing circuits should be leak tested before each use and on a monthly basis. Keep at least two of each breathing circuits on hand in case of a leak. Breathing circuits are consumable items and should be replaced every six months.

Rebreathing circuits and non-rebreathing circuits should be cleaned daily in a dilute chlorhexidine solution. Tubing and bags should be soaked for no more than 10 minutes and then thoroughly and completely rinsed in water after soaking. Remove as much of the water as possible from the circuits and bags by using centrifugal force. Hang circuits to dry after cleaning. Do not leave them attached to the anesthesia machine.

Anesthetic rebreathing bags

When selecting which size bag to use, the decision should be based on the patient's ideal body weight (See *Figure 4.6* and *Table 4.2*). Anesthetic rebreathing bags should be leak tested before each use and on a monthly basis. Keep at least two of each bag size on hand in case of a leak. Bags are consumable items and should be replaced every three to six months.

Figure 4.6

Anesthetic rebreathing bags

Table 4.2

Anesthetic Rebreathing Bag Size	
Wt. (kg)	**Bag Size**
0-4.5 kg	½-L bag
4.6-9 kg	1-L bag
9.1-27.2 kg	2-L bag
27.3-54.4 kg	3-L bag
54.5 and above	5-L bag

Oxygen cylinders

There are various sizes of oxygen cylinders in our practice. The approximate minutes of oxygen remaining in a partial tank can be calculated based on the oxygen tank's capacity and the oxygen flow rate (L/min). Full tanks, regardless of size, are pressurized to approximately 2,000 psi (pounds per square inch). This pressure decreases proportionally as the tank empties.

- The small E tanks hold 600 liters of oxygen. If there are no backup E tanks in the hospital, surgery should not be attempted with less than 500 psi remaining in the tank.
- The watermelon tanks that fit into the back of the anesthesia cart hold 1,200 L of oxygen. With 500 psi, there are 300 L of oxygen.
- The large H tanks hold 7,000 L of oxygen, and at 500 psi (1/4 left), 1,750 L of oxygen remains. If running a flow rate of 1 L/minute, there is adequate oxygen delivery for 1,750 minutes or 29 hours of anesthesia time.

Capacity (in L)/ service pressure (in psi) = remaining contents (in L)/gauge pressure (in psi)

OR

Capacity (in L)/ service pressure (in psi) x gauge pressure (in psi)/(L/min to be delivered) = minutes left at the flow rate.

Figure 4.7

Soda lime canister

Soda lime canister

One of the most important maintenance items on the anesthesia machine is the absorber assembly, which contains the canister for the CO_2 absorbent (soda lime, Carbolime®, Amsorb®, etc.) which removes carbon dioxide from the rebreathing circuit. The canister filled with absorbent is a common area for malfunctions in the anesthetic system and is a source of resistance during ventilation. It is removed regularly to change the CO_2 absorbent and leaks can result from failure to create a tight seal when replacing the canister. Proper packing of the canister is necessary to prevent flow of gases over a single pathway inside, which can lead to excessive dead space. Gently shake the canister when filling it with soda lime to prevent loose packing and reduce channeling. Packing too tightly causes dust formation and increases resistance to ventilation.

It is important to understand the function of the chemical absorbent. Calcium hydroxide is the primary component of CO_2 absorbents. Depending on the fresh gas inflow, all or part of the exhaled carbon dioxide may be absorbed chemically. Chemical absorption of carbon dioxide enables a lower flow of fresh gas, reduces waste of inhalant anesthetics and oxygen and minimizes the cost of anesthesia.

When checking a rebreathing system, make sure that the CO_2 absorbent is functional. CO_2 absorbents can become exhausted or desiccated when used beyond their capacity to hold carbon dioxide. Desiccation occurs when the absorbent becomes "dried out" whether from being utilized within the breathing circuit, sitting in the canister during periods when it is not in use, or if left unsealed in storage. Whereas fresh granules will be soft enough to crush, the exhausted granules are chemically altered and hard. Once the granules become hardened, they will no longer absorb carbon dioxide and should be thrown away and replaced immediately. Indicators of pH are added to the absorbents so that as chemical reactions happen, the color of the granules changes. Most CO_2 absorbents will turn from white to violet as the granules become exhausted. However, not all absorbents will maintain the violet color and the granules will revert back to white after a period of time. This does not indicate that the granules are safe to continue using. **CO_2 absorbents should be changed routinely; do not wait for color change to replace absorbent.**

When the granules are exhausted and carbon dioxide is not effectively removed from the rebreathing system, there is an increased potential for hypercapnia. Hypercapnia can lead to respiratory acidosis, and is also associated with sympathetic stimulation and cardiac arrhythmias that can lead to cardiac arrest. High levels of carbon dioxide can also depress the central nervous system and have anesthetic effects.

Another risk related to continued use of exhausted or desiccated CO_2 absorbent is that dangerous levels of carbon monoxide gas and compound-A may be generated within the anesthesia system. These chemicals are released through a reaction that occurs between the absorbent and the anesthetic agent (sevoflurane). These reactions are typically seen when absorbents that contain sodium hydroxide (NaOH) and/or potassium hydroxide (KOH) are still used after they have become desiccated.

Routinely changing the CO_2 absorbent will help prevent this reaction from occurring. The CO_2 absorbent should be changed based on anesthesia time. The following are recommendations based on the type of canister and amount of absorbent each canister holds. Please note that these are general recommendations only:

- The tidal volume of the patient is the determining factor; *i.e.*, the larger the patient, the more carbon dioxide is produced and the faster the granules may be exhausted.
- The soda lime canisters are 1,800 to 1,850 mL and hold approximately one full three-pound bag of

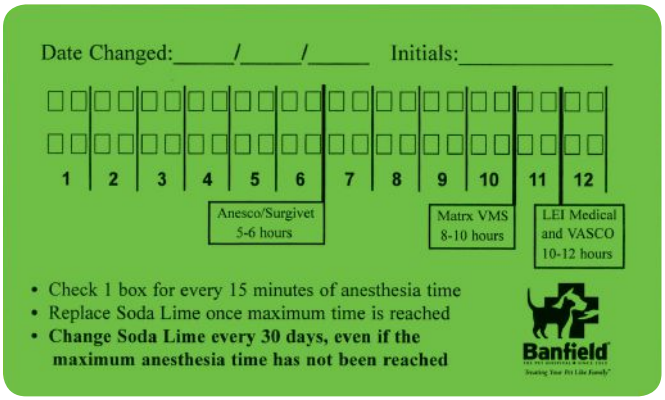
absorbent. Any absorbent left in the bag after filling the canister should be discarded and not stored in the hospital. The absorbent has an expected life of 10 to 12 hours of anesthesia time or four weeks maximum exposure to room air. If unsure of how long the absorbent has been in use, check the consistency of the granules before using.

- **Remember that the absorbent MUST be changed every 30 days, even if the color has not changed or the maximum anesthesia time has not been reached.**
- **When pouring the absorbent into the canister, avoid allowing granules to get in the center tube of the canister. Granules in the tube have the potential to enter the breathing circuit and the patient's airway.**

In an effort to ensure that absorbent is changed in the appropriate time frame, use soda lime stickers, 3- by 5-inch stickers that are placed on the absorbent canister (*Figure 4.8*). For each 15 minutes of anesthesia, one box is checked off. When the maximum amount of anesthesia time has been reached:

- The CO_2 absorbent is changed.
- The sticker is removed. A new sticker is placed on the canister.

Figure 4.8



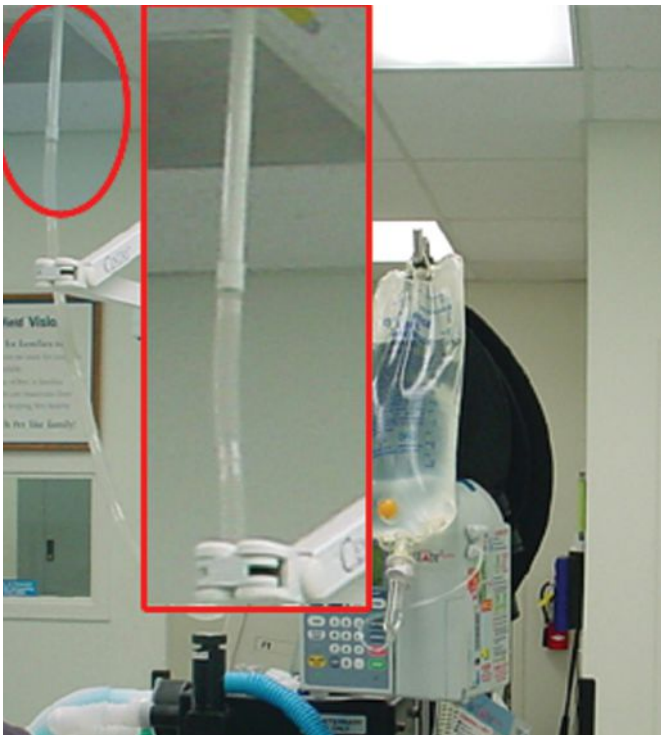
Soda lime sticker

Evacuation system

If the active waste gas evacuation (scavenger) system is out of balance, anesthetic gases will follow the path of least resistance. If negative pressure is applied to the pop-off valve on the rebreathing head or the bag bleed valve on the non-rebreathing system, the patient may not be getting the proper dose of anesthetic. To prevent this, the evacuation system must be hooked up and adjusted properly.

- One end of 22 mm translucent, white corrugated tubing attaches to the fitting in the ceiling, the other end attaches to the waste gas interface valve on the machine. **Note: Do not connect 22 mm tubing from the ceiling directly to the pop-off valve or bag bleed valve.**
- One end of the 19 mm evacuation, blue corrugated tubing attaches to either the pop-off valve on the rebreathing head or the bag bleed valve on the non-rebreathing system; the other end attaches to the waste gas interface valve on the machine.

Figure 4.9



Evacuation system

The ceiling adjustment handle, if the hospital is equipped with one, must be in the proper position to attain the proper negative pressure. This is at approximately a 45-degree angle (adjustments may be needed). Newer hospitals will not have an adjustment handle because the new waste gas interface has an auto-regulation feature.

If the waste gas interface valve is bypassed and the negative pressure from the evacuation system in the ceiling is applied directly to the anesthesia system's pop-off valve or bag bleed valve, it will be difficult to maintain an appropriate plane of anesthesia, and the patient may not stay anesthetized (Refer to *Troubleshooting,* page 52-53, for more information). All Banfield hospitals should have a scavenger system. This system has been installed for the safe removal of waste anesthesia gases generated during anesthesia. It is utilized in conjunction with the anesthesia machine. If your hospital has an "F-Air Canister" and not a fan-style system, contact the CTS Facilities Hotline (ext. 5566).

The scavenger unit is a UL-approved, custom-made exhaust fan housed in a 12-by 12- by 6-inch stainless steel box. This box is mounted above the ceiling tile in your hospital. It has been designed to draw in waste anesthesia gases and then expel those gases through a pipe in the roof of the building to the outside.

The system itself consists of preset balancing valves—gate valves with a 1 1/2-inch diameter copper or white-painted pipe extending 7 to 18 inches below it—that descend from the ceiling in the surgery and treatment rooms. The clear plastic tubing that comes with the anesthesia machine connects from the anesthesia machine to the end of the balancing valve pipe. The balancing valves are connected above the ceiling tile in both rooms to a series of horizontal 3-inch copper piping, which is connected directly to the scavenger unit intake opening.

Once the exhaled gases are drawn up through the balancing valve and piped into the unit, they are expelled into a copper pipe leading up through the roof to the outside.

This unit is turned on and off by a lighted wall switch commonly located inside or directly outside the surgery room. If the switch in your hospital is not a lighted one, contact CTS Facilities Hotline (ext. 5566) for assistance. All scavenger units are equipped with a fusible link to prevent motor damage or tripping of the electrical circuit. It is very important to **turn off** the scavenger unit when not in use. This unit was not designed to run continuously and, if left on, the life of the unit will be severely compromised. Older hospitals may have a scavenger unit located below the ceiling tile in the maintenance room. This unit is turned on and off by means of a toggle switch located on the unit itself. This unit's piping system above the ceiling is the same as all others.

In order to help all associates in the hospital quickly recognize the on-off switch for the scavenger system, use a label printer to make a "Scavenger" label to place on the switch cover plate. It is the doctor's responsibility to ensure each veterinary technician/assistant understands how the scavenger system works and why it is important to utilize it correctly.

Regulator

Figure 4.10

Oxygen regulator

The oxygen regulator is a medical grade, preset, non-adjustable regulator designed to reduce oxygen tank pressure from approximately 2,000 psi, when full, to approximately 50 psi. The oxygen regulator can fail, resulting in pressure being too high or too low.

A high-pressure failure of the regulator may result in one or more of the following:

- Failure of the oxygen quick-disconnects
- Failure of the oxygen check valves in dual gas supply
- Failure of tubing
- Failure of oxygen flush
- Oxygen leak from regulator

A low-pressure failure of the regulator may result in one or more of the following:

- Improper or insufficient oxygen flush
- Improper or insufficient oxygen delivered to patient
- Failure of oxygen to pass through the regulator

Solution: If any one of the above conditions exists, replace oxygen regulator. Call CTS Facilities Hotline (ext. 5566) before proceeding.

Manometer

Figure 4.11

Manometer

When not in use, the needle on the manometer gauge should be at zero. The re-zero screw is located at the 12 o'clock position under the crystal manometer cover. Remove the cover by turning counter-clockwise. Adjust the screw mechanism until the needle is zeroed. Replace manometer cover.

- If the manometer will not re-zero, or if the needle will not deflect proper pressure, it should be replaced.
- If the manometer cover is cracked, broken or missing, it should be replaced.

Oxygen flush valve

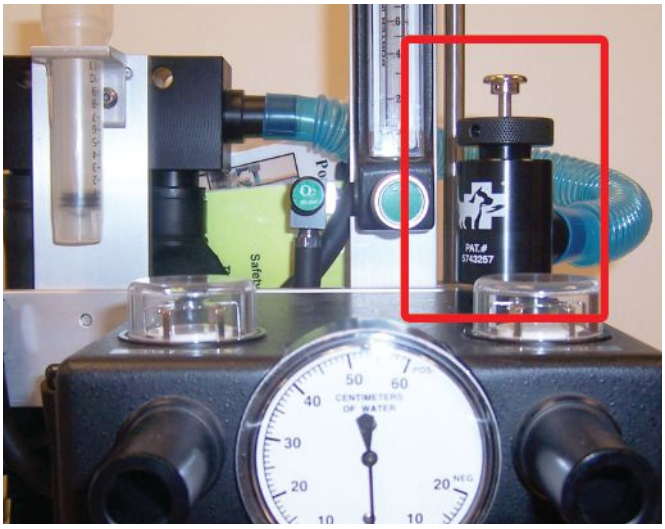
The oxygen flush valve allows the delivery of a high flow rate of oxygen (35 to 75 L/min), while bypassing the vaporizer. Using the flush valve will quickly fill the breathing system with pure oxygen, which can produce a rapid decrease in anesthetic depth. The flush valve is not intended for routine use when a patient is attached to the anesthesia machine, especially not when a non-rebreathing circuit is used or when the safety pressure relief valve is closed.

The flush valve should be used when performing a leak test on the anesthesia machine (See *Figure. 4.14*, page 51). The flush valve should not be used to inflate the rebreathing bag during an anesthetic procedure. Instead, turn up the oxygen flow rate until the bag fills.

Safety pressure relief valve

This valve is designed to stay open and can only shut when it is forcefully pressed down (See *Figure 4.14*, page 51).

Figure 4.12



Safety pressure relief valve

Vaporizer and anesthesia machine service

Vaporizer service: Because sevoflurane is a relatively clean anesthetic, it is recommended that sevoflurane vaporizers be professionally cleaned and calibrated every one to three years, depending on the type of vaporizer. Vaporizer maintenance includes the following:

- Leak test the vaporizer.
- Output test of the vaporizer using Lamtec® 605 infrared spectrophotometer or Riken analysis.
- A written report on the status of the vaporizer.

Fill new/empty vaporizers with sevoflurane 45 minutes prior to use to saturate the wick.

Anesthesia machine service: The entire anesthesia device will be serviced every two years. The service will include, but is not limited to, the following:

- Replace all tubing.
- Replace all seals.
- Replace top canister gasket.
- Replace bottom canister gasket.
- Replace dome "O" rings (two each).
- Replace downtube "O" ring.
- Leak test high pressure system.
- Leak test low pressure system.
- Inspect pop-off valve pressure.
- Inspect waste gas interface device.
- Re-zero manometer.
- Install mechanical stop oxygen flow control assembly, if not previously upgraded.
- Adjust existing mechanical stop oxygen flow control assembly if necessary.

- Inspect all components for proper fit, alignment, adjustment and operation.
- Consumable items will not be inspected or replaced at the two-year service. It is up to individual hospitals to ensure that their rebreathing sets, rebreathing bags and non-rebreathing systems are in proper condition for use.
- Anesthesia machine: It is **imperative** that the entire team associated with anesthetizing a pet understands how the machine works and can trace how oxygen flows through the unit to the pet (*Figure 4.13*).

Figure 4.13: Anesthesia System Flow Chart

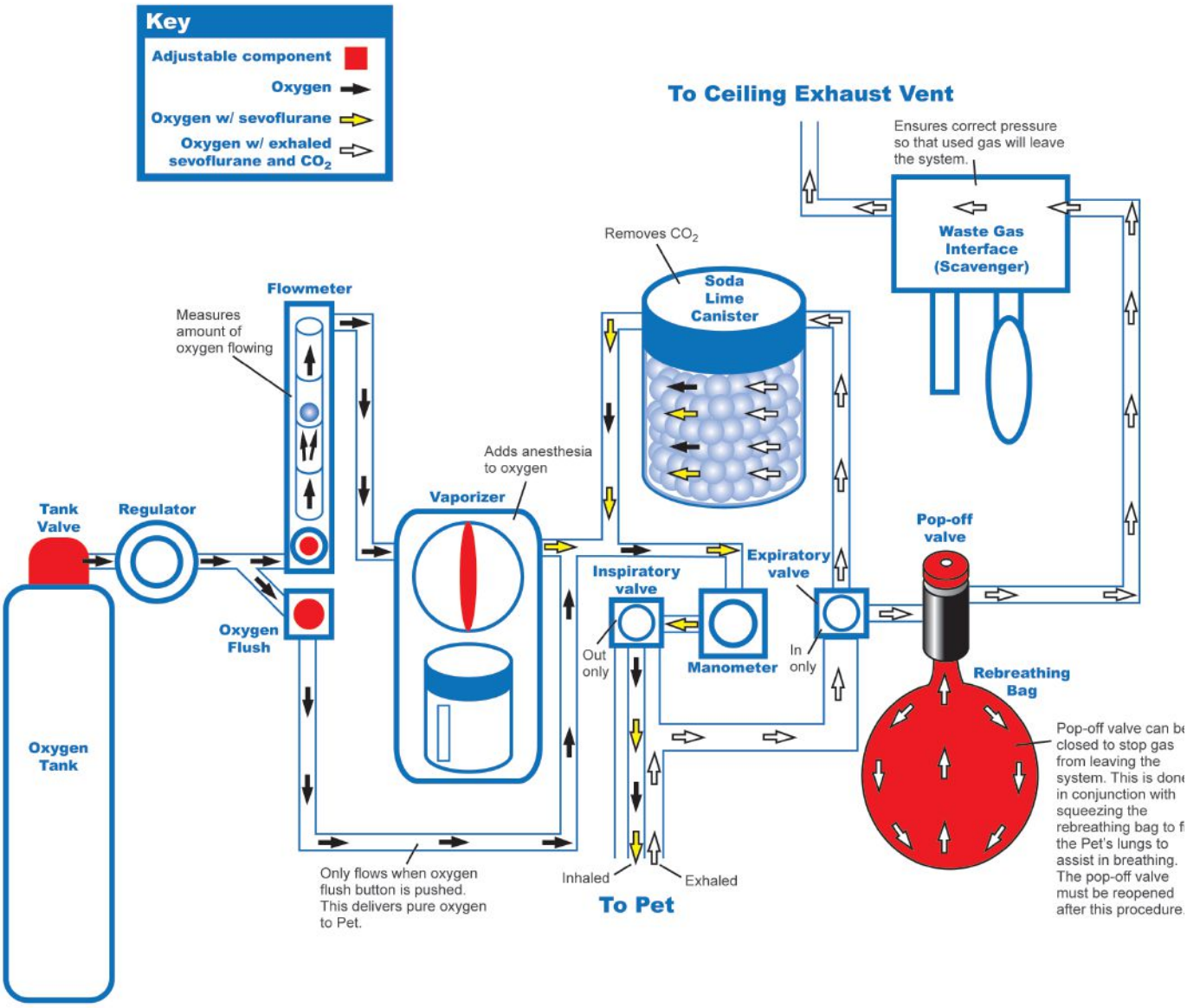
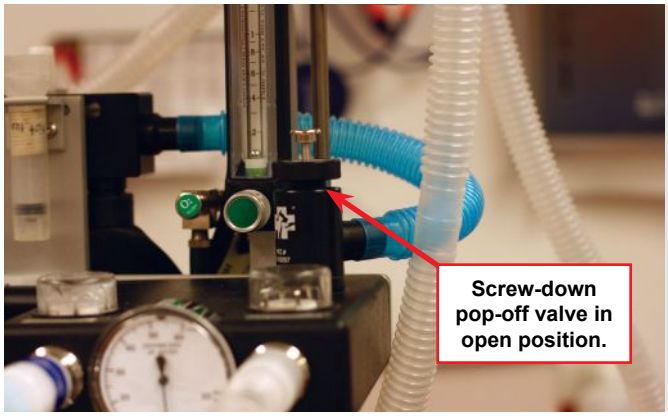


Figure 4.14

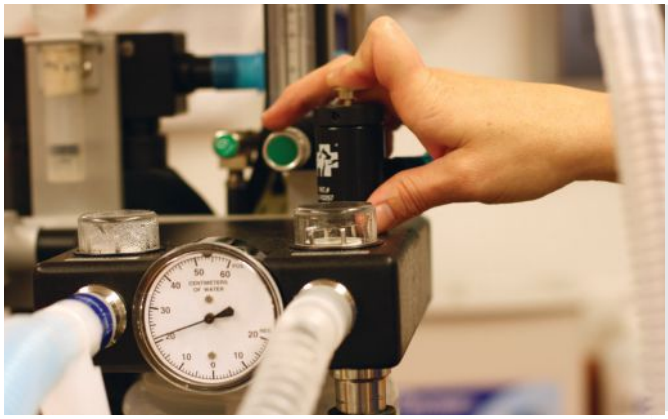
Pop-off Valve Functional Settings



Normal Operation

Screw-down pop-off valve is open and push-button valve is up.

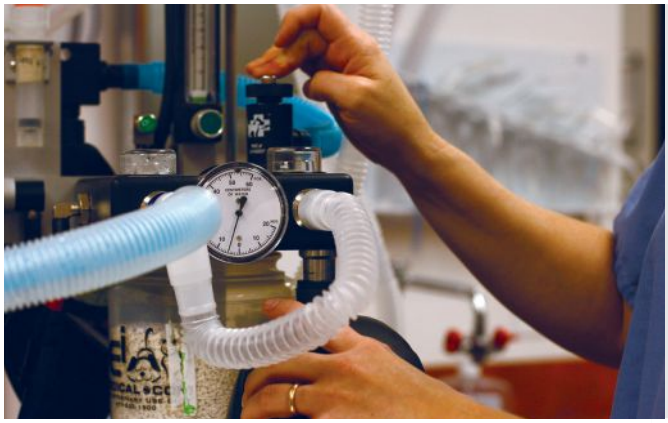
- In this position, the system is fully open and gas will pass freely.
- The manometer should read "0" with slight fluctuations during respiration.
- Squeezing the rebreathing bag should not create pressure in the system.



High Pressure Leak Check

Screw-down pop-off valve is closed and push-button valve is depressed.

- In this position, the system is completely sealed and very high pressures can be obtained. This allows a high pressure check for system leaks.
- **This position should never be used with a patient connected to the system.**
- The screw-down pop-off valve should be opened after the high pressure leak check is completed.



Manual Ventilation

Screw-down pop-off valve is open and push-button valve is depressed.

- In this position, the system is closed but will leak at pressures of 20 to 25 cm H_2O.
- This allows enough pressure to manually ventilate the patient without risking excessive pressure, which can cause pulmonary damage and death.

User Error Safety

Screw-down pop-off valve is closed and push-button valve is open.

- In this position, the system is partially closed but will leak at 0.5 cm H_2O. This will not cause injury to the patient but depressing the push-button valve to ventilate the patient would allow excessive pressure and could injure the patient.
- This setting is designed to stop patient deaths associated with leaving the pop-off valve closed, but it is not recommended for normal operation.

TROUBLESHOOTING

When performing any troubleshooting on the anesthesia machine, it is imperative to consider how each part works together, and to check each part to accurately identify any leaks or broken equipment.

For example, if patients are not staying anesthetized even with the vaporizer set to 4% or higher, complete the following steps using information outlined in the sections below:

1. Check for right bronchus intubation. When the endotracheal tube is placed in the right bronchus, anesthetic gas is only administered to one lung. If this occurs, back out the endotracheal tube and repeat intubation.
2. Check the breathing circuit and endotracheal tube for physical obstructions–if found, remove.
3. Check the system for any leaks–check the entire system as there may be more than one leak.
4. Check the evacuation system for the appropriate balance of positive and negative pressure.
5. Check the oxygen flowmeter and regulator.
6. Check that the vaporizer is filled and working correctly.

Note: Questions can be directed to your medical director, a medical advisor (ext. 7800), or the CTS Facilities Hotline (ext. 5566).

Checking for leaks:

- Performing a leak test will verify that the system is maintaining pressure.
- This should be performed prior to every anesthetic procedure.

Performing the leak test on the anesthesia cart:

- Close the pop-off valve and cover the end of the anesthesia tube with your palm or finger, or utilize the small, white plastic cylinder found on the back of the anesthesia cart as a plug.
- Push the oxygen flush bag (not to be used when a patient is attached to the anesthesia system) or turn the flowmeter on until the manometer reads approximately 20 cm H_2O, or the rebreathing bag is filled.
- While still covering the end of the anesthesia tube, monitor the manometer–it should stay at a fairly constant pressure.
- If the pressure remains fairly constant, with the oxygen turned off, the machine can be considered free of leaks on the low pressure side.
- If the manometer reading drops rapidly, the bag deflates rapidly, or there is a hissing sound, there is a leak. See below on identifying and correcting leaks in the circuit.
- While still covering the end of the anesthesia tube, reopen the pop-off valve to the usual setting.
- Make certain that the pop-off valve is reopened; a closed pop-off valve can result in serious anesthesia complications including the death of the pet.
- While still covering the end of the anesthesia tube, squeeze any remaining gas in the rebreathing bag to ensure the gas has an unobstructed way out through the evacuation system.

Identifying and correcting leaks:

- If the system does not maintain pressure, check all hoses, including the rebreathing circuit; the rebreathing bag; the area around the pop-off valve, vaporizer inlet and outlets; any mechanical fittings; the "O" rings; the CO_2 absorbent canister for cracks and proper seating; and any other fittings or seals.
- Windex® can be sprayed on the hoses and around the connections while performing the leak test to identify where a potential leak may be. Keep in mind that it may take a few seconds for bubbles to appear around a leak after application of the Windex®. To correct, replace the hose, bag, seal or equipment where the leak has been identified.

Checking for leaks around the endotracheal tube:

- While the patient is still intubated and connected to the anesthesia machine, close the pop-off valve and squeeze the rebreathing bag until an inspiratory pressure of 18 to 20 cm H_20 is reached.
- Do not hold the breath for longer than two to three seconds.
- While administering the breath, listen for a hissing or leaking sound around the endotracheal tube.
- If a leak is NOT heard, do not add/remove air from the cuff.
- Checking the cuff for leaks and cuff inflation may need to be repeated three to five minutes after the anesthetic inhalant has been started. As the patient becomes anesthetized, the muscles in the trachea and larynx will relax, which may cause a leak to develop.

Correcting leaks around the endotracheal tube:

- If a leak is heard around the endotracheal tube while performing a leak test, only add air to the cuff until the sound stops.
- Air should be added in small increments to prevent over-inflation from occurring.

Checking the evacuation system:

- The scavenger drop tubes should have negative air pressure present at the opening. A very slight intake of air should be felt when placing your hand near the opening. To test the level of suction of the evacuation system, hold a tissue to the opening and watch to ensure that the tissue is *gently* drawn to the scavenger tube. **Do not allow the tissue to be drawn into the tube.**
- Ensure that the evacuation system is turned on prior to testing.
- If there is too much suction or negative pressure, the scavenger system will pull anesthesia through the system along with the waste gases.
- If there is not enough negative pressure, waste gases will not be pulled from the breathing circuit and may cause potential harm to patients and hospital associates.
- If your hospital evacuation system has an adjustment handle, ensure that it is set to approximately a 45-degree angle.
- To correct a pressure imbalance, contact the CTS Facilities Hotline (ext. 5566) for assistance.

Checking the oxygen tanks and flowmeter:

- Turn off oxygen flowmeter. Turn on oxygen tank. Watch oxygen tank pressure gauge on the regulator. When the needle on the gauge is stable, turn off oxygen tank. If needle drops, there is a leak. The faster the needle drops, the bigger the leak.
- Possible sources of leak:
  - Oxygen regulator or hose nut is not tight. **Solution:** Tighten oxygen regulator and hose nut.
  - Oxygen flowmeter flow control assembly stuck in open position. Float (ball) in flowtube will not go to zero. The float may be stuck in the flowmeter such that it is perceived that oxygen is flowing, when it is not. Debris in the flowmeter may be causing it to fail. **Solution:** Replace oxygen flow control assembly.
  - Oxygen flush seal defective (very rare). Oxygen will leak past oxygen flush valve and dilute the concentration of anesthetic in the breathing circle. **Solution:** Replace entire oxygen flowmeter and flush assembly (rail system).
  - Loose fitting on back of flowmeter (rare). **Solution:** Tighten fitting with crescent wrench.
  - Faulty check valve in dual gas supply (very rare). **Solution:** Replace check valve.
- Check the oxygen flowmeter control/knob (identified by a green plastic knob). Oxygen flow control assembly, found on earlier models, may be damaged. Over-tightening of oxygen flow control assembly results in damage to seat (where oxygen can leak past seat so that oxygen flow cannot shut off) or damage to needle valve (where needle valve can break off in seat which prevents the flow of oxygen–knob and shaft continue to turn without oxygen flowing).
- If oxygen flush does not work, check to ensure that oxygen tank is on. Open tank valve by several turns.
- If oxygen flush and oxygen flowmeter do not work and tank is on, the regulator needs to be replaced or the oxygen tank needs to be replaced. **Solution:** Try another oxygen tank, if problems persist, change out regulator.
- If the oxygen flowmeter control/knob is deemed defective (you are able to continually turn it past the point of normal function), it will be replaced with a flowmeter control/knob that contains a built in mechanical stop.

Checking the vaporizer:

- As vaporizers begin to fail, the amount of anesthetic gas produced may be less than the percentage noted on the dial. Before calling for service, check the following:
  - Ensure the vaporizer is not empty.
  - Check the evacuation system as noted above.
  - Check for any leaks in the breathing circuit as noted above.
  - Check the regulator and oxygen flowmeter as noted above.
  - The vaporizer drain and fill cap are both tightened down.
  - The inlet and outlet adaptors on the vaporizer fit snugly.

SECTION 5:

Preanesthetic Evaluation

SECTION 5

Preanesthetic Evaluation

PREANESTHETIC EVALUATION

All anesthesia protocols begin with a thorough patient history and physical examination—two critical steps in determining anesthetic risk. Why is this important? Most, if not all, clients are very concerned about anesthetic risk. Even when their pet appears healthy and the procedure is routine, clients want to be accurately informed of all risks.

The majority of clients view their pets as family members. According to the American Animal Hospital Association (AAHA), 70% of pet owners think of their pets as children. Caring clients will avoid unnecessary risk. How do we best manage risk, assuring our clients, and ourselves, that we are doing everything possible to maximize patient safety?

Using a systematic approach to preanesthetic patient evaluation is one essential step that, as part of an entire anesthetic system, has improved outcomes in Banfield hospitals. The goals of a preanesthetic medical assessment are to:

- Decrease morbidity and mortality with anesthesia
- Determine the health status of a patient to minimize the risk of adverse events
- Increase quality of care
- Promote a problem-oriented approach to the procedures
- Earn clients' trust by ensuring their pet's safety and well-being
- Provide baseline test results for future health care when applicable

Gathering information

The preanesthetic evaluation answers three questions:

1. Is the patient in the best possible condition or optimal health to undergo anesthesia?
2. Does the patient have a concurrent condition that should be addressed before the anesthetic procedure?
3. Does the health status or concurrent medication influence the anesthetic event, or delay or even cancel the procedure?

The most important step of the preanesthetic examination is to accurately determine the patient's health status. The preanesthetic evaluation is critical in minimizing the risk of morbidity and mortality, enabling the clinician to anticipate and possibly prevent potential complications during anesthesia.

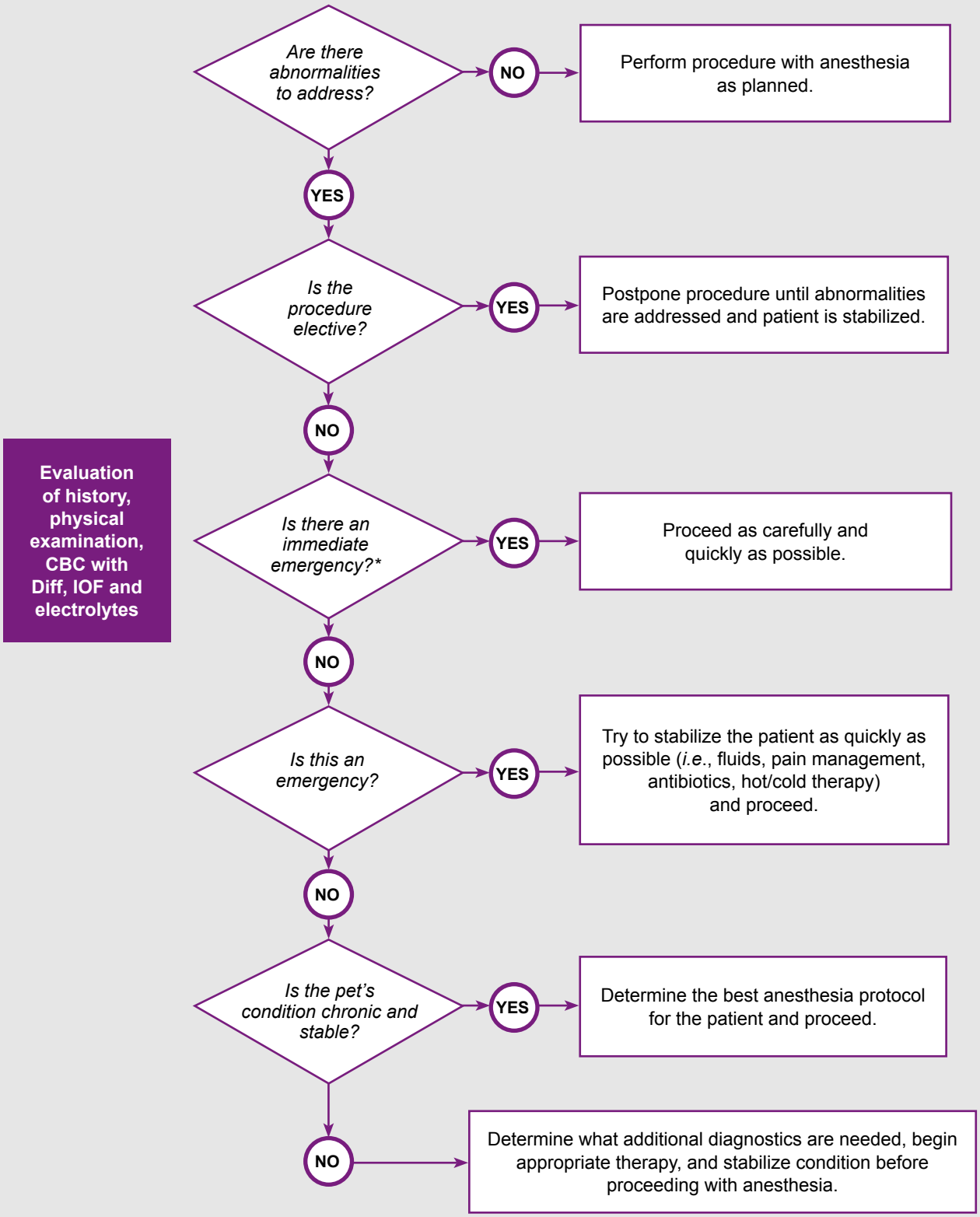
Proper assessment of a patient's health, use of the safest anesthetic agents, and diligent monitoring and support of perfusion allow most procedures to be done with reasonable safety and produce the desired outcome. Appropriate anesthetic protocols and support of perfusion require understanding of the overall objectives of anesthesia and surgery.

Evaluating the patient may reveal reasons to delay, cancel or reschedule the procedure until the pet is stable. This will also allow time for additional testing, to obtain more information on the pet's health or, if necessary, find a more experienced team to manage the high-risk patient.

Banfield believes a standardized, systematic approach is the best method to minimize risk. Consistency eliminates confusion that may occur in busy hospitals with multiple doctors using different protocols. A consistent protocol also permits analysis and aids in the establishment of best practices. An evidence-based approach shows that some protocols are safer than others, and objective data further defines and improves patient care.

Another goal of preanesthetic testing is the establishment of baseline data. Despite practitioners' efforts, client compliance with preanesthetic testing is still an issue. In many cases, collecting the preoperative blood sample may be the only opportunity to determine baseline clinical pathologic data. Practitioners and clients should not underestimate the value of establishing a biochemical and hematologic baseline for patients. Charting trends over time is one of the best opportunities for early diagnosis and treatment of disease.

Anesthesia Decision Algorithm



* An immediate emergency is when a patient cannot breathe or is bleeding from a major vessel and needs to be under anesthesia in less than 15 minutes.

Evaluating preanesthetic patients

A complete patient evaluation—performed before any anesthetic procedure—should consider signalment, medical history, physical examination findings and laboratory data. A step-by-step approach helps practitioners detect potential complications and take action to prevent them (See *Anesthesia Decision Algorithm,* page 56). Because the pet's health status and disease history are critical factors in determining the appropriate anesthetic protocol (See *Banfield Anesthesia Protocol,* page 58), evaluation involves more than performing a battery of tests. It requires using the information to determine the safest method if anesthesia is appropriate. A pet's signalment may warrant special consideration, as age, gender and breed are equally important elements to the preanesthetic assessment.

A thorough medical history is particularly important as it may reveal previous disease and anesthetic complications, concurrent medications or other facts, such as a recent meal, that may impact procedures. The veterinary team also needs to document preventive care treatments such as vaccinations, parasite control, dental care and disease screening tests. If you find preventive care deficiencies, take steps to correct them before performing an elective procedure. If the procedure cannot be postponed, avoid administering vaccinations and deworming medications until the patient fully recovers from anesthesia. It is also important to inform the medical team of every procedure being performed on the patient, as well as any medical history that could lead to an anesthetic complication. This ensures that the entire team has received the same information, which minimizes the chance of miscommunication during anesthesia.

ASA status

The American Society of Anesthesiologists (ASA) has established guidelines for overall health status in human patients and has devised a Physical Status Classification System. This is a quick and effective tool designed to allow doctors to be able to standardize (as much as possible) physical status and, in many cases, to help predict anesthetic risk. In veterinary medicine, it has been shown that ASA status can be used as a predictor of anesthetic risk. In pets scoring a 1 to 2 on the ASA, there is little to no significant increase in anesthetic risk, but in pets scoring a 3, 4 or 5, the risk goes up significantly. Therefore, we recommend assigning an ASA status to every pet before proceeding with anesthesia. If a patient scores a 3, 4 or 5, consider whether to proceed with anesthesia (after informing the clients of increased risk with anesthesia), further stabilize the patient, or cancel the procedure.

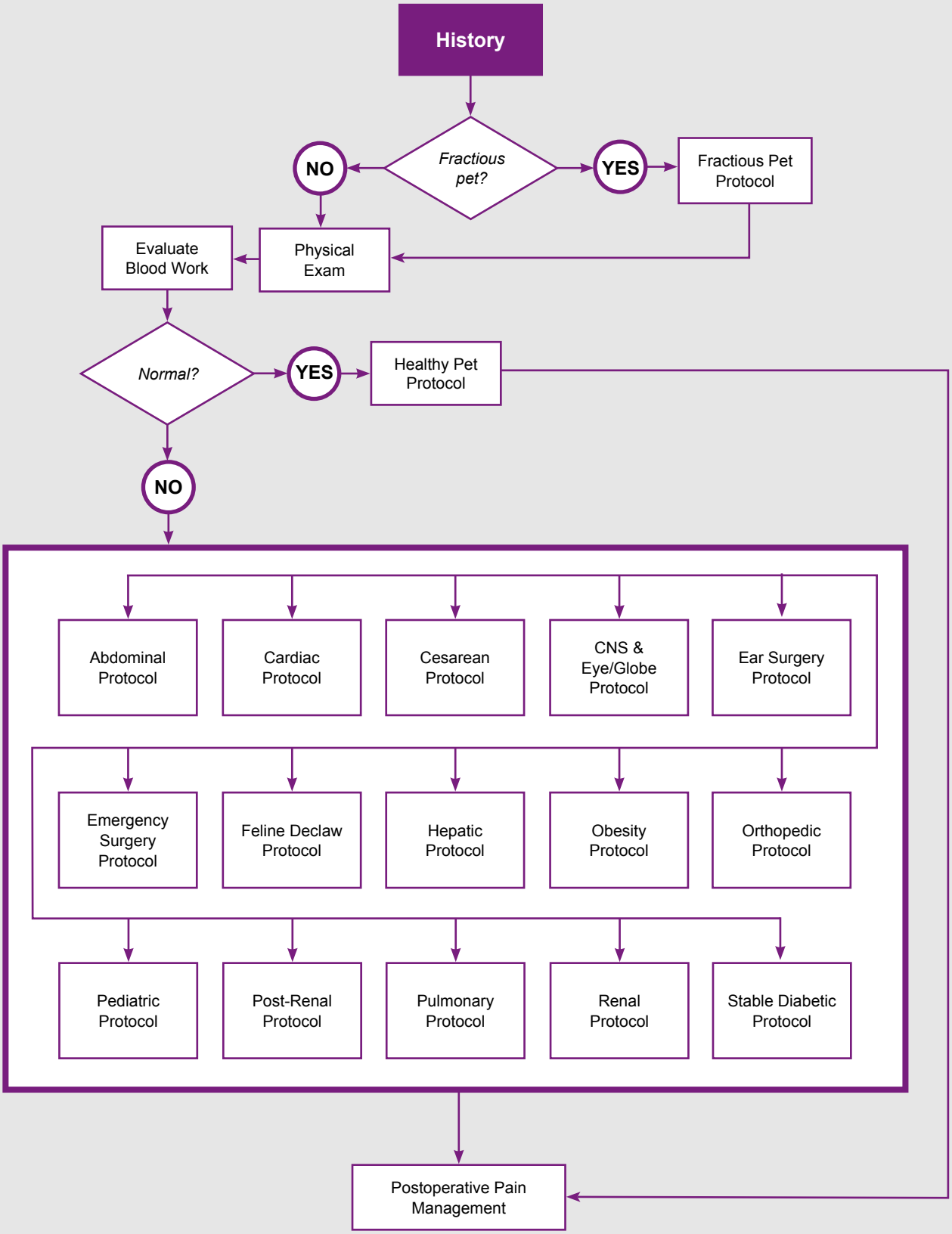
The ASA Scale

Grade 1	A normal, healthy pet
Grade 2	A pet with mild systemic disease which may or may not be associated with the surgical complaint (*i.e.*, mild anemia, obesity or geriatric patients)
Grade 3 (fair)	A pet with moderate systemic disease which may or may not be associated with the surgical complaint and which limits activity, but is not incapacitating (*i.e.*, mitral valve insufficiency or collapsing trachea)
Grade 4 (poor)	A pet with severe systemic disease that interferes with the pet's normal function and is incapacitating and a constant threat to life (*i.e.*, uncompensated heart failure, severe traumatic pneumothorax or severe abdominal bleed from a ruptured mass)
Grade 5 (critical, grave)	A pet that is moribund and requires immediate surgery and is not expected to live 24 hours, with or without surgery

Physical examination

Before any anesthetic procedure, conduct a thorough and deliberate physical examination. Record findings in the patient's medical record. When possible, resolve any issues before anesthetizing the pet. A detailed evaluation of the cardiovascular and pulmonary systems is vital, as all anesthetic drugs depress cardiovascular and pulmonary function to some extent. The liver and kidneys also need specific assessment because of their role in metabolizing and eliminating anesthetic drugs. Again, any findings that are not within normal limits should be evaluated to determine if it is more appropriate to postpone the anesthetic event and work up the abnormality or to go forward with anesthesia. Practitioners may need to adjust the anesthesia protocol to ensure the pet's safety.

Banfield Anesthesia Protocol



Assessing cardiovascular function and overall health

Banfield practice uses a five-step approach in conjunction with a full physical exam before any anesthetic procedure to assess cardiovascular function and the pet's overall health (See *Canine/Feline Anesthesia Physical Examination,* page 61). Any abnormalities noted should be addressed prior to proceeding with anesthesia.

1. Monitor heart rate, pulse quality and assess the heart rate to femoral pulse ratio. These parameters are key to evaluating perfusion prior to anesthesia. Adequate perfusion is vital to a successful anesthetic outcome. Bradycardia, tachycardia, poor or bounding pulses, or heart rate: pulse rate ratio that is not 1:1 may indicate significant underlying abnormalities.

2. Evaluate mucus membrane color and capillary refill time. Abnormal mucus membrane color can indicate underlying problems: pale (anemia, hypovolemia or shock), brick red (sepsis, hyperthermia or polycythemia/hemoconcentration), icterus (liver disease or hemolytic disease) and cyanosis (poor oxygenation secondary to cardiac or pulmonary disease). Capillary refill time should be < 2 seconds.

3. Auscultate the heart for murmurs or obvious arrhythmias. Murmurs in cats should be considered significant unless proven otherwise. Perform an ECG and recommend referral for a cardiac workup with echocardiography. Remember, the grade of murmur in cats does not correlate with the degree of disease present and cats may have significant cardiac disease even if a murmur can't be auscultated. Murmurs in juvenile canine patients are usually either a physiologic murmur, which should resolve with a stress test, or congenital. In general, congenital heart defects pose a considerable risk for an adverse anesthetic event. Such patients should be considered high-risk and undergo anesthetic procedures only at a practice equipped to address these special needs. In adult canine patients, it is important to determine if the murmur is a new finding or if there is evidence of disease progression or signs of heart failure. It is ideal to perform preanesthetic chest radiographs on all cases of known cardiac disease. If any concerns exist, a cardiac workup with echocardiography should be recommended prior to proceeding with anesthesia.

4. Auscultate the entire lung field to ensure normal sounds, airflow, oxygenation and ventilation. Step back from the patient to determine respiratory rate and pattern and to listen for any abnormal sounds. Many times in patients with respiratory symptoms, the problem can be localized with a thorough physical exam. Noises heard without a stethoscope are frequently related to the upper airways; nasal, pharyngeal/laryngeal or tracheal areas. Cough can be due to airway disease, pulmonary or cardiac disease or a combination of both. Rapid respirations are not always associated with pulmonary disease and can be a result of fever, acidosis or fear. In patients with respiratory distress, close observation of the timing may help narrow the possible etiologies. Inspiratory distress suggests upper airway or pleural space disease; expiratory distress suggests lower airway disease; rapid, shallow respirations suggest pleural space disease; and labored or deep respirations may indicate an upper airway obstruction. In cats, an expiratory wheeze may be heard with bronchial spasms.

5. Evaluate the patient's temperature, prior to premedication as well as following premedication, and prior to induction, for hypothermia or hyperthermia. If the temperature is not within normal ranges, the cause should be identified, corrected or appropriately addressed prior to proceeding with anesthesia.

Anesthesia cycle

To ensure safety, we recommend following the *Anesthesia Cycle Protocol*, page 60, which provides step-by-step guidelines to follow during anesthesia–from checking anesthesia equipment to patient observation following the procedure.

Anesthesia Cycle

Phase 1: Preanesthetic Evaluation

- Check Anesthesia Equipment*
- Review Medical Records
- Fractious Pet Protocol, Perform PE, Draw Blood, & Place IV Cath
- Review & Document PE Findings**
- Review Blood Test Results**
- Select Anesthesia Protocol
- Select and Administer Premeds***
- Wait 30 minutes for Premed Effect

Phase 2: Induction and Intubation

- Evaluate Patient/Cardiovascular System**
- Administer Induction Agent
- Place Endotracheal Tube & Secure
- Attach Patient to Anesthesia Machine
- Attach Monitors
- Evaluate Patient/Cardiovascular System

Phase 3: Monitoring

- Perform Surgical Prep and Move Patient
- Evaluate Patient/Cardiovascular System
- Perform Procedure
- Evaluate and Document Patient Anesthesia Monitoring Parameters Every 5 Minutes
- Adjust Anesthesia Based on Patient Needs
- Evaluate Patient Temp Every 5 min****

Phase 4: Recovery

- Discontinue Sevoflurane
- Continue Oxygen for 3-5 Minutes
- Evaluate Patient Cardiovascular System
- Remove ET Tube When Patient Swallows
- Monitor Continuously Until Patient Sternal and TRP WNL
- Record Anesthesia in Medical Records Using Anesthesia Stamp*****
- Update Soda Lime Hour Usage
- Observe Patient for Minimum of 2 Hours

* All anesthesia equipment should be checked and working properly. Check anesthesia machine for leaks and ensure the remaining hour usage for soda lime meets or exceeds expected procedure time.

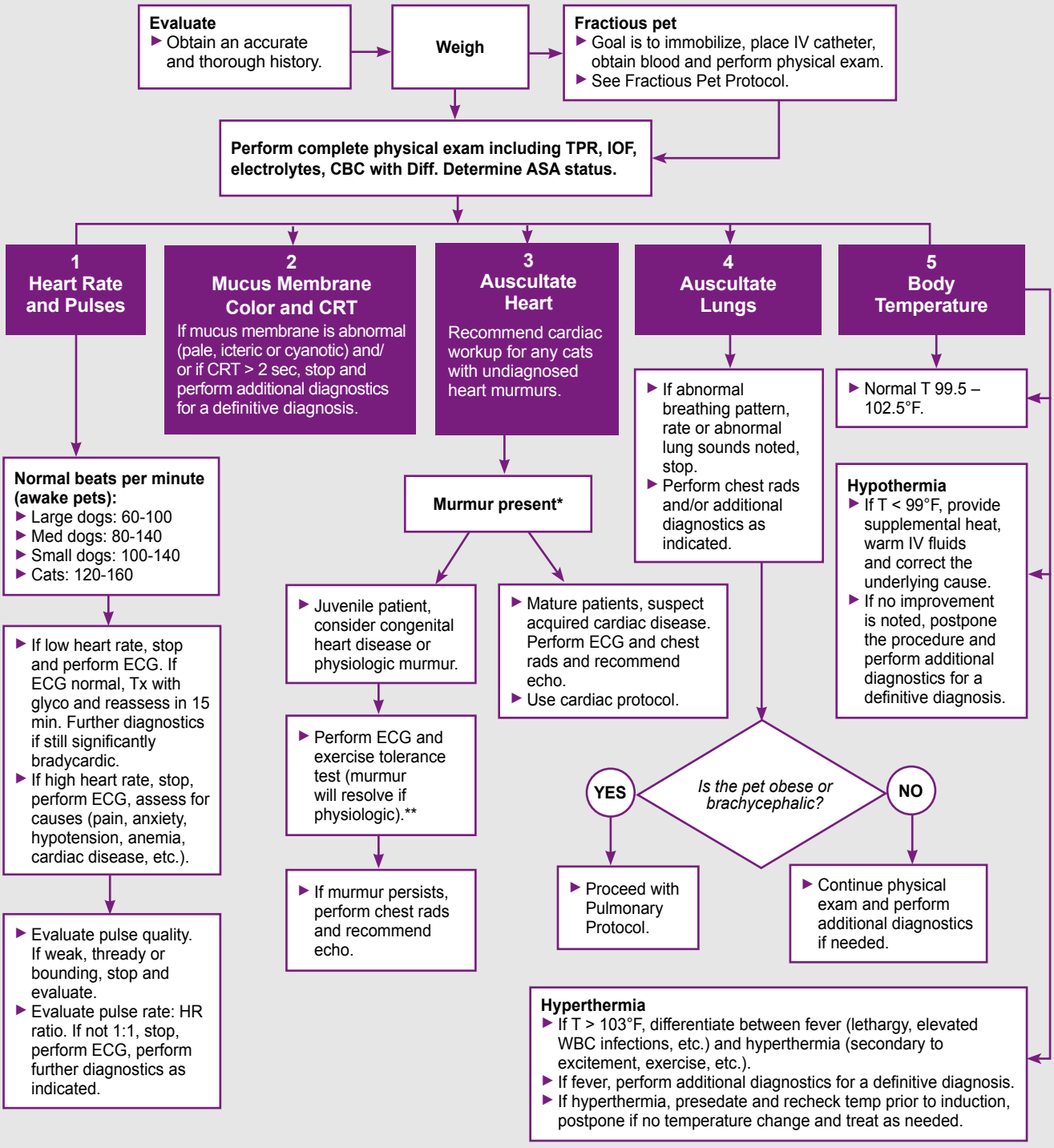
** Abnormalities should be evaluated and corrected prior to anesthesia, then documented in patient file.

*** If patient is apparently healthy and may be difficult to handle a second time, healthy pet premeds may be given at the time blood is drawn and catheter placed; if abnormalities are discovered on blood work, anesthesia should be delayed for at least 24 hours.

**** If temperature is low, actively warm patient (See page 77).

***** Indicate rebreathing vs. non-rebreathing system; initial and maintenance oxygen flow rates and sevoflurane percentage; pulse oximeter readings; endotracheal (ET) tube size; drug doses in mg or mL (mg/mL) and routes; temperature, pulse, respiration (TPR); (pre-induction, intra-op, postop, and pre-release); fluid type and rate; anesthesia and recovery time.

Canine/Feline Anesthesia Physical Examination



***Murmur present**

Patient < 3 years old with murmur

Patient <3 years old: Consider congenital diseases and characterize the murmur based on timing and the point of maximal intensity (PMI). See appropriate cardiac references or call a medical advisor for further guidance. If the patient exhibits clinical symptoms such as cough, exercise intolerance, inadequate development, cardiac cachexia, ascites, collapse or respiratory distress, consider echocardiogram and refer unless it's an emergency.

Mature patient with murmur

Mature patients with acquired murmurs typically develop degenerative valvular disease (primarily dogs) or myocardial disease (cats and dogs). Obtain thoracic radiographs and ECG. If the patient exhibits clinical symptoms, postpone the procedure and consider echocardiogram and treat the patient accordingly. If the patient has no clinical signs of cardiac disease, recommend echocardiogram and proceed to the Cardiac Protocol if condition has been stable over a reasonable period of time and pet will benefit immediately from the procedure to be done.

****Exercise tolerance test:** Perform ECG and immediately walk dog vigorously for 10 minutes. Recheck ECG. Normal = heart rate increase is less than 25% of pre-walk HR and returns to normal within five minutes.

Laboratory data

Perform a routine complete blood count and serum chemistry profile to evaluate the pet's current health status. Laboratory data are especially important in apparently healthy patients to ensure that potential problems are uncovered. Practitioners may need to request additional diagnostics depending on the results. Address any abnormalities before anesthesia. Try to correct them before anesthesia, with the goal of preventing or minimizing adverse events and addressing any underlying conditions. An ill patient's condition and laboratory values can change in just a few hours. In these situations, it is best to collect and evaluate the complete blood cell count (CBC), serum chemistry profile and electrolytes just before the anesthetic procedure.

Using a systematic approach to evaluate laboratory data lets practitioners address abnormal results in a timely fashion (See *Preanesthetic Blood Work Evaluation*, page 63). Much like the physical examination algorithm, this system guides practitioners through the appropriate diagnostic tests, such as urinalysis, bile acids testing, electrocardiogram (ECG), ultrasound and supportive care, depending on the findings. Thoroughly addressing aberrant findings before anesthesia places the patient in the best possible condition to undergo the procedure.

Many compromised patients have electrolyte abnormalities. Depending on the underlying cause, abnormalities may or may not be clinically significant. In addition to evaluating serum electrolytes, an ECG can provide information about clinical effects of electrolyte abnormalities. For example, hyperkalemia frequently produces decreased P waves, increased PR intervals, spiked T waves and bradycardia. Address any abnormalities before anesthesia.

Practice tips

Lipemic blood samples may be seen if the patient has recently eaten or if there is an underlying condition such as hypothyroidism, diabetes mellitus, pancreatitis or primary hyperlipidemia. Additionally, lipemia can interfere with some serum chemistry profile results. If lipemia is discovered, wait a few hours and draw a new blood sample for evaluation. If the second sample is also lipemic, evaluate further.

Additional preanesthetic diagnostics may include specific serum chemistries, blood pressure testing, radiography, ultrasound, microbiology, toxicology, cytology, coagulation tests or serum electrolytes. Choose the best tests to determine whether anesthesia is safe and in the pet's best interest.

This approach to evaluating the preanesthetic patient helps determine the best anesthesia protocol for the pet (See *Banfield Anesthesia Protocol*, page 58). **Once premedications have been administered, and before induction, it is essential to re-evaluate the pet's major organ systems using the five-step approach previously discussed, because administered drugs can have profound effects on cardiovascular and pulmonary systems.** This evaluation may change the practitioner's intended anesthetic protocol or prompt postponement of anesthesia to further evaluate unexpected findings.

Conclusion

When preanesthetic evaluation reveals abnormalities, it is the practitioner's responsibility to appropriately address each one before proceeding. How is "appropriately address" defined? There is no simple answer; it depends on the situation and the abnormality.

Ideally, the practitioner decides if further diagnostics or supportive care are necessary. How long to administer supportive care before the anesthetic procedure (minutes, hours, days, weeks) is based on the practitioner's assessment. In emergency situations, the patient may be stabilized for only a short time such as when there is only enough time to administer shock fluids to optimize perfusion. On the other hand, elective procedures may be delayed until the abnormalities are resolved or stabilized. In all cases, the practitioner's goal is to place the patient in the best condition possible before the anesthetic procedure or decide anesthesia is not in the pet's best interest.

In the end, the patient's condition on recovery should be as good as or better than before anesthesia.

Preanesthetic Blood Work Evaluation*

HCT, Hgb, RBC Count

- If < 25% (dogs) or < 20% (cats), perform further diagnostics for a definitive diagnosis.
- Postpone or transfuse prior to non-elective surgery.
- If > 55% (dogs) or > 45% (cats), look for underlying causes (dehydration, hypoxia, HCM in cats).
- Perform further diagnostics for definitive diagnosis.
- If non-elective surgery, use Pre-renal Protocol.
- If HCT < 15% or > 60%**, critical, STOP and address immediately.

Platelets, Clotting Factors

- If PLT < 200,000, confirm with blood smear (# PLT per 100x field x 15,000). Perform BMBT.
- If PLT < 125,000, postpone all elective procedures until PLT normalizes.
- If abnormal BMBT, ACT, PT or PTT, postpone or transfuse (fresh frozen plasma or fresh whole blood) prior to surgery.
- If PLT < 60,000, critical, STOP and address immediately.

BUN/Creatinine

BUN

- If BUN < 8 (dogs) or < 15 (cats), perform pre and post BA.
- If BUN > 27 (dogs) or > 35 (cats) and Crea > 1.8 (dogs) or > 2.2 (cats), palpate bladder and/or perform abdo rads to rule out urinary obstruction or rupture and check urine specific gravity.
- If USG > 1.030 (dogs) or > 1.035 (cats), look for causes of pre-renal azotemia, rehydrate and recheck values prior to proceeding with pre-renal azotemia protocol.
- If USG < 1.030 (dogs) or < 1.035 (cats), perform additional diagnostics for a definitive diagnosis; consider renal disease or pre-renal factors like Addison's disease. If non-elective surgery, proceed with Renal Protocol.

ALT/Bilirubin/ALP

- If elevated, perform pre- and post-BA (if TBili > 2 or if patient is icteric, BA will be elevated and the test will be redundant).
- If BA normal, and surgery non-elective, proceed with Hepatic Protocol.
- If BA abnormal, perform further diagnostics to obtain a definitive diagnosis (abdo rads, abdo U/S, liver FNA/BX, coag tests, etc.)

Albumin/ Total Protein

- If TP < 4.5 and/ or albumin < 2, postpone and perform additional diagnostics for a definitive diagnosis.
- If surgery is non-elective, administer fresh frozen plasma prior to surgery.
- Use appropriate protocol, but do not use acepromazine.
- If TP < 3 and/or albumin < 1, critical, STOP and address immediately.

WBC/Neutrophils

- If WBC < 4,000 and/ or Neut < 2,000, confirm with manual differential. If any abnormalities noted, postpone and perform further diagnostics for a definitive diagnosis.
- If non-elective surgery, proceed with Abdominal Protocol.
- If WBC > 20,000, perform manual differential. If not stress leukogram, perform additional diagnostics for a definitive diagnosis (inflammation, infection, immune disease, corticosteroids, Cushing's disease, bone marrow disease, neoplasia).
- If non-elective procedure, proceed with Abdominal Protocol.
- WBC < 2,000 and/or Neut < 1,000, critical, STOP and address immediately.

MCV, MCH, MCHC**

- If abnormal, check pulse oximetry values.
- If MCV is low, check pre- and post-BA to rule out liver shunt.

Potassium

- If K > 6, stop, perform ECG and further diagnostics to check for urinary obstruction, renal disease, ruptured bladder, etc.
- Calculate Na:K ratio, if < 27, perform an ACTH stim for Addison's disease.
- If non-elective surgery, proceed using 0.9% NaCl for IV fluids.
- If K < 3.5, STOP, perform ECG and further diagnostics to check for GI potassium loss, renal disease, hyperthyroidism, etc.
- If non-elective surgery, proceed with appropriate IV fluid potassium supplementation and reassess K levels frequently.
- If K < 2.5 or > 7.5, critical, stop and address immediately.

Glucose

- If BG > 175 (dogs) or > 250 (cats), stop and repeat values in several hours.
- If still elevated, stop and submit fructosamine and perform a UA, postpone surgery pending results.
- If not DM, and values remain elevated, check for hyperthyroidism or Cushing's disease.
- If non-elective surgery, proceed with appropriate protocol.
- If BG < 70, stop, assess patient and recheck in several hours.
- If still decreased, perform diagnostics to check for juvenile hypoglycemia, sepsis, Addison's disease, etc.
- If non-elective procedure, proceed with IV dextrose supplementation and frequent BG rechecks.
- If BG > 600 or < 40, critical, STOP and address immediately.

Calcium

- If Ca > 12, perform additional diagnostics, including iCa; check for renal disease, neoplasia, Addison's disease, hyperparathyroidism, etc.
- If non-elective procedure, proceed with Cardiac Protocol.
- If Ca < 8, check albumin levels.
- If Ca > 16 or < 7, critical, STOP and address immediately.

Lipemia

- Recheck blood test in several hours, if lipemia persists, evaluate diet, check for hypothyroidism, DM, pancreatitis, etc.
- If non-elective surgery, proceed with most appropriate protocol.

* Normal adult versus pediatric values will vary.
**Pets living in higher altitudes and some breeds such as Greyhounds may have naturally occurring hematocrit elevations.

SECTION 6:

Induction and Intubation

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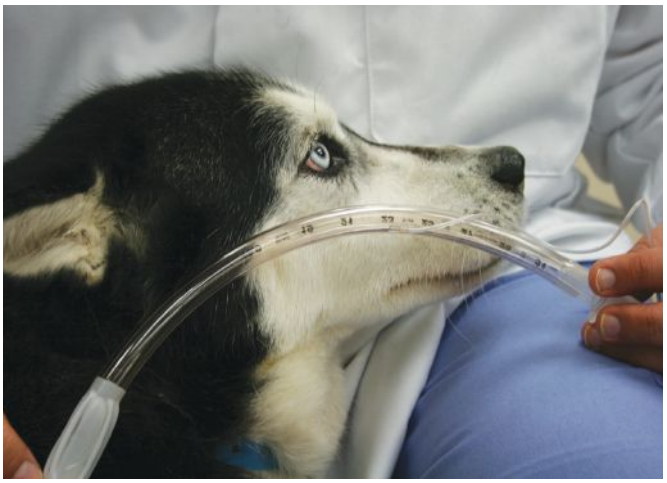
Induction and Intubation

INTUBATION

Endotracheal (ET) tubes must be used during general anesthesia to properly manage the patient's airway. The cuff is an inflatable balloon-like device near the end of the ET tube designed to fill the air space between the outer walls of the tube and the inner walls of the trachea, so that the patient cannot breathe around the tube and thus receive an inadequate or inappropriate amount of oxygen and anesthetic gas. Inflating the cuff also prevents contaminants, such as vomitus or water, from entering the patient's airways, which can result in aspiration pneumonia. Use the following directions to intubate a patient:

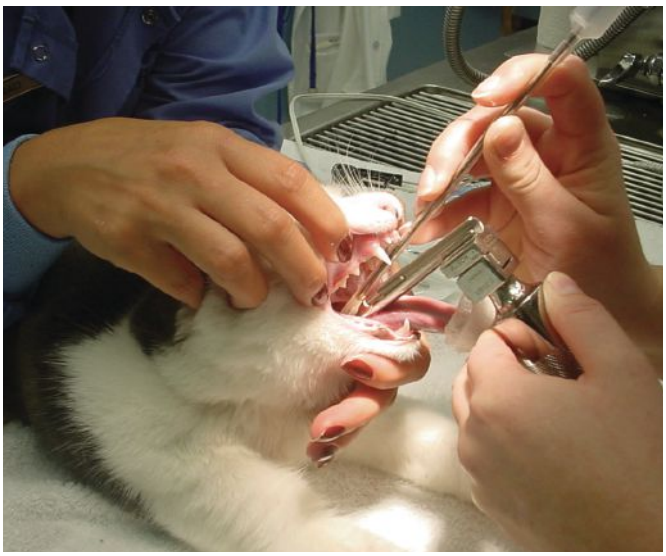
- Have the proper equipment ready to intubate **before** anesthetic induction.
- Choose an appropriately sized ET tube (See *Endotracheal Tube Selection*, page 43). Have two or three sizes readily available.
- **Before using the ET tube, check the cuff for leaks as follows:**
  - Gently inflate the cuff using a syringe of air inserted at the end of the air line. Watch the cuff inflate. Over-inflation will destroy the cuff.
  - Remove the syringe and gently squeeze the cuff to determine if there are any leaks.
  - Once you have confirmed there are no leaks, deflate the cuff by reattaching the syringe and withdrawing the plunger to remove the air from the cuff. The cuff must be deflated before intubation.
- During intubation, a member of the hospital team supports the patient in sternal recumbency, on its chest, with the head up.
- Measure ET tube so that it will reach only to the thoracic inlet. Mark this location on the tube and tie gauze around the spot (*Figure 6.1*).
- Using an appropriate stylet in flexible tubes is helpful. If using a stylet, ensure it does not protrude beyond the distal end of ET tube or through the Murphy eye.
- Apply lubricating jelly to the ET tube. Lubricating jelly assists in sliding the ET into place, thus preventing tissue damage.
- While supporting the patient, the hospital team member opens the patient's mouth wide and gently pulls the tongue forward (*Figure 6.2*). Using a laryngoscope to visualize the laryngeal folds, place the ET tube into the trachea, taking care that the end of the ET tube does not pass beyond the thoracic inlet.
- Once the tube is in place, palpate the end of the tube through the trachea to ensure the tip is just cranial to the thoracic inlet. Grip trachea with thumb and forefinger and slide tube in and out a few millimeters. You should be able to feel the end of the tube slide past your fingers.

Figure 6.1



Measure the ET tube so it will reach only to the thoracic inlet.

Figure 6.2



Intubating a cat

- Auscultate all lung fields to detect and correct intubation; this will ensure proper placement and airflow. If inadequate airflow is noted, deflate the endotracheal tube cuff and back the tube out until good airflow is auscultated. Movement of the rebreathing bag is a good indicator of airflow as is ventilatory effort.
- If poor flow is noted, inspect the endotracheal tube for kinking. If mucus is noted in the oral cavity, inspect the endotracheal tube for a mucus plug. This may require extubation.
- To decrease the risk of ET tube migration, secure tube around the patient's maxilla/nose or the back of head, using the gauze strip. A rubber band may be used for small dogs and cats.

- Once the patient is intubated, inflate the cuff as follows:
  - Listen for leaks before inflating the ET tube; if the ET tube is a tight fit, little to no cuff inflation is necessary. Using the manometer as a guide, only inflate to prevent a leak at a pressure of approximately 18 to 20 cm H_20.
  - If the cuff needs inflating, insert the syringe at the end of the air line. Inject air into the line; the cuff at the other end will inflate. Do not overfill the cuff, as excessive pressure can injure the patient's airway. A recommended method is to inflate the cuff by incrementally adding 0.5 mL of air until a leak cannot be heard.
  - **Pressure-check the cuff—the cuff should restrict air flow at 18 to 20 cm H_2O, and should leak before the pressure is 25 cm H_2O.**
- Tracheal damage can easily occur if you aren't careful. Mucosal irritation can cause a severe cough after recovery. Tracheal lacerations can lead to subcutaneous (SC) emphysema, pneumomediastinum, pneumothorax and death. Most lacerations are caused by inappropriate use of stylets, improper lubrication, over-inflation of the cuff or twisting of the ET tube when repositioning the patient.
- **Always disconnect the ET tube from the breathing system before repositioning the patient. Twisting of the tube in the airway can cause serious damage. Use caution when moving an intubated patient.**

Tips for intubation and airway management in cats

A cat's larynx is very sensitive to mechanical stimulation, is easily irritated and can be damaged if mishandled. Laryngospasm is most likely to occur if forced intubation is attempted while the cat is too lightly anesthetized. Mild laryngospasms are bothersome; severe laryngospasms can result in death.

- Make sure the cat is adequately anesthetized before attempting intubation. Attempting to intubate a cat in a light anesthetic plane is likely to cause coughing and laryngospasm. Simply increasing the depth of anesthesia will allow intubation in most cases.
- Use topical viscous lidocaine to desensitize the larynx. **Do not use benzocaine (Cetacaine®)—it causes methemoglobinemia in cats.** Dip the end of a Q-tip® in topical lidocaine, as it works faster than using injectable lidocaine. If the viscous isn't available, place a few drops of injectable lidocaine on a Q-tip®, gently swab the laryngeal area, wait 60 to 90 seconds, then attempt intubation. Avoid using too much lidocaine; it absorbs systemically and could cause toxicity.
- Extend the cat's neck, pull the tongue forward, and open the mouth by pulling down on the jaw. Use a small blade laryngoscope to aid visualization. Place the lubricated endotracheal tube just in front of the larynx with the bevel ventral. Without touching the arytenoids, wait for a breath, then gently insert the tube while rotating the tip.
- If a patient laryngospasms and is in danger, place a large-gauge needle into the trachea percutaneously and administer pure oxygen until swelling decreases.

OXYGEN FLOW RATES DURING ANESTHESIA

Rebreathing circuit

- Current anesthesia protocols call for a transition phase with oxygen flow rates of 3 L/min and sevoflurane level at 3% during the first three minutes of anesthesia when pets are induced with propofol and dexmedetomidine is not on board. This is because propofol is rapidly redistributed from the blood to tissues so the pet will tend to wake rapidly after induction. The transition phase will result in a smooth transition from induction to maintenance anesthesia. **These same settings are not necessary with Telazol® induction or in patients with dexmedetomidine on board.**
- **Sevoflurane requirements are significantly lowered when using dexmedetomidine as a premedication.**
- Following the transition phase, oxygen flow rates are decreased to 1 to 1.5 L/min. In the majority of patients, higher oxygen flow rates are not necessary to maintain oxygen saturation greater than 94%. Higher oxygen flow rates vaporize sevoflurane at a faster rate, thus increasing the cost of anesthesia. Higher oxygen flow rates may also contribute to hypothermia, especially in small pets.

Non-rebreathing circuit (Bain's)

- Generally, flow rates around 3 L/minute will be needed for the duration of anesthesia (See *Non-rebreathing circuit*, page 44).

ASSISTED VENTILATION

- An anesthetized patient breathing spontaneously should be bagged twice per minute, not to exceed the pressure listed below. This ensures full inflation of the entire lung field and helps reduce atelectasis.
- Patients that are not breathing spontaneously require assisted ventilation at 10 to 12 breaths per minute, not to exceed the pressure listed below.
- Ventilation should be delivered in a manner similar to normal respiration–apply steady pressure to the bag and avoid holding inspiratory pressure. The manometer should return to zero between breaths.
- It is important to deliver the correct inspiratory pressure to avoid adverse pulmonary function or complications:
  - 12 to 15 cm H_2O for small pets and pets with chronic pulmonary disease.
  - 20 cm H_2O for medium to large pets.
  - 25 cm H_2O may be required for giant pets.
- The pressure relief "pop-off" valve should be open when not assisting ventilation, and should only be closed to reach desired positive pressure during assisted ventilation.

SECTION 7:

Monitoring

SECTION 7

Monitoring

MONITORING

Anesthetic drugs depress the autonomic nervous system (ANS), decreasing the ability of the ANS to maintain tissue perfusion. Without proper perfusion, vital organs and body systems are deprived of the oxygen they need, which results in significant, and sometimes deadly, complications. Careful and constant monitoring is imperative to a positive anesthetic outcome. **The primary cause for crisis during or after anesthesia is the failure to notice a problem when it first occurs** (See *Anesthesia Monitoring and Emergency Algorithm*, page 80).

Make every attempt to maintain the following critical values in anesthetized pets:

Table 7.1

Critical Values	
PARAMETER	**GOAL**
Temperature	100°F to 102.5°F
Blood pressure	**Systolic:** 100 to 120 mmHg **Mean:** 80 to 100 mmHg **Diastolic:** 60 to 80 mmHg
Pulse quality	Strong
Mucus membrane color	Pink
Capillary refill time	< 2 seconds
Respiratory rate	15 to 20 breaths/minute
SpO_2 (oxygen saturation)	95%-100%
$ETCO_2$ (end-tidal carbon dioxide)	35 to 40 with normal capnogram
Heart rate (without dexmedetomidine). (See *Bradycardia associated with dexmedetomidine premedication*, page 71, for heart rate minimums with dexmedetomidine)	**Large dogs:** 60 to 100 bpm **Medium dogs:** 80 to 100 bpm **Small dogs:** 80 to 120 bpm **Cats:** 120 to 180 bpm
ECG	Normal sinus rhythm

Three goals of monitoring

- Anticipate complications
- Recognize complications
- Correct complications

Anesthetized patients should be continuously monitored, and assessments recorded at a minimum of five-minute intervals, then documented in the medical notes. Patients should be constantly monitored (*i.e.*, temperature, pulse, respiration (TPR), physical exam (PE) and level of consciousness are all normal) until they can maintain a sternal position, then evaluated every 15 to 30 minutes until discharge (See *Recovery*, page 81). The purpose of monitoring and documenting values is to look for adverse trends that can be addressed before they cause harm.

MANUAL ASSESSMENT

The most important monitor is the associate who is dedicated to monitoring the patient. This person should be actively monitoring the patient, not merely relying on the values provided by monitoring equipment. The following parameters should be continuously monitored and recorded in the medical notes:

- Mucus membrane (MM) color
- Capillary refill time (CRT)
- Heart rate
- Respiratory rate
- Temperature
- Thoracic auscultation
- Pulse quality
- Pain assessment
- Anesthetic depth estimation

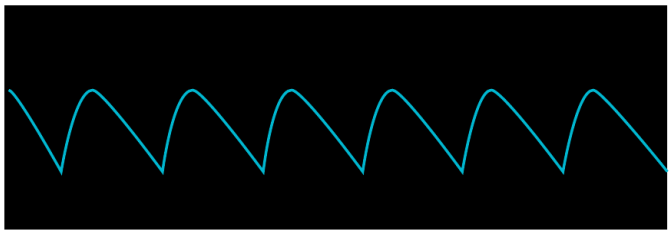
ANESTHETIC DEPTH ESTIMATION

Anesthetic depth and concurrent patient plane of anesthesia are dose-dependent on the ongoing percentage of anesthetic gas being delivered. As anesthesia dosage increases, depth is enhanced and the anesthetic safety margin decreases. In other words, the deeper the patient is, the less leeway for monitoring error exists. Anesthetic depth may be estimated by skeletal muscle tone, selected reflexes (*i.e.*, withdrawal) and central or ventral eye position. Blood pressure is another indication of anesthetic depth. Direct response to surgical stimulation is the most reliable method of determining depth of anesthesia. **If uncertain about a patient's anesthetic depth, assume they are too deep!**

PULSE OXIMETRY

Pulse oximetry is a noninvasive method of monitoring both pulse rate and the percentage of oxygenated hemoglobin in the arterial blood. The monitor works by differentiating the ratio of light absorption during pulsatile and non-pulsatile blood flow. Most pulse oximeters provide a pulse wave and a digital display of pulse rate and the percent of hemoglobin saturated with oxygen (SpO_2).

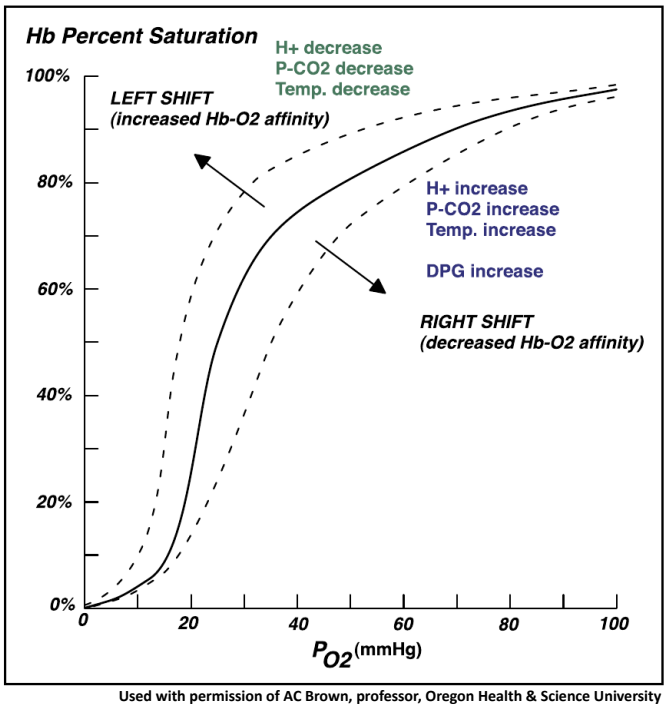
Figure 7.1: SpO_2 Waveform



Pulse oximetry helps evaluate the ability of the lungs to deliver oxygen and is an indirect indicator of the partial pressure of blood oxygen (PO_2) available to perfuse tissues. Normal arterial PO_2 is between 80 to 110 mmHg. There is not a 1:1 correlation between SpO_2 and PO_2 and this relationship is demonstrated by the oxyhemoglobin dissociation curve.

The amount of available oxygen (PO_2) in the blood drops off sharply at SpO_2 values below about 95%. In general, an SpO_2 of 98% correlates to a PO_2 of 100 mmHg; SpO_2 of 95% correlates to PO_2 of 80 mmHg; and SpO_2 of 90% correlates to PO_2 of 60 mmHg. This demonstrates that a SpO_2 of 90% indicates moderate to severe hypoxemia while an SpO_2 of 95% is within the commonly accepted normal PO_2 range, although at the lower end of that acceptable range. SpO_2 should be maintained above 95% in anesthetized patients.

Figure 7.2: Oxyhemoglobin Dissociation Curve



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Normal oxygen saturation in the blood is > 98% when breathing room air. Patients under anesthesia breathing 100% O_2 should remain at or near 99% to 100% SpO_2. Due to the oxygen hemoglobin dissociation curve, pulse oximeters are best used to detect **hypoxemia** (PO_2 < 60 to 65 mmHg) as indicated by SpO_2 values below 95%. Hypoxia is a life-threatening condition in which oxygen delivery is inadequate to meet metabolic demands.

Hypotension, tachycardia, hypothermia, movement and poor probe placement can create measurement errors. Pulse oximeter probes should be placed in non-pigmented areas that have little to no hair, such as the tongue, lip, ear, toe web, vulva and prepuce.

INTERVENTIONS FOR HYPOXIA

If SpO_2 is < 95:

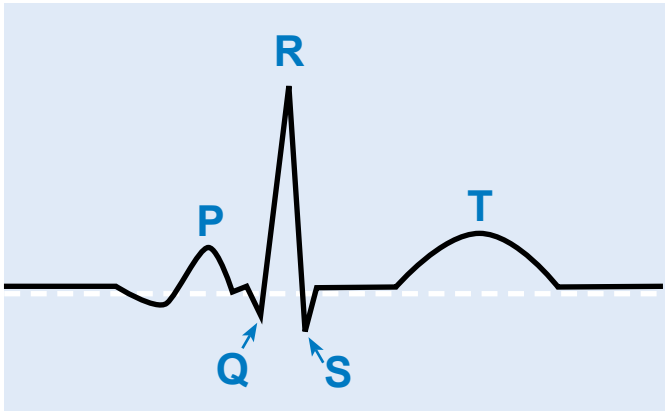
- Decrease sevoflurane by 25%.
- Increase O_2 to 2L/min.
- Check endotracheal (ET) tube visually for placement.
  - Bronchial-intubation
  - Esophageal intubation
- Check ET tube visually for obstruction to airflow (mucoid plug, blood clot, foreign object).
- If ET tube cannot be placed, then perform needle tracheocentesis and supply 100% O_2.
  - If ET tube placement can be verified, start assisted ventilation. See *Assisted Ventilation* section on page 67 for more information.

- Check pulse quality.
- Increase fluid to 20 to 80 mL/kg/hr.
- If patient is hypotensive, refer to hypotension treatment on page 74.

ELECTROCARDIOGRAM

An electrocardiogram (ECG) is a graphical representation of the electrical activity in the heart. The amplitude and duration of that electrical activity combine to provide a waveform. The parts of an ECG tracing are associated with the waves of electrical activity that spread through the myocardium.

Figure 7.3: Normal ECG



- P wave: Atrial depolarization
- PR interval: Time between the start of atrial systole and the start of ventricular systole
- QRS complex: ventricular depolarization
- T wave: Repolarization of the ventricular myocardium

ECGs should be monitored for arrhythmias, conduction abnormalities and heart rate. Evaluate the waveforms and intervals for morphology, uniformity and regularity. Lead II is most commonly monitored in small animal veterinary medicine.

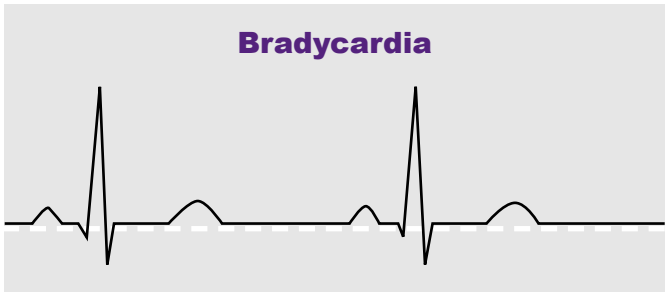
Common ECG artifacts are:

- Respiratory: appears as an uneven baseline correlated to the patient's breathing. Can be caused by dyspnea or deep respirations.
- Movement: appears as baseline changes during patient or ECG lead movement.
- Electric: appears as jagged baseline. Can be caused by electrical devices plugged into the same circuit as the ECG monitor or by other medical equipment being used nearby the patient.

INTERVENTIONS FOR HEART RATE AND ECG ABNORMALITIES

The first step in intervention should be manually assessing the patient to determine if the changes are equipment artifacts or actual changes within the patient. Changing lead placement, re-wetting the leads with alcohol and/or conductive gel can also help in determining the cause of the changes.

Figure 7.4: Bradycardia



Bradycardia associated with dexmedetomidine premedication:

Dexmedetomidine is expected to cause a significant bradycardia. This effect is a physiologic response to the associated peripheral vasoconstriction and increase in systemic blood pressure seen with this class of drugs and does not usually require intervention.

Severe bradycardia for patients medicated with dexmedetomidine is defined as:

- Large dogs: < 45-50 bpm
- Medium dogs: < 50-60 bpm
- Small dogs: < 60-70 bpm
- Cats: < 90-100 bpm

Treatment:

- Reverse dexmedetomidine:
  - Dogs: Administer atipamezole (Antisedan®) IM at the same volume of dexmedetomidine used. Dexmedetomidine should only be used in dogs for immobilization, not for premedications prior to general anesthesia.
  - Cats: Administer atipamezole IM at same volume of dexmedetomidine used (1/3 volume of DKT).

Do NOT administer atropine or glycopyrrolate unless the dexmedetomidine has been fully reversed.

Bradycardia not associated with dexmedetomidine premedication:

Bradycardia is defined as HR < :

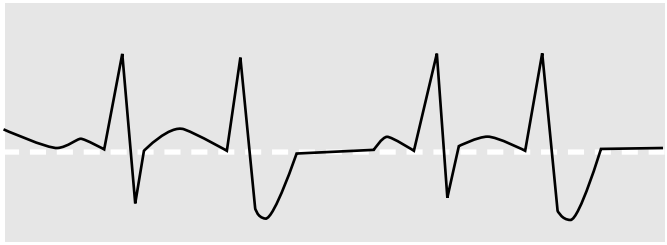
- Large dogs: 60 bpm
- Medium dogs: 80 bpm
- Small dogs: 100 bpm
- Cats: 120 bpm

Treatment:

- Decrease sevoflurane by 25%.
- Increase O_2 flow rate.
- Increase fluids to:
  - Dogs: 20 mL/kg bolus (up to 80 mL/kg)
  - Cats: 5 mL/kg bolus (up to 40 mL/kg)
- Monitor blood pressure
- If heart rate continues to decrease:
  - Give glycopyrrolate (0.01 mg/kg IV)
- If glycopyrrolate is ineffective:
  - Give atropine (0.02 to 0.04 mg/kg IV)
- If atropine is ineffective after two minutes
  - Give epinephrine (0.01 to 0.02 mg/kg IV)

Ventricular premature contractions

Figure 7.5: Ventricular Premature Contractions

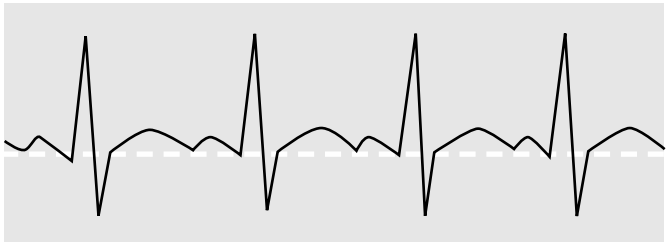


A ventricular premature contraction (VPC) is a contraction originating in the ventricle that happens before a contraction is expected.

- Decrease sevoflurane 25% to 50%.
- Increase O_2 to 2 L/min.
- Increase IV fluids to:
  - Dogs: 20 mL/kg bolus (up to 80 mL/kg)
  - Cats: 5 mL/kg bolus (up to 40 mL/kg)
- Assess for pain and treat.
- If ineffective and the patient is hemodynamically unstable (HR > 200, sBP < 80, MAP < 60 and/or SpO_2 < 95):
  - Lidocaine bolus:
    - Dogs: 2 to 4 mg/kg IV
    - Cats: 0.25 to 0.5 mg/kg IV
    - Use second IV line.
  - If lidocaine bolus is effective, convert to constant rate infusion (CRI):
    - 1 liter NaCl + 50 mLs 2% lidocaine (1,000 mg)
      - Dogs: 4 mL/kg/hr to control VPCs
      - Cats: 0.6 to 1 mL/kg/hr
  - Slow or stop CRI if bradycardia develops.

Sinus tachycardia

Figure 7.6: Sinus Rhythm with an Increased Ventricular Rate



Treatment when sinus tachycardia is associated with movement:

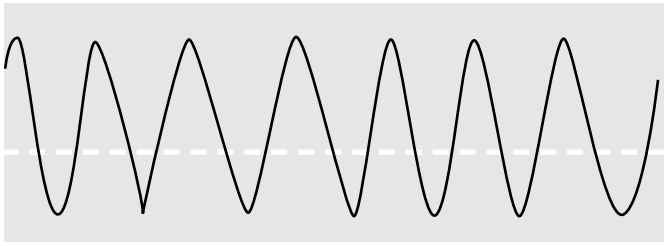
- Address pain first.
  - Consider additional analgesia for painful procedures (increase sevoflurane or administer analgesics, dental blocks, local nerve blocks, etc.).
- Assess anesthetic circuit for leaks, sevoflurane content in vaporizer, O_2 flow and tank for appropriate 0_2 level.

Treatment when sinus tachycardia is not associated with movement:

- Decrease sevoflurane by 25%.
- Increase fluids to:
  - Dogs: 20 mL/kg bolus (up to 80 mL/kg)
  - Cats: 5 mL/kg bolus (up to 40 mL/kg)
- Watch for VPCs.
- Address hypotension if present.

Ventricular tachycardia

Figure 7.7: A Series of More Than Three to Four VPCs in a Row



Treatment:

- Lidocaine bolus:
  - Dogs: 2 to 4 mg/kg IV
  - Cats: 0.25 to 0.5 mg/kg IV
  - Use second IV line.
- If effective, convert to CRI:
  - 1 Liter NaCl + 50 mLs 2% lidocaine (1,000 mg)
    - Dogs: 4 mL/kg/hr to control VPCs
    - Cats: 0.6 to 1 mL/kg/hr
  - Slow or stop CRI if bradycardia develops.

BLOOD PRESSURE

One of the ways to monitor organ perfusion is to look at the patient's blood pressure values. Anesthetized patients are at risk for hypotension due to depression of cardiac output due to inhaled and injectable anesthetics. Unaddressed hypotension will compromise perfusion of the kidneys, heart and brain, leading to organ dysfunction or even death. Blood pressure is also a key measurement to monitor for significant internal bleeding, to titrate IV fluid administration, monitor anesthetic depth and evaluate the patient's overall health status. It is important to remember that blood pressure is only one component of a complex system of hemodynamics and not an exact indicator of cardiac output or organ perfusion.

Blood pressure parameters, systolic, diastolic and mean arterial pressure (MAP) contribute to the bigger clinical picture of perfusion.

- Systolic pressure is the measurement of the maximum arterial pressure during ventricular contraction (systole).
- Diastolic pressure is the measurement of the minimum arterial pressure during ventricular relaxation (diastole).
- MAP is the time-weighted average of arterial pressure exerted during the cardiac cycle (one heartbeat). MAP cannot be directly averaged since the duration of diastole is typically longer than the duration of systole. The following equation is used to approximate MAP: MAP = diastolic BP + 1/3 (systolic BP - diastolic BP). The simplest way to define MAP is to think of it as the "average" blood pressure for the patient. **MAP is the most important blood pressure-related parameter to help us evaluate overall tissue perfusion.**
- Pulses are created by the difference in systolic and diastolic arterial pressures.
  - Strong pulse: The arterial pulse is easily and consistently palpable in the peripheral arteries.
  - Decreasing pulse quality: This is likely due to a decrease in systolic pressure and, therefore, a decrease of the pulse pressure.
  - "Thready" quality: This is due to a further decrease in systolic blood pressure.
  - "Bounding" or "water-hammer" pulse quality: This is due to systolic hypertension or volume overload—fluid overload, congestive heart failure (CHF), kidney failure.

There are several methods for measuring blood pressure:

- Direct measurements can be obtained by placing a catheter into an artery and connecting it to a transducer. The transducer converts the mechanical signals into electrical energy, which is typically displayed on a monitor as a continuous pressure waveform as well as a numeric reading. This type of blood pressure monitoring provides accurate readings, but requires special equipment and a high level of technical proficiency for placement.
- Indirect measurements are obtained by using an inflatable cuff that detects blood flow after occlusion of a superficial artery by either detection of blood flow oscillations in the cuff or detection of sound waves traveling through the artery. This technique is noninvasive and requires less technical skill. The two different methods are known as oscillometric or Doppler indirect blood pressure detection.

The Doppler blood pressure method uses cuffs that are blown up by a hand pump and a transducer to emit and receive ultrasonic waves. Doppler monitoring only measures systolic blood pressure, therefore the MAP cannot be determined when using this method.

Oscillometric measurement is a type of indirect measurement that detects periodic fluctuations produced by movement of the arterial wall. As the cuff is deflated, oscillations rapidly increase at systolic pressure, reach a maximum at the MAP, and then rapidly decrease at the diastolic pressure. Inflation and deflation of the cuff are usually automated and most oscillometric devices will provide systolic, diastolic and MAP. Because this type of monitoring is based on fluctuations occurring underneath the cuff, several factors can affect the accuracy of readings.

- The width of the cuff should be 40% of the circumference of the patient's limb. If the cuff is too large, readings will be underestimated. If the cuff is too small, the readings will be overestimated. The cuff should fit snugly. Tape or other materials should not be used to secure the cuff.
- The cuff should be placed on a limb or at the base of the tail. It is important to keep the cuff at the same level as the heart, regardless of where it is placed. Cuff placements higher than the heart will produce low readings and placements lower than the heart will produce high readings. The best cuff placements are over the brachial or median arteries on the front leg or the medial coccygeal artery on the tail.
- The tubing connecting the cuff to the monitor should be free of kinks and kept from bouncing. The movement of the tubing may be interpreted as fluctuations occurring during the blood pressure reading.
- Accuracy depends on proper cuff placement and size.
- Cuffs should not be placed on any extremity being used for IV fluids or for pulse oximetry monitoring.

INTERVENTIONS FOR BLOOD PRESSURE ABNORMALITIES

Goal to maintain systolic blood pressure at:

- Systolic: 100 to 120 mmHg
- Mean: 80 to 100 mmHg
- Diastolic: 60 to 80 mmHg

Hypotension is defined as:

- Decreasing pulse quality
- Systolic pressure < 100 mmHg
- Mean arterial pressure < 80 mmHg

Treatment:

- Increase IV fluid rate:
  - Dogs: 20 mL/kg bolus (up to 80 mL/kg)
  - Cats: 5 mL/kg bolus (up to 40 mL/kg)
  - Frequently reassess for response to therapy.
- If continued decrease or "thready" pulse quality, and still hypotensive, maintain increased fluid rate and add hetastarch as follows:
  - Dogs: 5 mL/kg bolus (up to 20 mL/kg/day)
  - Cats: 2.5 mL/kg bolus (up to 10 mL/kg/day)
  - Evaluate ECG
- If no response:
  - Give ephedrine (0.1 to 0.2 mg/kg IV)
    - Best to dilute 0.1 mL ephedrine in 0.9 mL NaCl to = 5 mg/mL
  - May repeat dose in 15 to 20 minutes if effective
- If no response to above:
  - Give dobutamine (1 to 5 µg/kg/min CRI).
  - 25 mg dobutamine in 1 liter of normal saline via microdrip. This equals 25 µg/mL CRI.
  - Deliver at this rate:
    - 3 kg pet = 1 drop/4 sec
    - 5.4 kg pet = 1 drop/2 sec
    - 11 kg pet = 1 drop/sec
    - 22 kg pet = 2 drops/sec
    - 34 kg pet = 3 drops/sec
    - 45 kg pet = 4 drops/sec

Hypertension is defined as:

- "Bounding" pulse quality
- Systolic > 120 mmHg
- Mean > 100 mmHg

Treatment:

- Treat underlying causes
  - Fluid overload
  - Fever
  - Heart failure
- Frequent reassessment of BP and pulse quality

END TIDAL CO_2

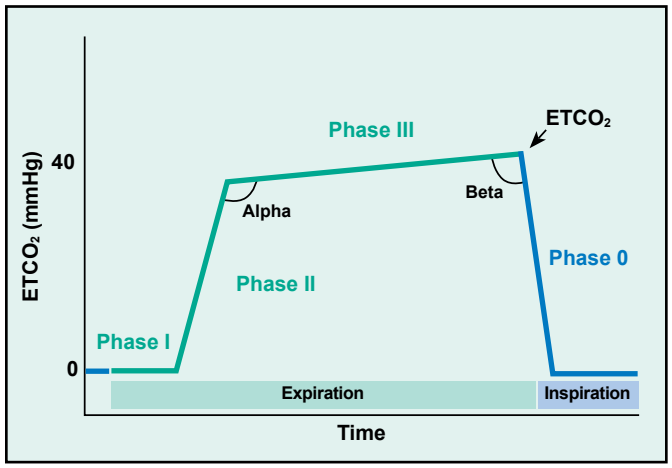
Monitoring carbon dioxide (CO_2) by capnometry and capnography contributes to maintaining a clear picture of what is happening in the anesthetized patient. Both capnometry and capnography provide information about patient ventilation, cardiac output, pulmonary perfusion and systemic metabolism.

Infrared light absorption via mainstream or sidestream is the most common method for measuring CO_2 in respiratory gases.

- In mainstream capnometers and capnographs, the CO_2 measurement sensor and sampling tube is located between the endotracheal tube and breathing circuit. Advantages include real-time measurement of CO_2—typically a response rate of <100 milliseconds. Disadvantages include: increased dead space in the patient breathing circuit produced by the sensor; kinking of the endotracheal tube caused by the weight of the sensor; sensor contaminated caused by secretions and condensation which can destroy the sensor and cause sensor interference; and sensor damage from improper handling.
- In sidestream capnometers and capnographs, the CO_2 sampling tube is located between the endotracheal tube and the breathing circuit, and the sensor is inside the equipment away from the sampling tube. Advantages include a lightweight sampling tube that will not kink the endotracheal tube, less chance of the sensor becoming damaged or contaminated because it is located away from the patient and sampling tube, and less dead space added to the patient breathing circuit. Disadvantages include a two to three second delay in CO_2 readings, and the sampling line can become plugged by secretions and condensation.
- End-tidal carbon dioxide ($ETCO_2$) value estimates arterial CO_2.
- The capnogram waveform displays expired CO_2 over time. This waveform validates the $ETCO_2$ value and provides the opportunity to monitor trends in the patient's CO_2 levels.
  - The expiratory baseline is the beginning of exhalation and should be at zero. If the baseline is above zero or begins to rise, this can signify desiccated CO_2 absorbent, a calibration error in the sensor itself or the presence of water on the sensor windows.
  - A normal waveform will have a sloped rise as gas is exhaled from the lungs.
  - Abnormal waveforms can indicate esophageal intubation, disconnection of the breathing circuit,

hypoventilation, hypotension or airway obstruction among many other situations. For more information, see *Abnormal Capnography Trends*, page 76.

Figure 7.8: Normal Capnogram



When monitoring capnography and $ETCO_2$ in a patient, it is important to keep the larger clinical picture in mind. A change in $ETCO_2$ may be the first indication of an event occurring within the patient, so when an abnormality is noted, the trends of all other vitals being monitored should be taken into consideration before making a decision to intervene.

INTERVENTIONS FOR HYPER- AND HYPOCARBIA

(See *Abnormal Capnography Trends*, page 76.)

Hypocarbia is defined as $ETCO_2$ as < 35 mmHg and can be due to:

- Over-ventilation (by far most common cause in anesthetized patients)
- Very poor tissue perfusion

Treatment:

- Evaluate ventilation and SpO_2.
  - If spontaneously breathing at increased rate and SpO_2 is > 95%, evaluate depth of anesthesia and analgesia.
    - Increase sevoflurane if appropriate.
    - May need to administer additional analgesia if anesthetic depth is appropriate and over-ventilation is not occurring.
  - If overventilation is occurring:
    - Do not ventilate as frequently and reassess $ETCO_2$ every two minutes until stable.
- Evaluate blood pressure and CRT.
  - If hypotensive, then treat hypotension appropriately.

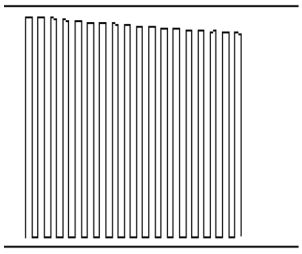
Hypercarbia is defined as $ETCO_2$ > 45 mmHg and is usually due to:

- Decreased ventilation
- Airway disease
- Airway obstruction
- Anesthesia machine malfunction

Treament:

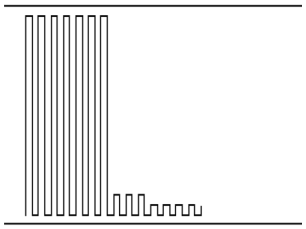
- Verify O_2 supply and anesthesia machine function.
- Verify ET tube patency and placement.
- Decrease sevoflurane by 25%.
- Ventilate pet. See *Assisted Ventilation* section on page 67 for more information.
- Reassess $ETCO_2$ and SpO_2 frequently.
- Evaluate capnograph and capnograph trends.

Abnormal Capnography Trends



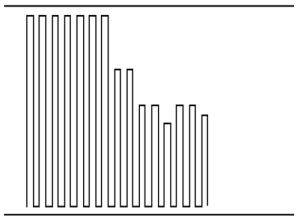
= Slow decrease in $ETCO_2$:

- **Hyperventilation**
- Fall in body temperature
- Falling lung/body perfusion
- Intervene:
  - With fluid support
- Monitor BP
  - Active warming



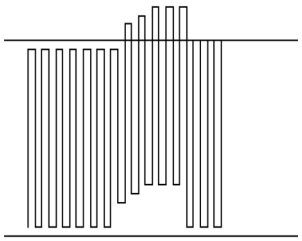
= Sudden drop to zero in a spontaneously breathing pet:

- Kinked ET tube
- Extubated patient
- Disconnected sensor
- Disconnected circuit



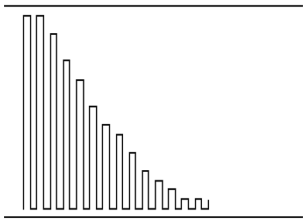
= Sudden drop not to zero:

- Leak in circuit
- Deflated cuff
- Obstruction
- Acute bronchospasm



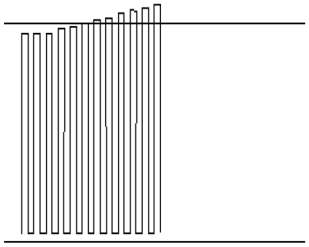
= Sudden rise in baseline:

- Flutter valve stuck in absorber system
- Bad soda lime
- Calibration error
- Interventions: **Evaluate system**



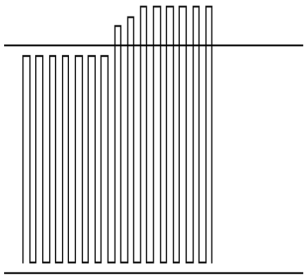
= Exponential decrease in CO_2:

- Circulatory arrest
- Air/clot embolism
- Sudden, severe hyperventilation



= Gradual increase in CO_2:

- Hypoventilation
- Absorption of CO_2 from peritoneum
- Rapidly rising body temperature



= Sudden rise in CO_2:

- Injection of sodium bicarbonate
- Release of tourniquet
- Sudden increase in BP

TEMPERATURE

Goal temperature is 100°F to 102.5°F. **Proactive preservation of body temperature is superior to reactive re-warming techniques.** Hypothermia–body temperature below 98°F–is common after 30 minutes of surgery and should actively be avoided and proactively managed to keep the pet's body temperature normal at all times.

Hypothermia is detrimental in a variety of ways:

- Correlated with increased mortality in humans
- Significant consequences of hypothermia such as:
  - Mild hypothermia causes peripheral vasoconstriction leading to increased heart rate and mean arterial pressure; severe hypothermia causes decreased responsiveness to catecholamines and bradycardia, hypotension and decreased cardiac output.

- Decreased oxygen carrying capacity of hemoglobin due to a left shift in the oxygen hemoglobin dissociation curve leading to hypoxia, pulmonary edema, acute respiratory distress syndrome or pneumonia.
- Decrease in cerebral blood flow (by 6% to 7% per 1.8°F drop in body temperature) can lead to neurologic impairment.
- Decrease in need for anesthetic agents to maintain appropriate depth of anesthesia and if not recognized by decreasing the inhalant anesthetic, this can result in excessive anesthetic depth.
  - **For every degree body temperature falls below 100°F, the anesthesia requirements decrease by approximately 5%**. For example, if the vaporizer is set at 2.5 and the patient temperature drops from 100°F to 98°F, the anesthetic decrease is 2°F x 5% = 10%, *i.e.*, a 2.5 vaporizer setting x 10% = 0.25 decrease. The anesthetic requirement, with all else being the same, results in a vaporizer setting of 2.25.
- Mild-moderate hypothermia can cause a "cold diuresis" due to decreased response to anti-diuretic hormone (ADH) and peripheral vasoconstriction.
- Severe hypothermia can cause significant decrease in renal blood flow leading to tubular necrosis.
- Decreased platelet function leads to increased bleeding tendencies.
- Prolongs recovery

Signs of significant hypothermia

- Hypotension
- Cyanosis
- Arrhythmias
- Cool extremities
- Decreased respiratory rate
- Shivering, which increases oxygen and glucose demand

Hypoglycemia and hypothermia can occur simultaneously, especially in pediatric or small pets. If a hypothermic patient is NOT shivering, check the blood glucose levels and correct any hypoglycemia that is noted.

PREVENTING HEAT LOSS AND INTERVENTIONS FOR HYPOTHERMIA

- Proactive maintenance of body temperature is superior to reactive reheating of a hypothermic patient. Prevention should begin when premedications are given prior to anesthesia. Several ways exist to prevent body heat loss and correct hypothermia:
- Passive warming:
  - Prevent further heat loss by placing blankets or insulating pad between kennel or surgery table to reduce conductive heat loss.
  - Keep the pet covered (place towels over the nonsurgical fields or a warming blanket).
  - Consider wrapping the extremities of small or at-risk patients with heat loss barrier material such as aluminum foil or plastic bubble wrap (be sure to remove before the patient is conscious).
- Active surface heating:
  - Forced air and warm water circulating blankets will prevent hypothermia as well as warm hypothermic pets. These blankets can be used under, over or wrapped around patients during anesthesia. Anesthetized and immobile patients are at a greater risk for thermal burns. The lowest effective temperature setting should be selected and the patient should be carefully monitored to avoid thermal burns.
  - A kennel heating pad can also be used pre- and post-anesthesia as long as the patient is awake and mobile enough to move off the heat source if needed.
- Active core warming:
  - Administer warm IV fluids using an IV fluid warmer. Place this device as close to the patient as possible to maximize its effectiveness and minimize heat loss to the cooler air surrounding the IV tubing.
    - It is not recommended to place the IV line in hot water to warm fluids. Temperature control is harder to maintain and the hot water could spill and burn the patient. IV fluid bags should not be placed in the microwave to warm as this may cause hot spots in the fluids that could burn the patient.
  - Use of warm abdominal lavage solutions can significantly increase core temperature. Abdominal lavage solutions can be warmed to temperatures of 104°F to 109°F before instillation to the abdomen and will help re-warm the pet.

Other warming methods:

- Use warm surgical scrub solution in only the necessary amount (do not drench the patient).
- Use a minimal amount of alcohol during the surgical prep or use sterile saline instead of alcohol.
- Reduce oxygen flow rates during anesthesia to maximize the effects of warming in the rebreathing circuit, but maintain an adequate flow rate to support proper oxygenation (See *Oxygen Flow Rates During Anesthesia*, page 67).
- Hair dryers can cause thermal burns, thus they should not be used for patient warming.

Patient Anesthesia Monitoring Form – Canine/Feline

Date: _____

Pet Name: _____ **Weight (kg):** _____ **ASA Status:** _____ **Procedure(s):** _____

Date of Birth:_____ **Species:** Dog Cat **Temperature:** _____ **Heart Rate/Pulse:** _____ **Pulse Quality:** _____ **Respiratory Rate:** ____

Premedication		**Route of Admin**	**Time Given**	**Associate**
Acepromazine (1 mg/mL)	0.05 mg/kg **x** _____ kg ÷ 1 mg/mL = _____ mL (maximum single dose 1.5 mg)	SC ***or*** IM		
Butorphanol (10 mg/mL)	0.2 ***to*** 0.4 mg/kg **x** _____ kg ÷ 10 mg/mL = _____ mL	SC ***or*** IM		
Telazol (100 mg/mL) (fractious dogs)	1 ***to*** 4 mg/kg **x** _____ kg ÷ 100 mg/mL = _____ mL	IM		
Dexmedetomidine/Ketamine/Torbugesic (DKT) (fractious cats)	0.035 ***to*** 0.065 mL/kg **x** _____ kg = _____ mL	IM		
Midazolam (1 mg/mL)	0.1 ***to*** 0.2 mg/kg **x** _____ kg ÷ 1 mg/mL = _____ mL	IM		
_____ (_____mg/mL)	_____ mg/kg **x** _____ kg ÷ _____ mg/mL = _____ mL			

Evaluation After Premedications & Prior to Induction

Temperature: _____ **Heart Rate/Pulse:** _____ **Pulse Quality:** _____ **Respiratory Rate:** _____ **Sedation Level:** none / mild / adequate / excessive

Induction		**Amount Given**	**Associate**
Propofol (10 mg/mL) IV	1 ***to*** 6 mg/kg **x** _____ kg ÷ 10 mg/mL= _____ mL (give to effect)	_____ mL	
_____ (_____mg/mL)	_____ mg/kg x _____ kg ÷ _____ mg/mL = _____mL (give to effect)	_____ mL	

Fluid Therapy	**1st hour under anesthesia**	**after 1st hour under anesthesia**	**Total Volume Administered**
Lactated Ringer's Solution (LRS) (canine dose)	10 mL/kg/hr **x** _____kg= _____mL/hr	5 mL/kg/hr **x** _____kg= _____mL/hr	_____mL
Lactated Ringer's Solution (LRS) (feline dose)	5 mL/kg/hr **x** _____kg= _____mL/hr	2.5 mL/kg/hr **x** _____kg= _____mL/hr	_____mL
_____	5 ***to*** 10 mL/kg/hr **x** _____kg= _____mL/hr	2.5 ***to*** 5 mL/kg/hr **x** _____kg= _____mL/hr	_____mL

Intubation **Time Intubated:**_____ **Time Surgery Started:**_____ **Catheter Gauge:**_____ **Endotracheal Tube Size:** _____ **Associate:** _____

Local & Regional Blocks		**Block Type**	**Time Given**	**Associate**
Bupivacaine 0.5% (5 mg/mL)	1 ***to*** 2 mg/kg **x** _____kg ÷ 5 mg/mL = _____mL (maximum feline dose 1 mg/kg; decrease 50- 75% in pregnant patients)			
Lidocaine 2% (20 mg/mL)	1 ***to*** 2 mg/kg **x** _____kg ÷ 20 mg/mL = _____mL (decrease 50- 75% in pregnant patients)			

Emergency Medications		**Route of Admin**	**Time Given**			**Associate**
Atipamazole (5 mg/mL) (Dexmedetomidine reversal; feline dose)	0.012 ***to*** 0.021 mL/kg **x** _____ kg = _____mL	IM				
Glycopyrrolate (0.2mg/mL)	0.01 mg/kg **x** _____kg ÷ 0.2 mg/mL = _____mL	IM ***or*** IV				
Atropine (0.54 mg/mL)	0.02 ***to*** 0.04 mg/kg **x** _____kg ÷ 0.54 mg/mL = _____mL	IV				
Epinephrine (1 mg/mL) (CPR dose)	0.2 mg/kg **x** _____kg ÷ 1mg/mL = _____mL	IV				
Lidocaine (20 mg/mL) (canine bolus)	2 ***to*** 4 mg/kg **x** _____kg ÷ 20mg/mL = _____mL	IV				
Lidocaine (20 mg/mL) (feline bolus)	0.25 ***to*** 0.5 mg/kg **x** _____kg ÷ 20 mg/mL = _____mL	IV				
Hetastarch 6% Solution (bolus)	2.5 ***to*** 5 mL/kg **x** _____kg = _____mL	IV				
Ephedrine (5 mg/mL) (every 15-20 minutes; 2 dose limit)	0.1 ***to*** 0.2 mg/kg **x** _____kg ÷ 5 mg/mL = _____mL	IV				
Dobutamine	1 ***to*** 5 µg/kg/min **x** _____kg = _____µg/min	IV				
_____ (_____mg/mL)	_____mg/kg **x** _____kg ÷ _____mg/mL = _____mL	SC ***or*** IM ***or*** IV				

NSAID / Opioid / Antibiotic Medication	**Amount Given**	**Route of Admin**	**Time Given**	**Drug, Strength, Dose, Duration**
NSAID: _____		PO SC IM IV		**NSAID TGH:**_____
Opioid: _____		PO SC IM IV		**Opioid TGH:**_____
Antibiotic: _____		PO SC IM IV		**Antibiotic TGH:**_____

Recovery

Time Surgery Ended: _____ **Time Extubated:** _____ **Time Sternal:** _____ **Temperature:** _____ **Heart Rate/Pulse:** _____ **Pulse Quality:** _____ **Respiratory Rate:** _____

PATIENT ANESTHESIA MONITORING FORM

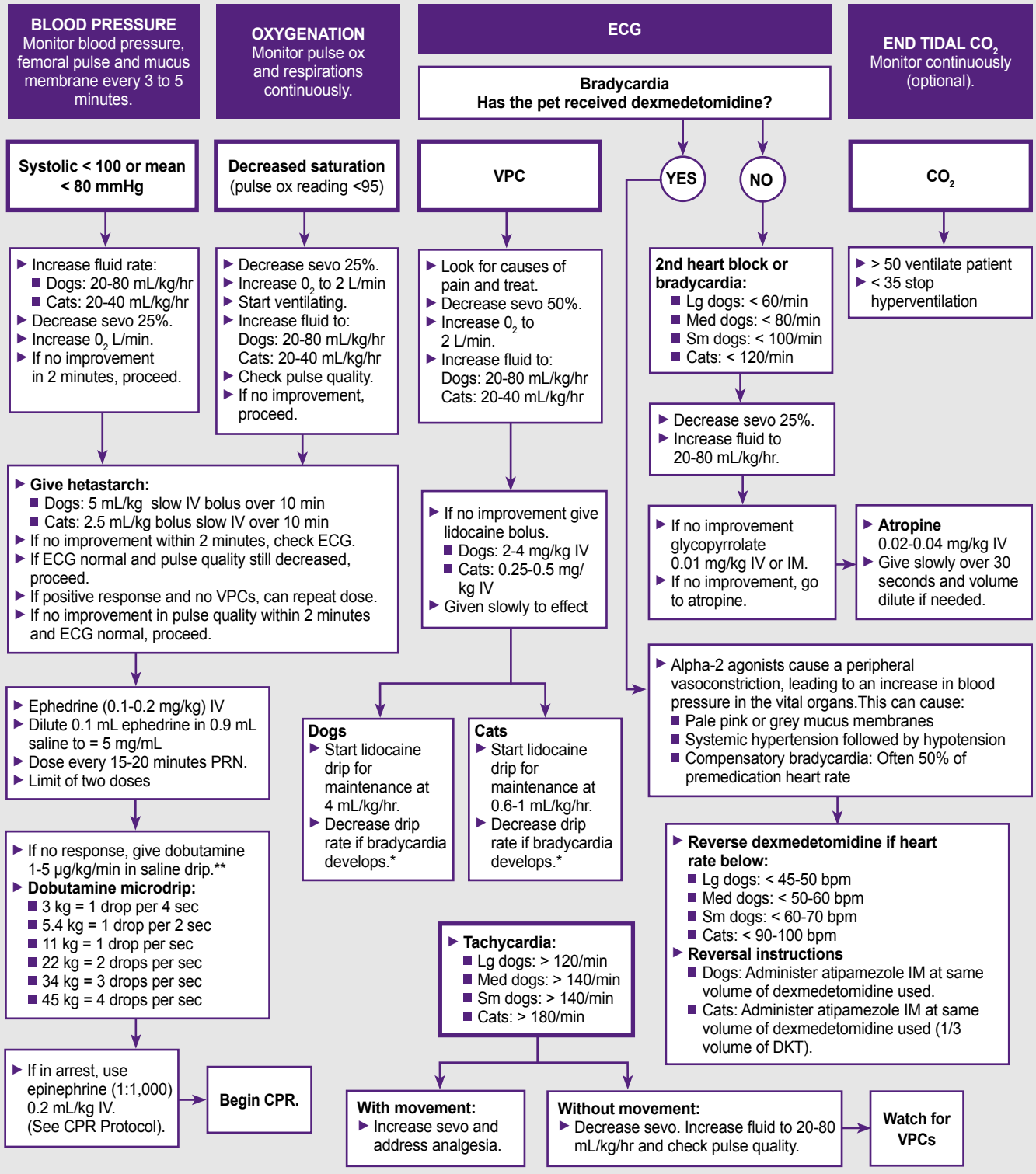
Pet's Name: _____

	Induction ____:____	5 min ____:____	10 min ____:____	**15 min** ____:____	20 min ____:____	25 min ____:____	**30 min** ____:____	35 min ____:____	40 min ____:____	**45 min** ____:____
Sevo %										
O_2 Flow (L/min)										
Fluid Rate (mL/hr)										
Heart/Pulse Rate										
SpO_2										
RR										
CRT/MM	/	/	/	/	/	/	/	/	/	/
Pulse Quality										
ECG Rhythm										
$ETCO_2$										
BP (Sys/Dia/MAP)	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
Temperature										
Anesthetic Depth (Appropriate/Light/Deep)										
Pain Assessment (0-4)										

	50 min ____:____	55 min ____:____	**60 min** ____:____	65 min ____:____	70 min ____:____	**75 min** ____:____	80 min ____:____	85 min ____:____	**90 min** ____:____	95 min ____:____
Sevo %										
O_2 Flow (L/min)										
Fluid Rate (mL/hr)										
Heart/Pulse Rate										
SpO_2										
RR										
CRT/MM	/	/	/	/	/	/	/	/	/	/
Pulse Quality										
ECG Rhythm										
$ETCO_2$										
BP (Sys/Dia/MAP)	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
Temperature										
Anesthetic Depth (Appropriate/Light/Deep)										
Pain Assessment (0-4)										

Anesthesia Monitoring And Emergency Algorithm

Procedures to be used during anesthesia: Monitoring by surgical assistant required. Record pulse, pulse quality, blood pressure, RR, O_2 saturation, ECG q 5 minutes, and record temperature q 5 minutes or as your state practice act requires.



* Lidocaine drip = 1,000 mL saline plus 50 mL of 2% lidocaine = 1 mg/mL. Lidocaine drip cannot be used for volume loading, so a second IV catheter and line will be needed.

** 25 mg dobutamine in 1 liter of normal saline via microdrip. 25 mg/1,000 mL = 0.025 mg/mL = 25 µg/mL; 11 kg dog @ 2 µg/kg/min = 1 mL/min–administer 1 drop/sec (via microdrip) monitor pulse and ECG. As pulse increases, decrease dobutamine. If VPCs and tachycardia develop, decrease dobutamine.

SECTION 8:

Recovery

SECTION 8

Recovery

RECOVERY

(See the *Pain Management* section, starting on page 15, and *Banfield Protocol* sections, starting on page 83, for managing postoperative pain.)

Extubation

Continue oxygen for three to five minutes after discontinuation of sevoflurane. After an anesthetic procedure, patients should stay intubated until they have regained the ability to swallow, but before being able to move their heads. For brachycephalic pets, keep them intubated as long as possible. Keeping patients intubated until they can swallow increases the likelihood that they can protect their own airways.

Monitoring during recovery

Along with induction and intubation, the recovery period is one of the most critical phases of an anesthetic procedure. Monitoring during recovery will allow intervention if an adverse event occurs.

Patients that develop pulmonary edema during anesthesia may not show signs until several hours later. This is one of many reasons that patients must be monitored for at least two hours postanesthesia and why preanesthetic stabilization and evaluation are so critical to successful anesthesia outcomes.

Manual assessment
Continuous manual assessment is required until the patient is sternal. The patient should then be monitored, including pain assessment, every 15 to 30 minutes until discharge. A final TPR should be taken just prior to discharge. The patient should not be released unless the TPR is normal. Transfer to an overnight care facility for continued monitoring and treatment as indicated by the patient's condition.

Pulse oximetry
SpO_2 should be monitored until the patient is extubated. Patients at high risk for respiratory depression may need SpO_2 monitored until they are sternal.

Electrocardiogram
Anesthetic-induced cardiovascular depression is not eliminated once the gas anesthetic is turned off. Cardiovascular function improves over time. The ECG should be monitored until the patient is extubated. Patients with cardiovascular risks may need ECG monitoring throughout recovery.

Blood pressure
As stated above, anesthetic-induced cardiovascular depression is not eliminated once the gas anesthetic is turned off, and cardiovascular function improves over time. Blood pressure should be monitored until extubation. Patients at high risk for cardiovascular depression may need intermittent or continuous blood pressure monitoring throughout recovery.

End-tidal CO_2
$ETCO_2$ should be monitored until extubation.

Temperature
Hypothermia will prolong recovery. Keep patients warm during recovery by:

- Placing blankets or insulating pad between kennel or surgery table to reduce conductive heat loss.
- Keeping the pet covered (place towels or a warming blanket over the pet).
- Using forced air and warm water circulating blankets. These blankets can be used under, over or wrapped around patients during anesthesia. Anesthetized and immobile patients are at a greater risk for thermal burns. The lowest effective temperature setting should be selected and the patient should be carefully monitored to avoid thermal burns.
- A kennel heating pad can also be used post-anesthesia as long as the patient is awake and mobile enough to move off the heat source if needed.

IV catheter removal
It is recommended to keep IV catheters in until patient is fully recovered. Some protocols specify that the IV catheter should not be removed until just prior to discharge. Having emergency venous access is important during this stage of the anesthetic cycle.

SECTION 9:

Protocols

SECTION 9

Banfield Protocols

GENERAL ANESTHESIA CONSIDERATIONS FOR ALL PROTOCOLS

Preoperative assessment

- Perform a complete physical examination (PE) and preanesthetic blood work before administering any preanesthetic or anesthetic drug.
  - All abnormalities noted on PE and preanesthetic lab work must be addressed. This may mean postponement of general anesthesia, further diagnostic workup and selection of a specialized protocol.
  - Fractious patients are the exception, and the Fractious Pet Protocol should be followed.
- Preanesthetic blood work includes a complete blood cell count (CBC) with manual differential (Diff) and internal organ function (IOF) screen including electrolytes (lytes). These tests must be performed during the following intervals:
  - For healthy (no pre-existing disease), young pets (< 2 years of age) for elective surgery: CBC with Diff, preop IOF with lytes within two weeks of procedure.
  - Non-elective procedures and/or > 2 years of age: CBC with Diff, full IOF with lytes within 48 hours of procedure.

Premedications

- Maximum total dose of acepromazine for any pet is 1.5 mg. **Acepromazine may be used with caution or at half the calculated dose in Boxer breeds or sighthound breeds.** Keep in mind, however, when premedication doses are reduced, the amount of induction medication and inhalation anesthetic required are often increased, which can have adverse effects on the pet as well.
- Dilute premedications administered subcutaneously (SC) or intramuscularly (IM) to a total volume of 0.5 to 3 mL depending on the patient's size. Dilute with sterile water. Volume dilution improves accuracy of dosing, especially in small pets.
- Acepromazine should be pre-diluted to 1 mg/mL in a separate vial to allow proper dose administration (See *Directions for Dilution of Acepromazine*, page 35).
- Antibiotics other than cefazolin must be administered a minimum of one hour before anesthesia or following complete recovery due to protein binding.
- Allow 30 minutes for premedications to take effect before induction of general anesthesia.
- **Repeat PE, temperature, pulse, respiration (TPR) after premedications** to assess cardiovascular parameters after premeds have taken effect and before induction. An electrocardiogram (ECG) is helpful. Heart rate is expected to decrease as sedation occurs and anxiety is controlled. Some cats with hypertrophic cardiomyopathy will have the same or higher heart rate following premedication—re-evaluate pet if this is noted.
- If premeds are given more than three hours before induction, repeat premeds at half dose 30 minutes before induction.

Induction

- Propofol should be administered slowly (**over** 30 to 60 seconds in 1/4 dose increments), to effect, to minimize adverse cardiovascular effects. Bradycardia and apnea may develop after rapid administration.
- The average dose of propofol following premedication for healthy pets is 2 to 4 mg/kg for dogs and 2 to 6 mg/kg for cats. Dose for ill pets may be significantly reduced.
- Because of propofol's rapid induction and rapid elimination—an approximately three- to five-minute window of duration—the technique of "overpressure" is required to ensure a smooth transition to sevoflurane. For overpressure, sevoflurane delivery concentrations should be set at 3% using an oxygen flow rate of 3 L/minute for the first three minutes (3%/3 L/3 min). For this technique to be effective, the respiratory rate must be near normal, or assisted ventilation is used to assure adequate intake and uptake of the inhalation agent. Following the initial three minutes, the oxygen flow only is decreased to 1 to 1.5 L/min (rebreathing circuit), and sevoflurane concentration is adjusted, to effect. **Overpressuring is not done if Telazol® or dexmedetomidine (Dexdomitor®) combination is used.**
- If running sevoflurane at 4% or above, look for system leaks, improper intubation or inadequate oxygen flow rate, or inadequate pain control.

- It is best to avoid vaccinations in association with general anesthesia. If vaccines must be given, wait until the pet has been fully recovered for at least two hours.

Maintenance and monitoring

Local blocks:

- Drug doses for local blocks are cumulative doses per pet and drug (add lidocaine and bupivacaine)
- Testicular block for neuters
  - Lidocaine
    - Small dogs and cats: 1 to 2 mg/kg divided per testicle
    - Medium and large dogs: 2 mg/kg divided per testicle
- Line block
  - Lidocaine: 1 to 2 mg/kg dogs and 1 mg/kg cats

OR

  - Bupivacaine 1 to 2 mg/kg dogs and 1 mg/kg cats
- Field block
  - Bupivacaine 1 to 2 mg/kg dogs and 1 mg/kg cats

Perioperative antibiotics are not recommended for clean elective procedures lasting < 90 minutes:

- Ampicillin:10 mg/kg IM
- Cefazolin: 22 mg/kg slow IV
- Clindamycin (dental): 5.5 to 11 mg/kg PO

See *Perioperative Antibiotics*, page 13, for more information.

Postoperative pain management

- **Postoperative analgesic options should include a nonsteroidal anti-inflammatory drug (NSAID) and opioid depending on procedure, health status of pet and pain scale recommendation.**
- Opioids:
  - General considerations for opioid administration postop: can be given when sevoflurane is discontinued as long as last dose of butorphanol was at least one hour prior and the pet's temperature is greater than 98°F.
  - Hydromorphone or fentanyl CRI can be initiated postoperatively as long as it's been two to four hours since hydromorphone was given preoperatively and the patient's temperature is above 98°F.
  - Options: (Choose one)
    - Butorphanol: 0.2 to 0.4 mg/kg IM. Continue butorphanol at 0.2 to 0.4 mg/kg IM q one to two hours PRN if NSAID alone is not controlling pain. Dysphoria can be seen with butorphanol, especially with multiple doses.

OR

    - Buprenorphine: 0.005 to 0.02 mg/kg SC, IM (dogs) and 0.005 to 0.01 mg/kg SC, IM, transmucosal (cats) can be substituted for butorphanol for postoperative pain management. This drug has a longer duration of effect (up to six to eight hours reliably) but may take up to an hour to reach peak effect. This drug can be administered by applying the drug transmucosally in cats, NOT by swallowing.

OR

    - Hydromorphone: 0.05 to 0.2 mg/kg IM, SC, IV q 4 to 6 hrs (dogs) and 0.05 to 0.1 mg/kg IM, SC, IV q 4 to 6 hrs (cats). Be sure to closely monitor body temperature in cats as hydromorphone can cause significant hyperthermia in felines. Should a cat's temperature increase to > 103°F, then administration of buprenorphine 0.005 to 0.01 mg/kg IV will generally reverse most of the hyperthermic effect and maintain the analgesic effect.

OR

    - Fentanyl CRI as described on page 21.

- NSAIDs can be given when sevoflurane is discontinued as long as pet: has no underlying condition contraindicating NSAID use (renal failure, liver disease, significant gastrointestinal compromise or recent corticosteroid administration); is well-hydrated; has received intraoperative fluids; and no risk of significant hemorrhage exists.
  - Carprofen (Rimadyl®) at 4 mg/kg SC, initial dose only (dogs)
  - Meloxicam 0.2 mg/kg SC, initial dose only (cats)
- Dysphoria: Do not confuse pain with dysphoria. If patient seems excitable or agitated, an additional dose of acepromazine or midazolam may be necessary if it has been at least four hours for acepromazine, or two hours for midazolam since the previous dose, and pulse quality and mucus membrane color are good. Give 1/2 of the premed dose of acepromazine or midazolam IM (dogs), SC (cats).

To go home

- **Go home with NSAIDs and/or opioid as appropriate for health status and pain level**.
- NSAID: Dispense same NSAID that was utilized postoperatively.
  - Carprofen 4 mg/kg PO once daily or divided into two equal doses for three to seven days (dogs)
  - Meloxicam 0.05 mg/kg PO daily for a maximum of two to three days (cats). **Use with caution**.
- Opioid:
  - Oral tramadol 2 to 4 mg/kg q 8 hrs (dogs) and 2 to 4 mg/kg q 12 hrs (cats)

OR

  - Oral buprenorphine 0.01 mg/kg transmucosal q 8 hrs (cats)

Healthy Pet Protocol: Soft Tissue Surgery

Premedication:
- Acepromazine 0.05 mg/kg (max dose 1.5 mg)

AND

Butorphanol 0.2-0.4 mg/kg IM (dogs), SC (cats)
- Wait 30 minutes.

Induction:
- Propofol

Dogs: 2-4 mg/kg slow IV to effect
Cats: 2-6 mg/kg slow IV to effect

Maintenance:
- Sevoflurane 1%-4% in 100% O_2 to effect.

Local block:
- Intratesticular and line blocks as indicated. Lidocaine or bupivacaine 1-2 mg/kg (dogs), 1 mg/kg (cats)

Antibiotic:
- As appropriate; ampicillin 10 mg/kg IM

Support:
- Dogs: LRS at 10 mL/kg/hr IV
- Cats: LRS at 5 mL/kg/hr IV
- Decrease rate by 50% after one hour if hemodynamically stable.

Postoperative pain management:
- Dogs: Carprofen 4 mg/kg SC once
- Cats: Meloxicam 0.2 mg/kg SC once

OR
- Cats: Robenacoxib (Onsior®)1 mg/kg PO upon recovery

And, if needed for pain:
- Butorphanol 0.2-0.4 mg/kg IM q 2 hours

OR
- Dogs: Buprenorphine 0.005-0.02 mg/kg SC, IM q 6-12 hrs
- Cats: Buprenorphine 0.005-0.01 mg/kg SC, IM q 6-12 hrs

Discharge instructions:
- Dogs: Carprofen 2 mg/kg PO q 12 hours for 3-5 additional days.
- Cats: Meloxicam 0.05 mg/kg PO q 24 hours for 3 additional days. **Use with caution.**

OR
- Cats: Robenacoxib 1 mg/kg PO q 24 for total of 3 doses
- Add opioid as indicated for pain level.

HEALTHY PET PROTOCOL: SOFT TISSUE SURGERY

(For standard recommendations, see *General Anesthesia Considerations for All Procotols,* page 83.)

Postoperative pain management

Postoperative analgesic options include:

- An NSAID and an opioid depending on procedure completed, health status of the pet and pain scale recommendation.
- Butorphanol at 0.2 to 0.4 mg/kg IM can be given when sevoflurane is discontinued as long as previous dose was at least one hour prior and the pet's temperature is greater than 98°F.

OR

- Buprenorphine: 0.005 to 0.02 mg/kg SC, IM (dogs) and 0.005-0.01 mg/kg SC, IM, transmucosal (cats) can be substituted for butorphanol for postoperative pain management. This drug has a longer duration of effect (up to six to eight hours reliably) but may take up to an hour to reach peak effect. This drug can be administered by applying the drug transmucosally in cats, NOT by swallowing.

AND

- Carprofen at 4 mg/kg SC, initial dose only (dogs), meloxicam 0.2 mg/kg SC, initial dose only (cats) or robenacoxib 1 mg/kg PO upon recovery, can be given as long as pet is well-hydrated, has received intraoperative fluids and no risk of significant hemorrhage exists.
- Continue butorphanol or buprenorphine if NSAID alone is not controlling pain.
- Do not confuse pain with dysphoria. If patient seems excitable or agitated, an additional dose of acepromazine may be necessary if it has been at least four hours since the previous dose and pulse quality and mucus membrane color are good. Give half of the premed dose of acepromazine IM (dogs), SC (cats).

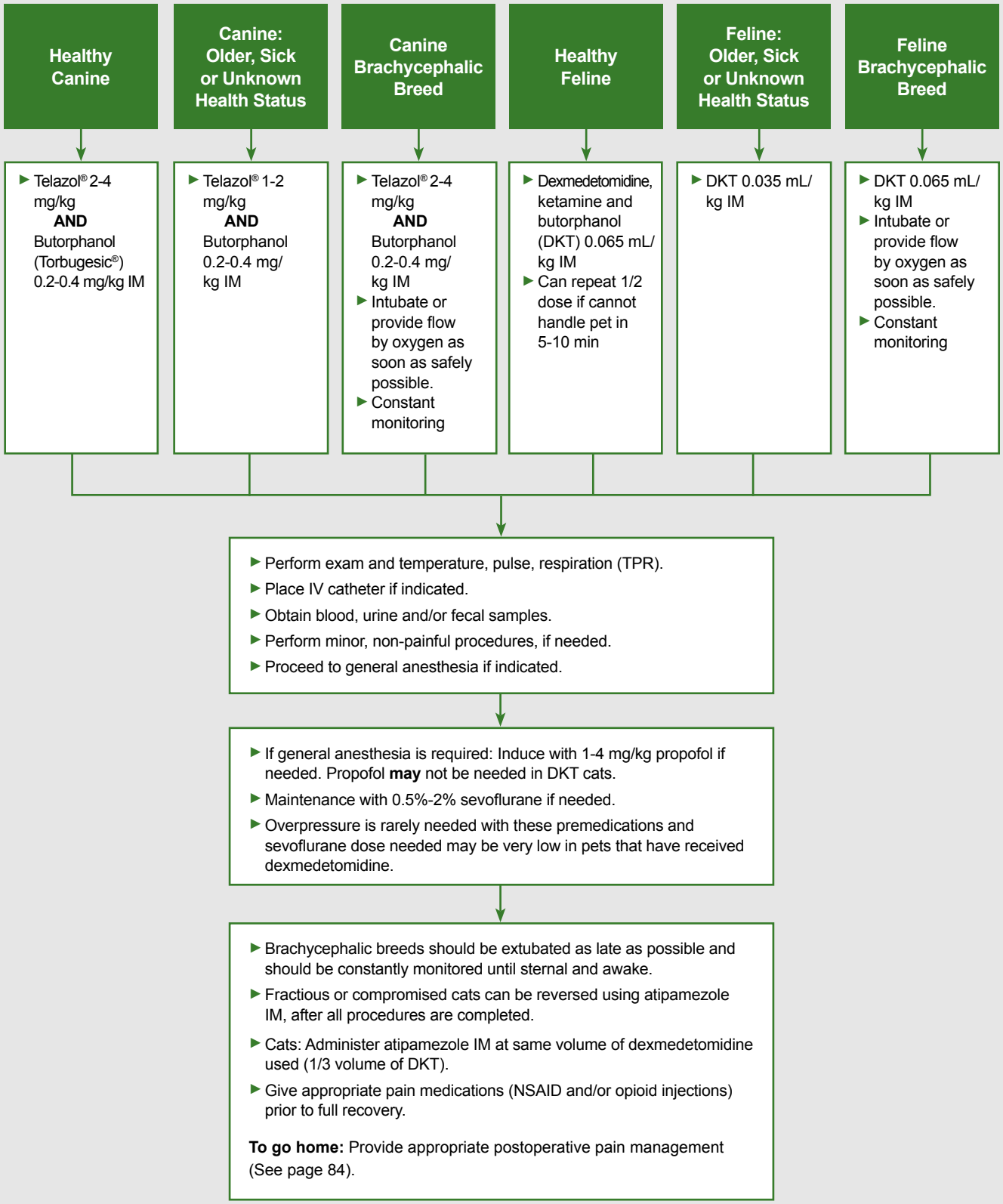
To go home

- Go home with NSAIDs and/or opioid as appropriate for health status and pain level (Please refer to pages 84 and the *Anesthesia Task Pain Chart*, pages 18-19).
- NSAID: Dispense the same NSAID that was utilized postoperatively.
  - Carprofen 4 mg/kg PO once daily or divided into two equal doses for three to five days (dogs)
  - Meloxicam 0.05 mg/kg PO daily for a maximum of two to three days (cats). **Use with caution**.
  - Robenacoxib can be given PO upon recovery from anesthesia, then PO once daily for total of three doses (cats).
- Opioid:
  - Oral tramadol 2 to 4 mg/kg (dogs) q 8 hrs and 2 to 4 mg/kg q 12 hrs (cats)

OR

Oral buprenorphine 0.01 mg/kg transmucosal q 8 hrs (cats)

Fractious Pet Protocol



SPECIAL CONSIDERATIONS FOR FRACTIOUS PET PROTOCOL

(For standard recommendations, see *General Anesthesia Considerations for All Procotols*, page 83.)

Preoperative assessment

Think. Make a good decision.

- Fractious pet is defined as:
  - It takes more than one member of the hospital team to restrain
  - More than one attempt to draw blood is made because of patient movement
  - Any signs of aggression

This protocol should be used before the pet is becoming out of control.

Premedications

- **If acepromazine has been given, and pet becomes fractious, STOP! DO NOT PROCEED with this protocol if Ace has already been given.** Postpone treatment for another day and begin with the Fractious Pet Protocol prior to excitement.
- The use of Telazol® or dexmedetomidine combination IM early in the course of events helps prevent catecholamine release and thus the adverse physiological events associated with catecholamines. Using the Fractious Pet Protocol after losing control of the pet is not the right decision unless the patient's injury or illness is life-threatening. Postpone treatment for another day if possible and immobilize the patient prior to excitement.
- Dexmedetomidine can cause nausea and vomiting following administration. Use of the DKT combination decreases the incidence of nausea and vomiting, but cats should be monitored closely following the injection of DKT.
- Dexmedetomidine combinations usually begin to take effect within two to 10 minutes, resulting in lateral recumbency in four to 17 minutes and providing 30 to 40 minutes of restraint time, with one to two hours for full recovery. **Use caution when handling these patients as some are occasionally capable of rousing enough to bite.** Therefore, Banfield does not recommend this combination for fractious dogs.
- The incidence of occult hypertrophic cardiomyopathy in apparently healthy cats has been estimated to be as high as 15%. For this reason, we do not recommend using Telazol® in fractious cats. Dexmedetomidine is an alpha-2 agonist which causes peripheral vasoconstriction. It has also been shown to increase left ventricular outflow in cats with hypertrophic cardiomyopathy. While **no** anesthetic is safe for cats with underlying heart disease, the judicious use of alpha-2 agonists is currently recommended in fractious patients when occult heart disease has not been ruled out.
- Telazol® should be volume-diluted with sterile water prior to injection to a total volume of 0.5 to 1 mL for improved absorption. If the initial dose does not provide adequate immobilization within 20 minutes, it can be repeated, but do **not** exceed 4 mg/kg. Most dogs, depending on temperament, will be lateral in two to three minutes. Telazol® will provide eight to 30 minutes of restraint time.
- For fractious patients requiring general anesthesia, allow 30 minutes for premedications to take effect before induction, except in the case of brachycephalic pets which should be induced and intubated as quickly as safely possible. During this time, an IV catheter should be placed and blood and urine samples drawn as needed. The pet should be kept warm, provided flow by oxygen as needed and monitored closely. Assess cardiovascular parameters after premeds have taken effect and before induction. An ECG may be beneficial during cardiac assessment.

Induction

- **Remember:** Telazol® or dexmedetomidine combinations will usually lower propofol induction dose by approximately 50% or may eliminate the need for it in some cases. Assess depth of immobilization; some patients can be intubated without further induction agents.
- Overpressure is rarely needed when these premeds are used, and the maintenance requirements for sevoflurane are frequently decreased by approximately 50% or more.

Maintenance and monitoring

- Dexmedetomidine can cause significant decreases in heart rate. While the addition of ketamine to the combination helps balance this effect, it is not unusual for cats under dexmedetomidine sedation to have heart rates from 100 to 120 bpm and pale mucus membranes. Because of the unique actions of dexmedetomidine, this is only considered a problem if significant bradycardia occurs (HR < 90-100) and/or blood pressure or SpO_2 are abnormal. **The first step if problems are noted is to reverse the dexmedetomidine.** Reversal instructions: Cats: Administer atipamezole IM at same volume of dexmedetomidine used (1/3 volume of DKT).

- **Avoid the use of atropine or glycopyrrolate in pets that have received dexmedetomidine, as they can cause significant tachycardia and hypertension.** Once dexmedetomidine has been fully reversed, these drugs can be used on an emergency basis if needed.
- Pulse oximetry monitoring can be more of a challenge in patients that have received dexmedetomidine. The tongue may turn bluish as a result of pooling blood, so it may not be possible to get accurate SpO_2 readings from the sensor. Try placing the probe on the pinna, toes or inguinal areas if possible.
- Blood pressure is expected to remain within normal limits with dexmedetomidine. If sBP < 100 or MAP < 80, follow the protocol for addressing this problem (See *Anesthesia Monitoring and Emergency Algorithm*, page 80).
- Continuous monitoring of patients during the recovery phase is just as important as during the procedure itself. Leave the endotracheal tube in place until the pet is able to swallow several times and/or is fighting the tube. This is especially true for brachycephalic pets.
- Because the tiletamine portion of Telazol® lasts longer in dogs than the zolazepam portion, some dogs may have a rough recovery following Telazol® administration. The addition of butorphanol will usually help smoothe the dog's recovery, however if excessive agitation, muscle tremors or rigidity, thrashing, vocalizing or hyperthermia occurs, midazolam can be administered at 0.1 mg/kg IM.
- **For brachycephalic or compromised cats, consider reversing the dexmedetomidine following the procedure to ensure a more rapid recovery.**

Postoperative pain management and to go home

- Make sure patients are fully recovered prior to releasing them to their owners.
- See *Healthy Pet Protocol* for soft tissue surgery recommendations, page 85.
- See *Orthopedic Protocol* for hard tissue recommendations, page 102.
- See *Abdominal Protocol* for ill pets on page 91.

Feline Declaw Protocol

Premedications:
- Acepromazine 0.05 mg/kg SC

AND
- Hydromorphone 0.05-0.1 mg/kg SC, IM
- Wait 30 minutes.

Induction:
- Propofol to effect 2-6 mg/kg slow IV

Local block:
- Bupivacaine 1 mg/kg total

Antibiotic:
- Cefazolin 22 mg/kg slow IV

Maintenance:
- Sevoflurane 1-4% to effect

Support:
- LRS at 5 mL/kg/hr IV
- Decrease rate by 50% after one hour if hemodynamically stable.

Post surgical pain management:
- **Day 1:**
  - Buprenorphine 0.005-0.01 mg/kg IM q 6-12 hrs

  AND
  - Meloxicam 0.2 mg/kg SC

  OR
  - Robenacoxib (Onsior®) 1 mg/kg PO upon recovery
- **Day 2:**
  - Buprenorphine 0.005-0.01 mg/kg transmucosal q 6-12 hrs

  AND
  - Meloxicam 0.1 mg/kg PO. Use with caution.

To go home:
- Meloxicam suspension 0.05 mg/kg PO q 24 hrs x 2 days. **Use with caution.**
- Robenacoxib 1 mg/kg PO q 24 for total of 3 doses

+/-
- Buprenorphine 0.01 mg/kg transmucosal q 8 hrs

SPECIAL CONSIDERATIONS FOR FELINE DECLAW PROTOCOL

(For standard recommendations, see *General Anesthesia Considerations for All Procotols*, page 83.)

Premedications

- Hydromorphone: Be sure to closely monitor body temperature in cats as hydromorphone can cause significant hyperthermia in felines. Should a cat's temperature increase to > 103°F, then administration of buprenorphine 0.005 to 0.01 mg/kg IV will generally reverse most of the hyperthermic effect and maintain the analgesic effect.
- Cefazolin 22 mg/kg slow IV at induction and repeated every 90 minutes until skin closure is generally preferred perioperatively in orthopedic procedures.

Maintenance and monitoring

- Apply the tourniquet **distal** to the elbow. Improper placement may cause neurapraxia, tissue necrosis and lameness. The radial nerve is most often affected, so it is important to place the tourniquet distal to the elbow.
- Local blocks:
  - It is standard of care to provide local analgesia when declaws are performed.
  - Bupivacaine is now recommended over lidocaine as it has been shown to have a faster onset of action (around five minutes) than previously believed when injected adjacent to nerves.[1]
  - Calculate bupivacaine dose carefully to avoid toxicity due to overdose. Remember, when using local anesthesia in more than one region (*e.g.*, declaw with neuter) that the maximum doses are cumulative. Do not exceed 1 mg/kg of bupivacaine.
  - Use a 25- to 22-gauge needle for subcutaneous injection. Avoid intravascular injection.
- Regional blocks:
  - Carpal blocks provide three to five hours of postoperative analgesia using bupivacaine 0.5%.
  - Superficial branches of the radial nerve are blocked by injecting the local anesthetic solution subcutaneously on the dorsomedial aspect of the carpus just proximal to the joint (*Figure 6.1*, page 90).
  - The median nerve and the palmar and dorsal cutaneous branches of the ulnar nerve are blocked by injecting local anesthetic solution subcutaneously medial and lateral to the carpal pad (*Figure 6.1*, page 90).
- Robenacoxib can be given PO upon recovery from anesthesia, then PO once daily for total of 3 doses.

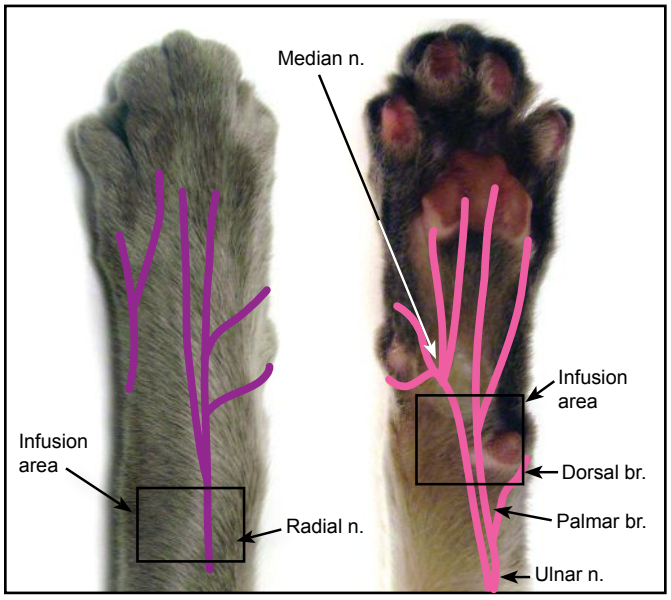
Postoperative pain management

- Duration of action for hydromorphone is approximately four hours. When used as a premedication, pain assessment or time since administration should be considered prior to giving buprenorphine postoperatively.
- Postoperative buprenorphine 0.01 mg/kg IM—can be given when sevoflurane is discontinued as long as the pet's temperature is greater than 98°F.
- Upon completion of surgery, administer one dose of meloxicam 0.2 mg/kg SC (Or, for robenacoxib (Onsior®), please see page 85) if renal and liver function are within normal limits, pet is normotensive and no hypotensive or hypoperfusion episodes occurred during the procedure. **Use with caution.**

To go home

- The following morning, administer a second dose of meloxicam at a decreased dose of 0.1 mg/kg PO (and buprenorphine if an adult or heavy cat) before removing bandages.
- Meloxicam should be prescribed as additional go-home pain management. A maximum of two doses of meloxicam 0.05 mg/kg q 24 hours (or robenacoxib, 1mg/kg/PO q 24 hours for a total of three doses as described on *page 85*) should be sent home. **Use with caution.** In addition, buprenorphine should be prescribed along with meloxicam in felines with additional pain concerns (*i.e.*, a difficult declaw), or in adult or heavier cats. Buprenorphine can be prescribed at 0.01 mg/kg TID as a transmucosal administration option. Due to buprenorphine's duration of analgesia (six to eight hours), it is superior to butorphanol as post-declaw pain management.
- Bandages should be removed prior to any feline going home post-declaw. Adult cats may need prolonged hospitalization and bandage care.

Figure 6.1: Regional Carpal Block



From left, dorsal and palmar views of the front feline paw

Source

1. Alhelail M, Al-Salamah M, Al-Mulhim M, Al-Hamid S. Comparison of bupivacaine and lidocaine with epinephrine for digital nerve blocks. *Emerg Med J.* 2010 Apr;27(4):335.

Abdominal Protocol

Stabilize Before Surgery

Candidates:
- Pyometra
- Gastrointestinal foreign bodies
- Cystitis/uroliths
- Peritonitis
- Abdominal masses
- Intussusceptions
- GDV

Stabilization:
- Place IV catheter.
- Treat shock (see below).
- Correct electrolyte, calcium or blood glucose abnormalities.
- Transfuse if needed.
- Keep warm.
- Minimize stress.

Support:
- Dogs: LRS at 10 mL/kg/hr IV
- Cats: LRS at 5 mL/kg/hr IV
- Decrease rate by 50% after one hour if hemodynamically stable.

Premedications:
- Midazolam 0.1-0.2 mg/kg IM

AND
- Butorphanol 0.2-0.4 mg/kg IM

OR
- Dogs: Hydromorphone 0.05-0.2 mg/kg IM, SC
- Cats: Hydromorphone 0.05-0.1 mg/kg IM, SC
- Wait 30 minutes.

Induction:
- Pre-oxygenate for five minutes via mask.
- Propofol
  - Dogs: 1-4 mg/kg slow IV to effect
  - Cats: 1-6 mg/kg slow IV to effect

Maintenance:
- Use lowest effective sevoflurane level.
- Perform line block with lidocaine (do not exceed 2 mg/kg total dose, dilute with sterile saline if needed).
- Antibiotic as appropriate
- Provide appropriate postoperative pain management (See page 92).

SPECIAL CONSIDERATIONS FOR ABDOMINAL PROTOCOL

(For standard recommendations, see *General Anesthesia Considerations for All Procotols*, page 83.)

Preoperative assessment

- Stabilize prior to anesthesia:
  - Manage shock. Initiate shock treatment with the appropriate crystalloid fluid. Dogs: 20 mL/kg bolus (up to 80 mL/kg). Cats: 5 mL/kg bolus (up to 40 mL/kg). Hetastarch may also be administered if needed. Dogs: 5 mL/kg bolus (up to 20 mL/kg/day). Cats: 2.5 mL/kg bolus (up to 10 mL/kg/day).
  - Manage arrhythmias. If Vtach or > 30% VPC **AND** sBP < 90, MAP < 60 or pulse-ox < 95 (on oxygen) administer lidocaine 2 to 4 mg/kg (dogs) or 0.25 to 0.5 mg/kg (cats) IV, then place a second IV catheter and begin a lidocaine constant rate infusion (CRI).
  - Correct any hydration deficits and electrolyte abnormalities prior to anesthesia.
  - Provide blood or plasma transfusion if needed.
  - Provide pain management (butorphanol 0.2 to 0.4 mg/kg IM q 1 to 4 hours as needed).
- Gastric dilatation volvulus (GDV) cases are not immediate surgical emergencies and require stabilization and decompression before general anesthesia. Passage of an orogastric tube or needle trocarization can be used for decompression during preoperative stabilization. True surgical emergencies are cases that require anesthesia within 15 minutes to save the patient's life and are not commonly seen in private practice (See *Emergency Surgery Protocol*, page 106).
- Recheck packed cell volume/total protein (PCV/TP), blood glucose (BG) and electrolytes as needed before proceeding to surgery.
- Appropriate antibiotics should be administered based on the individual case. Antibiotics other than cefazolin must be administered a minimum of one hour before anesthesia or following complete recovery.

Premedications

- **Do not use acepromazine.**
- If premeds are given more than three hours before induction, repeat premeds at half dose 30 minutes before induction.

Induction

- Propofol should be administered slowly to effect, to minimize adverse cardiovascular effects. Bradycardia and apnea may develop after rapid administration.
- The average dose of propofol is often less than is required by healthy pets. Err on the side of caution.

Maintenance and monitoring

- Sevoflurane concentration necessary to keep these patients in a general plane of anesthesia is usually significantly lower than is required by healthy pets.
- Overpressure may not be necessary in severely compromised pets.
- Repeat lab work as needed during anesthesia, especially in surgeries lasting more than one hour, consider rechecking PCV/TP, BG and/or electrolytes.
- Critically ill patients may be slow to recover from anesthesia. Monitor and document temperature, pulse, respiration (TPR) and other vitals frequently and provide supportive care, heat supplementation and pain management as necessary.
- Provide appropriate pain medications postoperatively (See *Anesthesia Task Pain Chart,* pages 18-19). See note under special considerations below regarding NSAIDs.

Postoperative pain management

- Postoperative analgesic options should include an NSAID and an opioid depending on procedure completed, health status of the pet and pain scale recommendation. Continue an opioid for pain management.
- Injectable NSAIDs should be avoided in cases where there was significant dehydration, shock, renal or liver impairment, gastrointestinal irritation, compromise or surgery to GI tract.
- **Mild to moderate pain:**
  - Butorphanol: 0.2 to 0.4 mg/kg IM. Continue butorphanol at 0.2 to 0.4 mg/kg IM q one to two hours PRN if NSAID alone is not controlling pain. Dysphoria can be seen with butorphanol, especially with multiple doses.

    OR
  - Buprenorphine: 0.005 to 0.02 mg/kg SC, IM (dogs) and 0.005-0.01 mg/kg SC, IM, transmucosal (cats) can be substituted for butorphanol for postoperative pain management. This drug has a longer duration of effect (up to six to eight hours reliably) but may take up to an hour to reach peak effect. This drug can be administered by applying the drug transmucosally in cats, NOT by swallowing.
- **Severe pain:**
  - Hydromorphone: 0.05 to 0.2 mg/kg IM, SC, IV q 4-6 hrs (dogs) and 0.05-0.1 mg/kg IM, SC, IV q 4-6 hrs (cats). Be sure to closely monitor body temperature in cats as hydromorphone can cause significant hyperthermia in felines. Should a cat's postoperative temperature increase to >103°F , then administration of buprenorphine 0.005 to 0.01 mg/kg IV will generally reverse most of the hyperthermic effect and maintain the analgesic effect.

    OR
  - Fentanyl CRI as described on page 21.

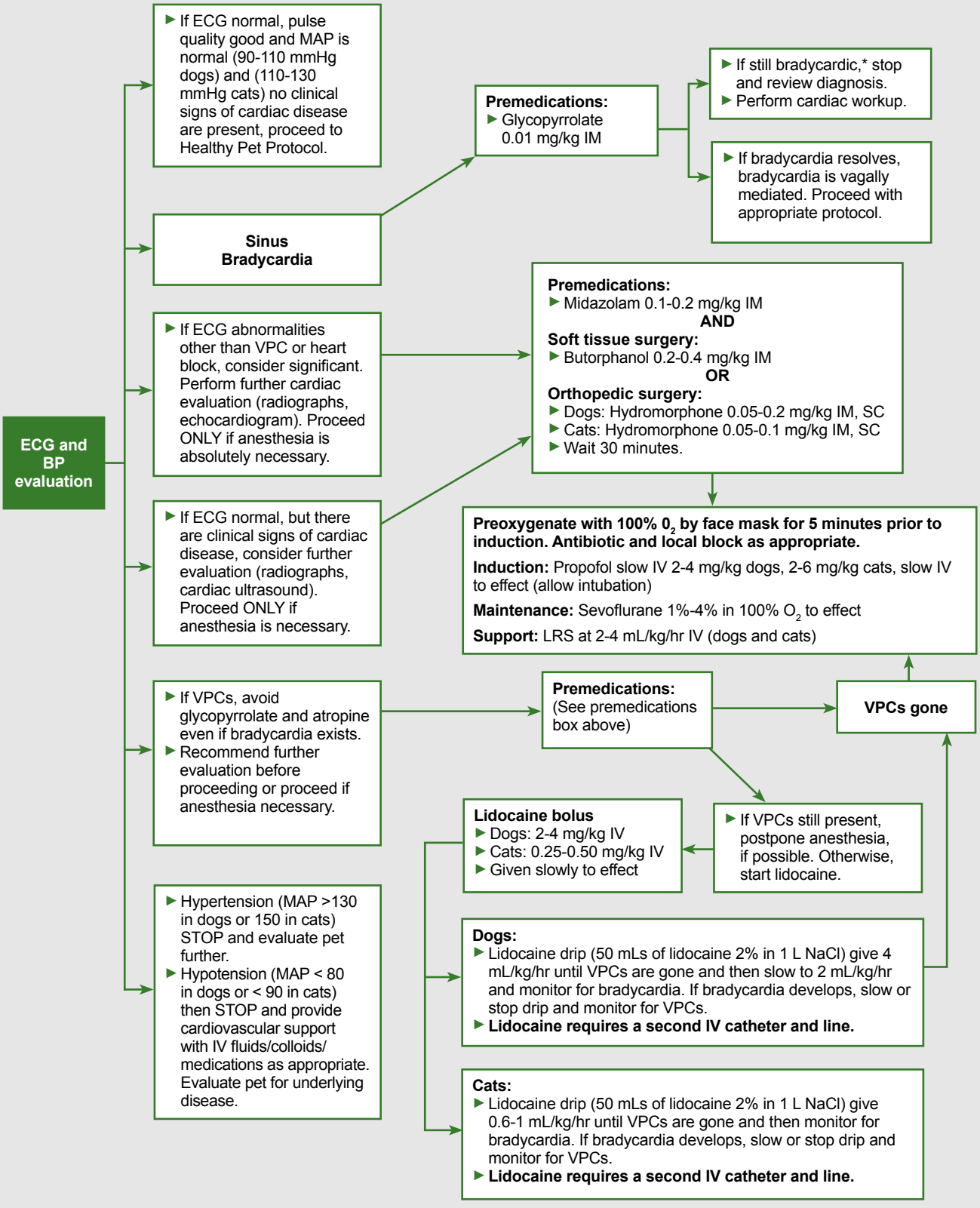
To go home

- Avoid the use of NSAIDs, or use with extreme caution, in patients with significant dehydration, shock, renal impairment or underlying gastrointestinal disease. The most recent research indicates that COX-2 is an important component in gastrointestinal healing and that COX-2 NSAIDs such as carprofen or meloxicam should be avoided in cases where gastrointestinal injury may be present, either as a result of protracted vomiting, primary gastrointestinal disease or gastrointestinal surgery.

- Opioid:
  - Oral tramadol 2 to 4 mg/kg q 8 hrs (dogs) and 2 mg/kg 4 mg/kg q 12 hrs (cats)

    OR
  - Oral buprenorphine 0.01 mg/kg transmucosal q 8 hrs (cats)

Cardiac Protocol



* Patients that are bradycardic after glycopyrrolate or atropine may still have a vagal stimulus present. Check for increases in ocular or intracranial pressure or full bladder.

SPECIAL CONSIDERATIONS FOR CARDIAC PROTOCOL

(For standard recommendations, see *General Anesthesia Considerations for All Procotols*, page 83.)

Preoperative assessment

- Cardiac patients should be stabilized as much as possible before proceeding with anesthesia. It is strongly recommended to take preanesthetic thoracic radiographs in any patients with known cardiac disease. An ECG should be assessed prior to administering any medications.

Premedications

- Avoid Telazol® and acepromazine in patients with known underlying cardiac disease.
- Heart rate should decrease post premedication administration. Should the heart rate increase, then evaluate pet, perform an ECG and consider postponing anesthesia to further evaluate the heart if at all possible.

Induction

- Monitor an ECG throughout the preanesthetic and anesthetic periods.
- Preoxygenate with 100% O_2 by face mask or flow-by for 5 minutes PRIOR to induction and minimize stress while handling cardiac patients.
- **Because propofol has significant adverse cardiovascular effects when bolused rapidly IV, ensure that the rate of administration is at least over one minute.**

Maintenance and monitoring

- Anesthetic monitoring is especially important in cardiac patients because they are more predisposed to adverse anesthetic events. Monitor ECG for bradycardia, tachycardia or arrhythmias. Monitor pulse oximeter for hypoxia and monitor MAP for hypertension or hypotension throughout the procedure and recovery periods. Intervene according to the *Anesthesia Monitoring and Emergency Algorithm*, page 80.
- IV fluid rates should be closely monitored as cardiac patients are more predisposed to fluid overload (watch for tachypnea, dyspnea, tachycardia, pale mucus membrane, chemosis, peripheral edema, pulmonary crackles, nasal discharge, watery vomiting and diarrhea).
- Be proactive to avoid significant hypothermia as this can put an undue stress on the heart.
- Critically ill patients may be slow to recover from anesthesia. Monitor and document temperature, pulse, respiration (TPR) and other vitals frequently and provide supportive care as necessary. Continue monitoring ECG, blood pressure and maintain on IV fluids until pet is sternal and extubated. Do not remove IV catheter until just prior to discharge if at all possible in case there is a need for immediate IV access.

Postoperative pain management and to go home

- See *Healthy Pet Protocol* for soft tissue surgery recommendations, page 85.
- See *Orthopedic Protocol* for hard tissue recommendations, page 102.
- See *Abdominal Protocol* for ill pets, page 91.

Hepatic Protocol

- Activated clotting time (ACT) or clotting profile (PT, PTT, platelet count) prior to procedure whenever significant liver disease is suspected.
  - If clotting tests are abnormal, postpone and transfuse (FFP, fresh whole blood).
  - Repeat clotting tests post transfusion and re-evaluate the need for general anesthesia.
  - If clotting tests are abnormal and anesthesia is deemed necessary, then refer to specialty facility for appropriate care.

Premedications:
- Midazolam 0.1-0.2 mg/kg IM

AND

Soft tissue surgery:
- Butorphanol 0.2-0.4 mg/kg IM

OR

Orthopedic surgery:
- Dogs: Hydromorphone 0.05-0.2 mg/kg IM, SC
- Cats: Hydromorphone 0.05-0.1 mg/kg IM, SC

Wait 30 minutes.

Induction:
- Propofol
  - Dogs: 1-4 mg/kg slow IV to effect
  - Cats: 1-6 mg/kg slow IV to effect

Maintenance:
- Sevoflurane 1%-4% to effect, inhaled.

Local block: as appropriate

Antibiotic: as appropriate

Support:
- Dogs: LRS at 10 mL/kg/hr IV
- Cats: LRS 5 mL/kg/hr IV
- Decrease rate by 50% after one hour if hemodynamically stable.

Recovery:
- During recovery, LRS at 5 mL/kg/hr
- If recovery greater than 20 minutes, warm patient and check blood glucose.
- May need to add additional dextrose to the fluids to maintain BG between 100-150 mg/dL.
- Provide postoperatively analgesia as appropriate.

SPECIAL CONSIDERATIONS FOR HEPATIC PROTOCOL

(For standard recommendations, see *General Anesthesia Considerations for All Procotols*, page 83.)

Preoperative assessment

- If a transfusion is given, premed with diphenhydramine (2 mg/kg IM) and postpone anesthesia until pet is more stable.
- Significant liver disease will affect the metabolism and, therefore, duration of action of most anesthetic drugs. For this reason, most drug doses should be based on the lower end of the dosage range.
- If serum albumin is below 2 g/dL then plasma transfusion and/or hetastarch 20 mL/kg/day (dogs), 10 mL/kg/day (cats) must be given for oncotic support and the need for anesthesia should be reassessed.
- Coagulation testing (ACT, PT, PTT) should be performed the day of surgery. Buccal mucosal bleeding time (BMBT) is not a valuable test for patients with liver disease as it only indicates functionality of platelets, not clotting factors.
- Clinical and subclinical coagulopathies can occur with severe hepatobiliary disease since most clotting factors are synthesized in the liver. Some patients with normal coagulation tests can still have bleeding tendencies due to changes in coagulation factor activity, disseminated intravascular coagulation (DIC) and portal hypertension-induced vascular congestion and fragility.
- A coagulopathy secondary to liver failure indicates severe hepatobiliary disease and is associated with a poor prognosis.
- Recommend having fresh frozen plasma (FFP) or blood available even if coagulation parameters are normal.

Induction

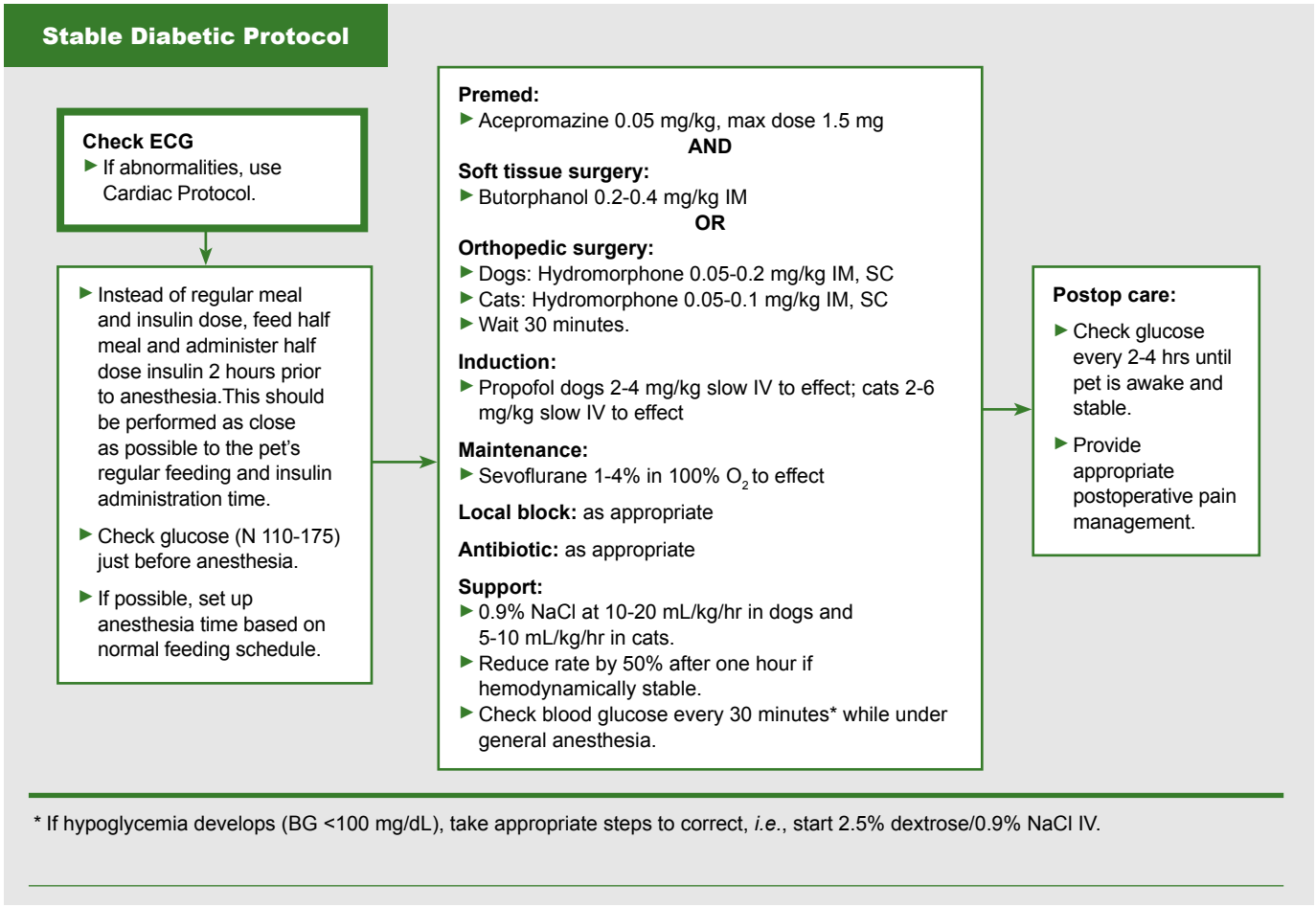
- The average dose of propofol is often less than is required by healthy pets. Err on the side of caution.

Maintenance and monitoring

- Critically ill patients may be slow to recover from anesthesia. Monitor and document TPR and other vitals, including blood glucose, frequently, and provide support. Give care as necessary.

Postoperative pain management and to go home

- NSAIDs should be avoided in patients with liver disease.
- See *Orthopedic Protocol* for hard tissue recommendations, page 102.
- See *Abdominal Protocol* for ill pets on page 91.



SPECIAL CONSIDERATIONS FOR STABLE DIABETIC PROTOCOL

(For standard recommendations, see *General Anesthesia Considerations for All Procotols*, page 83.)

Preoperative assessment

Non-stable diabetics should not be anesthetized unless there is a critical emergency that warrants the risk. If a true emergency procedure must be done, the following procedures are recommended:

- Correction of hypovolemia secondary to dehydration
- Thorough evaluation and correction of any electrolyte abnormalities

Maintenance and monitoring

- 0.9% NaCl is used as the IV fluid choice in diabetic patients.
- Continuous evaluation of the blood glucose levels (minimally every 30 min) and the addition or deletion of dextrose from the patient's IV fluids.
- Stabilization of hyperglycemia through the use of regular insulin injections (*e.g.*, Humulin® R) or CRI.
- Stabilization of hypoglycemia through the use of IV dextrose boluses (1 mL 50% dextrose per kg of body weight) or CRI.
- The goal of anesthetizing a diabetic patient is to achieve full consciousness and recovery as quickly as possible so the patient can return to a normal feeding schedule and metabolic state.[1]
- Ideal blood glucose levels will be between 150 and 250 mg/dL.[1]

Postoperative pain management and to go home

- See *Healthy Pet Protocol* for soft tissue surgery recommendations, page 85.
- See *Orthopedic Protocol* for hard tissue recommendations, page 102.
- See *Abdominal Protocol* for ill pets, page 91.

Reference

1. Thurman WJ, Grimm KA. *Lumb & Jones' Veterinary Anesthesia and Analgesia*. 4th ed. Oxford, England. Blackwell Publishing. 2007; 933.

Pulmonary Protocol

Check oxygen saturation now

Pulse ox normal and normal air movement present:

- Proceed.
- If pneumonia or asthma present, consider radiographs.

Premedications:

- Acepromazine 0.05 mg/kg, max dose 1.5 mg

AND

Soft tissue surgery:

- Butorphanol 0.2-0.4 mg/kg IM

OR

Orthopedic surgery:

- Dogs: Hydromorphone 0.05-0.2 mg/kg IM, SC
- Cats: Hydromorphone 0.05-0.1 mg/kg IM, SC

- Wait 30 minutes.
- Pre-oxygenate three to five minutes.

Induction:

- Dogs: Propofol 2-4 mg/kg slow IV to effect
  Cats: 2-6 mg/kg slow IV. Use rapid sequence induction** & be prepared to ventilate.

Maintenance:

- Sevoflurane 1-4% in 100% O_2 to effect

Local block: as appropriate

Antibiotic: as appropriate

Support:

- LRS IV 10 mL/kg/hr dog and 5 mL/kg/hr cat for first hour, decreasing rate by 50% if hemodynamically stable.
- Manual ventilation may be required. Provide appropriate postop pain management.

Pulse ox abnormal or respiratory distress present:

- Consider radiographs and thoracocentesis (look for pneumothorax, pleural effusion or diaphragmatic hernia).
- DO NOT overly stress*–consider butorphanol 0.2-0.4 mg/kg IM to calm.
- If sedation needed for diagnosis, use acepromazine 0.05 mg/kg (max dose 1.5 mg) plus butorphanol 0.2-0.4 mg/kg SC/IM.

  Note: If high risk, avoid acepromazine–use midazolam 0.2-0.4 mg/kg IM instead.
- Avoid stress* and provide O_2.

Pneumothorax or pleural effusion present:

- Drain chest & stabilize.
- Local block/immobilization preferred for chest tube placement.

Diaphragmatic hernia

ECG:

- If ECG normal, proceed. If ECG abnormal, see Cardiac Protocol.
- Resolve ECG abnormalities, then use Pulmonary Protocol for induction and maintenance.

* Avoid stress = the heart rate does not increase by 25% or more.
** "Rapid sequence induction" = have all needed supplies available at induction for quick intubation. Any delay in providing oxygen and an open airway increases risk of death.

SPECIAL CONSIDERATIONS FOR PULMONARY PROTOCOL

(For standard recommendations, see *General Anesthesia Considerations for All Procotols*, page 83.)

Preoperative assessment

- Stabilize prior to anesthesia:
  - Provide oxygen and check pulse oximeter.
  - **If upper airway is blocked, provide oxygen through an 18-gauge catheter needle placed into the trachea between the trachea rings as short-term emergency support.**
  - Thoracocentesis may be required prior to anesthesia if pneumothorax or pleural effusion is present.
  - Butorphanol (low dose recommended 0.2 mg/kg IM) may be required to calm a distressed pet.
  - Perform as complete a physical examination as possible. Obtain radiographs if possible, however it is imperative to minimize stress.
  - Assess cardiovascular parameters before induction. An ECG may be beneficial during cardiac assessment.
- It is important to choose the largest endotracheal tube that will fit easily and not irritate or traumatize the trachea (See *Endotracheal Tube Selection*, page 43). Inserting too small an endotracheal tube can cause a buildup of carbon dioxide and cause post-anesthesia complications.

Premedications

- Ensure premedications have taken effect before induction. An ECG may be beneficial during cardiac assessment. See algorithm, page 97.
- Monitor pulse oximetry and continue to provide oxygen.
- Pulse oximetry readings should be assessed before and after premedication administration. Carefully assess cardiovascular parameters after premeds.

Induction

- Preoxygenate three to five minutes prior to induction.
- Use the minimum amount of drugs for induction and the lowest sevoflurane percentage possible for the situation. **The average dose of propofol is often less than is required by healthy pets. Err on the side of caution.** Propofol should be administered slowly to effect, to minimize adverse cardiovascular effects. Bradycardia and apnea may develop after rapid administration.

Maintenance and monitoring

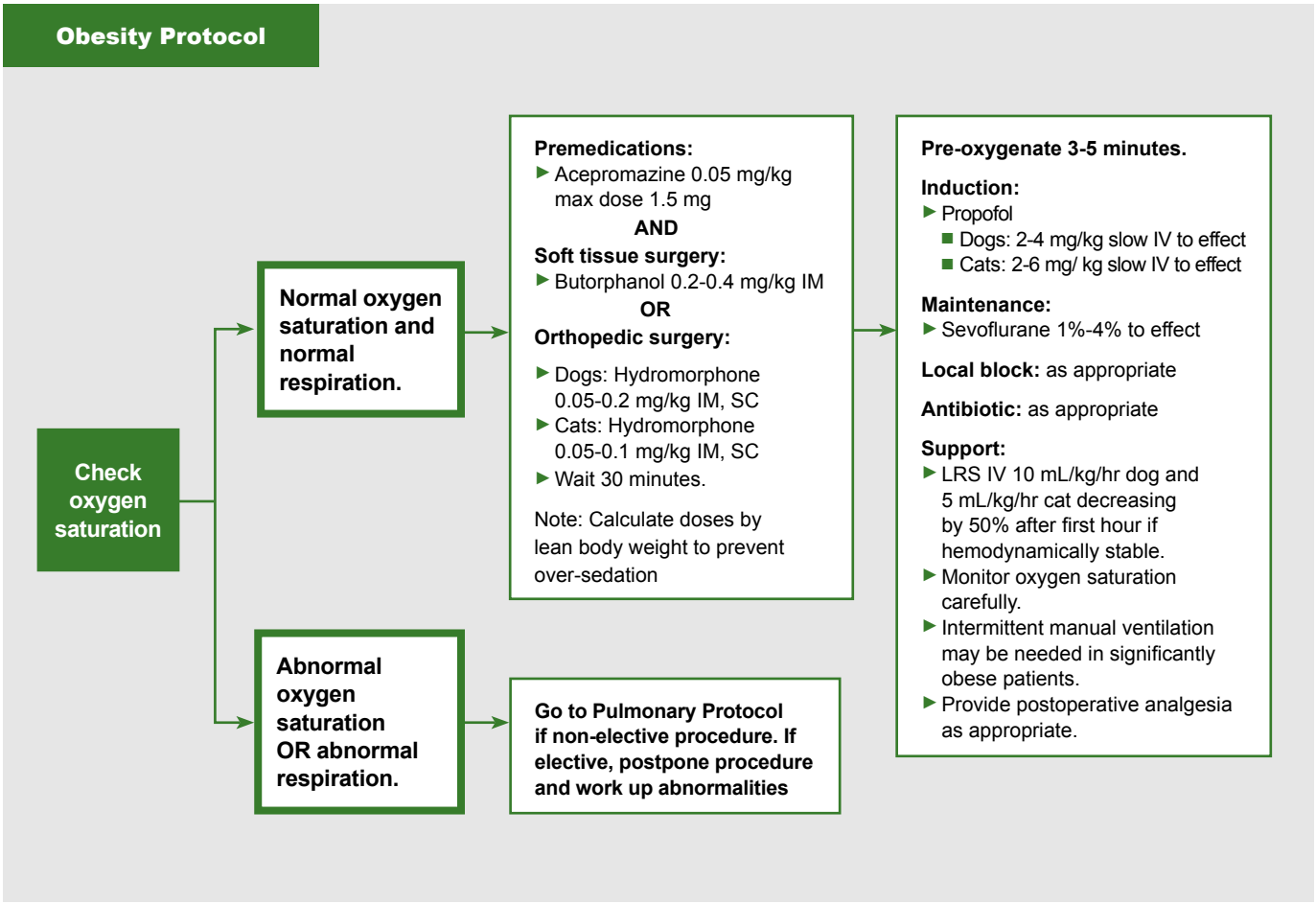
- Monitor pulse oximeter readings often as manual ventilation or thoracocentesis may be required.
- **When ventilating patients with chronic pulmonary disease, be sure to watch the manometer. Pressures should not exceed 12 to 15 cm H_20. Higher pressures can cause micro hemorrhage in the alveoli of compromised lung tissue. Such patients may wake up from anesthesia, only to die within a few hours of recovery.**

Postoperative pain management and to go home

- Critically ill patients may be slow to recover from anesthesia. Monitor and document TPR and other vitals frequently and provide supportive care, supplemental heat and pain management as necessary.
- Pain management: See appropriate protocol and consider premeds that are on board.
- See *Healthy Pet Protocol* for soft tissue surgery recommendations on page 85.
- See *Orthopedic Protocol* for hard tissue recommendations, page 102.
- See *Abdominal Protocol* for ill pets on page 91.

Think. Make a good decision.

Bradyarrythmias are common in patients with respiratory disease due to increased vagal tone, *e.g.,* brachycephalic breeds and patients with intrathoracic disease. Patients symptomatic for bradyarrythmias may display weakness, lethargy, depression and syncope. Sinus bradycardia is most often seen with increased vagal tone. Treatment is based on management of the underlying cause. A vagalytic/parasympathetic agent (atropine, 0.02-0.04 mg/kg) may be used in the awake, unmedicated patient to see if increased vagal tone is the source of the bradycardia. This dose is less likely to cause rebound sinus tachycardia and is much lower than the dose used to treat bradycardia that develops under anesthesia.



SPECIAL CONSIDERATIONS FOR OBESITY PROTOCOL

(For standard recommendations, see *General Anesthesia Considerations for All Procotols*, page 83.)

- It is important to adequately monitor oxygenation status in obese pets.
- It is possible to overdose obese pets. Dose according to lean body weight.
- Choose the largest endotracheal tube that will fit easily and not irritate or traumatize the trachea.

Preoperative assessment

Obesity protocol is designed for the obese but otherwise healthy pet. If obese and ill, please follow the appropriate protocol guidelines.

- Orthopedic surgery: See *Orthopedic Protocol*, page 102.
- Ill pet: See *Hepatic Protocol*, page 95, *Renal Protocol*, page 100, *Abdominal Protocol*, page 91.

Premedications

- Calculate doses by lean body weight.

Induction

- Pre-oxygenate three to five minutes prior to induction.
- Use the minimum amount of drugs for induction and the lowest sevoflurane percentage possible for the situation.

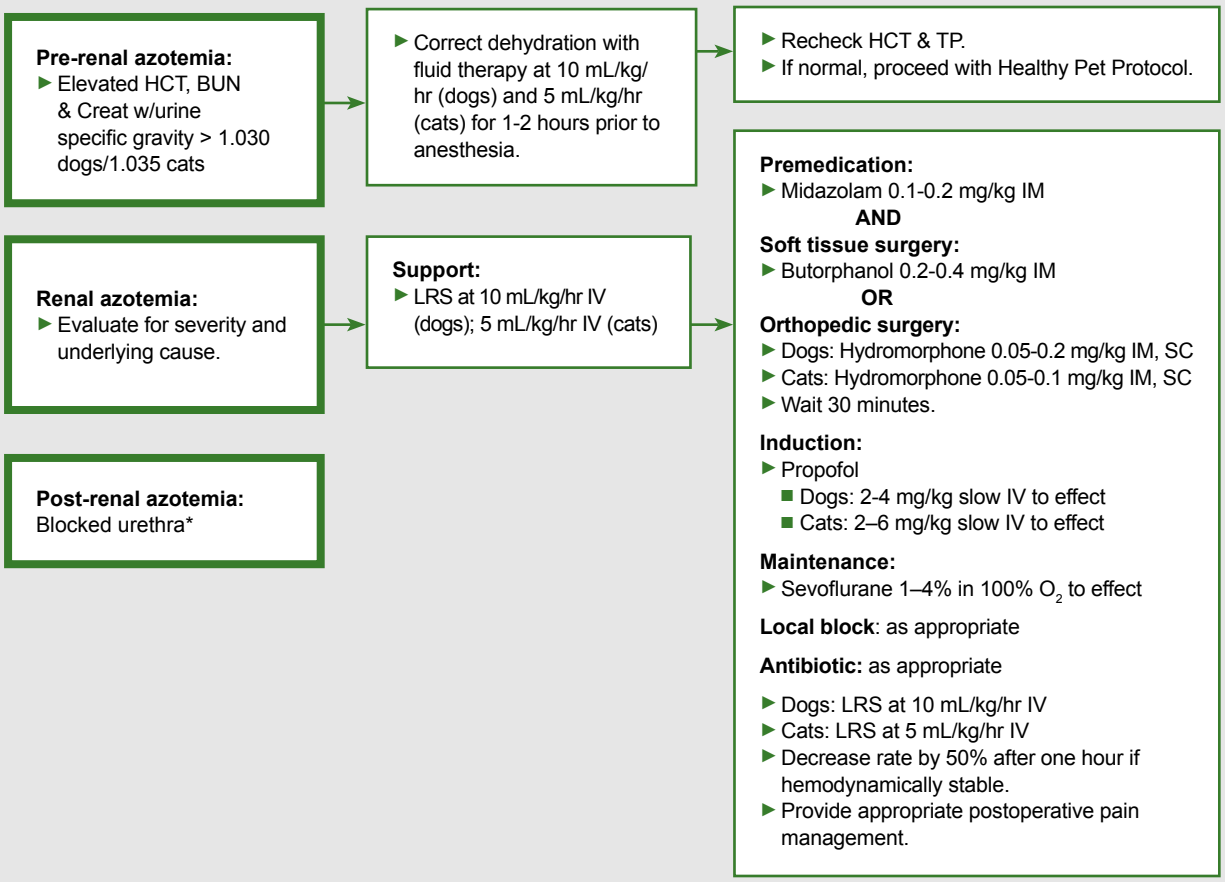
Maintenance and monitoring

- Monitor oxygen saturation carefully during post-operative recovery.

Postoperative pain management and to go home

- Pain management: See appropriate protocol and consider premeds that are on board.
- See *Healthy Pet Protocol* for soft tissue surgery recommendations, page 85.
- See *Orthopedic Protocol* for hard tissue recommendations, page 102.
- See *Abdominal Protocol* for ill pets, page 91.

Renal Protocol



*See *Post-renal Protocol*, page 101.

SPECIAL CONSIDERATIONS FOR RENAL PROTOCOL

(For standard recommendations, see *General Anesthesia Considerations for All Procotols*, page 83.)

Preoperative assessment

- Kidney disease will affect the clearance and, therefore, duration of action of most anesthetic drugs. For this reason, most drug doses should be based on the lower end of the dosage range.
- If serum albumin is below 2 g/dL, then plasma transfusion and/or hetastarch must be given for oncotic support, and the need for anesthesia should be reassessed.

Induction

- The average dose of propofol is often less than is required by healthy pets. Err on the side of caution.

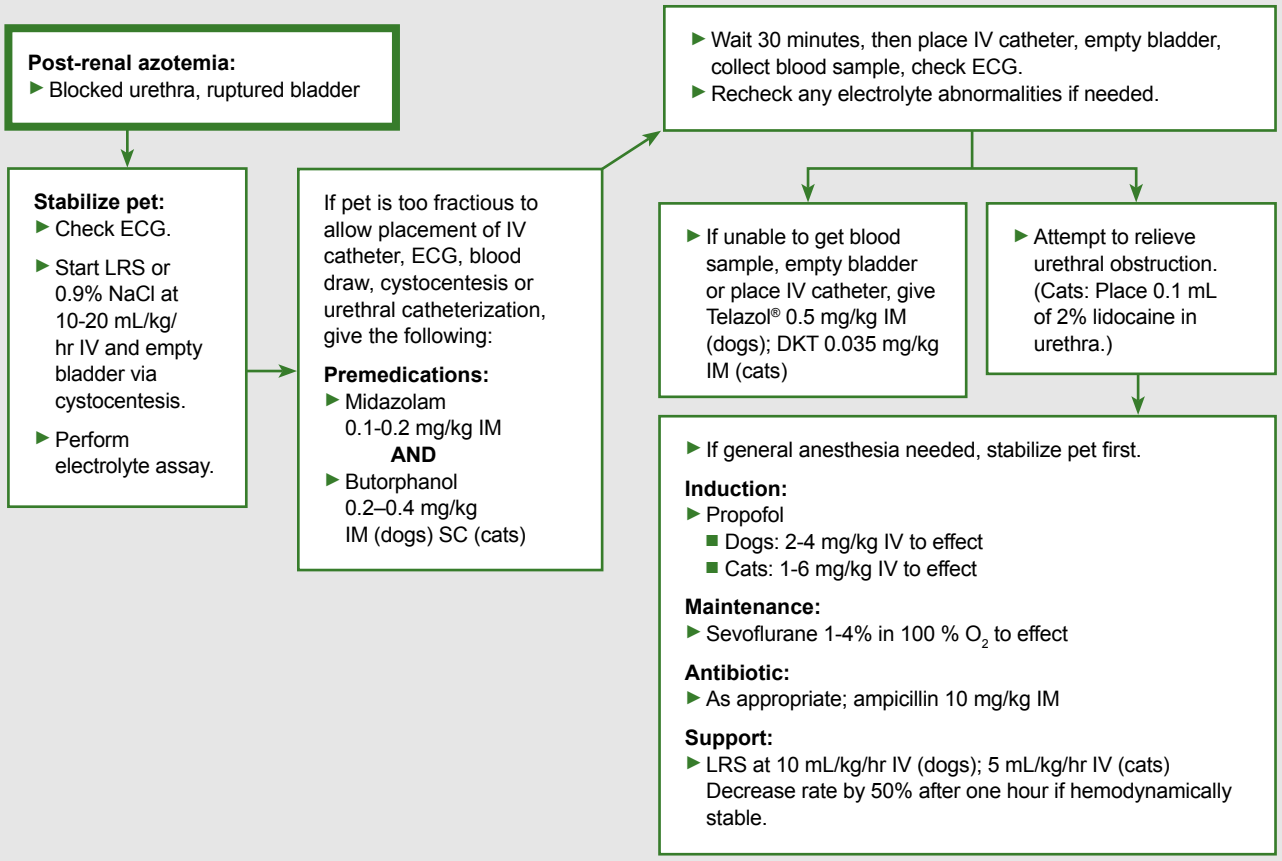
Maintenance and monitoring

- Critically ill patients may be slow to recover from anesthesia. Monitor and document temperature pulse respiration (TPR) and other vitals, including blood glucose, frequently, and provide support. Give care as necessary.

Postoperative pain management and to go home

- NSAIDs should be avoided in patients with renal disease.
- See *Orthopedic Protocol* for hard tissue recommendations, page 102.
- See *Abdominal Protocol* for ill pets, page 91.

Post-Renal Protocol



SPECIAL CONSIDERATIONS FOR POST-RENAL PROTOCOL

(For standard recommendations, see *General Anesthesia Considerations for All Procotols*, page 83.)

(See *Renal Protocol,* page 100, for additional details.)

Preoperative assessment

- Bladder rupture by cystocentesis is rare, while anesthesia death in patients with urethral obstruction is common. The primary goal is to lower the potassium level.
- The most common ECG abnormalities are due to hyperkalemia (ECG abnormalities: bradycardia, 1st degree AV block, dropped P waves, spiked T waves) and need to be corrected before heavy sedation or general anesthesia.
- If the patient is shocky, anesthesia is contraindicated. Correct shock before induction. Propofol should be administered slowly to effect, to minimize adverse cardiovascular effects. Bradycardia may develop after rapid administration.

Induction

- **If general anesthesia needed, stabilize pet first.**

Recovery

- Continuous ECG monitoring
- Recheck electrolytes q 2 hours initially until normal.
- Post-obstructive diuresis commonly occurs. Make sure to manage fluid therapy appropriately.

Postoperative pain management and to go home

- NSAIDs should be avoided in patients with renal disease.
- See *Abdominal Protocol* for ill pets on page 91.

Orthopedic Protocol

Premedications:
- Acepromazine 0.05 mg/kg SC, IM (max dose 1.5 mg)

AND
- Hydromorphone: 0.05-0.2 mg/kg SC, IM in dogs; 0.05-0.1 mg/kg SC, IM in cats
- Wait 30 minutes.

Induction: Propofol
- Dogs: 2-4 mg/kg slow IV to effect
- Cats: 2-6 mg/kg slow IV to effect

Maintenance: Sevoflurane 1%-4% to effect, in 100% O_2

Local block: +/- epidural*

Antibiotic: Cefazolin 22 mg/kg slow IV q 90 min

Support: LRS at 10 mL/kg/hr IV (dogs); 5 mL/kg/hr IV (cats). Decrease rate by 50% after one hour if hemodynamically stable.

Postsurgical pain management:
- Fentanyl CRI † as detailed below (as long as cardiovascular function is normal)

OR
- Dogs: Hydromorphone 0.05-0.2 mg/kg IM, SC, IV q 4-6 hrs
- Cats: Hydromorphone 0.05-0.1 mg/kg IM, SC, IV q 4-6 hrs

AND
- Dogs: Carprofen 4 mg/kg once SC
- Cats: Meloxicam 0.2 mg/kg once SC

OR
- Cats: Robenacoxib (Onsior®)1 mg/kg PO upon recovery

Discharge instructions:
- Dogs: Carprofen 2 mg/kg PO q 12 hours for 3-5 additional days
- Cats: Meloxicam 0.05 mg/kg PO q 24 hours for 3 additional days. **Use with caution.**

OR
- Cats: Robenacoxib 1 mg/kg PO once daily for total of 3 doses
- Add opioid as indicated for pain level.

* Doctor needs to be certified by medical director in order to perform epidurals (See *Techniques for Epidural Analgesia*, page 32).
† See *Fentanyl Constant Rate Infusion (CRI) Recipe,* page 21.

SPECIAL CONSIDERATIONS FOR ORTHOPEDIC PROTOCOL

(For standard recommendations, see *General Anesthesia Considerations for All Procotols*, page 83.)

Premedications

- Cefazolin 22 mg/kg slow IV at induction and repeated every 90 minutes until skin closure is generally preferred perioperatively in orthopedic procedures.

Postoperative pain management

- Postoperative analgesic options should include an NSAID and an opioid depending on procedure completed, health status of the pet and pain scale recommendation.
- Opioids:
  - Hydromorphone: 0.05 to 0.2 mg/kg IM, SC, IV q 4 to 6 hrs (dogs) and 0.05 to 0.1 mg/kg IM, SC, IV (cats). Be sure to closely monitor body temperature in cats as hydromorphone can cause significant hyperthermia in felines. Should a cat's postoperative temperature increase to > 103°F, then administration of buprenorphine 0.005 to 0.01 mg/kg IV will generally reverse most of the hyperthermic effect and maintain the analgesic effect.

OR

  - Fentanyl CRI as described on page 21.

AND

- NSAID can be given when sevoflurane is discontinued as long as pet has no underlying condition contraindicating NSAID use (renal failure, liver disease, significant gastrointestinal compromise or recent corticosteroid administration) and is well-hydrated, has received intraoperative fluids and has no risk of significant hemorrhage.
  - Dogs: Carprofen at 4 mg/kg SC (initial dose only)
  - Cats: Meloxicam 0.2 mg/kg SC (initial dose only) or robenacoxib1mg/kg PO upon recovery
- Dysphoria: Do not confuse pain with dysphoria. If patient seems excitable or agitated, an additional dose of acepromazine or midazolam may be necessary if it has been at least four hours for acepromazine or two hours for midazolam since the previous dose and pulse quality and mucus membrane color are good. Give 1/2 of the premed dose of acepromazine or midazolam IM (dogs) SC (cats).

To go home

- Fentanyl CRIs are discontinued as above **prior** to discharging to home, but **may** be left in place if pet is transferred to a veterinary specialty facility for overnight care.
- Go home with NSAIDs and/or opioid as appropriate for health status and pain level (Please refer to pages 84 and the *Anesthesia Task Pain Chart*, pages 18-19).
- NSAID: Dispense the same NSAID that was utilized postoperatively.
  - Carprofen in dogs 4 mg/kg PO once daily or divided into two equal doses for three to five days.
  - Meloxicam in cats 0.05 mg/kg PO daily for a maximum of two to three days. **Use with caution.** Or robenacoxib 1 mg/kg PO daily for total of 3 three doses.

  Opioid:
  - Tramadol 2 to 4 mg/kg PO q 8 hrs (dogs)and 2 to 4 mg/kg q 12 hrs (cats)

OR

  - Buprenorphine 0.01 mg/kg transmucosal q 8 hrs (cats)

Ear Surgery Protocol

Candidates:
- Total ear ablation
- Lateral ear resection
- Bulla osteotomy

Premedications:
- Acepromazine 0.05 mg/kg SC, IM (max dose 1.5 mg)

AND
- Hydromorphone
  Dogs: 0.05-0.2 mg/kg SC, IM
  Cats: 0.05-0.1 mg/kg SC, IM
- Wait 30 minutes.

Induction:
- Telazol® 1-2 mg/kg IV slow to effect (Telazol® should be diluted with sterile water to a volume of 1-3 mL and given to effect to allow for intubation.)
- Sevoflurane 1%-3% to effect in 100% O_2

Support:
- LRS at 10 mL/kg/hr IV (dogs); 5 mL/kg/hr IV (cats). Decrease rate by 50% after one hour if hemodynamically stable.

- Consider "soaker" catheter
- Go home on an opioid and/or an NSAID as appropriate for health status and pain level.
- Dogs:
  - Carprofen
    2 mg/kg PO q 12 X 3-5 days
    +/-
  - Tramadol
    2-4 mg/kg PO q 8 hrs
- Cats:
  - Meloxicam suspension
    0.05 mg/kg PO q 24 X 3 days. **Use with caution.**

OR
- Cats: Robenacoxib (Onsior®) 1 mg/kg PO q 24 X 3 days

+/-
  - Tramadol
    2-4 mg/kg PO q 12 hrs

OR
  - Buprenorphine
    0.01 mg/kg transmucosal q 8 hrs

* See *Fentanyl Constant Rate Infusion (CRI) Recipe*, page 21.

SPECIAL CONSIDERATIONS FOR EAR SURGERY PROTOCOL (OTHER THAN PINNA)

(For standard recommendations, see *General Anesthesia Considerations for All Procotols*, page 83.)

Premedications

- Cefazolin (22 mg/kg slow IV at induction and repeated every 90 minutes until skin closure) is generally preferred perioperatively.
- Hydromorphone (0.05 to 0.2 mg/kg SC, IM in dogs; 0.05 to 0.1 mg/kg SC, IM in cats) and acepromazine. This will allow for fentanyl CRI to be instituted upon recovery.

Induction

- Induce healthy pets for ear surgery with Telazol® 1 to 2 mg/kg IV, rather than propofol. This helps avoid the need for higher doses of sevoflurane to prevent head movement during surgery. Telazol® should be diluted with sterile water to a volume of 1 to 3 mL and given, to effect, to allow for intubation.
- "Overpressure" technique is **not** needed when using Telazol® as induction agent.

Postoperative pain management

- Postoperative analgesic options include the use of an opioid with an NSAID and possibly a regional block:
  - Hydromorphone: 0.05 to 0.2 mg/kg IM, SC, IV q 4-6 hrs (dogs) and 0.05-0.1 mg/kg IM, SC, IV (cats). Be sure to closely monitor body temperature in cats as hydromorphone can cause significant hyperthermia in felines. Should a cat's postoperative temperature increase to > 103°F, then administration of buprenorphine 0.005 to 0.01 mg/kg IV will generally reverse most of the hyperthermic effect and maintain the analgesic effect.

OR
  - Fentanyl CRI as described on page 21.

AND (optional):
  - "Soaker" catheters can be placed prior to surgical closure as described on page 32 and remain in place for several days postoperatively.

AND
  - NSAID can be given when sevoflurane is discontinued as long as pet has no underlying condition contraindicating NSAID use (renal failure, liver disease, significant gastrointestinal compromise or recent corticosteroid administration); is well-hydrated; has received intraoperative fluids; and has no risk of significant hemorrhage.

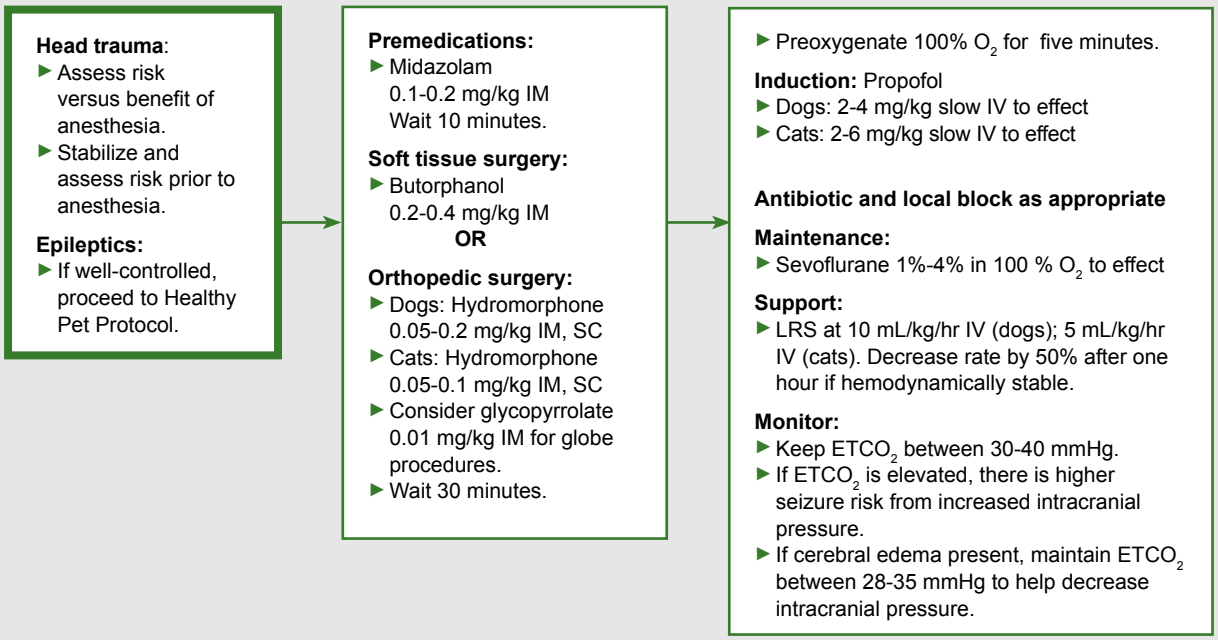
- Carprofen at 4 mg/kg SC, initial dose only (dog)
- Meloxicam 0.2 mg/kg SC, initial dose only (cats)
- Robenacoxib (Onsior®) 1 mg/kg upon recovery (cats)

- Dysphoria: Do not confuse pain with dysphoria. If patient seems excitable or agitated, an additional dose of acepromazine or midazolam may be necessary if it has been at least four hours for acepromazine or two hours for midazolam since the previous dose and pulse quality and mucus membrane color are good. Give 1/2 of the premed dose of acepromazine or midazolam IM (dogs) (SC cats).

To Go Home

- Fentanyl CRIs are discontinued **prior** to discharging to home, but **may** be left in place if pet is transferred to a veterinary specialty facility for overnight care.
- Pre-loaded lidocaine syringes or loaded soaker catheter reservoir can be dispensed with the client to be used at home for several days postoperatively as described on page 32.
- Dispense the same NSAID that was utilized postoperatively (carprofen in dogs and meloxicam in cats–**use with caution**–or in cats, robenacoxib, 1 mg/kg PO once daily for total of three doses).
- **For most aural procedures, NSAIDs alone are not expected to provide sufficient analgesic.** Oral tramadol (2 to 4 mg/kg in dogs q eight hrs and 2 to 4 mg/kg in cats q 12 hrs) or transmucosal buprenorphine (0.01 mg/kg q 8 hrs in cats) should also be sent home for analgesia. Both tramadol and buprenorphine can be used with NSAIDs or corticosteroids.

CNS & Eye/Globe Protocol



SPECIAL CONSIDERATIONS FOR CNS & EYE/GLOBE PROTOCOL

(For standard recommendations, see *General Anesthesia Considerations for All Procotols*, page 83.)

Preoperative assessment

- **Critically assess the need to go to anesthesia in any patient with head trauma.** Most pets should be stabilized with appropriate fluid support, O_2 support, analgesics as needed and referred for specialty level care. If that is not possible, proceed with caution.
- **Most important caveat**: Do nothing that could cause **increase** in intracranial pressure (ICP) such as coughing, vomiting, jugular occlusion (for venipuncture) or drug effects.
- Tonometry can be used to evaluate for increased ICP. Marked bilaterally increased intraocular pressures can indicate increased ICP.
- Globe caution: Bradycardia can occur due to the trigeminovagally mediated oculocardiac reflex. If this is severe **and** associated with hypotension, then glycopyrrolate 0.01 mg/kg IV may be used. OK to premedicate with glycopyrrolate if globe traction expected.

Premedication

- Administer midazolam 0.1-0.2 mg/kg IM 10 minutes **prior** to butorphanol administration.
- Telazol®, ketamine and opiate drugs that can cause vomiting (morphine, hydromorphone) use is contraindicated in head trauma patients at this time.
- Preoxygenate with 100% O_2 for five minutes by face mask if possible.

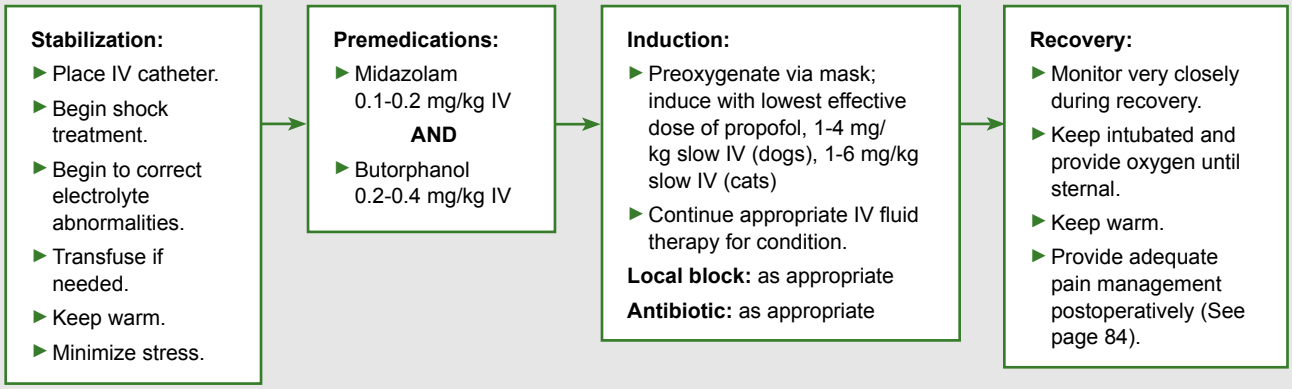
Maintenance and monitoring

- Keep $ETCO_2$ between 30 to 40 mmHg.
- If $ETCO_2$ is elevated there is higher seizure risk from increased ICP.
- If cerebral edema present, maintain $ETCO_2$ between 28 to 35 mmHg to help decrease ICP.
- **Monitor head trauma patients frequently for changing neurological status.**

Postoperative pain management and to go home

- See *Healthy Pet Protocol* for soft tissue surgery recommendations, page 85.
- See *Orthopedic Protocol* for hard tissue recommendations, page 102.
- See *Abdominal Protocol* for ill pets, page 91.

Emergency Surgery Protocol



SPECIAL CONSIDERATIONS FOR EMERGENCY SURGERY PROTOCOL

(For standard recommendations, see *General Anesthesia Considerations for All Procotols*, page 83.)

Preoperative assessment

- **Stabilize prior to anesthesia:**
  - **Manage shock.**
  - Initiate shock treatment with the appropriate crystalloid fluid. Dogs: 20 mL/kg bolus (up to 80 mL/kg). Cats: 5 mL/kg bolus (up to 40 mL/kg). Hetastarch may also be administered if needed at the following doses: Dogs: 5 mL/kg bolus (up to 20 mL/kg/day). Cats: 2.5 mL/kg bolus (up to 10 mL/kg/day).
  - **Manage arrhythmias.**
  - If ventricular tachycardia (V tach) or > 30% ventricular premature contractions (VPC) **AND** systolic blood pressure (sBP) < 90, mean arterial pressure (MAP) < 60, or SpO_2 < 95 (on oxygen) administer lidocaine 2 to 4 mg/kg (dogs) or 0.25 to 0.5 mg/kg (cats) IV, then place a second IV catheter and begin a lidocaine CRI.
  - Begin to correct dehydration and electrolyte abnormalities.
  - Begin transfusions on significantly anemic patients or those where significant acute hemorrhage has occurred.
  - Provide oxygen if indicated.
  - **Provide pain management (butorphanol 0.2 to 0.4 mg/kg SC, IM q one to four hours as needed).**
  - Avoid the use of NSAIDs, or use with extreme caution, in patients with dehydration, shock, renal impairment or underlying gastrointestinal disease. For this reason, the use of NSAIDs in critical patients is limited until they are stabilized. The most recent research indicates that COX-2 is an important component in gastrointestinal healing and that COX-2 NSAIDs such as carprofen or meloxicam should be avoided in cases where gastrointestinal injury may be present, either as a result of vomiting, primary gastrointestinal disease or gastrointestinal surgery. In these cases, the use of opioids is more appropriate postoperatively.
  - **True emergencies requiring immediate anesthesia are rare. A true emergency requiring immediate surgery would include an airway obstruction or acute life-threatening hemorrhage. Most pets will have a better outcome if stabilized before anesthesia or surgery.** For example, the survival rate for patients with traumatic diaphragmatic hernias greatly increases if the pet is stabilized at least 24 hours prior to surgery. **Gastric dilatation-volvulus (GDV) cases require stabilization and decompression before general anesthesia for the best patient outcome. These examples don't meet the definition of "emergency" as used in this protocol. Emergencies are surgical cases that require anesthesia within 15 minutes to save the patient's life.**
  - Perform as complete a physical examination as possible. **If the urgency of the situation precludes preanesthetic blood work, run it as the patient is being examined and anesthetized.**
  - Assess cardiovascular parameters before induction. An electrocardiogram (ECG) may be beneficial during cardiac assessment.

Premedications

- **Do not use acepromazine.**
- The IV route is preferred for premedication in true emergency cases to allow for rapid induction and intubation and the establishment of a patent airway (See *Special Considerations for Emergency Surgery Protocol*, page 106).
- With true emergency anesthesia, premeds, including butorphanol, may not have had time to take complete effect prior to induction.

Induction

- Use the minimum amount of drugs for induction and the lowest sevoflurane percentage possible for the situation. The average dose of propofol is often less than is required by healthy pets. Err on the side of caution. Propofol should be administered slowly to effect, to minimize adverse cardiovascular effects. Bradycardia and apnea may develop after rapid administration.

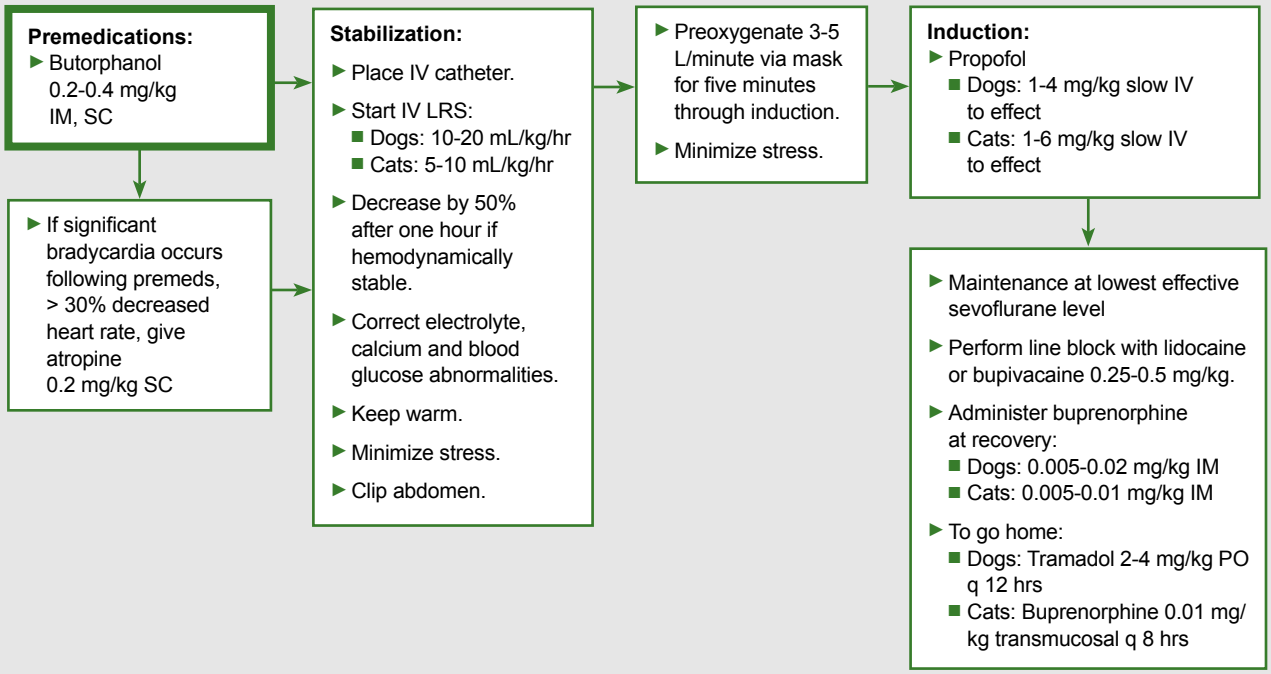
Maintenance and monitoring

- Overpressure may not be necessary in severely compromised patients.
- Monitor closely to see if patient is getting deeper because of premeds, and decrease sevoflurane, if appropriate.
- Repeat lab work as needed, especially in surgeries lasting more than one hour, consider rechecking packed cell volume, total protein (PCV/TP), blood glucose (BG) and/or electrolytes.
- Critically ill patients may be slow to recover from anesthesia. Monitor and document temperature, pulse and respiration (TPR) and other vitals frequently and provide supportive care, supplemental heat and pain management as necessary.
- Provide appropriate pain medications postoperatively (See *Anesthesia Task Pain Chart*, pages 18-19; see notes at top of page 106 regarding NSAIDs).

Postoperative pain management and to go home

- Critical patients should be transferred to an overnight emergency clinic or 24-hour referral hospital for continued care postoperatively.
- Postoperative pain management is imperative to the successful surgical and medical management of the emergency or critical patient. Pain management must be tailored to the individual patient. Refer to the *General Anesthesia Considerations for All Protocols* on page 83 for treatment options. Utilize the Colorado State University acute pain scale guidelines on pages 16-17, to closely and frequently monitor the patient and provide adequate pain control.

Cesarean Protocol



SPECIAL CONSIDERATIONS FOR CESAREAN PROTOCOL

(For standard recommendations, see *General Anesthesia Considerations for All Procotols*, page 83.)

Preoperative assessment

- Stabilization and correction of dehydration and electrolyte abnormalities should be performed prior to anesthesia. Radiographs or ultrasound should be performed to allow for complete assessment, prognosis and treatment plan development.

Premedications

- All drugs that cross the blood brain barrier can cross the placenta and effect fetus(es).
- Premedications decrease maternal stress and anxiety and help prevent the adverse effects associated with catecholamine release such as decreased blood flow to the uterus and fetus(es). Premedication also allows for lower doses of induction and inhalant anesthetics, which can have significant cardiovascular and respiratory depressant effects on the fetus(es).
- Studies have shown that alpha-2 agonists, ketamine and benzodiazepines cause reduced puppy and kitten vigor, and should be avoided. **Acepromazine should not be used in pregnant patients.**
- Perioperative antibiotics should be used in critical or compromised patients as well as those where any contamination occurred during the surgical procedure. Cefazolin IV is the antibiotic of choice and can be given in the preoperative, intraoperative and/or postoperative period as needed.

Induction

- Continue oxygenation via mask until the patient is intubated; this helps prevent maternal, and subsequent fetal, hypoxia. The lowest effective dose of propofol should be used. Propofol should be administered slowly to effect, to help prevent apnea and hypotension which has been associated with rapid boluses.

Maintenance and monitoring

- While it is important to deliver the puppies or kittens as quickly as possible to reduce the length of exposure to inhalation anesthetics, the surgeon should wait at least 15 to 20 minutes post-induction before removing them from the uterus to allow for redistribution and metabolism of the injectable anesthetic agents which were administered. During this time, a surgical prep, line block and opening of the abdominal cavity should occur. Lidocaine and bupivacaine doses should be decreased by 50% to 75% in pregnant patients.

- It is imperative to monitor oxygenation, blood pressure and body temperature of the patient and address any abnormalities as quickly as possible.
- Puppy or kitten resuscitation should involve providing warmth, gentle stimulation during drying and oxygen. When respiration is not occurring, intubation, oxygen supplementation and injection of a drop of naloxone sublingually can be tried. It is not recommended to swing newborns, or to use Dopram®, which significantly increases cerebral oxygen demand and is contraindicated during hypoxic episodes.
- Newborns should be placed with the mother as soon as recovery occurs. Do not leave puppies and kittens unobserved until the mother makes a full recovery; crushing injuries can be fatal to the newborn. Provide a warm, safe environment.

Postoperative pain management

- Buprenorphine 0.005 to 0.02 mg/kg SC, IM (dogs) and 0.005-0.01 mg/kg SC, IM (cats) when sevoflurane is discontinued, as long as last dose of butorphanol was at least one hour prior and the pet's temperature is greater than 98°F.

To go home

- Oral tramadol can be used for dogs and cats, and transmucosal buprenorphine should be prescribed for cats for postoperative pain management.
  - Oral tramadol 2 to 4 mg/kg q 8 hrs (dogs) and 2 to 4 mg/kg q 12 hrs (cats)
  - Oral buprenorphine: 0.01 mg/kg transmucosal q 8 hrs (cats)
- The use of NSAIDs postoperatively is controversial because there is a concern about the effect on the renal development of puppies and kittens and is not recommended at this time.

Pediatric Pet Protocol (<16 weeks of age)

Premedications:
- Glycopyrrolate 0.01 mg/kg IM

AND
- Midazolam 0.1 mg/kg IM

PLUS
- Butorphanol 0.2-0.4 mg/kg IM
- Wait 30 minutes.

Induction:
- Propofol to effect 1-4 mg/kg slow IV

Maintenance:
- Sevoflurane 1-4% in 100% O_2 to effect

Local block:
- As appropriate; lidocaine 1 mg/kg

Antibiotic:
- As appropriate; cefazolin 22 mg/kg slow IV q 90 min

Support:
- LRS 4-10 mL/kg/hr IV. Decrease by 50% in one hour if hemodynamically stable.

Postoperative pain management:
- Butorphanol 0.2-0.4 mg/kg IM or IV q 2-4 hours for pain

OR
- Buprenorphine 0.005-0.01 mg/kg IM or transmucosal (cats) q 8-12 hours for pain

To go home:
- Puppies: Butorphanol 0.2-04 mg/kg PO q 4-6 hrs
- Kittens: Buprenorphine 0.01 mg/kg q 8-12 hrs transmucosal

SPECIAL CONSIDERATIONS FOR PEDIATRIC PET PROTOCOL (< 16 WEEKS OF AGE)

(For standard recommendations, see *General Anesthesia Considerations for All Procotols*, page 83.)

Preoperative examination

- Puppies and kittens develop hypothermia, hypoglycemia and dehydration more quickly than older patients. It is unnecessary to withhold food from nursing puppies and kittens before anesthesia. In weaned puppies and kittens, fasting should not be for more than one or two hours.
- The normal heart rate of puppies and kittens is 200 or more beats per minute.
- Normal respiratory rate is 15 to 35 breaths per minute. Respiratory system is best evaluated by observation of the rate, rhythm and character of breathing.
- Normal body temperature for patients < 2 weeks of age is 96°F to 97°F, which increases to 100°F by 4 weeks of age.
- Dehydration occurs rapidly in puppies and kittens. Hydration status can be assessed by moistness of mucus membranes, position of eyes in their orbits, heart rate, character of peripheral pulses and capillary refill time. Skin turgor is not useful for assessment of hydration status in puppies and kittens < 6 weeks of age.
- In puppies and kittens < 6 weeks of age, urine should be clear and colorless, and any color tint indicates dehydration.
- Preanesthesia blood work includes a complete blood count (CBC) with differential and internal organ function (IOF) screen. Perform these tests within 48 hours of anesthetic induction. Sample size may be limited, therefore packed cell volume (PCV), evaluation of white blood cell morphology, blood glucose and blood urea nitrogen (BUN) are the priorities. A complete urinalysis may be helpful as well.
  - High PCVs are common the first few days of life. These levels decrease to 27% by 7 weeks of age and thereafter increase to normal adult levels.
  - Puppies and kittens have higher white blood cell counts in the first few days of life than adults. By 3 weeks of age, white blood cell counts decrease, then peak again at 7 weeks of age.
  - Albumin levels in puppies < 4 weeks of age are lower than adult levels–adult levels are attained by 8 weeks of age–consequently, puppies and kittens have a greater sensitivity to highly protein-bound medications.
  - BUN and urine-specific gravity levels are lower in puppies and kittens than in adults because renal function is undeveloped.
- Puppies and kittens have lower blood pressures, stroke volumes and peripheral vascular resistance, but higher heart rates, cardiac outputs, plasma volumes, and central venous pressures than adult cats and dogs. The pediatric heart is less able to increase the stroke

volume (force of contraction) and, therefore, cardiac output depends primarily on heart rate. **Bradycardia is defined as < 150 beats/min and should be addressed quickly.**

Premedication

- Pet owners will occasionally request that 1- to 3-day-old puppies have their dewclaws removed. Banfield does not condone performing ear cropping or tail docking for cosmetic reasons, but dewclaws in neonatal pups are often removed to prevent future trauma. While there is ambiguity in the veterinary community with regards to appropriate anesthesia for this procedure, a frequently practiced procedure involves the placement of an SC drop of 0.5% to 1% lidocaine over each dewclaw to be removed, waiting 10 minutes, then proceeding with dewclaw removals.
- Midazolam requires hepatic metabolism, and duration of action may be prolonged in pets < 8 weeks of age. It produces good muscle relaxation with minimal central nervous system (CNS) and cardiovascular depression. However, it does have a dose-dependent respiratory depressant effect and may cause hypoventilation or apnea, so careful monitoring of the respiratory system is necessary. In debilitated patients, it may be best to avoid its administration.
- Because cardiac output in puppies and kittens is heart-rate dependent and they inherently have high vagal tone, administration of an anticholinergic is necessary before induction of general anesthesia. This also decreases respiratory tract secretions, which reduce the potential for airway obstruction and/or laryngotracheal aspiration. This may not be effective in patients < 2 weeks of age.
- Allow 30 minutes for premedications to take effect prior to induction of general anesthesia. Assess cardiovascular parameters after premedications have taken effect and prior to induction.

Induction

- Propofol should be administered as a slow bolus over one to two minutes until desired effect is achieved. Bradycardia, hypotension and respiratory depression may develop after rapid administration. Care should be taken in puppies and kittens < 8 weeks of age. Debilitated patients may be mask induced with sevoflurane.
- Intubation may be difficult in small patients. Care must be taken to avoid laryngeal trauma, which may induce swelling. If intubation cannot be performed, a tightly fitting mask can be used to minimize dead space.

Maintenance/monitoring

- The oxygen demand of puppies and kittens is two to three times that of adult dogs and cats. The respiratory rate must be two to three times greater than the adult rate to meet the minute ventilation necessary for the greater oxygen demand. A high respiratory rate during anesthesia must be maintained. This will also cause a more rapid induction and recovery inhalation anesthesia due to the increased rate of exchange of gases in the lungs.
- Intermittent positive-pressure ventilation is likely needed to prevent hypoventilation and atelectasis. Airway pressures should not exceed 15 cm H_2O. Extreme care is required to prevent lung trauma and pneumothorax. Pets > 4 weeks of age can be allowed to ventilate spontaneously.
- If running sevoflurane at 4% or above, look for system leaks, improper intubation or inadequate oxygen flow rate.
- During prolonged procedures, blood glucose should be checked periodically.

Postoperative pain management

- Uncontrolled pain in neonates and pediatric patients can lead to permanent alternations in CNS responses to nociceptor input later in life and set them up for chronically elevated responses to pain.
- Postoperative butorphanol at 0.2 to 0.4 mg/kg IM or IV q 1 to 2 hrs PRN can be given when sevoflurane is discontinued as long as the previous dose was at least one hour prior and the patient's temperature is greater than 98°F.
- Buprenorphine can be substituted for butorphanol and can be given at a dose of 0.005 to 0.01 mg/kg SC or transmucosal q 8 to 12 hrs (cats).
- If patient is dysphoric, midazolam 0.1 to 0.3 mg/kg IV can be given slowly to effect, and monitor temperature and cardiovascular function closely.

To go home

- Avoid NSAIDs.
- Dogs: Butorphanol 0.2 to 0.4mg/kg PO q 4 to 6 hours
- Cats: Buprenorphine transmucosal 0.01 mg/kg q 8 to 12 hours

Source

1. Hoskins J. *Veterinary Pediatrics: Dogs and Cats from Birth to Six Months.* 3rd ed. Philadelphia, Pa. Saunders. 2001; 525-547.

Anesthesia Protocols Summary Chart

PROTOCOL	PREMEDICATIONS	INDUCTION AGENTS	ADDITIONAL CONSIDERATIONS	POSTOPERATIVE ANALGESIA	TO GO HOME
Healthy Pet Soft Tissue Surgery	▫ **Acepromazine** 0.05 mg/kg, max dose 1.5 mg Dogs: IM Cats: SC AND **Butorphanol** 0.2-0.4 mg/kg Dogs: IM Cats: SC	▫ **Propofol** Dogs: 2-4 mg/kg slow IV to effect Cats: 2-6 mg/kg slow IV to effect	▫ Drug doses for local blocks are cumulative doses per patient and drug (add lidocaine and bupivacaine). ▫ Testicular block for neuters • **Lidocaine** ▫ Large and medium dogs: 2 mg/kg divided per testicle ▫ Small dogs and cats: 1-2 mg/kg divided per testicle ▫ Line block • **Lidocaine** 1-2 mg/kg dogs and cats OR • **Bupivacaine** Dogs: 2 mg/kg Cats: 1 mg/kg ▫ Field Block • **Bupivacaine** Dogs: 2 mg/kg • Cats: 1 mg/kg ▫ Perioperative antibiotics are not recommended for clean elective procedures lasting < 90 minutes • **Ampicillin:** 10 mg/kg IM • **Cefazolin:** 22 mg/kg slow IV at induction • **Clindamycin (dental)**: 5.5-11 mg/kg PO	▫ Administer when discontinuing sevoflurane as long as it has been 1 hr since premed of butorphanol and the pet's temperature is above 98°F. ▫ NSAID consideration • Ensure there is no underlying health issue that contraindicates use and that the pet is well-hydrated, has received intra-operative fluids and no risk of significant hemorrhage exists. ▫ Dogs: • **Carprofen injectable** 4 mg/kg SC AND • **Butorphanol** 0.2-0.4 mg/kg SC q 2 hrs OR • **Buprenorphine** 0.005-0.02 mg/kg SC/IM q 6-12 hrs ▫ Cats: • **Meloxicam injectable** 0.2 mg/kg SC once OR • **Robenacoxib (Onsior®)** 1 mg/kg PO upon recovery AND • **Butorphanol** 0.2-0.4 mg/kg SC q 2 hrs OR • **Buprenorphine** 0.005-0.01 mg/kg SC/ IM q 6-12 hrs	▫ Dogs: • **Carprofen** 2 mg/kg PO q 12 hrs X 3-5 days +/- • **Tramadol** 2-4 mg/kg PO q 8 hrs ▫ Cats: • **Meloxicam suspension** 0.05 mg/kg PO q 24 hrs X 3 days. **Use with caution.** OR • **Robenacoxib** 1 mg/kg PO once daily for total of 3 doses AND +/- • **Tramadol** 2-4 mg/kg PO q 12 hrs OR • **Buprenorphine** 0.01mg/kg transmucosal q 8 hrs
Feline Declaw Protocol	▫ **Acepromazine** 0.05 mg/kg SC AND ▫ **Hydromorphone** 0.05-0.1 mg/kg SC, IM	▫ **Propofol** 2-6 mg/kg slow IV to effect	▫ **Cefazolin** 22 mg/kg slow IV at induction ▫ Local nerve blocks ▫ **Bupivacaine** 1 mg/kg in cats Remember: Dose is cumulative per pet. ▫ Hyperthermia can be seen in cats secondary to hydromorphone administration. If temp > than 103°F develops, administer: ▫ **Buprenorphine** 0.005-0.0.01 mg/kg IV/IM	▫ Day 1 • **Meloxicam injectable** when sevoflurane discontinued 0.2 mg/kg SC OR • **Robenacoxib** 1 mg/kg PO upon recovery AND • **Buprenorphine** 0.005-0.01mg/kg SC/IM 2-4 hrs post hydromorphone q 6 -12 hrs ▫ Day 2 • **Meloxicam injectable** 0.1 mg/kg SC OR • **Robenacoxib** 1 mg/kg PO once daily for total of 3 doses AND • **Buprenorphine** 0.005-0.01 mg/kg transmucosal q 6 -12 hrs	▫ **Meloxicam suspension** 0.05 mg/kg PO q 24 hrs X 2 days. **Use with caution.** OR ▫ **Robenacoxib** 1 mg/kg PO once daily for total of 3 doses +/- ▫ **Buprenorphine** 0.01 mg/kg transmucosal q 8 hrs

Anesthesia Protocols Summary Chart

PROTOCOL	PREMEDICATIONS	INDUCTION AGENTS	ADDITIONAL CONSIDERATIONS	POSTOPERATIVE ANALGESIA	TO GO HOME
Abdominal Protocol **Renal Protocol** **Hepatic Protocol** **Emergency Protocol**	▫ **Midazolam** • 0.1-0.2 mg/kg IM • IV for Emergency Protocol AND For soft tissue surgery ▫ **Butorphanol** • 0.2-0.4 mg/kg Dogs: IM Cats: SC • IV for Emergency Protocol OR For orthopedic surgery ▫ **Hydromorphone** • Dogs: 0.05-0.2 mg/kg IM/SC • Cats: 0.05-0.1 mg/kg IM/SC	▫ **Propofol** • Dogs: 1-4 mg/kg slow IV to effect • Cats: 1-6 mg/kg slow IV to effect	**Abdominal** • Stabilize prior to anesthesia. • Manage shock. • Manage arrhythmias. • Manage pain. **Renal** • Support with IV fluids prior to anesthesia. **Hepatic** • Consider ACT, PT, PTT. • Consider FFP transfusion. **Emergency** • Begin shock treatment. • Pre-oxygenate. • Manage arrhythmias. ▫ See Healthy Pet Protocol. • **Antibiotic** as appropriate • **Local blocks** as appropriate	▫ Administer when discontinuing sevoflurane as long as it has been 1 hour since premed of butorphanol and the patient's temperature is above 98°F. ▫ Dogs: • **Butorphanol** 0.2-0.4 mg/kg SC q 2 hrs OR • **Buprenorphine** 0.005-0.02 mg/kg SC/IM q 6-12 hrs ▫ Cats: • **Butorphanol** 0.2-0.4 mg/kg SC q 2 hrs OR • **Buprenorphine** 0.005-0.01 mg/kg SC/IM q 6-12 hrs ▫ See Orthopedic Protocol if doing hard tissue surgery, **avoid NSAIDs.**	▫ Dogs: • **Tramadol** 2-4 mg/kg PO q 8 hrs ▫ Cats: • **Tramadol** 2-4 mg/kg PO q 12 hrs OR • **Buprenorphine** 0.01 mg/kg transmucosal q 8 hrs ▫ See Orthopedic Protocol if doing hard tissue surgery, **avoid NSAIDs.**
Orthopedic Protocol	▫ **Acepromazine** 0.05 mg/kg max dose 1.5 mg Dogs: IM Cats: SC AND ▫ **Hydromorphone** • Dogs: 0.05-0.2mg/kg IM/SC • Cats: 0.05-0.1 mg/kg IM/SC	▫ **Propofol** • Dogs: 2-4 mg/kg slow IV to effect • Cats: 2-6 mg/kg slow IV to effect	▫ **Cefazolin** 22 mg/kg slow IV at induction ▫ Local block (see Healthy Pet Protocol) as appropriate or epidural for hind limb procedure ▫ Hyperthermia can be seen in cats secondary to hydromorphone administration. If temp > than 103°F develops, administer **buprenorphrine** 0.005-0.01 mg/kg IV/IM.	▫ **Hydromorphone** or **Fentanyl CRI** can be initiated as long as it has been 2-4 hours since hydromorphone premed and the patient's temperature is above 98°F. ▫ **Fentanyl CRI** (see CRI protocol) OR ▫ **Hydromorphone** • Dogs: 0.05 to 0.2 mg/kg IM, SC, IV q 4-6 hours • Cats: 0.05-0.1mg/kg IM, SC, IV q 4-6 hours AND (as long as there are no contraindications) ▫ **Carprofen** injectable • Dogs: 4 mg/kg SC ▫ **Meloxicam injectable** • Cats: 0.2 mg/kg SC OR ▫ **Robenacoxib (Onsior®)** 1 mg/kg PO upon recovery	▫ Go home on an opioid and/or an NSAID as appropriate for health status and pain level. ▫ Dogs: • **Carprofen** 2 mg/kg PO q12 X 3-5 days +/- • **Tramadol** 2-4 mg/kg PO q 8 hrs ▫ Cats: • **Meloxicam suspension** 0.05 mg/kg PO q 24 X 3 days. **Use with caution.** OR • **Robenacoxib** 1 mg/kg PO once daily for total of 3 doses +/- • **Tramadol** 2-4 mg/kg PO q 12 hrs OR • **Buprenorphine** 0.01mg/kg transmucosal q 8 hrs

Anesthesia Protocols Summary Chart

PROTOCOL	PREMEDICATIONS	INDUCTION AGENTS	ADDITIONAL CONSIDERATIONS	POSTOPERATIVE ANALGESIA	TO GO HOME
Cardiac Protocol	▫ **Midazolam** 0.1-0.2 mg/kg IM ▫ For soft tissue surgery • **Butorphanol** 0.2-0.4 mg/kg Dogs: IM Cats: SC OR ▫ For orthopedic surgery • **Hydromorphone** ▫ Dogs: 0.05-0.2 mg/kg IM/SC ▫ Cats: 0.05-0.1 mg/kg IM/SC	▫ Pre-oxygenate. ▫ **Propofol** • Dogs: 2-4 mg/kg slow IV to effect • Cats: 2-6 mg/kg slow IV to effect	▫ Evaluate ECG prior to and continuously throughout procedure. • Address arrhythmias. ▫ Evaluate blood pressure. ▫ IV fluid rate is lower than standard rate for all other protocols • LRS 2-4 mL/kg/hr IV ▫ See Healthy Pet Protocol: • Antibiotic as appropriate • Local block as appropriate	▫ See Healthy Pet Protocol for soft tissue surgery. ▫ See Orthopedic Protocol for orthopedic surgery. ▫ See Abdominal Protocol for ill pets (renal, liver, etc.).	▫ See Healthy Pet Protocol for soft tissue surgery. ▫ See Orthopedic Protocol for orthopedic surgery. ▫ See Abdominal Protocol for ill pets (renal, liver, etc.).
Pulmonary Protocol	▫ **Acepromazine** 0.05 mg/kg max dose 1.5 mg Dogs: IM Cats: SC OR In high risk patients avoid acepromazine and use: ▫ **Midazolam** 0.1-0.2 mg/kg IM AND For soft tissue surgery: ▫ **Butorphanol** 0.2-0.4 mg/kg Dogs: IM Cats: SC OR For orthopedic surgery: ▫ **Hydromorphone** • Dogs: 0.05-0.2 mg/kg IM/SC • Cats: 0.05-0.1 mg/kg IM/SC	▫ Pre-oxygenate. ▫ **Propofol** • Dogs: 2-4 mg/kg slow IV to effect • Cats: 2-6 mg/kg slow IV to effect	▫ Pneumothorax or pleural effusion present: Drain chest and stabilize. Local block/immobilization preferred for chest tube placement. ▫ Pulse ox abnormal or respiratory distress present: Consider radiographs and thoracocentesis (look for pneumothorax, pleural effusion or diaphragmatic hernia). ▫ DO NOT overly stress–consider **butorphanol** 0.2-0.4 mg/kg IM to calm and O_2. ▫ Ventilate, pressures should not exceed 12 to 15 cm H_20. ▫ Antibiotic as appropriate ▫ Local block as appropriate	▫ See Healthy Pet Protocol for soft tissue surgery. ▫ See Orthopedic Protocol for orthopedic surgery. ▫ See Abdominal Protocol for ill pets (renal, liver, etc.).	▫ See Healthy Pet Protocol for soft tissue surgery. ▫ See Orthopedic Protocol for orthopedic surgery. ▫ See Abdominal Protocol for ill pets (renal, liver, etc.).

Anesthesia Protocols Summary Chart

PROTOCOL	PREMEDICATIONS	INDUCTION AGENTS	ADDITIONAL CONSIDERATIONS	POSTOPERATIVE ANALGESIA	TO GO HOME
Stable Diabetic Protocol	▫ Soft tissue surgery, see Healthy Pet Protocol. ▫ Orthopedic surgery, see Orthopedic Protocol.	▫ **Propofol** • Dogs: 2-4 mg/kg slow IV to effect • Cats: 2-6 mg/kg slow IV to effect	▫ Give ½ meal and ½ insulin dose 2 hours prior to anesthesia. ▫ Check glucose just before induction, q 30 min during anesthesia and q 2-4 hours postop. ▫ See Healthy Pet Protocol. • Antibiotic as appropriate • Local block as appropriate • 0.9 % NaCl is fluid of choice	▫ See Healthy Pet Protocol for soft tissue surgery. ▫ See Orthopedic Protocol for orthopedic surgery. ▫ See Abdominal Protocol for ill pets (renal, liver, etc.).	▫ See Healthy Pet Protocol for soft tissue surgery. ▫ See Orthopedic Protocol for orthopedic surgery. ▫ See Abdominal Protocol for ill pets (renal, liver, etc.).
Obesity Protocol	▫ Soft tissue surgery, see Healthy Pet Protocol. ▫ Orthopedic surgery, see Orthopedic Protocol. **CALCULATE DOSE ON LEAN BODY WEIGHT!**	▫ Pre-oxygenate ▫ **Propofol** • Dogs: 2-4 mg/kg slow IV to effect • Cats: 2-6 mg/kg slow IV to effect **CALCULATE DOSE ON LEAN BODY WEIGHT!**	▫ Monitor ECG prior to and continuously throughout procedure. ▫ See Healthy Pet Protocol. • Antibiotic as appropriate • Local block as appropriate **CALCULATE DOSE ON LEAN BODY WEIGHT!**	▫ See Healthy Pet Protocol for soft tissue surgery. ▫ See Orthopedic Protocol for orthopedic surgery. ▫ See Abdominal Protocol for ill pets (renal, liver, etc.). **CALCULATE DOSE ON LEAN BODY WEIGHT!**	▫ See Healthy Pet Protocol for soft tissue surgery. ▫ See Orthopedic Protocol for orthopedic surgery. ▫ See Abdominal Protocol for ill pets (renal, liver, etc.). **CALCULATE DOSE ON LEAN BODY WEIGHT!**
CNS & Eye/ Globe Protocol	▫ **Midazolam** 0.1-0.2 mg/kg IM ▫ WAIT10 MINUTES ▫ For soft tissue: • **Butorphanol** 0.2-0.4 mg/kg Dogs: IM Cats: SC OR ▫ For orthopedic surgery: • **Hydromorphone** Dogs: 0.05-0.2 mg/kg IM/SC Cats: 0.05-0.1 mg/kg IM/SC ▫ Consider **glycopyrrolate** 0.01 mg/kg IM for globe procedures.	▫ Pre-oxygenate ▫ **Propofol** • Dogs: 2-4 mg/kg slow IV to effect • Cats: 2-6 mg/kg slow IV to effect	▫ Monitor ECG prior to and continuously throughout procedure. ▫ Maintain $ETCO_2$ between 30-40 mm Hg, lower (28-35 mmHg) if cerebral edema present. ▫ **Globe caution:** • Bradycardia can occur due to the trigeminovagally mediate oculocardiac reflex. Treat if it develops. • **Glycopyrrolate 0.01 mg/kg IV** ▫ See Healthy Pet Protocol. • Antibiotic as appropriate • Local block as appropriate	▫ See Healthy Pet Protocol for soft tissue surgery. ▫ See Orthopedic Protocol for orthopedic surgery. ▫ See Abdominal Protocol for ill pets (renal, liver, etc.).	▫ See Healthy Pet Protocol for soft tissue surgery. ▫ See Orthopedic Protocol for orthopedic surgery. ▫ See Abdominal Protocol for ill pets (renal, liver, etc.).

Anesthesia Protocols Summary Chart

PROTOCOL	PREMEDICATIONS	INDUCTION AGENTS	ADDITIONAL CONSIDERATIONS	POSTOPERATIVE ANALGESIA	TO GO HOME
Cesarean Protocol	▫ **Butorphanol** 0.2-0.4 mg/kg Dogs: IM Cats: SC ▫ If significant bradycardia occurs following premeds, > 30% decrease in heart rate, give **atropine** 0.2 mg/kg SC.	▫ Pre-oxygenate. ▫ **Propofol** • Dogs: 1-4 mg/kg slow IV to effect • Cats: 1-6 mg/kg slow IV to effect	▫ Line block • **Lidocaine** 0.25-0.5 mg/kg dogs and cats OR • **Bupivacaine** 0.25-0.5 mg/kg dogs and cats ▫ Antibiotic as needed • **Cefazolin** 22 mg/kg slow IV at induction	▫ **Buprenorphine** • Dogs: 0.005-0.02 mg/kg • Cats: 0.005-0.01 mg/kg ▫ IM at recovery ▫ Currently we do not recommend NSAIDs in nursing bitches or queens.	▫ **Tramadol** • Dogs: **Tramadol**: 2-4 mg/kg PO q 12 hrs • Cats: **Buprenorphine**: 0.01 mg/kg transmucosal q 8 hrs ▫ Currently, we do not recommend NSAIDS in nursing bitches or queens.
Ear Surgery (non pinna surgery)	▫ **Acepromazine** 0.05 mg/kg max dose 1.5 mg Dogs: IM Cats: SC AND ▫ **Hydromorphone** • Dogs: 0.05-0.2 mg/kg IM/SC • Cats: 0.05-0.1 mg/kg IM/SC	▫ **Telazol®** 1-2 mg/kg IV slowly to effect ▫ Dilute with sterile water to a volume of 1-3 mL	▫ **Telazol®** is utilized to help minimize shaking of the head during surgery. ▫ **Do not overpressure** upon transition to sevoflurane. ▫ **Cefazolin** 22 mg/kg slow IV at induction and q 90 min during procedure	▫ Soaker catheter for local block ▫ **Hydromorphone** or a **Fentanyl CRI** can be initiated as long as it has been 2-4 hours since hydromorphone premed and the pet's temperature is above 98°F. ▫ **Fentanyl CRI** (see CRI protocol) OR ▫ **Hydromorphone** • Dogs: 0.05 to 0.2 mg/kg IM, SC, IV q 4-6 hours • Cats: 0.05-0.1 mg/kg IM, SC, IV q 4-6 hours ▫ **Plus (as long as there are: no contraindications)** ▫ **Carprofen injectable** • Dogs: 4 mg/kg SC ▫ **Meloxicam injectable** • Cats: 0.2 mg/kg SC OR • **Robenacoxib (Onsior®)** 1 mg/kg PO upon recovery	▫ Consider "soaker" catheter ▫ Go home on an opioid and/or an NSAID as appropriate for health status and pain level. ▫ Dogs: • **Carprofen** 2 mg/kg PO q 12 hrs X 3-5 days +/- • **Tramadol** 2-4 mg/kg PO q 8 hrs ▫ Cats: • **Meloxicam suspension** 0.05 mg/kg PO q 24 hrs X 3 days. **Use with caution.** OR • **Robenacoxib** 1 mg/kg PO once daily for total of 3 doses +/- • **Tramadol** 2-4 mg/kg PO q 12 hrs OR • **Buprenorphine** 0.01mg/kg transmucosal q 8 hrs
Fractious Pet Protocol Canine: ▫ **Healthy and ill canine** ▫ **Canine brachycephalic breed**	▫ **Telazol®** IM • Healthy pet: 2-4 mg/kg • Ill pet: 1-2 mg/kg AND ▫ **Butorphanol** 0.2-0.4 mg/kg IM	▫ May not be needed! ▫ **Propofol** • 0-4 mg/kg slow IV to effect	▫ **Do not overpressure** upon transition to sevoflurane. ▫ Brachycephalic breeds • Intubate or provide flow by oxygen as soon as safely possible. ▫ See Healthy Pet Protocol • Local block as appropriate • Antibiotic as appropriate	▫ See Healthy Pet Protocol for soft tissue surgery. ▫ See Orthopedic Protocol for orthopedic surgery. ▫ See Abdominal Protocol for ill pets (renal, liver, etc.).	▫ See Healthy Pet Protocol for soft tissue surgery. ▫ See Orthopedic Protocol for orthopedic surgery. ▫ See Abdominal Protocol for ill pets (renal, liver, etc.).

Anesthesia Protocols Summary Chart

PROTOCOL	PREMEDICATIONS	INDUCTION AGENTS	ADDITIONAL CONSIDERATIONS	POSTOPERATIVE ANALGESIA	TO GO HOME
Fractious Pet Protocol Feline: ▫ **Healthy and ill feline** ▫ **Brachycephalic feline**	▫ **Dexmedetomidine, ketamine and butorphanol (DKT)** • Healthy pet: 0.065 mL/kg IM • Ill pet: 0.035mL/kg IM	▫ May not be needed! ▫ **Propofol** 0-4 mg/kg slow IV to effect	▫ **Do not overpressure** upon transition to sevoflurane. • May not need sevoflurane • **Start with 0.5% to1%** ▫ Can reverse after all procedures are completed. • **Atipamezole** (1/3 volume of DKT) IM ▫ Brachycephalic breeds • Intubate or provide flow by oxygen as soon as safely possible. ▫ See Healthy Pet Protocol. • Local block as appropriate • Antibiotic as appropriate	▫ See Healthy Pet Protocol for soft tissue surgery. ▫ See Orthopedic Protocol for orthopedic surgery. ▫ See Abdominal Protocol for ill pets (renal, liver, etc.).	▫ See Healthy Pet Protocol for soft tissue surgery. ▫ See Orthopedic Protocol for orthopedic surgery. ▫ See Abdominal Protocol for ill pets (renal, liver, etc.).
Pediatric Pet Protocol (< 16 weeks of age)	▫ **Glycopyrrolate** 0.01 mg/kg IM AND ▫ **Midazolam** 0.1 mg/kg IM AND ▫ **Butorphanol** 0.2-0.4 mg/kg IM	▫ **Propofol** 1-4 mg/kg slow IV to effect	▫ The cardiac output of pediatric pets is much more heart rate dependent than adult patients. ▫ Antibiotic as needed • **Cefazolin 22 mg/kg slow IV** at induction ▫ Local block as needed • **Lidocaine 1 mg/kg**	▫ **Butorphanol** 0.2-0.4 mg/kg IM or IV q 2-4 hours prn for pain OR ▫ **Buprenorphine** 0.005-0.01 mg/kg SC or q 8-12 hrs	▫ Dogs: • **Butorphanol** 0.2-0.4 mg/kg PO q 4-6 hours ▫ Cats: • **Buprenorphine** 0.01 mg/kg transmucosal q 8-12 hours
Post-Renal Protocol	▫ Start LRS or saline at 10-20 mL/kg/hr IV. ▫ Empty bladder via cystocentesis. ▫ Evaluate electrolytes. ▫ If needed: • **Midazolam** 0.1-0.2 mg/kg IM AND • **Butorphanol** 0.2-0.4 mg/kg Dogs: IM Cats: SC ▫ If needed: • **Telazol®** ▫ Dogs: 0.5 mg/kg IM • **DKT** ▫ Cats: 0.035 mL/kg IM	▫ If needed: • **Propofol** ▫ Dogs: 2-4 mg/kg slow IV to effect ▫ Cats: 1-6 mg/kg slow IV to effect	▫ Correct electrolyte and fluid abnormalities with IV fluids and emptying the bladder via cystocentesis before attempting general anesthesia. ▫ Can use 0.1 mL of 2% lidocaine in urethra if needed. ▫ Recheck electrolytes every 2 hours as needed. ▫ Antibiotic as indicated • **Ampicillin** 10 mg/kg IM	▫ Avoid use of NSAIDs. ▫ See Abdominal Protocol.	▫ Avoid use of NSAIDs. ▫ See Abdominal Protocol.

SECTION 10:

CPR

SECTION 10
CPR

SPECIAL CONSIDERATIONS FOR CPR PROTOCOL

Cardiopulmonary arrest is defined as "the abrupt and unexpected cessation of spontaneous and effective ventilation and circulation." This can be the natural ending of a full life or the result of trauma or disease states. If cardiopulmonary arrest is because of a potentially reversible traumatic or medical condition, then prompt application of sound cardiopulmonary resuscitation (CPR) techniques while addressing the underlying cause of the arrest may allow restoration of life signs.

Effective CPR requires a highly trained, efficient and coordinated team, appropriate monitoring devices and medications, and prompt application of CPR techniques. Even with aggressive and effective CPR, survival rates are low–less than 10%. Controversy exists as to the best CPR techniques and protocol. Therefore, we have combined recommendations from many sources to produce a reasonable CPR protocol that will benefit the greatest number of patients and utilize equipment, techniques and medications that should be available in all of our hospitals.

The goal of the following CPR protocol is to provide an outline for closed-chest CPR in dogs and cats. This protocol is a template. To be effective, it will require training of a team of hospital associates who can work together efficiently.

Recommended team training should include:

1. All doctors and paraprofessionals must familiarize themselves with the protocol.

2. Develop a hierarchy of who will be "running the code" according to who is available. The doctor present will usually be running the code, but a lead veterinary technician/assistant may need to initiate the code.

3. Have frequent drills with your team to rehearse CPR. Consider bringing in a stuffed animal as the dummy. This should include the leader assigning duties and directing the code.

4. Rotate teams and individual responsibilities during the code drill so that each team member is comfortable doing each job during a code.
5. Determine division of labor during a code by the number of associates available. A person may have more than one job responsibility. Assigned roles of responsibility include:
   - Running the code
   - Ventilations
   - Chest compressions: 100-120/min. Rotate the person doing compressions every three to four minutes to keep up adequate strength of compressions.
   - Attach monitors (ECG, pulse ox, etc.).
   - Evaluate/monitor patient.
   - Place and maintain IV catheter.
   - Administer drugs–record doses, time, pet response.
   - Supportive care (lube eyes, heating pad, etc.)
   - Gopher
   - Monitoring
   - Recording

This CPR protocol does not replace the *Anesthetic Monitoring and Emergency Algorithm* on page 80. The CPR protocol only applies to anesthetic cases once cardiopulmonary arrest is noted.

Cardiopulmonary arrest

Cardiopulmonary arrest: Drug choice is based on ECG rhythm.

NOTE: All ECGs are recorded at 50 mm/sec and 1 cm = 1 mv.

Cardiopulmonary Arrest Algorithm

No respiration. Pulse present.

* Establish airway. Intubate. Ventilate with oxygen (connect to anesthetic machine with oxygen only).

‡ Connect to monitors (continuous ECG & pulse ox). Place IV catheter. Start IV fluids.

Diagnose & treat underlying disorders.

Reassess patient.

No respiration. No pulse. No heartbeat.

* Establish airway. Intubate. Ventilate with oxygen (connect to anesthetic machine with oxygen only).

≤ Cardiac compressions 100-120/min

‡ Connect to monitors (continuous ECG & pulse ox) Place IV catheter. Start IV fluids.

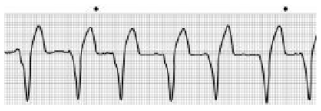
Doctor or lead veterinary technician/assistant to assign duties

- Ventilations
- Compressions
- Attach monitors (ECG, pulse ox, etc.).
- Evaluate/monitor patient.
- Place & maintain IV catheter.
- Administer drugs—record doses, time, pet response.
- Supportive care (lube eyes, heating pad, etc.)
- Gopher

MONITORING INCLUDES:

- Heart rate
- ECG rhythm
- Pulse quality/deficits
- Capillary refill time and mucus membrane color
- Respiratory rate (assisted or spontaneous)
- Pulse oximetry
- Temperature
- Blood volume**—(PCV/TP, hemorrhage, pulse quality, heart rate)**
- Pupillary light response & other cranial nerve reflexes (note any changes & presence or absence of reflexes)
- Level of consciousness
- Urine production (place urinary catheter if stable, monitor output)
- Blood glucose

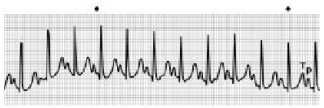
Ventricular tachycardia



° Lidocaine

Evaluate for response, reassess patient.

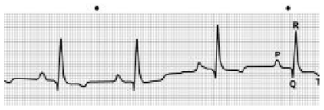
Sinus tachycardia



‡ IV fluids Assess blood volume, continue to ventilate.

Evaluate for response, reassess patient.

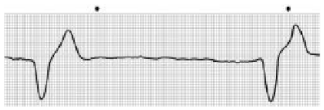
Normal rate & rhythm



° Monitor, provide supportive care.

Evaluate for response, reassess patient.

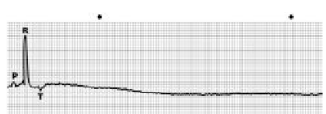
Bradycardia



° Atropine: 1st epinephrine: 2nd if necessary.

Evaluate for response, reassess patient.

Asystole



° Atropine: 1st epinephrine: 2nd if necessary.

Evaluate for response, reassess patient.

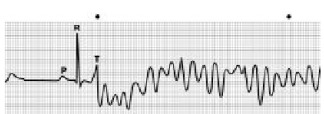
Electromechanical dissociation:

- Any and all pulseless rhythms
- Difficult to rule out weak ventricular function
- Dogs: Femoral pulse disappears with a systolic pressure of 60 mm of Hg and heart sounds disappear below a systolic blood pressure of 50 mm of Hg.

° Epinephrine: 1st dexamethasone: 2nd if necessary.

Evaluate for response, reassess patient.

Ventricular fibrillation



° Epinephrine: 1st lidocaine bolus: 2nd if necessary.

Evaluate for response, reassess patient.

* VENTILATION (100% oxygen)

- Establish airway (laryngoscope, endotracheal tube, tie in place).
- Connect to anesthesia machine with 0_2 only.
- Give two long breaths (1.5-2 seconds each), monitor for spontaneous ventilation.
- If spontaneous ventilation does not resume, continue at 10-15 breaths per minute (two for every 15 chest compressions).
  - Dogs: 15-20 cm H_20
  - Cats: 12-17 cm of H_20
- Chronic lung disease: < 12 cm of H_20

≤ EXTERNAL CHEST COMPRESSIONS

< 4.5 kg, lateral recumbency

- Place fingers of one hand on one side of the chest and thumb on the other side at level of 4th-5th intercostal space, avoid compressions with fingertips.
- 100-120 compressions/minute
- Should decrease chest diameter by 25%-33%.

> 7 kg, lateral recumbency

- Stand with patient's spine closest to you.
- Center over highest portion of chest wall at level of 4th-5th intercostal space.
- 100-120 compressions/minute
- Should decrease chest diameter by 25%-33%, chest wall should be allowed to completely recoil between compressions.

‡ FLUIDS

- **Place largest catheter possible, central preferred,** *i.e.* jugular catheter. 0.9% NaCl.
- **Give following dose as initial bolus, then reassess for ongoing rate.**
  - Dogs: 20 mL/kg
  - Cats: 5 mL/kg
- **Adjust continued fluid therapy for underlying disease,** *i.e.* congestive heart failure.
  - Dogs: 40-80 mL/kg/hr
  - Cats: 20-40 mL/kg/hr
- **Assess need for colloids:** (TP < 3.5, Alb < 1.5, poor pulse quality w/ adequate crystalloid administration, need for rapid volume expansion. Establish second IV line).
- **Hetastarch:**
  - Dogs: 10-20 mL/kg over first hour in increments of 5 mL/kg/5-10 min
  - Cats: 5-10 mL/kg over first hour in increments of 5 mL/kg/5-10 min
- **Fresh frozen plasma:** 5-10 mL/kg at 20 mL/kg/hr
- **Assess need for oxygen carrying fluids:** (HCT or PCV < 25% or significant hemorrhage. Establish second IV line).
- **Packed red blood cells:** 5-10 mL/kg at 10-20 mL/kg/hr
  - Dogs: No need for cross match with first transfusion.
  - Cats: Always blood type or cross match.
- **Fresh whole blood:** 5-20 mL/kg at 10-20 mL/kg/hr, cross match as above

STOP **Think. Make a good decision.**

INTRACARDIAC INJECTIONS NOT APPROPRIATE. DO NOT ADMINISTER.

o IV DRUGS

- Always bolus 10-30 mL 0.9% NaCl after each medication. Raise extremity for 10-20 seconds & wait 30 seconds to two minutes for response; repeat drug doses as necessary.
- **Atropine IV or IO** (0.54 mg/mL)
  0.04 mg/kg IV or IO (0.33 mLs for a 4.5 kg pet)
- **Epinephrine IV or IO** (1:1000 = 1 mg/mL)
  Start with low dose and progress to high dose.
  - Low dose = 0.01 mg/kg IV or IO (0.05 mLs for a 4.5 kg pet)
  - High dose = 0.1 mg/kg IV or IO (0.5 mLs for a 4.5 kg pet)
- **Lidocaine IV or IO** (2% solution = 20 mg/mL)
- Monitor with ECG, use with caution in cats. Start with bolus and if successful convert to CRI.
  - Dog bolus: 2-4 mg/kg IV or IO (0.5-1 mL for a 4.5 kg dog)
  - Cat bolus: 0.2 mg/kg (0.04 mL for a 4.5 kg cat)
- **Lidocaine CRI** (lidocaine drip - 1 L saline and 50 mL 2% lidocaine)
  - Dog: 4 mL/kg/hr to control VPCs. Decrease drip rate if bradycardia develops. Use second IV catheter for administration.
  - Cats: 0.6-1 mL/kg//hr to control VPCs. Use caution in cats, monitor closely for bradycardia and decrease drip rate if bradycardia develops. Use second IV catheter for administration.
- **Dexamethasone sodium phosphate IV** (4 mg/mL)
  4.4 mg/kg (5 mL for a 4.5 kg pet)

INTRATRACHEAL DRUGS

Atropine, epinephrine, lidocaine

- Double the IV dose.
- Administer through a red rubber catheter advanced beyond the end of endotracheal tube.
- Follow with 5-10 mL 0.9% NaCl to flush drug through red rubber catheter.
- Hyperventilate after administration for 10 seconds.

POST RESUSCITATION

- **Monitor:** (See *Cardiopulmonary Arrest Algorithm*, page 120).
- **Support organ systems:** Consider all appropriate measures.
- **Respiratory:** Supplemental oxygen (nasal or e-collar)
- **Cardiac:** Supplemental oxygen (nasal or e-collar), furosemide, lidocaine, dobutamine, IV fluids, continued positive pressure ventilation with oxygen.
- **Neurologic:** Supplemental oxygen (nasal or e-collar), continued ventilation with oxygen to reduce carbon dioxide levels, mannitol, corticosteroids, furosemide, dobutamine.
- **Renal:** Continued fluid therapy. If normovolemic and normotensive and oliguric (less than 1 mL of urine/kg/hr produced) consider mannitol or furosemide with or without a dobutamine drip–dogs only.
- **Drugs to consider:**
  - **Mannitol** (0.5-1 g/kg IV over 20 minutes)
  - **Furosemide** (2-4 mg/kg IV)
  - **Dobutamine** (4-20 µg/kg/min IV: 25 mg in 1 L of saline via microdrip = 25 µg/mL. Monitor pulse and ECG–as pulse increases, decrease dobutamine. If VPCs or tachycardia develop, decrease drip rate).
  - **Lidocaine CRI**, corticosteroids (**dexamethasone SP** 4-10 mg/kg IV or **methylprednisolone, Na succinate** 10-30 mg/kg IV)
  - **Dopamine** (dogs only) 0.5-3 µg/kg/minute (dopamine 40 mg/mL add 1/2 mL = 20 mg to 1 L 0.9% NaCl = 20 µg/mL, microdrip set = 60 drops/mL, 9 kg dog at 2 µg/kg/minute = 20 µg/minute = 1 drop every 3 seconds), broad spectrum antibiotics. Consider referral for 24-hour care when stable for transport.

SECTION 11:

Exotics

SECTION 11

Anesthetic Considerations for Small Exotic Patients

■ Birds ■ Reptiles ■ Ferrets ■ Rabbits ■ Guinea Pigs ■ Chinchillas ■ Rodents ■ Hedgehogs

INTRODUCTION

Many resources exist for those interested in anesthesia of exotic patients. This section is not meant to be inclusive of all resources, but is designed to provide general practitioners with clinically practical, effective, safety-oriented guidelines based on commonly accepted anesthetic practices for exotic species. As with any species, no guideline is perfect for every individual patient. The best formula for a positive anesthetic outcome involves good medical judgment, and careful attention to the whole patient—from initial evaluation and preparation through anesthesia, recovery and post-procedure care.

Exotic patient anesthesia is essentially the same as feline and canine anesthesia. However, application requires modification of apparatus due to small patient size, recognition of variable drug sensitivities, species idiosyncrasies, challenges of restraint and monitoring limitations. The six basic steps of anesthesia apply to exotic patients as well as dogs and cats.

1. **Preanesthetic evaluation:** Client education, patient history and health status, laboratory information
2. **Preanesthetic preparation:** Fasting (when appropriate), stabilization of systemic status, fluid and oxygen supplementation, equipment and hospital team, premedication, venous access if appropriate
3. **Monitoring:** Cardiopulmonary parameters, end-tidal CO_2 monitoring (CO_2 is ideal in larger patients, but not currently available at all Banfield hospitals), blood pressure, pulse oximetry, temperature, plane of anesthesia, hydration status
4. **Induction:** Provides a smooth transition into unconsciousness and allows airway to be established and secured (tracheal intubation is not recommended in all species—see individual protocols)
5. **Maintenance:** Temperature maintenance, prevention of hypoglycemia, hypovolemia and hypothermia
6. **Postoperative care:** Recovery, temperature maintenance, pain control, fluid balance

Proper application of these six steps must address the following issues:

- Evaluation of medical history, physical state and laboratory data
- Stabilization of physiological status before induction of anesthesia
- Minimization of anesthetic time—preparation is key
- Correct anesthetic drug dose selection (consider health status, species, breed, and pre-existing conditions and complications)
- Maintenance of patent airway, oxygen support and monitoring
- Monitoring and support of cardiovascular function (fluids and adrenergic drugs)
- Monitoring and support of body temperature (supplemental heat, reduction of body heat loss)
- Continued monitoring and support until complete recovery
- Analgesia/tranquilization to decrease pain, stress and excitement during induction or recovery
- Preparation (adequate hospital team training and equipment) for normal and complicated cases; prepare to address potential adverse outcomes

Special considerations for exotic patient anesthesia

The small body size of many exotic mammals and avian species equates to increased metabolism compared to dogs and cats; reptiles generally have slower metabolism. This variability has a significant impact on anesthetic considerations. Metabolism levels may increase or decrease drug requirements or duration of action compared to dogs and cats, increase the risk of hypoglycemia due to fasting and increase oxygen requirements in many species. Most exotic patients are extremely sensitive to any period of apnea or hypoxemia, no matter how short. For example, reptiles may survive an initial hypoxemic anesthesia episode, only to die days or weeks later from hypoxic renal damage.

High body surface area to volume ratio predisposes small patients to significant body heat loss during anesthesia. Hypothermia produces prolonged drug metabolism and recovery. Small size makes intubation, venous access and anesthetic monitoring difficult and often requires size-specific or adapted equipment. A high level of skill is imperative to provide the specialized care needed for successful exotic patient care and anesthesia.

PREANESTHETIC EVALUATION

Discuss realistic expectations and potential outcomes with the client.

- Provide client education about aftercare and present an accurate treatment plan before the procedure. Include client education about prognosis and anesthetic risk; exotic patients can respond differently to anesthetic procedures compared to dogs and cats. Due to small body size and related factors, exotic patients are more prone to anesthetic and surgically related complications.

Obtain an accurate body weight, usually in grams.

- Accurate body weight is imperative to calculate correct drug and fluid doses.

Perform as complete a physical exam as possible.

- Obtain a complete history and determine if the patient can reasonably be handled. Evaluate the patient's health status–healthy or compromised? Determine "awake" resting pulse rate, temperature and respiratory rate when possible. Patients that cannot be examined without chemical restraint should be evaluated based on visual observation and history. Handle stressed patients for as short a period as possible. In some cases, sedation or anesthesia of sick patients to allow evaluation is preferable to the stress induced by struggling and restraint.

Become familiar with common ailments of each species.

- Evaluate any pre-existing conditions or clinical signs including anemia, cyanosis, cachexia or obesity, anorexia (fasting), icterus, weakness or central nervous system (CNS) depression, dehydration, ascites, respiratory or cardiovascular abnormalities, tissue trauma and clotting abnormalities. Use appropriate caution in patients with hepatic, renal or other compromise. Stabilize systemic status if possible, including treatment for pain if appropriate.

Perform preanesthetic blood work whenever possible.

- This includes complete blood cell count (CBC)/ differential and a chemistry profile. It may not be possible to obtain adequate blood sample volumes from very small patients. However, a sample adequate to perform a packed cell volume (PCV), total protein (TP), blood glucose and blood smear/differential is usually obtainable from all but the very smallest patients. Consider urinalysis, fecal examination and other blood tests as appropriate to the case.
- The current in-house blood chemistry machine will run chemistries on rabbits, ferrets, many avian species, reptiles and rodents. The in-house CBC machine will run CBCs on rabbits and ferrets. Practitioners will have to refer to a text for ferret normals. "Rabbit normal" cards are available for the in-house Scil machines. A "rabbit" card for CBCs can be obtained by submitting a purchase requisition form to Medical Resources (See instructions in SmartHelp). In most cases, CBCs for reptiles and avian species will need to be sent to a reference lab. A manual count can be performed in-house if practitioners have skill in reading avian and reptile blood smears.
- Address any preanesthetic blood work abnormalities before proceeding with anesthesia. When emergency surgery is truly necessary, stabilize the patient as much as possible before anesthesia. Situations where surgery is required before any stabilization has been performed are extremely rare.

Blood Sample Guidelines for Healthy Patients*

Species	Blood Sample Volumes**
Reptiles:	Up to 0.5 mL per 100 grams of body weight (0.5% of body weight) **Examples:** ▶ 100 gram patient, can take 0.5 mL ▶ 1,000 gram patient, can take 3 to 5 mL
Rabbits, Ferrets & Rodents:	Up to 0.5 mL per 100 grams of body weight (0.5% of body weight) **Examples:** ▶ 100 gram patient, can take 0.5 mL ▶ 1,000 gram patient, can take 3 to 5 mL
Avian Species:	Up to 1 mL per 100 grams body weight

*Adapted from ANTECH Diagnostics sample collection information.
**Take smaller amounts from compromised patients.

Reference laboratories can often supply micro-sized blood collection tubes to facilitate send-out diagnostic workups for small patients. Check the comments below each exotic patient blood test in the current reference lab services directory. The reference lab information indicates which collection tubes or containers are best and specifies minimum volume amounts for each test. The most accurate result will be obtained by following these sample container guidelines.

PREANESTHETIC PREPARATION

Ensure that the proper supplies and equipment are available.

The following items will be needed:

- Non-rebreathing circuit (at 2 L O_2 flow)
- Warm fluids: 0.9% NaCl is recommended. Use intravenous fluid warmer.
- Supplemental heat source: warm water circulating blanket, warm air incubator, or other appropriate warming device
- Pulse oximeter, ECG, blood pressure (BP) unit, thermometer, stethoscope, CO_2 monitoring for patients > 2 kg if available
  - Small BP cuffs: #1 size cuffs are available
- Optimal: 24-gauge, 3/4-inch intravenous (IV) catheters or 23- to 20-gauge needles or bone marrow needles for intraosseous (IO) catheters
- Appropriately sized face masks or intubation supplies including:
  - Small face masks:
    - When using a face mask, it may be necessary to make or obtain special oxygen delivery equipment, including tiny masks made from syringe cases with a latex glove diaphragm over the end.
  - Endotracheal tubes:
    - Large, over-the-needle-catheters or red rubber tubes with homemade gas adaptors
    - 2 mm and larger endotracheal tubes
    - Specialty endotracheal tubes also exist (<2 mm sizes, +/- uncuffed types)
  - Mouth gags (to prevent unexpected tube bite-through)
  - Laryngoscope or otoscope to facilitate intubation
  - Lidocaine gel: **use very small amounts** and only when needed to facilitate endotracheal intubation. Lidocaine toxicity is possible in small exotic patients.
  - Ambu® bag, pediatric or neonate (especially for reptiles–see reptile section)

Some surgeons are aided by a brace or support that can be placed over small patients to allow a place for the hands to rest while performing surgery. These can be fashioned from polyvinyl chloride (PVC) pipe cut into various lengths and placed over part of the patient.

Become familiar with preanesthetic fasting recommendations. Some exotic patients should not be fasted or fasted for only short periods before anesthesia to prevent hypoglycemia.

Recommended Preoperative Fasting/Water Withholding Times for Exotic Patients

Species	Fasting Time Recommendations	Water Withdraw Recommendations
Ferret	4 hrs (don't fast patients with insulinomas)	2 hrs
Rabbit	30 min	0-30 min (mouth should be empty of food and water)
Guinea Pig/ Chinchilla	4 hrs	2 hrs
Small Rodents	0	0
Hedgehogs	2-4 hrs	2 hrs
Reptiles	4-6 hrs (or longer in large species)	0-1 hrs
Smaller Avian Species	4-6 hrs	0-2 hrs (want empty crop)
Larger Psittacines	8-12 hrs	0-2 hrs (want empty crop)

Allow stressed patients to calm before anesthesia. Overstimulation and high sympathetic tone can override sedatives and predispose to vasoconstriction, increased myocardial workload and cardiac arrhythmias. Some exotic patients (particularly rabbits and many birds) may benefit from hospitalization the night before anesthesia to allow acclimatization to the hospital environment and to gather samples for preanesthetic testing. This reduces stress in the immediate preanesthetic period.

Maintenance of correct body temperature is imperative. Warm subcutaneous (SC), IV or IO fluids should be administered before, during and after anesthesia. Provide supplemental heat as needed, especially during surgery and recovery–use heating blankets, warm air or

incubators. **Avoid thermal burns—monitor heat sources closely.** Place a dry barrier (towel layers) between patients and heating blankets to reduce potential for burns. Incubators pre- and postsurgically are ideal.

Prepare to perform anesthesia in a warm immediate environment. Clip hair or pluck feathers cautiously from as small an area as possible and do as much prep as possible prior to induction (wait until patient is anesthetized to pluck feathers, as this is painful). In birds, masking tape can be used to tape feathers away from the surgical site. Use warmed surgical prep solutions. Substitute warm, diluted chlorhexidine or saline for scrub rinses; avoid alcohol. Cover as much of the patient as possible during surgery to retain body heat. Use clear, adhesive plastic surgery drapes whenever possible. Use adhesive tape sparingly; the delicate skin of small patients can tear easily. Masking, paper or autoclave tape may be better choices.

Start fluid administration before anesthesia. Be sure to use warmed fluids. Choose a balanced crystalloid fluid for routine perioperative fluid administration; 0.9% NaCl is recommended. Set an IV or IO catheter when possible; IV is generally preferred. Whenever possible, a fluid pump and microdrip set should be used to ensure accurate delivery rates and volumes. SC fluids should be administered if IV or IO access is not available. Be aware that SC fluid therapy may not be adequate to correct pre-existing dehydration in the immediate preoperative period. **Stabilize and correct dehydration before anesthesia**.

IV, IO catheter placed:

- Begin administration of warm IV or IO fluids at 5 to 10 mL/kg/hr before induction of anesthesia when possible. Continue fluids until recovery is complete.

No IV, IO catheter placed:

- Begin administration of warm fluids at 5 to 10 mL/kg/hr SC. Administer 1/4 of the calculated hourly dose every 15 minutes starting before induction of anesthesia, continuing through recovery.

Fluid support is vital to maintain hydration, blood volume and fluid balance. Measure fluids, control fluid rates, and monitor patients carefully to prevent fluid overload.

Fluid Rates	
Maintenance fluid rate:	1.5-4 mL/kg/hr
Anesthesia fluid rate:	5-10 mL/kg/hr
Shock fluid rate:	30-80 mL/kg/hr

SMALL MAMMALS

The following information outlines recommended injection sites and other information pertinent for various small mammal species. **Special note for atropine in rabbits**: Many rabbits have serum atropinase, which reduces the efficacy of atropine. When an anticholinergic is desired, use glycopyrrolate instead.

Recommended Injection Sites for Small Mammals

Species	Injection and Catheter Sites	Comments Use 25-gauge needles for venipuncture and 24-gauge IV catheters for venous placement
Ferret	SC, IM IO: Proximal femur IV: cephalic, jugular, lateral saphenous, lateral tail	SC, IM: Medication administration IO: Medication administration, catheterization IV: Medication administration (all), catheterization (not tail vein)
Rabbit	SC, IM IO: Trochanteric fossa of femur, tibia IV: Marginal ear, cephalic, lateral saphenous, jugular	SC, IM: Medication administration IO: Medication administration, catheterization IV: Medication administration (all), catheterization (lateral saphenous poor for catheter).
Guinea Pig	SC, IM IO: Trochanteric fossa of femur IV: Marginal ear, medial saphenous, lateral saphenous proximal to hock, jugular	SC, IM: Medication administration IO: Medication administration, catheterization IV: Medication administration, catheterization (difficult) General: Self-mutilation can occur with IM injections, vascular access often difficult due to short, mobile, friable veins.
Rat and Mouse	SC, IM IO: Proximal femur IV: Jugular, lateral tail	SC, IM: Medication administration IO: Medication administration, catheterization IV: Medication administration General: Lateral tail veins are difficult to obtain blood from except by capillary action.
Gerbil	SC, IM IO: Proximal femur IV: Lateral tail, saphenous, metatarsal	SC, IM: Medication administration IO: Medication administration, catheterization IV: Medication administration
Hamster	SC, IM IO: Proximal femur, tibial crest IV: Lateral tarsus, cephalic	SC, IM: Medication administration, IM maximum volume is 0.25 mL IO: Medication administration, catheterization IV: Medication administration, IV access difficult—use 27 or smaller gauge needles
Chinchilla	SC, IM IO:Proximal femur IV: Femoral, cephalic, lateral saphenous, jugular, auricular, lateral abdomen, tail	SC, IM: Medication administration, IM maximum volume is 0.3 mL, IM use 23-gauge or smaller needles IO: Medication administration, catheterization IV: Medication administration, use 25-gauge or smaller needles
Hedgehog	SC, IM IO: Tibia, proximal femur IV: Jugular, cephalic, lateral saphenous, femoral	SC, IM: Medication administration, IM maximum volume is 0.3 mL, IM use 23-gauge or smaller needles IO: Medication administration, catheterization IV: Medication administration, use 25-gauge or smaller needle

Premedication is recommended for all small mammals: It calms, improves handling, reduces the amount of induction and maintenance agents needed, smoothes recovery, reduces vagal effects and may prolong analgesia. Premedication is optimal if it can be performed without causing excess stress. See species-specific recommendations in the individual protocols that follow.

When mask anesthetic induction is used, small mammals often hold their breath. Deep, rapid respiration occurs after "breath holding," leading to rapid uptake and anesthetic overdose. Use low induction concentrations of inhalant anesthesia. Use small masks and monitor for apnea.

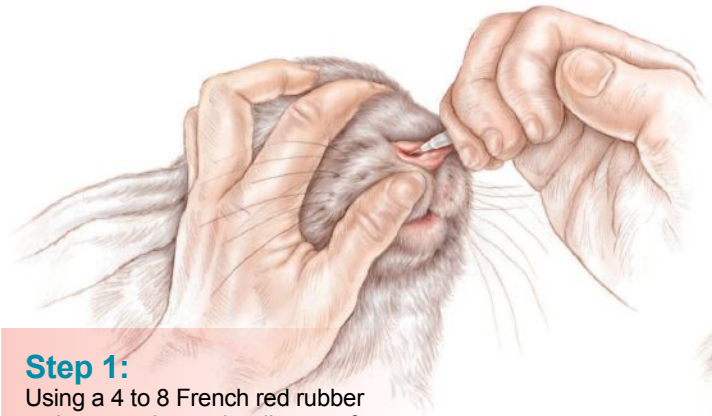
Appropriate pain control is extremely important. Small mammals, especially rabbits, often react poorly to pain and become anorexic, lethargic and may self-mutilate.

Suggested reading for injection and catheter sites in small mammals:

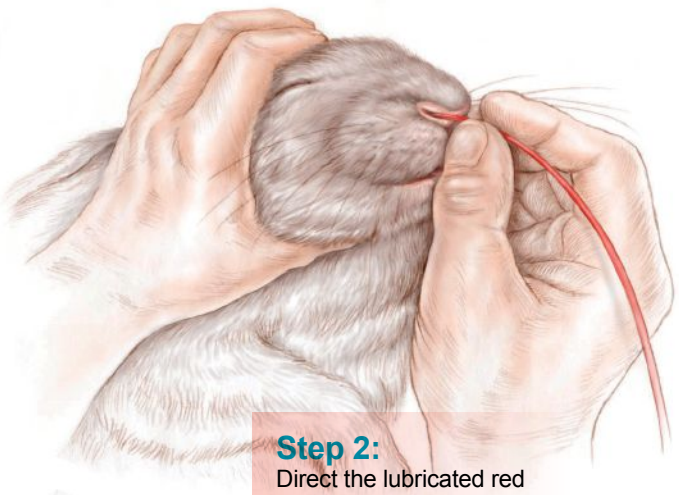
1. Heard D (ed). *Vet Clin North Am Exotic Anim Pract.* 2001 Jan;4(1).
2. Quesenberry K, Carpenter J. *Ferrets, Rabbits, and Rodents, Clinical Medicine and Surgery*. 2nd ed. Philadelphia, Pa. Saunders. 2004.
3. Longley L. *Anaesthesia of Exotic Pets.* Philadelphia, Pa. Saunders. 2008.

Technique for Intranasal Intubation of Rabbits

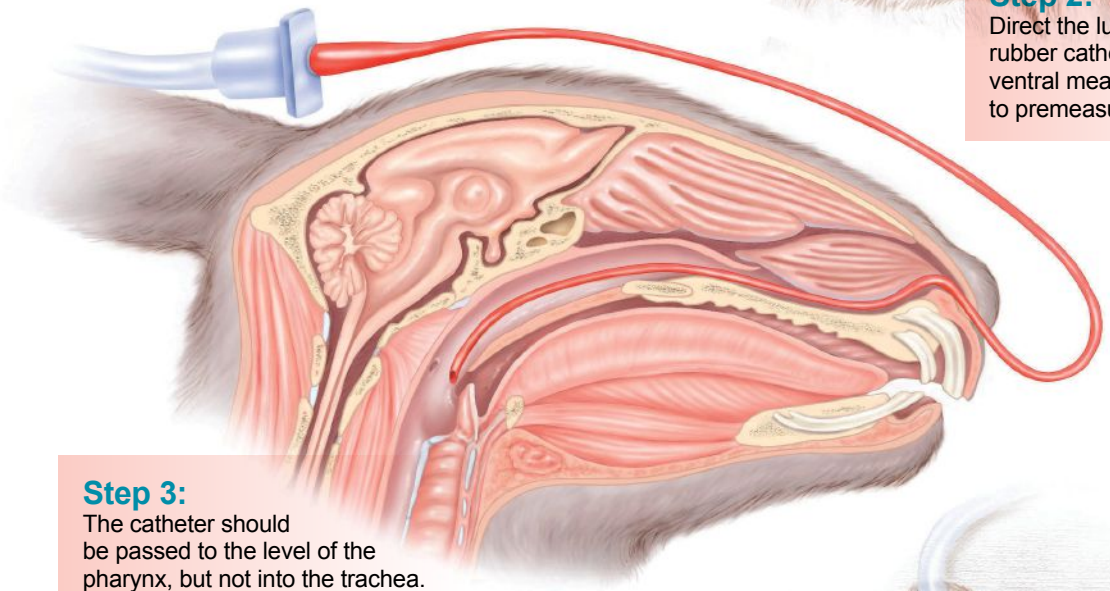
Tracheal intubation is optimal. Great care must be used–repeated attempts at tracheal intubation can cause significant laryngeal edema or spasm. Nasal intubation is strongly recommended when unable to perform tracheal intubation on the first attempt or when the practitioner has little experience with tracheal intubation in rabbits.



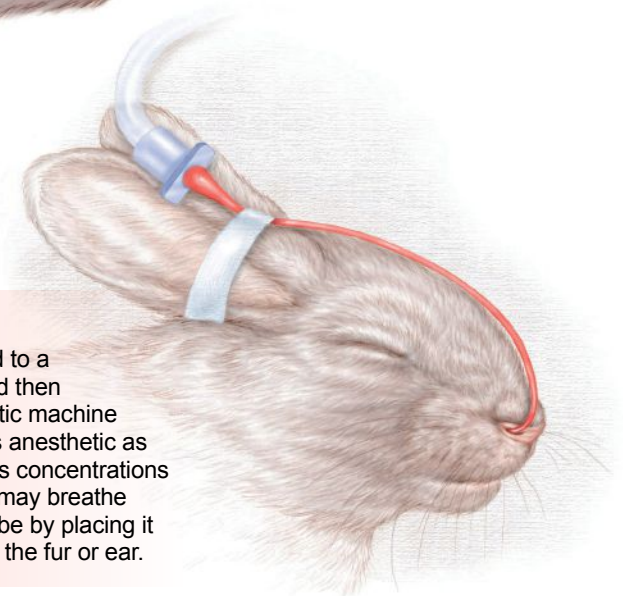
Step 1:
Using a 4 to 8 French red rubber catheter, estimate the distance from the nasal opening to the level of the pharynx and mark the tube. After induction, instill two to three drops of lidocaine into one nostril.



Step 2:
Direct the lubricated red rubber catheter in the ventral meatus and pass to premeasured mark.



Step 3:
The catheter should be passed to the level of the pharynx, but not into the trachea. Avoid inserting the tube too deeply as it may pass into the esophagus.



Step 4:
The catheter can be connected to a small tracheal tube adaptor and then hooked to the existing anesthetic machine tubing. Deliver oxygen and gas anesthetic as with a tracheal tube. Higher gas concentrations may be needed as the patient may breathe around the tube. Secure the tube by placing it up over the head and taping to the fur or ear.

Biological illustration by Laurie O'Keefe

REPTILES

The following information covers recommended injection sites, premedication usage and the special respiratory support needs of reptiles.

Historically, it has been preferable to administer injections into the cranial half of the body of reptiles to decrease drug passage through the renal portal system. Recent studies indicate that the injection site may be less significant on the metabolism of some drugs than previously thought. However, the coccygeal vein blood of some lizards does appear to enter the renal portal system. Therefore, renal-toxic drugs, drugs with a very high first-pass renal excretion rate or anesthetic drugs are best administered in the cranial half of the body in reptiles.

Recommended Injection Sites for Reptiles

Reptile Type	Injection and Catheter Sites	Use	Comments
Snake	IV: Jugular (right), coccygeal, heart (recommend to reserve for urgent need), palatine (medium to large snakes once already anesthetized) IM: Paravertebral musculature preferred	IV: Medication administration, catheterization (difficult in general, use jugular if attempting) IM: Medication administration	Right jugular vein is larger than left—incise 4 to 7 scutes cranial to the heart at the junction of the ventral scutes and right lateral body scales. Jugular is identified by blunt dissection just medial to tips of ribs. Coccygeal vein is located on ventral midline of tail. Use 27- to 22-gauge needle—insert 1/3 of distance from cloaca to tail to avoid hemipenes (males) and anal sacs. Aspirate until blood or bone encountered. If unsuccessful, reposition cranially or caudally. Difficult to use in small snakes. Heart (recommend to reserve for urgent need). Use 27- to 25-gauge needles in smaller snakes, 22-gauge in very large snakes. Insert needle at a 45-degree angle to ventricles and aspirate gently. Palatine vein is not routinely recommended. Usually accessed while patient is under anesthesia or a secure mouth gag is in place. Difficult to control hemorrhage if vein is lacerated. Located medial to palatine teeth in roof of mouth.
Lizard	IV: Cephalic, ventral abdominal, jugular, coccygeal IM: Proximal limbs (shoulder to elbow) recommended IO: Distal femur, proximal tibia Not recommended: Distal limb (below elbow) IM, SC injections may cause tissue necrosis.	IV: Medication administration, catheterization (cephalic, +/-jugular) IM: Medication administration IO: Medication administration, catheterization, IO is preferred catheterization site in most lizards	Jugular vein is located on lateral neck, more dorsal than would be expected in mammals. Requires a longitudinal incision and blunt dissection to visualize. Coccygeal vein is located on ventral midline of tail. Insert small gauge needle sufficiently caudal to the cloaca to avoid hemipenes (males) and anal sacs. Vessel is entered directly from ventral midline or laterally. Insert needle ventral to transverse process and advance until vertebral body is contacted. While gently aspirating, walk needle ventrally around vertebral body until vessel is found. Cephalic vein is located on dorsal (anterior) surface of the foreleg–a cut down incision from the elbow distal and medial over the dorsal forearm may allow visualization of vein. This vein can be difficult to locate or maintain a catheter in for some patients. Ventral abdominal vein is located on ventral midline and can be entered percutaneously following small skin incision on midline to visualize vessel. Can also be catheterized in some patients. IO site access: ■ Proximal tibia: Differentiate from lateral fibula. Pass catheter through tibial crest and advance needle to medial surface of leg as it is passes into the bone. ■ Distal femur: Flex stifle. Curve in distal femur usually allows catheter to be introduced proximal to the joint. ■ Radiographs (2 views) are helpful to access correct IO placement.

Recommended Injection Sites for Reptiles (cont'd)

Reptile Type	Injection and Catheter Sites	Use	Comments
Turtle and Tortoise	IV: Jugular, dorsal coccygeal, brachial, subcarapacial (supravertebral) IM: Proximal limbs (shoulder to elbow) recommended IO: Carapace/ plastron bridge (difficult), distal femur, proximal tibia Not recommended: Distal limb (below elbow) IM/SC injections may cause tissue necrosis.	IV: Medication administration, catheterization (jugular) IM: Medication administration IO: Medication administration, catheterization (difficult)	Jugular vein is located on lateral surface of neck auricular scale, usually near the 10 and 2 o'clock positions. The right jugular is often larger than the left. Some patients may be percutaneously catheterized; others require a longitudinal incision for visualization. Dorsal coccygeal vein is located in midline of tail, dorsal to vertebrae. Clean injection sites of feces or debris. Insert needle in midline and advance until bone is contacted. Gentle aspiration allows identification of vessel. Subcarapacial (supravertebral) venous sinus: located beneath the carapace on midline just caudal to the last cervical vertebrae and just in front of the first thoracic vertebrae. This is midline on the underside of the carapace, usually just caudal to where the skin meets the carapace. The patient's head must be extended or retracted to allow access to the site. IO site access: ■ Carapace/plastron bridge: Pass needle at an acute angle through the bony bridge between carapace and plastron. This is difficult to do, and catheter usually enters the coelomic cavity rather than the intramedullary space. ■ Distal femur, proximal tibia: similar to lizards (above), but generally more difficult to place due to curved femur shape. Catheters can become dislodged as patient pulls limb into shell. ■ Radiographs (2 views) are helpful to access correct IO placement.

Premedication is recommended for all reptiles: It calms, improves handling, reduces the amount of induction and maintenance agents needed, smoothes recovery, reduces vagal effects and may prolong analgesia. Premedication is optimal if it can be performed without causing excess stress. See species specific recommendations noted in the individual anesthetic protocols that follow.

Reptiles have unique respiratory physiology:

- More recent evidence suggests that low oxygen concentrations stimulate reptilian respiration while high oxygen concentrations depress it. Oxygen-rich environments cause respiratory depression in some reptilian species. Pre-induction oxygenation is not routinely recommended in most otherwise healthy reptiles. However, reptiles can suffer from hypoxemia and survive the initial insult only to die days or weeks later from hypoxic renal damage. **Therefore, supplementation with 100% oxygen is required during induction and anesthesia; intubation is strongly recommended.** Room air is recommended during recovery.
- **Intubation is recommended whenever possible.** Reptiles lack a functional muscular diaphragm and will benefit from assisted ventilation [manual or positive pressure ventilation (PPV)] with anesthetic gas and oxygen (via tracheal tube) during anesthesia. This supports adequate tidal volume and oxygen delivery. An assistant can provide PPV as needed.
- Due to the need for PPV during anesthesia, reptiles often become hyperoxygenated. **Room air (rather than 100% oxygen) is recommended during recovery for most reptile species.** After anesthetic gas is discontinued, provide one to two minutes of PPV (not to exceed 10 to 12 cm water pressure) with 100% oxygen supplementation to allow excretion of anesthetic gas from the lungs. Then disconnect the oxygen and, **using room air only**, provide occasional PPV breaths until spontaneous respirations are stimulated; attempt to mimic the patient's preanesthetic respiratory rate and depth. Use a pediatric or neonatal Ambu® bag. Monitor patients carefully. Recovery progresses caudal to cranial. Extubate when movement has begun to occur.

In cases where mask/chamber anesthetic induction is used, reptiles can be resistant, with some species being nearly impossible to induce by mask or chamber alone (especially turtles/tortoises and aquatic species). If mask/chamber induction is attempted, use small masks/chambers and low induction concentrations of inhalant anesthesia–do not exceed 5% sevoflurane.

Suggested reading for injection and catheter sites in reptiles:

1. Heard D (ed). *Vet Clin North Am Exotic Anim Pract.* 2001. Jan;4(1).
2. Bonagura, JD (ed). *Kirk's Current Veterinary Therapy XII, Small Animal Practice.* Philadelphia, Pa. W.B. Saunders. 1995.
3. Longley L. *Anaesthesia of Exotic Pets.* Philadelphia, Pa. W.B. Saunders. 2008.

AVIAN SPECIES

The following information outlines recommended injection sites, considerations for the use of premedications, and induction techniques for avian species.

Recommended Injection Sites for Avian Species

	Injection and Catheter Sites	Use	Comments
Avian Species	IV: Ulnar (basilic, brachial), medial metatarsal (caudal tibial), right jugular IM: Pectoral muscles recommended IO: Distal ulna (birds > 500 grams), proximal tibiatarsus (birds < 500 grams)	IV: Medication administration, catheterization (not jugular) IM: Medication administration IO: Medication administration, catheterization	Ulnar (basilic, brachial) is located near elbow on ventral aspect of wing. Use for birds over 150 grams. Hematoma forms easily—apply pressure for 2 to 3 minutes postvenipuncture. Medial metatarsal is located on medial aspect of proximal metatarsus. Jugular (right side)–extend neck and part or wet feathers to visualize. This is the easiest vein to access in small birds. Hematoma forms easily—apply pressure for 2 to 3 minutes postvenipuncture. Take care to not occlude the trachea. Birds often attempt to damage catheters. When a catheter is placed, secure it well with sutures and/or tape and a dressing. **IO access sites:** ■ Distal ulna: Flex carpus. Identify dorsal condyle of distal ulna, insert needle just behind it. Direct needle under dorsal condyle and proximally into ulnar shaft. ■ Proximal tibiatarsus: Identify cranial cnemial crest of proximal tibiatarsus between and just distal to the femoral condyles. Direct needle into the tibial plateau just posterior to cnemial crest and distally into marrow cavity. ■ Radiographs (2 views) are helpful to access correct IO placement.

Premedication is recommended for most birds. Although some practitioners do not routinely use premedications in birds, they are recommended as they calm, improve handling, reduce the amount of induction and maintenance agents needed, smoothe recovery, reduce vagal effects and may prolong analgesia. Premedication is optimal if it can be performed without causing excess stress. See species-specific recommendations noted in the individual anesthetic protocols that follow.

When mask anesthetic induction is used, birds often hold their breath. In birds, deep, rapid respiration occurs after "breath holding," leading to rapid uptake and anesthetic overdose. Use low induction concentrations of inhalant anesthesia–do not exceed 5% sevoflurane. Use small masks and monitor for apnea.

Suggested reading for catheter and injection sites in avian species:

1. Heard D (ed). Analgesia and anesthesia. *Vet Clin North Am Exotic Anim Pract.* 2001. Jan; 4(1).
2. Bonagura, JD (ed). *Kirk's Current Veterinary Therapy XII, Small Animal Practice.* Philadelphia, Pa. W.B. Saunders. 1995.
3. *Manual of Psittacine Birds*. British Small Animal Veterinary Association. Ames, Iowa. Iowa State University Press. 1996.
4. Longley L. *Anaesthesia of Exotic Pets*. London, England. W.B. Saunders. 2008.

ANESTHETIC MONITORING

Careful and continual patient monitoring is an absolute requirement of quality care during anesthesia and can be the difference between a sucesssful procedure and one that ends in severe complications or even death. Monitoring should be performed continually through induction, anesthesia and recovery. This includes anesthetic depth, cardiopulmonary status (ECG, BP, pulse oximetry, end-tidal CO_2), temperature, and hydration status as much as is allowed by patient size.

Routine monitoring methods are useful in larger rabbits, ferrets, guinea pigs, chinchillas, reptiles and avian species. Pulse oximetry, ECG, and BP or end-tidal CO_2 monitoring can be used in larger patients. However, end-tidal CO_2 may not be accurate and adds considerable dead space to the breathing circuit if used in patients under 2 kilograms. Pulse oximetry and ECG monitoring can be used on most patients with some equipment modification. However, some monitors cannot read the rapid heart rate of small mammals and pulse oximetry provides variable results in birds, making careful manual monitoring imperative.

Pulse oximetry probes are useful on ears, tongue, tail, and feet/toes. Rectal pulse oximetry probes are appropriate for ferrets, rabbits and larger rodents. Rectal probes can

be used in the cloacas of some reptiles. Oxygen saturation below 94% indicates hypoxemia; take immediate steps to correct it. Be aware that pulse oximetry monitors have variable sensitivity in avian species. They should be used as an adjunct to manual monitoring and can show trends in oxygenation, but should not be relied upon as a primary monitoring tool in birds. Probes can be placed in the cloaca or on the tongue of some larger birds.

ECG leads can be attached directly to the skin, to paper clips placed on skin folds, stainless steel sutures placed in the skin, or small 25-gauge needles placed just into the skin. However, do not waste anesthetic time placing sutures, paper clips, or needles if regular ECG leads will work. If the leads are too tight for delicate skin, loosen them before use. Triangulate the heart for the best reading. Use contact gel rather than alcohol-based contact solutions. Additionally, some ECG monitors have plastic ECG clips that are less traumatic for delicate skin.

Blood pressure can be monitored in rabbits, ferrets, larger birds, and some larger chinchillas.

Manual monitoring techniques are important in exotic patients. During anesthesia, pulse rate and character can be expected to decrease by roughly 20% compared to awake resting rates. If they fall below this range, reduce the anesthetic concentration being used. Respirations should be slow, regular and stable.

Monitor respiration carefully. Most exotic patients are extremely sensitive to even brief periods of apnea or hypoxemia. Small airways and endotracheal tubes are prone to obstruction with respiratory secretions (See page 129 for more information on reptiles). Chest wall and rebreathing bag movement as well as condensation and clearing of the face mask/endotracheal tubing aid in the evaluation of respiratory rate and effort. Increased respiratory effort or abnormal respiratory sounds (squeaking, wheezing, unexpected silence) are indictors of impending airway obstruction. **Rabbits, guinea pigs, and chinchillas are especially at risk for respiratory obstruction due to excess salivation during mask delivery of anesthetic gases. Birds are at risk of endotracheal tube obstruction due to the relatively thick respiratory secretions of some species.**

Maintenance and measurement of body temperature is imperative. Small patients can lose as much as 10°F in 15 minutes (See *Exotic Patient Anesthesia Monitoring Form,* pages 152-153).

Loss of response to a toe pinch indicates a surgical anesthetic plane has been reached. Blink response is not a reliable indictor of anesthetic depth in all exotic patients. Blink response may be impossible (snakes) or difficult to access in reptiles and very small patients. Rabbits especially may exhibit a variable blink response even at deeper planes of anesthesia.

Corneal response varies from species to species. Loss of a previously present corneal response is an indicator of excessive anesthetic depth; anesthetic concentration should be decreased.

Prevent hypoglycemia. If hypoglycemia is present or suspected, warm fluids with 2.5% dextrose should be given, preferably IV. If this route is not available, fluid can be given IO or SC, but absorption time lags significantly for SC administration. Additionally, some consider SC dextrose administration concerning in patients with concurrent infections.

Minimize blood and body fluid losses and provide maintenance and replacement fluids as needed. Avoid hypovolemia by administering fluids at a rate of 5 to 10 mL/kg/hr.

ANESTHETIC INDUCTION AND MAINTENANCE

Induction

The goal of induction is a smooth transition into unconsciousness and to allow placement of an endotracheal tube if possible. Tracheal intubation is optimal. However, it is not routinely recommended in all species due to the difficulty and potential to inflict life-threatening laryngeal injury in some species (especially rabbits and rodents). See individual species protocols for induction medications and doses.

- Compromised patients should receive at least 1/4 of their hourly fluid requirement volume **before** premedications are given whenever possible.
- **Reptiles:** Reptiles should be intubated whenever possible. Assisted ventilation is recommended (via endotracheal tube) in anesthetized reptiles as they are prone to respiratory depression during anesthesia, especially when induced with propofol (See page 129 for more information on reptiles).
- **Do not exceed 5% sevoflurane for mask induction. Provide oxygen at 2 L/minute.**
- Avoid the stress of struggling. Use a sedative dose of ketamine, midazolam, or Telazol® depending on species (See individual protocols).
- Pre-oxygenation is recommended if it can be performed without stress (except in most reptiles).
- Rabbits: Intubation is optimal when it can be performed without causing laryngeal irritation or trauma. (Rabbits are especially prone to laryngeal trauma. See *Technique for Intranasal Intubation of Rabbits*, page 128). Nasal intubation is strongly recommended when unable to perform tracheal intubation.
- Minimal injectable volume of Telazol® is 0.1 mL. If the patient's needed dose will be a smaller volume than 0.1 mL, dilute to at least 0.1 mL total volume in sterile water before injection (See below).

Example Telazol® dilution:

- Patient needs 5 mg Telazol®. Telazol® is 100 mg/mL, so 5 mg would be 0.05 mL. Minimal desired volume is 0.1 mL/dose (mL/100 mg x 5 mg = 0.05 mL).
- Draw up 0.1 mL of 100 mg/mL Telazol® in a TB syringe and 0.1 mL of sterile water in a separate TB syringe.
- Using a third TB syringe with the capped needle detached and the plunge partially pulled out, add the Telazol® and the sterile water into the third TB syringe through the needle attachment opening. Replace the capped needle firmly. Mix well by flicking the syringe multiple times. This results in a diluted Telazol® solution of 50 mg/mL (a 1:2 dilution). 5 mg of a 50 mg/mL solution (mL/50 mg x 5 mg) = 0.1 mL per dose. Depress plunger to eject excess air and solution until desired amount, in this case, 0.1 mL.

When mask anesthetic induction is used, small patients often hold their breath. In mammals and birds, deep, rapid respiration occurs after "breath holding," leading to rapid uptake and anesthetic overdose. Use low induction concentrations of inhalant anesthesia–do not exceed 5% sevoflurane. Use small masks and monitor for apnea. Reptiles can be resistant to mask induction, with some species being nearly impossible to induce by mask alone (especially turtles/tortoises and aquatic species).

Tracheal tube sizes of 2 to 3 mm are useful in larger patients (> 2 lbs). Smaller patients may require specialty tubes available from exotic anesthesia specialty manufacturers (such as Cook's Veterinary Products). For very small patients, 18-gauge IV catheters with the needle stylet removed or red rubber feeding tubes with opened ends and homemade adaptors can sometimes be substituted. Tube tie-ins (gauze or tape strips, IV line or latex tubing) should be attached to these small tubes before intubation. A very small amount of lidocaine gel (endotracheal tube lubricant) should facilitate tube placement. Use small amounts of lidocaine gel; lidocaine toxicity is possible in small patients.

Maintenance

Maintenance of small mammals is very similar to that of dogs and cats. Careful and continual patient monitoring is an absolute requirement of quality care during anesthesia and can be the difference between a successful procedure and one that ends in severe complications or even death (See *Anesthetic Monitoring*, page 131). Protective eye ointment should be used. Body temperature must be maintained during induction, anesthesia and through recovery. Perform anesthesia in a warm immediate environment and keep surgical and anesthetic time to a minimum. Heat is easily lost through exposed extremities–cover them (See *Preanesthetic Preparation*, page 125).

Special note: If glycopyrrolate is used as a premedication, atropine administration for treatment of bradycardia during anesthesia must be adjusted accordingly. **Give 1/4 to 1/2 the usual** atropine dose in such cases. Remember that glycopyrrolate is a better anticholinergic choice in rabbits.

POSTOPERATIVE CARE

Monitor respiratory function carefully, as obstruction can easily occur before the patient is fully awake. For reptiles and birds, it is especially important to minimize orthostatic hypotension by maintaining the patient in a natural body plane (horizontal and sternal for reptiles and mammals, horizontal and lateral for birds) and by performing changes in body position slowly.

Recover exotic patients in a warm environment—an incubator is ideal. Dry areas of wet hair or skin to decrease conductive heat loss. Maintain support of cardiovascular and pulmonary function and monitor body temperature until patient is fully recovered. As with dogs and cats, this includes supplemental heat and fluid support until the patient is able to swallow, sit sternal and is at normal body temperature. Mammals (except for chinchillas and some rabbits) and avian species may benefit from warm ambient or cage temperatures of 68°F to 77°F during the first 24 hours post-anesthesia. Keep chinchillas below 75°F (optimal: 68°F to 72°F) as they easily become over-heated. Monitor chinchillas and rabbits carefully when providing supplemental warmth; both species are prone to heat stress. Reptiles benefit from slightly higher ambient temperatures (77°F to 86°F for temperate and aquatic reptiles, 86°F for tropical reptiles). Be sure to avoid hyperthermia in all species.

Continue fluid support, as drinking may be decreased during this period. Continue to provide postoperative analgesia. Monitor and record vitals in the medical record as with dogs and cats.

Postoperative pain control

Exotic patients benefit from analgesics just as dogs and cats do. Lethargy, anorexia and self-mutilation may occur if postsurgical pain is not controlled. Small mammals, especially rabbits, are very reactive to pain; pain control is strongly recommended. Most anesthesiologists recommend pre-emptive analgesia, including local blocks where appropriate. Analgesia given before the onset of pain or before recovery from anesthesia is thought to be most effective. Recovery is improved if pre-emptive as well as postsurgical analgesia is provided.

The duration of opioid analgesia can vary greatly by species and by individual. For instance, some patients may need repeat dosing of butorphanol as often as every one to two hours, while others may need it every 12 to 24 hours. Monitor all recovering patients frequently for pain or excess sedation. Multimodal pain control (*i.e.*, an opioid plus an NSAID) generally provides better analgesia than one drug alone. However, NSAIDs may not be the right choice for every individual; use them as appropriate for each patient.

Analgesic Drug Doses for Exotic Patients

Pain Management	Butorphanol	Buprenorphine	Meloxicam	Carprofen
Ferret	0.1-0.5 mg/kg q 2-4 hrs IM, SC	0.01-0.03 mg/kg IM, SC q 8-12 hrs		1 mg/kg PO q 12-24 hrs
Rabbit	0.1-1 mg/kg q 2-4 hrs IM, SC	0.01-0.05 mg/kg IM, SC q 6-12 hrs	0.1-0.2 mg/kg PO q 24 hrs	1-2.2 mg/kg PO, SC q 12 hrs
Mouse, Gerbil, Hamster	2 mg/kg q 2-4 hrs SC	0.05-0.1 mg/kg SC q 6-12 hrs		
Guinea Pig, Chinchilla	1-2 mg/kg q 4 hrs SC	0.05 mg/kg SC q 8-12 hrs		1-2 mg/kg PO q 12-24 hrs
Rat	2 mg/kg q 2-4 hrs SC	0.05-0.1 mg/kg SC q 6-12 hrs	0.2 mg/kg PO, SC q 24 hrs	
Hedgehog	0.2 mg/kg q 6-8 hrs SC	0.01-0.5 mg/kg SC, IM q 6-12 hrs		
Reptile	1 mg/kg q 12-24 hrs IM	0.01 mg/kg IM (best), SC q 24 hrs	0.1 mg/kg IM (best), SC q 24 hrs	1-4 mg/kg PO, SC, IM, IV q 24 hrs one time; followed with half dose q 24-72 hrs if needed.
Avian	1 mg/kg q 24 hrs IM	0.01-0.05 mg/kg IM q 8-12 hrs	0.1-0.2 mg/kg PO, IM q 24 hrs	1-2 mg/kg PO, IM, SC, IV q 12-24 hrs

Note on individual protocols: Each patient should be treated as unique—differences between species, breeds, strains and individuals exist. This individuality influences which anesthetic drugs are appropriate, and whether mask, tracheal or injectable anesthesia maintenance is best.

Inhalant anesthesia via an endotracheal tube is the first choice if reasonably possible. In some species, tracheal intubation is difficult (guinea pigs/rabbits) or impractical (very small patients). Multiple attempts at intubation should be avoided as laryngeal edema and subsequent respiratory obstruction can occur. Rabbits are especially prone to laryngeal edema or airway spasm if repeated attempts are made at tracheal intubation.

Mask maintenance is appropriate when an endotracheal tube (or nasal tube for rabbits) is not in place, but great care must be taken to decrease the risk of respiratory obstruction or possible aspiration of gastrointestinal tract contents. The head and neck of exotic patients can be slightly raised to reduce the potential for aspiration in susceptible species. Positioning reptiles and small mammals with the head and neck extended, tongue pulled out, and in sternal recumbency will reduce the potential for obstruction. Birds should be placed lateral recumbency as a first choice to prevent body weight from inhibiting normal thoracic movement. Prolonged dorsal recumbency, and to a greater extent, ventral recumbency, can reduce avian ventilation. Guinea pigs and rabbits may benefit from having the front half of the body raised slightly to reduce pressure of abdominal organs on the diaphragm. Reptiles can be resistant to mask induction, with some species being nearly impossible to induce by mask alone (especially turtles/tortoises and aquatic species).

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EMERGENCY DRUGS: QUICK REFERENCE CHART FOR EXOTIC ANIMALS

Jack Kottwitz, DVM and Susan Kelleher, DVM

The effective use of appropriate drugs during an emergency situation can mean the difference between life and death for exotic patients. This chart was developed to compile information that is widely scattered throughout the literature and provide accurate doses of emergency drugs for exotic species commonly encountered in a private practice.

The chart has combined two different formats: 1) specific doses for the veterinarian to calculate and administer in precise amounts, and 2) drug volumes pre-calculated (at the highest dose in a given dose range) for incrementally increasing weights of individual species. This format allows for easy tracking of necessary drug doses by technical staff during anesthesia and can lessen the burden of the veterinarian in the event of an emergency.

Because the highest dose and general weight range were used for the pre-calculated portion of the chart, caution is advised. For multiple administrations of specific drugs, doses should be accurately calculated to prevent a potentially fatal overdose.

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Rabbits

Drug/Strength	Dosage/Route	0.25 kg	0.5 kg	0.75 kg	1 kg	1.5 kg	2 kg	2.5 kg	3 kg	3.5 kg	4 kg	5 kg	6 kg
Epinephrine (1 mg/mL = 1:1000)	0.2-1 mg/kg IV, IM, IO	0.25	0.5	0.75	1	1.5	2	2.5	3	3.5	4	5.0	6
Atropine* (0.54 mg/mL)	0.1-0.5 mg/kg IM, SC	0.2	0.5	0.7	0.9	1.4	1.9	2.3	2.8	3.2	3.7	4.6	5.6
Glycopyrrolate (0.2 mg/mL)	0.02 mg/kg SC, IM	0.03	0.05	0.08	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.5	0.6
Dexamethasone (NaSP) (4 mg/mL)	2 mg/kg IV, IM (use with caution)	0.13	0.25	0.38	0.5	0.75	1	1.25	1.5	1.75	2	2.5	3
Doxapram (20 mg/mL)	2-5 mg/kg SC, IV, q15 min	0.06	0.13	0.19	0.25	0.38	0.5	0.63	0.75	0.9	1	1.3	1.5
Diazepam (5 mg/mL)	1-3 mg/kg IM, IV, IO	0.15	0.3	0.45	0.6	0.9	1.2	1.5	1.8	2.1	2.4	3	3.6
Midazolam (1 mg/mL)	0.5-2 mg/kg IM, IV, intranasally	0.5	1	1.5	2	3	4	5	6	7	8	10	12
Furosemide (50 mg/mL)	1-4 mg/kg SC, IM, IV, q 4-6 hrs	0.02	0.04	0.06	0.08	0.12	0.16	0.2	0.24	0.28	0.32	0.4	0.48
Fluids (LRS, 0.9% saline)	50-100 mL/kg/day IV, IO, SC	25	50	75	100	150	200	250	300	350	400	500	600

*Atropine is effective in rabbits, but a higher dosage than other species and more frequent re-dosing is necessary because of the atropinase enzyme.

Ferrets

Drug/Strength	Dosage/Route	0.25 kg	0.5 kg	0.6 kg	0.7 kg	0.8 kg	0.9 kg	1 kg	1.2 kg	1.4 kg	1.6 kg	1.8 kg	2 kg
Epinephrine* (1 mg/mL = 1:1000)	0.02-0.2 mg/kg IV, IM	0.05	0.1	0.12	0.14	0.16	0.18	0.2	0.24	0.28	0.32	0.36	0.4
Atropine (0.54 mg/mL)	0.02-0.055 mg/kg IV, IM, SC	0.03	0.05	0.06	0.07	0.08	0.09	0.1	0.12	0.14	0.16	0.18	0.2
Glycopyrrolate (0.2 mg/mL)	0.01 mg/kg IM	0.01	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.07	0.08	0.09	0.1
Dexamethasone (NaSP) (4 mg/mL)	4-8 mg/kg IV, IM	0.5	1	1.2	1.4	1.6	1.8	2	2.4	2.8	3.2	3.6	4
Doxapram (20 mg/mL)	1-2 mg/kg SC, IV, q15 min	0.03	0.05	0.06	0.07	0.08	0.09	0.1	0.12	0.14	0.16	0.18	0.2
Diazepam (5 mg/mL)	1-2 mg/kg IM, IV, IO, intranasally, rectally	0.1	0.2	0.24	0.28	0.32	0.36	0.4	0.48	0.56	0.64	0.72	0.8
Midazolam (1 mg/mL)	0.5-1 mg/kg IM, IV, SC	0.25	0.5	0.6	0.7	0.8	0.9	1	1.2	1.4	0.6	1.8	2
Furosemide (50 mg/mL)	2-4 mg/kg SC, IM, IV, q4-6h	0.02	0.04	0.05	0.06	0.06	0.07	0.08	0.1	0.11	0.13	0.14	0.16
Diphenhydramine (50 mg/mL)	1-2 mg/kg IM, IV	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.06	0.06	0.07	0.08
Fluids (LRS, 0.9% saline)	70 mL/kg/day IV, SC	17.5	35	42	49	56	63	70	84	98	112	126	140

*Use lower dose of epinephrine for anaphylaxis. Use with caution if concurrent administration of diphenhydramine.

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Birds (PSITTACINES)

Drug/Strength	Dosage/Route	0.05 kg	0.1 kg	0.2 kg	0.3 kg	0.4 kg	0.5 kg	0.6 kg	0.7 kg	0.8 kg	0.9 kg	1 kg	1.5 kg
Epinephrine (1 mg/mL = 1:1000)	0.5-1 mg/kg IV, IM, IO, intrathoracic	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	1.5
Atropine (0.54 mg/mL)	0.5 mg/kg IM, SC	0.05	0.09	0.19	0.28	0.37	0.46	0.56	0.65	0.74	0.83	0.93	1.4
Doxapram (20 mg/mL)	20 mg/kg IM, IV, IO	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	1.5
Dexamethasone (NaSP) (4 mg/mL)	2-4 mg/kg IV, IM	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	1.5
Ca-gluconate (100 mg/mL)	50-100 mg/kg IV slowly or IM	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	1.5
Diazepam (5 mg/mL)	0.5-1 mg/kg IM, IV, IO	0.01	0.02	0.04	0.06	0.08	0.1	0.12	0.14	0.16	0.18	0.2	0.3
Fluids (LRS, 0.9% saline)	50-100 mL/kg/day IV ICe, SC, IO	5	10	20	30	40	50	60	70	80	90	100	150

Chinchillas

Drug/Strength	Dosage/Route	0.25 kg	0.5 kg	0.6 kg	0.7 kg	0.8 kg	0.9 kg	1 kg	1.2 kg	1.4 kg	1.6 kg	1.8 kg	2 kg
Epinephrine* (0.1 mg/mL)	0.003 mg/kg* IV, IM, IO	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.06
Atropine (0.54 mg/mL)	0.2 mg/kg IV, IM, SC	0.09	0.19	0.22	0.26	0.3	0.33	0.37	0.44	0.52	0.59	0.67	0.74
Glycopyrrolate (0.2 mg/mL)	0.01-0.02 mg/kg SC, IM	0.03	0.05	0.06	0.07	0.08	0.09	0.1	0.12	0.14	0.16	0.18	0.2
Dexamethasone (NaSP) (4 mg/mL)	4-5 mg/kg IV, IM, SC	0.31	0.63	0.75	0.88	1	1.13	1.25	1.5	1.75	2	2.3	2.5
Doxapram (20 mg/mL)	5-10 mg/kg SC, IV, q15 min	0.13	0.25	0.3	0.35	0.4	0.45	0.5	0.6	0.7	0.8	0.9	1
Diazepam (5 mg/mL)	0.5-3 mg/kg IM, IV, IO, intranasally, rectally	0.15	0.3	0.36	0.42	0.48	0.54	0.6	0.72	0.84	0.96	1.08	1.2
Midazolam (1 mg/mL)	0.5-1 mg/kg IM, IV	0.25	0.5	0.6	0.7	0.8	0.9	1	1.2	1.4	1.6	1.8	2
Furosemide (50 mg/mL)	1-4 mg/kg SC, IM, IV, q 4-6hrs	0.02	0.04	0.05	0.06	0.06	0.07	0.08	0.1	0.11	0.13	0.14	0.16
Ca-gluconate (100 mg/mL)	100 mg/kg IP	0.25	0.5	0.6	0.7	0.8	0.9	1	1.2	1.4	1.6	1.8	2
Fluids (LRS, 0.9% saline)	50-100 mL/kg/day IV, IO, SC	25	50	60	70	80	90	100	120	140	160	180	200

*Dilute standard concentration epinephrine 10x to 0.1 mg/mL for use in chinchillas.

Rodents and Guinea Pigs

Drug/Strength	Dosage/Route	0.05	0.075 kg	0.1 kg	0.2 kg	0.3 kg	0.4 kg	0.5 kg	0.6 kg	0.7 kg	0.8 kg	0.9 kg	1 kg
Epinephrine* (0.01 mg/mL)	0.003 mg/kg* IV, IM, IO	0.02	0.02	0.03	0.06	0.09	0.12	0.15	0.18	0.21	0.24	0.27	0.3
Atropine† (0.54 mg/mL)	0.05-0.4 mg/kg IM, SC	0.04	0.06	0.07	0.15	0.22	0.3	0.37	0.44	0.52	0.59	0.67	0.74
Glycopyrrolate (0.2 mg/mL)	0.01-0.02 mg/kg SC, IM	0.01	0.01	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.1
Dexamethasone (NaSP) (4 mg/mL)	4-5 mg/kg IV, IM	0.06	0.09	0.13	0.25	0.38	0.5	0.63	0.75	0.88	1	1.13	1.25
Doxapram (20 mg/mL)	5-10 mg/kg SC, IV, q15 min	0.03	0.04	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
Diazepam†† (5 mg/mL)	0.5-3.0 mg//kg IM, IV, IO, intranasally	0.03	0.05	0.06	0.12	0.18	0.24	0.3	0.36	0.42	0.48	0.54	0.6
Midazolam (1 mg/mL)	0.5-1 mg/kg IM, IV	0.05	0.08	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Furosemide** (5 mg/mL)	1-4 mg/kg** SC, IM, IV, q 4-6hrs	0.04	0.06	0.08	0.16	0.24	0.32	0.4	0.48	0.56	0.64	0.72	0.8
Fluids (LRS, 0.9% saline)	50-100 mL/kg/day IV, IO, SC	5	7.5	10	20	30	40	50	60	70	80	90	100

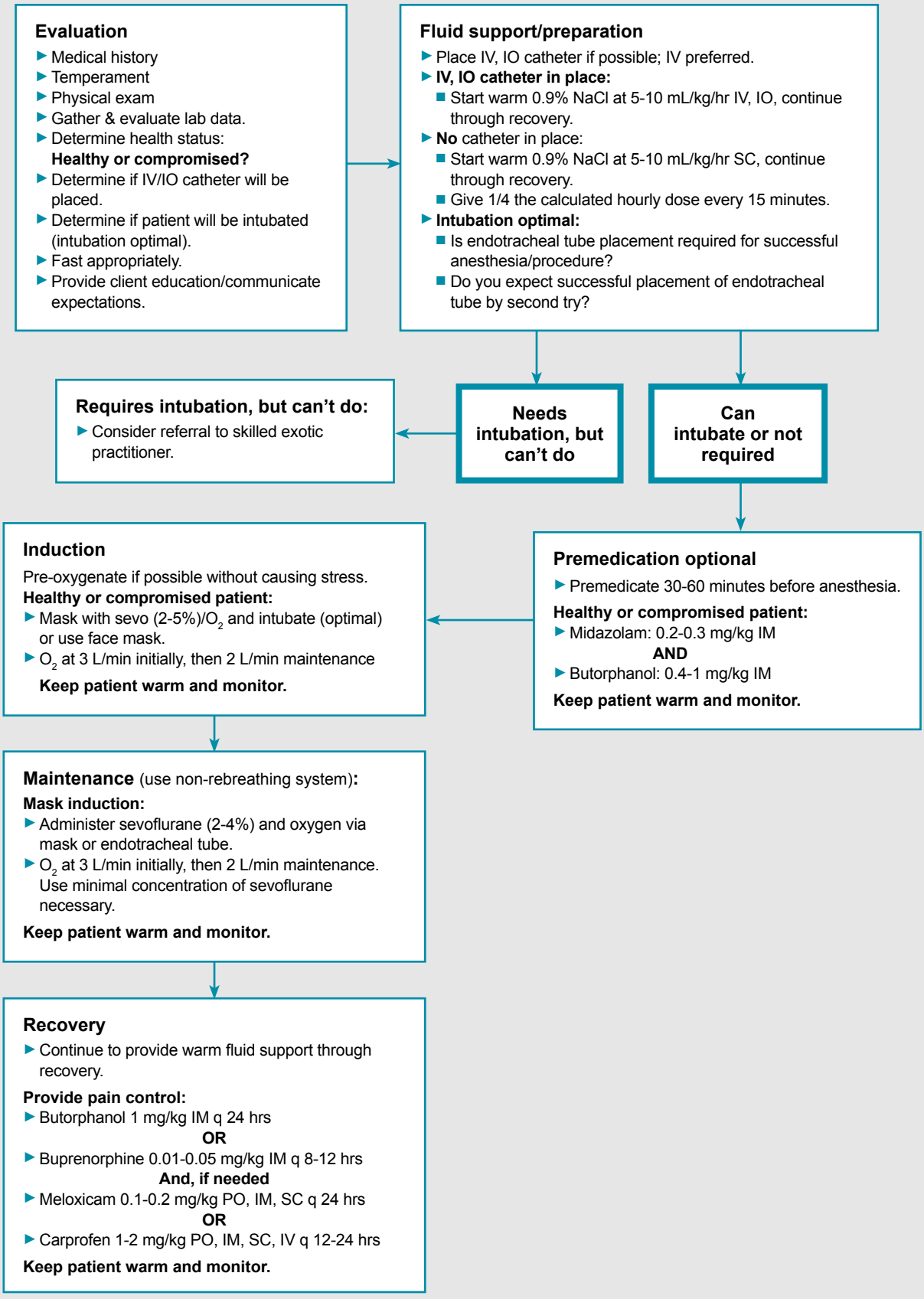
* Dilute standard concentration epinephrine 100x to 0.01 mg/mL for use in rodents.
** Dilute standard concentration furosemide 10x to 5 mg/mL for use in rodents.
† Guinea pigs' atropine dosage is 0.2 mg/kg. Some rats have atropinase.
†† Diazepam is used for seizures and intense pruritus. The lower dosage should be used for pruritus.

Reptiles

Drug/Strength	Dosage/Route	0.1 kg	0.3 kg	0.5 kg	0.75 kg	1 kg	2 kg	3 kg	4 kg	5 kg	6 kg	7 kg	8 kg
Atropine (0.54 mg/mL)	0.01-0.04 mg/kg IV, IM, SC	0.01	0.02	0.04	0.06	0.07	0.15	0.22	0.3	0.37	0.44	0.52	0.59
Glycopyrrolate (0.2 mg/mL)	0.01 mg/kg IM, IV	0.01	0.02	0.03	0.04	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4
Dexamethasone (NaSP) (4 mg/mL)	0.1-0.25 mg/kg IV, IM	0.01	0.02	0.03	0.05	0.06	0.13	0.19	0.25	0.31	0.38	0.44	0.5
Diazepam (5 mg/mL)	2.5 mg/kg IM, IV	0.05	0.15	0.25	0.38	0.5	1	1.5	2	2.5	3	3.5	4
Ca-gluconate (100 mg/mL)	100 mg/kg IV (slowly), IM, ICe	0.1	0.3	0.5	0.75	1	2	3	4	5	6	7	8
Fluids* (Reptile fluid solution)	10-25 mL/kg/day IV, IO, SC, ICe	2.5	7.5	12.5	18.75	25	50	75	100	125	150	175	200

*Reptile fluid solution: 1 part LRS, 2 parts 2.5% dextrose/0.45% NaCl, OR 1 part 5% dextrose in NaCl and 1 part 0.9% NaCl

Avian Species Anesthesia Protocol



AVIAN SPECIES ANESTHESIA PROTOCOL

(See *Anesthetic Considerations for Small Exotic Patients,* pages 123 to 137, before proceeding.)

- Consider all avian species as high-risk patients.
- Keep restraint time to a minimum. Stressful restraint and handling can cause death.
- Address life-threatening emergencies immediately. Delay further procedures until patient is stabilized.
- Birds are particularly susceptible to body heat loss; use a warming blanket (forced air/conductive polymer), radiant heat source (heat lamp at safe distance), elevated ambient temperature (incubator). Use caution to avoid burns or over-heating.
- **Intubation is optimal.** Positive pressure ventilation may be needed to prevent hypoxia during inhalant anesthesia. An appropriate mouth gag can be used to prevent tube "bite-through."
- Use non-cuffed endotracheal tubes or do not inflate cuffs if they exist. The tracheal mucosa is fragile and the complete tracheal rings of birds do not allow for significant expansion.
- Do not exceed 10 cm of water pressure during assisted ventilation. Mimic "awake" respiratory rate and depth.
- If unable to place endotracheal tube but intubation is required (such as respiratory compromise, surgery that will compromise airway, anesthesia time > 30 minutes expected), refer patient to skilled exotic practitioner.
- Pulse oximetry has variable usefulness in birds—attempt its use to track oxygenation trends, but don't rely on it as heavily as done with mammalian patients.
- Provide supplemental oxygen throughout induction, anesthesia and recovery.

Equipment and supplies: Face mask or intubation supplies (including lidocaine gel), non-rebreathing circuit, IV, IO catheter supplies, 0.9% NaCl (SC, IV, IO), supplemental heat source, monitoring equipment

Evaluation: History, physical exam, laboratory data (including uric acid), health status, determination if intubation required, client education

Preanesthetic preparation: Fast appropriately (small birds: four to six hrs; large birds: eight to 12 hrs), withhold water 0 to two hrs, IV, IO catheterization optimal (may need placement after induction), start fluid support at 5 to 10 mL/kg/hr (IV preferred)

Premedications

Use is optional. Generally calms induction/recovery, but may also cause delayed recovery in some cases. Administer 30 to 60 minutes before induction.

Healthy or compromised patient:

- Midazolam 0.2 to 0.3 mg/kg IM

AND

- Butorphanol 0.4 to 1 mg/kg IM

Induction

Pre-oxygenate (before induction) if possible without causing stress, then mask with sevoflurane/O_2. Intubation is optimal.

Maintenance: Deliver sevoflurane/O_2 via mask/endotracheal tube to effect, maintain body temperature, monitor, provide fluid support and supplemental oxygen.

Recovery: Maintain heat and fluid support.

Pain control:

- Butorphanol 1 mg/kg IM q 24 hrs

OR

- Buprenorphine 0.01-0.05 mg/kg IM q 8-12 hrs

And, if needed

- Meloxicam 0.1-0.2 mg/kg PO, IM, SC q 24 hrs

OR

- Carprofen 1-2 mg/kg PO, IM, SC, IV q 12-24 hrs

Dosages are suggested guidelines only—tailor actual amounts to individual patient needs.

Reptile Anesthesia Protocol

Evaluation
- Medical history
- Temperament
- Physical exam
- Gather & evaluate lab data.
- Determine health status: **Healthy or compromised?**
- Determine if IV, IO catheter will be placed.
- Determine if patient will be intubated (intubation optimal).
- Fast appropriately.
- Provide client education/communicate expectations.

Fluid support/preparation
- Place IV, IO catheter if possible.
- **IV, IO catheter in place:**
  - Start warm 0.9% NaCl at 5 mL/kg/hr IV, IO, continue through recovery.
- **No catheter in place:**
  - Start warm 0.9% NaCl at 5 mL/kg/hr intracoelomic (ICe), SC, continue through recovery.
  - Give 1/4 calculated hourly dose every 15 minutes.
- **Intubation strongly recommended**
  - Is endotracheal tube required for successful anesthesia/procedure?
  - Do you expect successful placement of endotracheal tube upon induction?
  - Reptiles usually need positive pressure ventilation (PPV), via an endotracheal tube, to prevent hypoxemia during anesthesia.

Needs intubation, but can't do

Requires intubation, but can't do:
- Consider referral to skilled exotic practitioner.

Can intubate

Premedicate 30-60 minutes before anesthesia:
Healthy or compromised patient:
- Midazolam 1 mg/kg IM

AND
- Butorphanol 1 mg/kg IM

Keep patient warm and monitor.

Yes IV, IO catheter

No IV, IO catheter

Induction (IV, IO catheter in place):
Healthy or compromised patient:
- Propofol 3-5 mg/kg IV, IO slowly to effect.
  - Give slowly in small boluses to reduce apnea.
  - Monitor for apnea.

Intubation strongly recommended (otherwise use face mask).
- Reptiles usually need PPV to prevent hypoxemia during anesthesia.

Keep patient warm and monitor.

Induction (No catheter in place):
Healthy patient:
- Attempt mask induction with sevoflurane (2-4%)/O_2 (first choice) or give ketamine 5-10 mg/kg IM, then mask with sevoflurane (1-4%)/O_2.
- O_2 at 3 L/minute initially, then 2 L/min for maintenance.
- Some reptiles can hold their breath for extended periods so mask induction not always an option.

Compromised patient:
- Mask with sevoflurane (2-5%)/O_2 (best choice).
- If struggling or significantly holding breath, give 5 mg/kg ketamine IM, then mask with sevoflurane (1-4%)/O_2 if needed.
- O_2 at 3 L/min initially, then 2 L/minute for maintenance
- Ketamine can cause prolonged recovery times in debilitated reptiles.
- Some reptiles can hold their breath for extended periods; mask induction not always an option.

Intubation strongly recommended (otherwise use face mask).
- Reptiles usually need PPV to prevent hypoxemia during anesthesia.

Keep patient warm and monitor.

Maintenance (use non-rebreathing system):
Propofol/mask induction:
- Administer sevoflurane (2-4%) oxygen via endotracheal tube (by mask if not intubated).
- Use minimal concentration of sevoflurane necessary.
- If intubated, ventilate at 2-6 bpm and don't exceed 10-12 cm water pressure.

Ketamine induction:
- Provide supplemental O_2 via endotracheal tube (mask if not intubated).
- Add sevoflurane at 1-4% as needed to maintain desired anesthetic plane.
- Use minimal concentration of sevoflurane necessary.
- If intubated, ventilate at 2-6 bpm and don't exceed 10-12 cm water pressure.

Keep patient warm and monitor.

Recovery
- Continue to provide warm fluid support through recovery.

Provide pain control:
- Butorphanol 1 mg/kg IM (best), SC q 12-24 hrs

OR
- Buprenorphine 0.01 mg/kg IM (best), SC q 24 hrs

And, if needed
- Carprofen 1-4 mg/kg PO, SC, IM, IV q 24 hrs one time; followed with half dose q 24-72 hrs if needed

OR
- Meloxicam 0.1 mg/kg IM (best), SC q 24 hrs

Keep patient warm and monitor.

REPTILE ANESTHESIA PROTOCOL

(See *Anesthetic Considerations for Small Exotic Patients,* pages 123 to 137, before proceeding.)

- **Intubation is strongly recommended.** Positive pressure ventilation (PPV), via an endotracheal tube, is usually needed to prevent hypoxemia during inhalant anesthesia and when propofol is used in most species.
- Use non-cuffed endotracheal tubes or do not inflate cuffs if they exist. Ventilate at 2 to 6 bpm (with no more than 1 to 2 seconds inspiration time) and don't exceed 10 to 12 cm of water pressure.
- Reptiles may survive an initial hypoxemic anesthesia episode, only to die days or weeks later from hypoxic renal damage—provide proper oxygenation by performing PPV whenever possible.
- If unable to place endotracheal tube, consider referral to skilled exotic practitioner, especially for patients with respiratory compromise, surgery that will compromise airway or with anesthesia time >15 minutes expected.
- Reptile respiration is stimulated by low oxygen concentrations. Supplemental oxygenation before induction and during postoperative recovery may not be needed—room air can speed recovery in some cases.
- Provide supplemental oxygen **during induction and anesthesia.**
- Perioperative fasting is recommended to reduce visceral volume (improves tidal volume) and because digestion is impaired during anesthesia and recovery.
- IV or IO fluid administration best, intracoelomic (ICe) second best and SC is better than none. SC administration may not be adequate for correction of dehydration or blood loss in the perianesthetic period.
- Debilitated, dehydrated or chilled reptiles have prolonged absorption times for fluids given SC.
- Optimal temperatures: temperate and aquatic reptiles, 77°F to 86°F; tropical reptiles, 86°F.

Equipment and supplies: Face mask or intubation supplies (including lidocaine gel), non-rebreathing circuit, IV, IO catheter supplies, 0.9% NaCl (SC, IV, IO, ICe), supplemental heat, monitoring equipment.

Evaluation: History, physical exam, laboratory data, health status, evaluate ability to intubate, client education.

Preanesthetic preparation: Fast four to six hours (longer in large species), withhold water zero to one hr, IV, IO catheterization optimal, start fluid support at 5 mL/kg/hr (IV, IO preferred).

Premedications

30 to 60 minutes before induction

Healthy or compromised patient:

- Midazolam 1 mg/kg IM

AND

- Butorphanol 1 mg/kg IM

Induction

Healthy patient:

- Propofol 3 to 5 mg/kg IV, IO to effect. Give slowly in small boluses to reduce apnea. If no IV, IO catheter, attempt mask induction with sevoflurane/O_2 or give ketamine 5 to 10 mg/kg IM wait for effect, then mask with sevoflurane/O_2 to effect. Some reptiles (especially turtles/tortoises) can hold their breath for extended periods, so mask induction is not always an option.

Compromised patient:

- Propofol 3 to 5 mg/kg IV, IO, to effect. Give slowly in small boluses to reduce apnea. If no IV, IO catheter, attempt mask induction with sevoflurane/O_2 (best choice). If struggling or significantly holding breath, give 5 mg/kg ketamine IM, wait for effect, then mask with sevoflurane/O_2 to effect. Ketamine can cause prolonged recovery times in debilitated reptiles. Some reptiles (especially turtles/tortoises) can hold their breath for extended periods, so mask induction is not always an option.

Maintenance: Intubation strongly recommended, provide sevoflurane/O_2 via endotracheal tube to effect (or mask if no tube), maintain body temperature, monitor, give fluid support and provide supplemental oxygen during induction and anesthesia.

Recovery: Maintain heat and fluid support.

Pain control:

- Butorphanol 1 mg/kg IM (best), SC q 12-24 hrs

OR

- Buprenorphine 0.01 mg/kg IM (best), SC q 24 hrs

And, if needed

- Carprofen 1-4 mg/kg PO, SC, IM, IV q 24 hrs one time; followed with half dose q 24-72 hrs if needed

OR

- Meloxicam 0.1 mg/kg IM (best), SC q 24 hrs

Dosages are suggested guidelines only—tailor actual amounts to individual patient needs.

Ferret Anesthesia Protocol

Evaluation
- Medical history
- Temperament
- Physical exam
- Gather & evaluate lab data.
- Determine health status: **Healthy or compromised?**
- Determine if IV/IO catheter will be placed.
- Determine if patient will be intubated (intubation optimal).
- Fast appropriately.
- Provide client education/communicate expectations.

Fluid support/preparation
- Place IV, IO catheter if possible; IV preferred
- **IV, IO catheter in place:**
  - Start warm 0.9% NaCl at 5-10 mL/kg/hr IV, IO, continue through recovery.
- **No catheter in place:**
  - Start warm 0.9% NaCl at 5-10 mL/kg/hr SC, continue through recovery.
  - Give 1/4 calculated hourly dose every 15 minutes.
- **Intubation optimal** and should be attempted in adults and large juveniles.
  - Is endotracheal tube required for successful anesthesia/procedure?
  - Do you expect successful placement of endotracheal tube by second try?

Needs intubation, but can't do

Requires intubation, but can't do:
- Consider referral to skilled exotic practitioner.

Can intubate or not required

Premedications
- Premedicate 30-60 minutes before anesthesia

Healthy patient:
- Acepromazine 0.1 mg/kg IM, SC

AND
- Butorphanol 0.2 mg/kg IM, SC

Compromised patient:
- Midazolam 0.1 mg/kg IM, SC

AND
- Butorphanol 0.1-0.2 mg/kg IM, SC

Keep patient warm and monitor.

Yes IV, IO catheter

No IV, IO catheter

Induction (IV, IO catheter in place):
Healthy or compromised patient:
- Propofol 2-6 mg/kg IV, IO to effect.
- Intubation optimal, otherwise use face mask.

Keep patient warm and monitor.

Induction (No catheter in place):
Healthy patient:
- Telazol® 6 mg/kg IM, then mask w/sevoflurane (1-4%)/O_2 if needed.
- O_2 at 3-L/min initially, then 2 L/min maintenance. If initial Telazol® dose has no effect after 20 minutes, can repeat 1/4-1/2 dose of Telazol® once.

Compromised patient:
- Mask w/sevoflurane (2-4%)/O_2.
- O_2 at 3- L/min initially, then 2 L/min maintenance.
- If struggling, give additional dose of midazolam 0.5 mg/kg (first choice) IM or Telazol® 1 mg/kg IM, wait 20 min, repeat mask attempt.
- Repeat Telazol® at 1 mg/kg dose once if needed.
- Intubation optimal, otherwise use face mask.
- Use minimal concentration of sevoflurane necessary.

Keep patient warm and monitor.

Maintenance (use non-rebreathing system):
Propofol/mask induction:
- Administer sevoflurane (2-4%) and oxygen via mask or endotracheal tube.
- O_2 at 3-4 L/min initially, then 2 L/min for maintenance.
- Use minimal concentration of sevoflurane necessary.

Telazol® induction:
- Provide supplemental O_2 via mask or endotracheal tube at 3 L/min initially, then 2 L/min for maintenance.
- Add sevoflurane at 1-4% as needed to maintain desired anesthetic plane.
- Use minimal concentration of sevoflurane necessary.

Keep patient warm and monitor.

Recovery
- Continue to provide warm fluid support through recovery.

Provide pain control:
- Butorphanol 0.1-0.5 mg/kg IM, SC q 2-4 hrs

OR
- Buprenorphine 0.01-0.03 mg/kg IM, SC q 8-12 hrs

And, if needed
- Carprofen 1 mg/kg PO q 12-24 hrs, three days maximum (make sure patient is hydrated)

Keep patient warm and monitor.

FERRET ANESTHESIA PROTOCOL

(See *Anesthetic Considerations for Small Exotic Patients,* pages 123 to 137, before proceeding.)

- Use gauze strips to hold the mouth open, allowing visualization of the larynx.
- **Tracheal intubation is optimal** and should be attempted in adult and large juvenile ferrets with a 2 to 3 mm endotracheal tube. **Do not try more than twice;** repeated attempts can cause significant laryngeal edema.
- If unable to place endotracheal tube but intubation required (such as respiratory compromise, surgery that will compromise airway, anesthesia time > 30 minutes expected), refer patient to skilled exotic practitioner.
- Palpebral reflexes may be lost at a surgical anesthetic plane.
- Underlying potential disease states to consider include adrenal tumors, cardiomyopathy, anemia, hypoglycemia and endocrinopathies.
- Provide supplemental oxygen throughout induction, anesthesia and recovery.

Equipment and supplies: Face mask or intubation supplies (including lidocaine gel), non-rebreathing circuit, IV, IO catheter supplies, 0.9% NaCl, SC, IV, IO, supplemental heat source, monitoring equipment

Evaluation: History, physical exam, laboratory data, health status, determination if intubation required, client education

Preanesthetic preparation: Fast most patients four hours (don't fast patients with insulinomas), withhold water two hours, IV, IO catheterization optimal (may need to be placed after premed or induction), start fluid at 5 to 10 mL/kg/hr (IV best).

Premedications

30 to 60 minutes before induction
Healthy patient:

- Acepromazine 0.1 mg/kg IM, SC

AND

- Butorphanol 0.2 mg/kg IM, SC

Compromised patient:

- Midazolam 0.1 mg/kg IM

AND

- Butorphanol 0.1 to 0.2 mg/kg IM, SC

Induction

Pre-oxygenate (before induction) if possible without causing stress, then:
Healthy patient with IV, IO catheter:

- Propofol 2 to 6 mg/kg IV, IO to effect

Healthy patient without IV, IO catheter:

- Telazol® 6 mg/kg IM, wait for effect and mask with sevoflurane/O_2 if needed. If initial Telazol® dose has no effect after 20 minutes, can repeat 1/4 to 1/2 dose of Telazol® once.

Compromised patient with IV, IO catheter:

- Propofol 2 to 6 mg/kg IV, IO to effect

Compromised patient without IV, IO catheter:

- Mask with sevoflurane/O_2 to effect. If struggling, give additional dose of midazolam at 0.5 mg/kg (first choice) or Telazol® (second choice) 1 mg/kg IM, wait 20 minutes and mask again. Repeat Telazol® at 1 mg/kg dose once if needed.

Maintenance: O_2 /sevoflurane via mask/endotracheal tube to effect, maintain body temperature, monitor, provide fluid support and supplemental oxygen.

Recovery: maintain heat and fluid support.

Pain control:

- Butorphanol 0.1 to 0.5 mg/kg IM, SC q 2 to 4 hrs

OR

- Buprenorphine 0.01 to 0.03 mg/kg IM, SC q 8 to 12 hrs

And, if needed

- Carprofen 1 mg/kg PO q 12-24 hrs for no longer than three days total (make sure patient is hydrated)

Dosages are suggested guidelines only—tailor actual amounts to individual patient needs.

Rabbit Anesthesia Protocol

Evaluation
- Medical history
- Temperament
- Physical exam
- Gather & evaluate lab data.
- Determine health status: **Healthy or compromised?**
- Determine if IV, IO catheter will be placed.
- Determine if patient will be intubated (intubation optimal).
- Fast appropriately.
- Provide client education/communicate expectations.

Fluid support/preparation
Place IV, IO catheter if possible; IV preferred.

- **IV, IO catheter in place:**
  - Start warm 0.9% NaCl at 5-10 mL/kg/hr IV, IO, continue through recovery.
- **No catheter in place:**
  - Start warm 0.9% NaCl at 5-10 mL/kg/hr SC, continue through recovery.
  - Give 1/4 calculated hourly dose every 15 minutes.
- **Intubation optimal.** If unable to easily perform tracheal intubation (which can be difficult), nasal intubation strongly recommended.
- **Exception:**
  - Pre-existing airway compromise or procedures that require tracheal intubation to protect airway may need referral to a skilled exotic practitioner.

Needs tracheal intubation

Requires tracheal intubation:
- Consider referral to skilled exotic practitioner.

Tracheal intubation not required (use nasal)

Premedications
- Premedicate 30-60 minutes before anesthesia.

Healthy or compromised patient:
- Midazolam 0.2 mg/kg IM (can go up to 1 mg/kg midazolam if fractious).

AND
- Butorphanol 0.2 mg/kg IM

Keep patient warm and monitor.

Induction
- Pre-oxygenate if possible without causing stress.

Healthy patient:
- Ketamine 10-20 mg/kg IM, wait 20 min, perform nasal intubation. Deliver sevoflurane (1-4%)/O_2 via tube as needed.
- O_2 at 3 L/min initially, then 2 L/min maintenance.
- If unable to perform nasal intubation, can maintain via face mask w/ sevoflurane (2-4%)/O_2.
- O_2 at 3 L/min initially, then 2 L/min maintenance, but intubation preferred.

Compromised patient:
- Mask w/sevoflurane (2-4%)/O_2 to effect, perform nasal intubation.
- Deliver sevoflurane (1-4%)/O_2 via tube as needed.
- O_2 at 3 L/min initially, then 2 L/min maintenance.
- If unable to perform nasal intubation, can maintain via face mask w/sevoflurane (2-4%)/O_2.
- O_2 at 3L/min initially, then 2 L/min maintenance, but intubation preferred.
- If struggling give ketamine 10 mg/kg IM, wait 20 min, perform nasal intubation and sevoflurane/O_2 delivery as above.

Keep patient warm and monitor.

Maintenance (use non-rebreathing system):

Mask induction:
- Administer sevoflurane (2-4%) and oxygen via nasal tube (face mask if no tube).
- O_2 at 3 L/min initially, then 2 L/min for maintenance.
- Use minimal concentration of sevoflurane necessary.

Ketamine induction:
- Provide supplemental O_2 via nasal tube (face mask if no tube) at 3 L/min initially, then 2 L/min for maintenance.
- Add sevoflurane at 1-4% as needed to maintain desired anesthetic plane.
- Use minimal concentration of sevoflurane necessary.

Keep patient warm and monitor.

Recovery
- Continue to provide warm fluid support through recovery.

Provide pain control:
- Butorphanol 0.1-1.0 mg/kg IM, SC q 2–4 hrs*

OR
- Buprenorphine 0.01-0.05 mg/kg IM, SC q 6-12 hrs *

And, if needed
- Meloxicam 0.2 mg/kg PO q 24 hrs (make sure patient is hydrated)

OR
- Carprofen 1-2.2 mg/kg PO, SC q 12 hrs (make sure patient is hydrated)

* Limit to two doses to reduce potential for GI motility issues.

Keep patient warm and monitor.

RABBIT ANESTHESIA PROTOCOL

(See *Anesthetic Considerations for Small Exotic Patients,* pages 123 to 137, before proceeding.)

- Difficult to anesthetize as they are easily stressed and can injure themselves, often have underlying lung disease, are prone to respiratory depression, can be difficult to intubate, may have significant anorexia postsurgically, and have great variability in drug response between breeds and individuals.
- Excess salivation can occur and can lead to airway obstruction. Monitor respiration carefully.
- Intubation is optimal. Great care must be used—repeated attempts at tracheal intubation can cause significant laryngeal edema or spasm. Nasal intubation strongly recommended when unable to perform tracheal intubation on the first attempt or when practitioner has little experience with tracheal intubation in rabbits.
- If tracheal intubation required (such as respiratory compromise, surgery that will compromise airway, anesthesia time > 20 minutes expected), but first attempt is unsuccessful, refer patient to skilled exotic practitioner.
- Palpebral reflex is highly variable. Do not rely on it as an indicator of anesthetic depth.
- Ear pinch reflex is lost at a surgical plane of anesthesia.
- Particularly vulnerable to corneal damage from drying or mechanical trauma during anesthesia. Lubricate eyes well. Use adequate padding or place "donut" pads around eyes to prevent trauma.
- Provide oxygen throughout induction, anesthesia and recovery.
- Pulse oximetry is critical during maintenance to monitor for hypoxemia.

Equipment and supplies: Face mask and intubation supplies (including lidocaine gel), non-rebreathing circuit, 0.9% NaCl (SC, IV, IO), IV, IO catheterization supplies, supplemental heat source, monitoring equipment.

Evaluation: History, physical exam, laboratory data, health status, determination if intubation required, client education.

Preanesthetic preparation: Fast and withhold water 30 minutes (be sure mouth is clear of food/liquid before induction), IV, IO catheterization optimal (may need to be placed after premed or induction), start fluid 5 to 10 mL/kg/hr (IV best).

Premedications

30 to 60 minutes before induction

Healthy or compromised patient:

- Midazolam 0.2 mg/kg IM (can go up to 1 mg/kg midazolam if fractious)

AND

- Butorphanol 0.2 mg/kg IM

Induction

Pre-oxygenate (before induction) if possible without causing stress, then:

Healthy patient:

- Ketamine 10 to 20 mg/kg IM, wait 20 minutes, perform nasal intubation, then sevoflurane/O_2 to effect if needed.

Compromised patient:

- Mask with sevoflurane/O_2 to effect, perform nasal intubation. If struggling, give ketamine 10 mg/kg IM, wait 20 minutes, perform nasal intubation, then sevoflurane/O_2 to effect if needed.

- **Maintenance:** O_2 /sevoflurane via nasal tube to effect (face mask if no tube), maintain body temperature, monitor, provide fluid support and supplemental oxygen.

Recovery: Maintain heat and fluid support.

Pain control:

- Butorphanol 0.1-1.0 mg/kg IM, SC q 2-4 hrs*

OR

- Buprenorphine 0.01-0.05 mg/kg IM, SC q 6-12 hrs *

And, if needed

- Meloxicam 0.2 mg/kg PO q 24 hrs (make sure patient is hydrated

OR

- Carprofen 1-2.2 mg/kg PO, SC q 12 hrs (make sure patient is hydrated)

* Limit to two doses to reduce potential for GI motility issues.

Dosages are suggested guidelines only—tailor actual amounts to individual patient needs.

Guinea Pig and Chinchilla Anesthesia Protocol

Evaluation
- Medical history
- Temperament
- Physical exam
- Gather & evaluate lab data.
- Determine health status:
  Healthy or compromised?
- Determine if IV, IO catheter will be placed.
- Determine if patient will be intubated (intubation optimal).
- Fast appropriately.
- Provide client education/communicate expectations.

Fluid support/preparation
- Attempt 24-gauge IV catheter once. Can also attempt IO catheter.

Supply fluid support:
- **IV, IO catheter in place:**
  - Start warm 0.9% NaCl at 5-10 mL/kg/hr IV, IO, continue through recovery.
- **No catheter in place:**
  - Start warm 0.9% NaCl at 5-10 mL/kg/hr SC, continue through recovery. Give 1/4 calculated hourly dose every 15 minutes.
- Intubation not routinely recommended

Exception: Pre-existing airway compromise or procedures that require intubation to protect airway may need referral to a skilled exotic practitioner.

Needs intubation

Requires tracheal intubation:
- Consider referral to skilled exotic practitioner.

Intubation not required

Premedication
- Premedicate 30-60 minutes before anesthesia.

Healthy or compromised patient:

Midazolam	1 mg/kg SC
	AND
Butorphanol	0.1 mg/kg SC

Keep patient warm and monitor.

Induction
- Pre-oxygenate if possible without causing stress.

Healthy patient:
- Telazol® 5 mg/kg SC, then mask w/sevoflurane (1-4%)/O_2 if needed.
- O_2 at 3 L/min initially, then 2 L/min maintenance.
- If initial Telazol® dose has no effect after 20 minutes, can repeat 1/4-1/2 dose of Telazol® once.

Compromised patient:
- Mask w/sevoflurane (2-4%)/O_2. O_2 at 3 L/min initially, then 2 L/min maintenance.
- If struggling can give Telazol® 1 mg/kg SC, wait 20 min, repeat mask attempt.
- Repeat Telazol® at 1 mg/kg dose once if needed

Keep patient warm and monitor.

Maintenance (use non-rebreathing system):

Mask induction:
- Administer sevoflurane (2-4%) & O_2 via face mask.
- O_2 at 3 L/min initially, then 2 L/min for maintenance.
- Use minimal concentration of sevoflurane necessary.

Telazol® induction:
- Provide supplemental O_2 via face mask at 3 L/min initially, then 2 L for maintenance.
- Add sevoflurane at 1-4% as needed to maintain desired anesthetic plane.
- Use minimal concentration of sevoflurane necessary.

Keep patient warm and monitor.

Recovery
- Continue to provide warm fluid support through recovery.

Provide pain control:
- Butorphanol 1-2 mg/kg SC q 4 hrs
  OR
- Buprenorphine 0.05 mg/kg SC q 8-12 hrs
  And, if needed
- Carprofen 1-2 mg/kg PO q 12-24 hrs (make sure patient is hydrated)

Keep patient warm and monitor.

GUINEA PIG AND CHINCHILLA ANESTHESIA PROTOCOL

(See *Anesthetic Considerations for Small Exotic Patients,* pages 123 to 137, before proceeding.)

- Potential for anesthetic complication is high as these patients stress easily, are difficult to intubate, are prone to postoperative complications, and have differing drug responses per individual.
- Intubation not recommended unless surgical procedures may compromise the airway or patient is significantly compromised. If intubation required (such as respiratory compromise, surgery that will compromise airway, anesthesia time > 30 minutes expected) refer patient to skilled exotic practitioner.
- Often need to clean out mouth prior to induction; have tendency to retain food in oral cavity.
- Attempt IV catheterization in larger patients once. Use 24-gauge IV catheter in cephalic vein.
- Anticholinergics can be used if excess respiratory secretions are present.
- Ear pinch and pedal withdrawal reflexes are lost at a surgical plane of anesthesia.
- Provide oxygen throughout induction, anesthesia and recovery.

Equipment and supplies: Face mask or intubation supplies (including lidocaine gel), non-rebreathing circuit, 0.9% NaCl SC, IV, IO, supplemental heat source, monitoring equipment

Evaluation: History, physical exam, laboratory data, health status, determination if intubation required, client education

Preanesthetic prep: Fast four hours and withhold water two hours, start fluid at 5 to 10 mL/kg/hr SC. Be sure mouth is clear of food/fluid before induction.

Premedication:

30 to 60 minutes before induction; in healthy patients, can be diluted in first dose of SC fluids

Healthy or compromised patient:

- Midazolam 1 mg/kg SC

AND

- Butorphanol 0.1 mg/kg SC

Induction:

Pre-oxygenate (before induction) if possible without causing stress, then:

Healthy patient:

- Telazol® 5 mg/kg SC, wait for effect, then mask with sevoflurane/O_2 if needed. If initial Telazol® dose has no effect after 20 minutes, can repeat 1/4 to 1/2 dose of Telazol® once.

Compromised patient:

- Mask with sevoflurane/O_2 to effect. If struggling, give sedative Telazol® dose 1 mg/kg SC, wait 20 minutes and mask again. Repeat Telazol® at 1 mg/kg dose once if needed.

Maintenance: O_2/sevoflurane via mask to effect, maintain body temperature, monitor, provide fluid support and supplemental oxygen.

Recovery: Maintain heat and fluid support.

Pain control:

- Butorphanol 1 to 2 mg/kg SC q 4 hrs

OR

- Buprenorphine 0.05 mg/kg SC q 8-12 hrs

And, if needed

- Carprofen 1 to 2 mg/kg PO q 12-24 hrs (make sure patient is hydrated)

Dosages are suggested guidelines only; tailor actual amounts to individual patient needs.

Rat, Mouse, Gerbil and Hamster Anesthesia Protocol

Evaluation:
- Medical history
- Temperament
- Physical exam
- Gather & evaluate lab data.
- Determine health status: **Healthy or compromised?**
- Determine if IV, IO catheter will be placed.
- Determine if patient will be intubated (intubation optimal).
- Fast appropriately.
- Provide client education/communicate expectations.

Fluid support/preparation
- Start warm 0.9% NaCl at 5-10 mL/kg/hr SC, continue through recovery. Give 1/4 calculated hourly dose q 15 min.
- Intubation & IV, IO catheterization not routinely recommended.

Exception:
- Pre-existing airway compromise or procedures that require intubation to protect airway may need referral to a skilled exotic practitioner.
- Is endotracheal tube required for successful anesthesia/procedure?

Needs intubation

Requires intubation:
- Consider referral to skilled exotic practitioner.

Intubation not required

Premedications
- Premedicate 30-60 minutes before anesthesia (doses given SC)

Healthy or compromised patient:

Butorphanol	0.1 mg/kg SC
	AND
Midazolam	1 mg/kg SC

Keep patient warm and monitor.

Induction
- Pre-oxygenate if possible without causing stress.

Healthy patient:
- Telazol® 5 mg/kg SC, then mask w/sevoflurane (1-4%)/O_2 if needed.
- O_2 at 3 L/min initially, then 2 L/min maintenance.
- If initial Telazol® dose has no effect after 20 minutes, can repeat 1/4-1/2 dose of Telazol® once.

Compromised patient:
- Mask w/sevoflurane (2-4%)/O_2.
- O_2 at 3 L/min initially, then 2 L/min maintenance.
- If struggling, can give Telazol® 1 mg/kg SC, wait 20 min, repeat mask attempt.
- Repeat Telazol® at 1 mg/kg dose once if needed.

Keep patient warm and monitor.

Maintenance (use non-rebreathing system)**:**

Mask induction:
- Administer sevoflurane (2-4%) and oxygen via face mask.
- O_2 at 3 L/minute initially, then 2 L/min for maintenance.
- Use minimal concentration of sevoflurane necessary.

Telazol® induction:
- Provide supplemental O_2 via face mask at 3 L/minute initially, then 2 L/min for maintenance.
- Add sevoflurane at 1-4% as needed to maintain desired anesthetic plane.
- Use minimal concentration of sevoflurane necessary.

Keep patient warm and monitor.

Recovery
- Continue to provide warm fluid support through recovery.

Provide pain control:
- **Mouse, Gerbil, Hamster:**
  Butorphanol 2 mg/kg SC q 2-4 hrs
  OR
  Buprenorphine 0.05- 0.1 mg/kg SC q 6-12 hrs
- **Rat:**
  Butorphanol 2 mg/kg SC q 2-4 hrs
  OR
  Buprenorphine 0.05- 0.1 mg/kg SC q 6-12 hrs
  And, if needed
  Meloxicam 0.2 mg/kg PO, SC q 24 hrs

Keep patient warm and monitor.

RAT, MOUSE, GERBIL AND HAMSTER ANESTHESIA PROTOCOL

(See *Anesthetic Considerations for Small Exotic Patients,* pages 123 to 137, before proceeding.)

- Intubation not recommended unless surgical procedures may compromise airway or patient is significantly compromised. If intubation required (such as respiratory compromise, surgery that will compromise airway, anesthesia time > 30 minutes expected) refer patient to skilled exotic practitioner.
- IV, IO catheter insertion not routinely recommended.
- Provide supplemental oxygen throughout induction, anesthesia and recovery.
- Tail and ear pinch, as well as pedal withdrawal reflexes disappear at a surgical anesthetic plane.
- Common diseases include respiratory infections (subclinical disease is common) and chronic otitis media.

Equipment and supplies: Face mask, non-rebreathing circuit, 0.9% NaCl, supplemental heat source, monitoring equipment

Evaluation: History, physical exam, laboratory data, health status, determination if intubation required, client education

Preanesthetic prep: DO NOT fast or withhold water. Start fluid at 5 to 10 mL/kg/hr SC.

Premedication:

30 to 60 minutes before induction; in healthy patients, can be diluted in first dose of SC fluids

Healthy or compromised patient:

- Midazolam 1 mg/kg SC

AND

- Butorphanol 0.1 mg/kg SC

Induction:

Pre-oxygenate (before induction) without stress if possible, then:

Healthy patient:

- Telazol® 5 mg/kg SC, wait for effect, then mask with sevoflurane/O_2 if needed. If initial Telazol® dose has no effect after 20 minutes, can repeat 1/4 to 1/2 dose of Telazol® once SC.

Compromised patient:

- Mask with sevoflurane/O_2. If struggling, give sedative Telazol® dose 1 mg/kg SC, wait 20 minutes and mask again. Repeat Telazol® dose at 1 mg/kg once if needed.

Maintenance: Sevoflurane/O_2 via mask to effect, maintain body temperature, monitor, provide fluid support and supplemental oxygen.

Recovery: Maintain heat and fluid support.

Pain control:

- **Mouse, gerbil, hamster:**
  - Butorphanol 2 mg/kg SC q 2-4 hrs

    OR
  - Buprenorphine 0.05- 0.1 mg/kg SC q 6-12 hrs
- **Rat:**
  - Butorphanol 2 mg/kg SC q 2-4 hrs

    OR
  - Buprenorphine 0.05- 0.1 mg/kg SC q 6-12 hrs

    And, if needed
  - Meloxicam 0.2 mg/kg PO, SC q 24 hrs

Hedgehog Anesthesia Protocol

Evaluation:
- Medical history
- Temperament
- Physical exam
- Gather & evaluate lab data.
- Determine health status: **Healthy or compromised?**
- Determine if IV/IO catheter will be placed.
- Determine if patient will be intubated (intubation optimal).
- Fast appropriately.
- Provide client education/communicate expectations.

Fluid support/preparation:
- Start warm 0.9% NaCl at 5-10 mL/kg/hr SC, continue through recovery. Give 1/4 calculated hourly dose every 15 minutes.
- Intubation & IV, IO catheter not routinely recommended.

Exception:
- Pre-existing airway compromise or procedures that require intubation to protect airway may need referral to a skilled exotic practitioner.
- Is endotracheal tube required for successful anesthesia/procedure?
- Extra care and specialized tubes are usually required in hedgehogs.

Needs intubation

Requires intubation:
- Consider referral to skilled exotic practitioner.

Intubation not required

Premedication:
- Premedicate 30-60 minutes before anesthesia

Healthy or compromised patient:
- Butorphanol 0.1 mg/kg IM, SC under furred skin

Keep patient warm and monitor.

Induction
- Pre-oxygenate if possible without causing stress.

Healthy or compromised patient:
- Mask w/sevoflurane (2-4%)/O_2.
- O_2 at 3 L/min initially, then 2 L/min maintenance.
- If significant struggling, give sedative dose of ketamine/diazepam (ketamine 5 mg/kg + diazepam 0.5 mg/kg, in separate syringes) IM, SC (under furred skin), wait 20 min, then mask again.

Keep patient warm and monitor.

Maintenance (use non-rebreathing system)**:**

Mask induction:
- Administer oxygen at 3 L/minute initially, then 2 L/min for maintenance and sevoflurane (0-4%) via face mask.
- Use minimal concentration of sevoflurane necessary.
- If the patient has received ketamine/diazepam, little to no sevoflurane may be needed, but continue to provide oxygen.

Keep patient warm and monitor.

Recovery:
- Continue to provide warm fluid support through recovery.

Provide pain control:
- Butorphanol 0.2 mg/kg SC (under furred skin) q 6–8 hrs

OR
- Buprenorphine 0.01-0.5 mg/kg SC (under furred skin), IM q 6-12 hrs

Keep patient warm and monitor.

HEDGEHOG ANESTHESIA PROTOCOL

(See *Anesthetic Considerations for Small Exotic Patients,* pages 123 to 137, before proceeding.)

- Intubation is very difficult and not recommended unless surgical procedures may compromise the airway or patient is significantly compromised.
- IV, IO catheter insertion not routinely recommended due to small body size.
- If intubation required (such as respiratory compromise, surgery that will compromise airway, anesthesia time > 30 minutes expected), refer patient to skilled exotic practitioner.
- Provide supplemental oxygen throughout induction, anesthesia and recovery.
- Common health problems include oral disease (including masses that can compromise respiration), dilated cardiomyopathy, hepatic lipidosis, obesity, renal disease and various types of neoplasia.
- Provide supplemental oxygen throughout induction, anesthesia and recovery.
- Administer SC drugs under furred skin. Skin under areas with spines can have very slow absorption.

Equipment and supplies: Face mask, non-rebreathing circuit, 0.9% NaCl, supplemental heat source, monitoring equipment

Evaluation: History, physical exam, health status, determination if intubation required, client education

Preanesthetic preparation: Fast most patients two to four hours, withhold water two hours, start fluid at 5 to 10 mL/kg/hr SC under furred skin.

Premedications

30 to 60 minutes before induction

Healthy or compromised patients:

- Butorphanol 0.1 mg/kg IM best if can be given without causing patient trauma, otherwise SC under furred skin. Premedications can be diluted in first dose of SC fluids, as long as fluids are administered under furred skin.

Induction

Pre-oxygenate (before induction) without stress if possible, then:

Healthy or compromised patient:

- Mask with sevoflurane (2-4%)/O_2. O_2 at 3 L/min initially, then 2 L/min maintenance. If significant struggling, give sedative dose of ketamine/diazepam (ketamine 5 mg/kg + diazepam 0.5 mg/kg, in separate syringes) IM, SC (under furred skin), wait 20 min, then mask again.

Maintenance: O_2/sevoflurane via mask/endotracheal tube to effect, maintain body temperature, monitor, provide fluid support and supplemental oxygen

Recovery: Maintain heat and fluid support.

Pain control:

- Butorphanol 0.2 mg/kg SC (under furred skin), IM q 6-8 hrs

OR

- Buprenorphine 0.01-0.5 mg/kg SC (under furred skin), IM q 6-12 hrs

Dosages are suggested guidelines only; tailor actual amounts to individual patient needs.

Exotic Patient Anesthesia Monitoring Form

Patient's Name: _____ **Weight (kg):** _____ **Procedure(s):** _____ **Date:** _____

Date of Birth: _____ **Species:** _____ **Temperature:** _____ **Pulse:** _____ **Respiratory Rate:** _____

Premedication				**Route of admin**	**Time given**	**Associate**
Acepromazine (1 mg/mL)	_____ mg/kg **x** _____ kg ÷ 1 mg/mL =	_____ mL		SC ***or*** IM		
Butorphanol (10 mg/mL)	_____ mg/kg **x** _____kg ÷ 10 mg/mL =	_____ mL		SC ***or*** IM		
Midazolam (1 mg/mL)	_____ mg/kg **x** _____ kg ÷ 1 mg/mL =	_____ mL		SC ***or*** IM		
_____ (_____mg/mL)	_____ mg/kg **x** _____kg ÷ mg/mL =	_____ mL		SC ***or*** IM		
_____ (_____mg/mL)	_____ mg/kg **x** _____kg ÷ mg/mL =	_____ mL		SC ***or*** IM		
_____ (_____mg/mL)	_____ mg/kg **x** _____ kg ÷ _____ mg/mL =	_____ mL		SC ***or*** IM		
_____ (_____mg/mL)	_____ mg/kg **x** _____ kg ÷ _____ mg/mL =	_____ mL		SC ***or*** IM		
Evaluation After Premedications & Prior to Induction						
Temperature: _____	**Pulse:** _____	**Pulse Quality:** _____	**Respiratory Rate:** _____	**Sedation Level:** none / mild / adequate / excessive		

Induction				**Route of admin**	**Amount given**	**Associate**
Propofol (10 mg/mL)	_____ mg/kg **x** _____ kg ÷ 10 mg/mL=	_____ mL	(give to effect)	IV		
Telazol (100 mg/mL)	_____ mg/kg **x** _____ kg ÷ 100 mg/mL=	_____ mL	(give to effect)			
Ketamine (100 mg/mL)	_____ mg/kg **x** _____ kg ÷ 100 mg/mL=	_____ mL	(give to effect)			
_____ (_____mg/mL)	_____ mg/kg x _____ kg ÷ _____ mg/mL =	_____ mL	(give to effect)			

Fluid Therapy **SC / IV / IO** (circle one)	1st hour under anesthesia		after 1st hour under anesthesia		**Total Volume Administered**
0.9% NaCl	_____ mL/kg/hr **x** _____kg=	_____mL/hr	_____ mL/kg/hr **x** _____kg=	_____mL/hr	mL
_____	_____ mL/kg/hr **x** _____kg=	_____mL/hr	_____ mL/kg/hr **x** _____kg=	_____mL/hr	mL

Intubation				
Intubation Performed (Y/N): _____	**Endotracheal Intubation (Y/N):** _____	**Nasal Intubation (Y/N):** _____	**Tube Size:** _____	
Time Intubated: _____	**Time Surgery Starts:** _____	**Catheter Placed (Y/N):** _____	**Catheter Gauge:** _____	**Associate:** _____

NSAID / Opioid / Antibiotic Medication	**Amount Given (Mg)**	**Route of Admin**	**Time Given**	**Drug, Strength, Dose Duration**
NSAID: _____		PO SC IM IV		**NSAID TGH:** _____
Opioid: _____		PO SC IM IV		**Opioid TGH:** _____
Other: _____		PO SC IM IV		**Other TGH:** _____

Recovery					
Time Surgery Ended: _____	**Time Extubated:** _____	**Time Sternal:** _____	**Temperature:** _____	**Pulse:** _____	**Respiratory Rate:** _____

Exotic Patient Anesthesia Monitoring Form

Patient's Name: _____

Monitoring Chart	Induction	5 min	10 min	**15 min**	20 min	25 min	**30 min**	35 min	40 min	**45 min**
Sevoflurane %										
O_2 Flow (L/min)										
Fluid Rate (mL/hr)										
Heart/Pulse Rate										
SpO_2										
RR										
CRT/MM	/	/	/	/	/	/	/	/	/	/
Pulse Quality										
ECG Rhythm										
$ETCO_2$										
BP (Sys/Dia/MAP)	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
Temperature										
Anesthetic Depth (Appropriate/Light/Deep)										
Pain Assessment (0-4)										
Monitoring Chart	50 min	55 min	**60 min**	65 min	70 min	**75 min**	80 min	85 min	**90 min**	95 min
Sevoflurane %										
O_2 Flow (L/min)										
Fluid Rate (mL/hr)										
Heart/Pulse Rate										
SpO_2										
RR										
CRT/MM	/	/	/	/	/	/	/	/	/	/
Pulse Quality										
ECG Rhythm										
$ETCO_2$										
BP (Sys/Dia/MAP)	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
Temperature										
Anesthetic Depth (Appropriate/Light/Deep)										
Pain Assessment (0-4)										

SECTION 12:

Appendix

Acepromazine

1 mg/mL*

*Acepromazine should be prediluted to 1 mg/mL to better allow accurate drug measurement.

DOSE: 0.05 mg/kg, IM in dogs and SC in cats for anesthesia protocols
Maximum single dose of acepromazine 1 mg/mL is 1.5 mg

- Order sterile water for injection and 30 mL empty sterile vials through BanfieldDirect.
- Draw 27 mL of sterile water with a sterile syringe and add it to the empty sterile vial.
- Draw 3 mL of 10 mg/mL acepromazine and add to the same vial—this will result in a 1 mg/mL solution.
- Vial should be labeled appropriately and dated.
- The solution is light sensitive. Protect it from light by wrapping the vial completely. If protected from light, the solution is stable at room temperature.

Pet weight		mL to administer
lbs	kg	
1	0.45	0.02 mL
2	0.90	0.05 mL
3	1.35	0.07 mL
4	1.80	0.09 mL
5	2.25	0.11 mL
6	2.70	0.14 mL
7	3.15	0.16 mL
8	3.60	0.18 mL
9	4.05	0.20 mL
10	4.50	0.23 mL
11	4.95	0.25 mL
12	5.40	0.27 mL
13	5.85	0.29 mL
14	6.30	0.32 mL
15	6.75	0.34 mL
16	7.20	0.36 mL
17	7.65	0.38 mL
18	8.10	0.41 mL
19	8.55	0.43 mL
20	9.00	0.45 mL
21	9.45	0.47 mL
22	9.90	0.50 mL
23	10.35	0.52 mL
24	10.80	0.54 mL
25	11.25	0.56 mL
26	11.70	0.59 mL
27	12.15	0.61 mL
28	12.60	0.63 mL
29	13.05	0.65 mL
30	13.50	0.68 mL
31	13.95	0.70 mL
32	14.40	0.72 mL
33	14.85	0.74 mL
34	15.30	0.77 mL
35	15.75	0.79 mL
36	16.20	0.81 mL
37	16.65	0.83 mL
38	17.10	0.86 mL
39	17.55	0.88 mL
40	18.00	0.90 mL
41	18.45	0.92 mL
42	18.90	0.95 mL
43	19.35	0.97 mL
44	19.80	0.99 mL
45	20.25	1.01 mL
46	20.70	1.04 mL
47	21.15	1.06 mL
48	21.60	1.08 mL
49	22.05	1.10 mL
50	22.50	1.13 mL

Pet weight		mL to administer
lbs	kg	
51	22.95	1.15 mL
52	23.40	1.17 mL
53	23.85	1.19 mL
54	24.30	1.22 mL
55	24.75	1.24 mL
56	25.20	1.26 mL
57	25.65	1.28 mL
58	26.10	1.31 mL
59	26.55	1.33 mL
60	27.00	1.35 mL
61	27.45	1.37 mL
62	27.90	1.40 mL
63	28.35	1.42 mL
64	28.80	1.44 mL
65	29.25	1.46 mL
66	29.70	1.49 mL
67	30.15	1.50 mL
68	30.60	1.50 mL
69	31.05	1.50 mL
70	31.50	1.50 mL
71	31.95	1.50 mL
72	32.40	1.50 mL
73	32.85	1.50 mL
74	33.30	1.50 mL
75	33.75	1.50 mL
76	34.20	1.50 mL
77	34.65	1.50 mL
78	35.10	1.50 mL
79	35.55	1.50 mL
80	36.00	1.50 mL
81	36.45	1.50 mL
82	36.90	1.50 mL
83	37.35	1.50 mL
84	37.80	1.50 mL
85	38.25	1.50 mL
86	38.70	1.50 mL
87	39.15	1.50 mL
88	39.60	1.50 mL
89	40.05	1.50 mL
90	40.50	1.50 mL
91	40.95	1.50 mL
92	41.40	1.50 mL
93	41.85	1.50 mL
94	42.30	1.50 mL
95	42.75	1.50 mL
96	43.20	1.50 mL
97	43.65	1.50 mL
98	44.10	1.50 mL
99	44.55	1.50 mL
100	45.00	1.50 mL

Atropine
0.54 mg/mL

DOSE: 0.02 - 0.04 mg/kg for Anesthesia Monitoring and Emergency Protocol

- Give slowly to effect.
- IV for cardiopulmonary resuscitation
- Atropine can cause an initial slowing of the heart rate that usually resolves within a few seconds.

Pet weight		mL to administer	
lbs	kg	0.02 mg/kg	0.04 mg/kg
1	0.45	0.02 mL	0.03 mL
2	0.90	0.03 mL	0.07 mL
3	1.35	0.05 mL	0.10 mL
4	1.80	0.07 mL	0.13 mL
5	2.25	0.08 mL	0.17 mL
6	2.70	0.10 mL	0.20 mL
7	3.15	0.12 mL	0.23 mL
8	3.60	0.13 mL	0.27 mL
9	4.05	0.15 mL	0.30 mL
10	4.50	0.17 mL	0.33 mL
11	4.95	0.18 mL	0.37 mL
12	5.40	0.20 mL	0.40 mL
13	5.85	0.22 mL	0.43 mL
14	6.30	0.23 mL	0.47 mL
15	6.75	0.25 mL	0.50 mL
16	7.20	0.27 mL	0.53 mL
17	7.65	0.28 mL	0.57 mL
18	8.10	0.30 mL	0.60 mL
19	8.55	0.32 mL	0.63 mL
20	9.00	0.33 mL	0.67 mL
21	9.45	0.35 mL	0.70 mL
22	9.90	0.37 mL	0.73 mL
23	10.35	0.38 mL	0.77 mL
24	10.80	0.40 mL	0.80 mL
25	11.25	0.42 mL	0.83 mL
26	11.70	0.43 mL	0.87 mL
27	12.15	0.45 mL	0.90 mL
28	12.60	0.47 mL	0.93 mL
29	13.05	0.48 mL	0.97 mL
30	13.50	0.50 mL	1.00 mL
31	13.95	0.52 mL	1.03 mL
32	14.40	0.53 mL	1.07 mL
33	14.85	0.55 mL	1.10 mL
34	15.30	0.57 mL	1.13 mL
35	15.75	0.58 mL	1.17 mL
36	16.20	0.60 mL	1.20 mL
37	16.65	0.62 mL	1.23 mL
38	17.10	0.63 mL	1.27 mL
39	17.55	0.65 mL	1.30 mL
40	18.00	0.67 mL	1.33 mL
41	18.45	0.68 mL	1.37 mL
42	18.90	0.70 mL	1.40 mL
43	19.35	0.72 mL	1.43 mL
44	19.80	0.73 mL	1.47 mL
45	20.25	0.75 mL	1.50 mL
46	20.70	0.77 mL	1.53 mL
47	21.15	0.78 mL	1.57 mL
48	21.60	0.80 mL	1.60 mL
49	22.05	0.82 mL	1.63 mL
50	22.50	0.83 mL	1.67 mL

Pet weight		mL to administer	
lbs	kg	0.02 mg/kg	0.04 mg/kg
51	22.95	0.85 mL	1.70 mL
52	23.40	0.87 mL	1.73 mL
53	23.85	0.88 mL	1.77 mL
54	24.30	0.90 mL	1.80 mL
55	24.75	0.92 mL	1.83 mL
56	25.20	0.93 mL	1.87 mL
57	25.65	0.95 mL	1.90 mL
58	26.10	0.97 mL	1.93 mL
59	26.55	0.98 mL	1.97 mL
60	27.00	1.00 mL	2.00 mL
61	27.45	1.02 mL	2.03 mL
62	27.90	1.03 mL	2.07 mL
63	28.35	1.05 mL	2.10 mL
64	28.80	1.07 mL	2.13 mL
65	29.25	1.08 mL	2.17 mL
66	29.70	1.10 mL	2.20 mL
67	30.15	1.12 mL	2.23 mL
68	30.60	1.13 mL	2.27 mL
69	31.05	1.15 mL	2.30 mL
70	31.50	1.17 mL	2.33 mL
71	31.95	1.18 mL	2.37 mL
72	32.40	1.20 mL	2.40 mL
73	32.85	1.22 mL	2.43 mL
74	33.30	1.23 mL	2.47 mL
75	33.75	1.25 mL	2.50 mL
76	34.20	1.27 mL	2.53 mL
77	34.65	1.28 mL	2.57 mL
78	35.10	1.30 mL	2.60 mL
79	35.55	1.32 mL	2.63 mL
80	36.00	1.33 mL	2.67 mL
81	36.45	1.35 mL	2.70 mL
82	36.90	1.37 mL	2.73 mL
83	37.35	1.38 mL	2.77 mL
84	37.80	1.40 mL	2.80 mL
85	38.25	1.42 mL	2.83 mL
86	38.70	1.43 mL	2.87 mL
87	39.15	1.45 mL	2.90 mL
88	39.60	1.47 mL	2.93 mL
89	40.05	1.48 mL	2.97 mL
90	40.50	1.50 mL	3.00 mL
91	40.95	1.52 mL	3.03 mL
92	41.40	1.53 mL	3.07 mL
93	41.85	1.55 mL	3.10 mL
94	42.30	1.57 mL	3.13 mL
95	42.75	1.58 mL	3.17 mL
96	43.20	1.60 mL	3.20 mL
97	43.65	1.62 mL	3.23 mL
98	44.10	1.63 mL	3.27 mL
99	44.55	1.65 mL	3.30 mL
100	45.00	1.67 mL	3.33 mL

Bupivacaine Local Anesthetic Blocks

0.5% (5 mg/mL)

DOSE: Dogs: 1 - 2 mg/kg for local blocks. Cats: 1 mg/kg for local blocks

- Doses are cumulative.
- Do not mix with lidocaine.

Pet weight		mL to administer	
lbs	kg	1.0 mg/kg	2.0 mg/kg
1	0.45	0.09 mL	0.18 mL
2	0.90	0.18 mL	0.36 mL
3	1.35	0.27 mL	0.54 mL
4	1.80	0.36 mL	0.72 mL
5	2.25	0.45 mL	0.90 mL
6	2.70	0.54 mL	1.08 mL
7	3.15	0.63 mL	1.26 mL
8	3.60	0.72 mL	1.44 mL
9	4.05	0.81 mL	1.62 mL
10	4.50	0.90 mL	1.80 mL
11	4.95	0.99 mL	1.98 mL
12	5.40	1.08 mL	2.16 mL
13	5.85	1.17 mL	2.34 mL
14	6.30	1.26 mL	2.52 mL
15	6.75	1.35 mL	2.70 mL
16	7.20	1.44 mL	2.88 mL
17	7.65	1.53 mL	3.06 mL
18	8.10	1.62 mL	3.24 mL
19	8.55	1.71 mL	3.42 mL
20	9.00	1.80 mL	3.60 mL
21	9.45	1.89 mL	3.78 mL
22	9.90	1.98 mL	3.96 mL
23	10.35	2.07 mL	4.14 mL
24	10.80	2.16 mL	4.32 mL
25	11.25	2.25 mL	4.50 mL
26	11.70	2.34 mL	4.68 mL
27	12.15	2.43 mL	4.86 mL
28	12.60	2.52 mL	5.04 mL
29	13.05	2.61 mL	5.22 mL
30	13.50	2.70 mL	5.40 mL
31	13.95	2.79 mL	5.58 mL
32	14.40	2.88 mL	5.76 mL
33	14.85	2.97 mL	5.94 mL
34	15.30	3.06 mL	6.12 mL
35	15.75	3.15 mL	6.30 mL
36	16.20	3.24 mL	6.48 mL
37	16.65	3.33 mL	6.66 mL
38	17.10	3.42 mL	6.84 mL
39	17.55	3.51 mL	7.02 mL
40	18.00	3.60 mL	7.20 mL
41	18.45	3.69 mL	7.38 mL
42	18.90	3.78 mL	7.56 mL
43	19.35	3.87 mL	7.74 mL
44	19.80	3.96 mL	7.92 mL
45	20.25	4.05 mL	8.10 mL
46	20.70	4.14 mL	8.28 mL
47	21.15	4.23 mL	8.46 mL
48	21.60	4.32 mL	8.64 mL
49	22.05	4.41 mL	8.82 mL
50	22.50	4.50 mL	9.00 mL

Pet weight		mL to administer	
lbs	kg	1.0 mg/kg	2.0 mg/kg
51	22.95	4.59 mL	9.18 mL
52	23.40	4.68 mL	9.36 mL
53	23.85	4.77 mL	9.54 mL
54	24.30	4.86 mL	9.72 mL
55	24.75	4.95 mL	9.90 mL
56	25.20	5.04 mL	10.08 mL
57	25.65	5.13 mL	10.26 mL
58	26.10	5.22 mL	10.44 mL
59	26.55	5.31 mL	10.62 mL
60	27.00	5.40 mL	10.80 mL
61	27.45	5.49 mL	10.98 mL
62	27.90	5.58 mL	11.16 mL
63	28.35	5.67 mL	11.34 mL
64	28.80	5.76 mL	11.52 mL
65	29.25	5.85 mL	11.70 mL
66	29.70	5.94 mL	11.88 mL
67	30.15	6.03 mL	12.06 mL
68	30.60	6.12 mL	12.24 mL
69	31.05	6.21 mL	12.42 mL
70	31.50	6.30 mL	12.60 mL
71	31.95	6.39 mL	12.78 mL
72	32.40	6.48 mL	12.96 mL
73	32.85	6.57 mL	13.14 mL
74	33.30	6.66 mL	13.32 mL
75	33.75	6.75 mL	13.50 mL
76	34.20	6.84 mL	13.68 mL
77	34.65	6.93 mL	13.86 mL
78	35.10	7.02 mL	14.04 mL
79	35.55	7.11 mL	14.22 mL
80	36.00	7.20 mL	14.40 mL
81	36.45	7.29 mL	14.58 mL
82	36.90	7.38 mL	14.76 mL
83	37.35	7.47 mL	14.94 mL
84	37.80	7.56 mL	15.12 mL
85	38.25	7.65 mL	15.30 mL
86	38.70	7.74 mL	15.48 mL
87	39.15	7.83 mL	15.66 mL
88	39.60	7.92 mL	15.84 mL
89	40.05	8.01 mL	16.02 mL
90	40.50	8.10 mL	16.20 mL
91	40.95	8.19 mL	16.38 mL
92	41.40	8.28 mL	16.56 mL
93	41.85	8.37 mL	16.74 mL
94	42.30	8.46 mL	16.92 mL
95	42.75	8.55 mL	17.10 mL
96	43.20	8.64 mL	17.28 mL
97	43.65	8.73 mL	17.46 mL
98	44.10	8.82 mL	17.64 mL
99	44.55	8.91 mL	17.82 mL
100	45.00	9.00 mL	18.00 mL

Buprenorphine
0.3 mg/mL

DOSE:
Dogs: 0.005 - 0.02 mg/kg SC, IM postoperatively
Cats: 0.005 - 0.01 mg/kg SC, IM, transmucosal postoperatively

Pet weight		Dose for dogs		Dose for cats
lbs	kg	0.005 mg/kg	0.02 mg/kg	0.01 mg/kg
1	0.45	0.01 mL	0.03 mL	0.02 mL
2	0.90	0.02 mL	0.06 mL	0.03 mL
3	1.35	0.02 mL	0.09 mL	0.05 mL
4	1.80	0.03 mL	0.12 mL	0.06 mL
5	2.25	0.04 mL	0.15 mL	0.08 mL
6	2.70	0.05 mL	0.18 mL	0.09 mL
7	3.15	0.05 mL	0.21 mL	0.11 mL
8	3.60	0.06 mL	0.24 mL	0.12 mL
9	4.05	0.07 mL	0.27 mL	0.14 mL
10	4.50	0.08 mL	0.30 mL	0.15 mL
11	4.95	0.08 mL	0.33 mL	0.17 mL
12	5.40	0.09 mL	0.36 mL	0.18 mL
13	5.85	0.10 mL	0.39 mL	0.20 mL
14	6.30	0.11 mL	0.42 mL	0.21 mL
15	6.75	0.11 mL	0.45 mL	0.23 mL
16	7.20	0.12 mL	0.48 mL	0.24 mL
17	7.65	0.13 mL	0.51 mL	0.26 mL
18	8.10	0.14 mL	0.54 mL	0.27 mL
19	8.55	0.14 mL	0.57 mL	0.29 mL
20	9.00	0.15 mL	0.60 mL	0.30 mL
21	9.45	0.16 mL	0.63 mL	0.32 mL
22	9.90	0.17 mL	0.66 mL	0.33 mL
23	10.35	0.17 mL	0.69 mL	0.35 mL
24	10.80	0.18 mL	0.72 mL	0.36 mL
25	11.25	0.19 mL	0.75 mL	0.38 mL
26	11.70	0.20 mL	0.78 mL	
27	12.15	0.20 mL	0.81 mL	
28	12.60	0.21 mL	0.84 mL	
29	13.05	0.22 mL	0.87 mL	
30	13.50	0.23 mL	0.90 mL	
31	13.95	0.23 mL	0.93 mL	
32	14.40	0.24 mL	0.96 mL	
33	14.85	0.25 mL	0.99 mL	
34	15.30	0.26 mL	1.02 mL	
35	15.75	0.26 mL	1.05 mL	
36	16.20	0.27 mL	1.08 mL	
37	16.65	0.28 mL	1.11 mL	
38	17.10	0.29 mL	1.14 mL	
39	17.55	0.29 mL	1.17 mL	
40	18.00	0.30 mL	1.20 mL	
41	18.45	0.31 mL	1.23 mL	
42	18.90	0.32 mL	1.26 mL	
43	19.35	0.32 mL	1.29 mL	
44	19.80	0.33 mL	1.32 mL	
45	20.25	0.34 mL	1.35 mL	
46	20.70	0.35 mL	1.38 mL	
47	21.15	0.35 mL	1.41 mL	
48	21.60	0.36 mL	1.44 mL	
49	22.05	0.37 mL	1.47 mL	
50	22.50	0.38 mL	1.50 mL	

Buprenorphine, cont'd

0.3 mg/mL

DOSE:
Dogs: 0.005 - 0.02 mg/kg SC, IM postoperatively
Cats: 0.005 - 0.01 mg/kg SC, IM, transmucosal postoperatively

Pet weight		Dose for dogs	
lbs	kg	0.005 mg/kg	0.02 mg/kg
51	22.95	0.38 mL	1.53 mL
52	23.40	0.39 mL	1.56 mL
53	23.85	0.40 mL	1.59 mL
54	24.30	0.41 mL	1.62 mL
55	24.75	0.41 mL	1.65 mL
56	25.20	0.42 mL	1.68 mL
57	25.65	0.43 mL	1.71 mL
58	26.10	0.44 mL	1.74 mL
59	26.55	0.44 mL	1.77 mL
60	27.00	0.45 mL	1.80 mL
61	27.45	0.46 mL	1.83 mL
62	27.90	0.47 mL	1.86 mL
63	28.35	0.47 mL	1.89 mL
64	28.80	0.48 mL	1.92 mL
65	29.25	0.49 mL	1.95 mL
66	29.70	0.50 mL	1.98 mL
67	30.15	0.50 mL	2.01 mL
68	30.60	0.51 mL	2.04 mL
69	31.05	0.52 mL	2.07 mL
70	31.50	0.53 mL	2.10 mL
71	31.95	0.53 mL	2.13 mL
72	32.40	0.54 mL	2.16 mL
73	32.85	0.55 mL	2.19 mL
74	33.30	0.56 mL	2.22 mL
75	33.75	0.56 mL	2.25 mL
76	34.20	0.57 mL	2.28 mL
77	34.65	0.58 mL	2.31 mL
78	35.10	0.59 mL	2.34 mL
79	35.55	0.59 mL	2.37 mL
80	36.00	0.60 mL	2.40 mL
81	36.45	0.61 mL	2.43 mL
82	36.90	0.62 mL	2.46 mL
83	37.35	0.62 mL	2.49 mL
84	37.80	0.63 mL	2.52 mL
85	38.25	0.64 mL	2.55 mL
86	38.70	0.65 mL	2.58 mL
87	39.15	0.65 mL	2.61 mL
88	39.60	0.66 mL	2.64 mL
89	40.05	0.67 mL	2.67 mL
90	40.50	0.68 mL	2.70 mL
91	40.95	0.68 mL	2.73 mL
92	41.40	0.69 mL	2.76 mL
93	41.85	0.70 mL	2.79 mL
94	42.30	0.71 mL	2.82 mL
95	42.75	0.71 mL	2.85 mL
96	43.20	0.72 mL	2.88 mL
97	43.65	0.73 mL	2.91 mL
98	44.10	0.74 mL	2.94 mL
99	44.55	0.74 mL	2.97 mL
100	45.00	0.75 mL	3.00 mL

Butorphanol (Torbugesic®)

10 mg/mL

DOSE: Dogs: 0.2 - 0.4 mg/kg IM. Cats: 0.2 - 0.4 mg/kg SC, for anesthesia protocols.

- There is no maximum single dose for butorphanol.
- Butorphanol can be repeated as needed every one to two hours.

Pet weight		mL to administer	
lbs	kg	0.2 mg/kg	0.4 mg/kg
1	0.45	0.01 mL	0.02 mL
2	0.90	0.02 mL	0.04 mL
3	1.35	0.03 mL	0.05 mL
4	1.80	0.04 mL	0.07 mL
5	2.25	0.05 mL	0.09 mL
6	2.70	0.05 mL	0.11 mL
7	3.15	0.06 mL	0.13 mL
8	3.60	0.07 mL	0.14 mL
9	4.05	0.08 mL	0.16 mL
10	4.50	0.09 mL	0.18 mL
11	4.95	0.10 mL	0.20 mL
12	5.40	0.11 mL	0.22 mL
13	5.85	0.12 mL	0.23 mL
14	6.30	0.13 mL	0.25 mL
15	6.75	0.14 mL	0.27 mL
16	7.20	0.14 mL	0.29 mL
17	7.65	0.15 mL	0.31 mL
18	8.10	0.16 mL	0.32 mL
19	8.55	0.17 mL	0.34 mL
20	9.00	0.18 mL	0.36 mL
21	9.45	0.19 mL	0.38 mL
22	9.90	0.20 mL	0.40 mL
23	10.35	0.21 mL	0.41 mL
24	10.80	0.22 mL	0.43 mL
25	11.25	0.23 mL	0.45 mL
26	11.70	0.23 mL	0.47 mL
27	12.15	0.24 mL	0.49 mL
28	12.60	0.25 mL	0.50 mL
29	13.05	0.26 mL	0.52 mL
30	13.50	0.27 mL	0.54 mL
31	13.95	0.28 mL	0.56 mL
32	14.40	0.29 mL	0.58 mL
33	14.85	0.30 mL	0.59 mL
34	15.30	0.31 mL	0.61 mL
35	15.75	0.32 mL	0.63 mL
36	16.20	0.32 mL	0.65 mL
37	16.65	0.33 mL	0.67 mL
38	17.10	0.34 mL	0.68 mL
39	17.55	0.35 mL	0.70 mL
40	18.00	0.36 mL	0.72 mL
41	18.45	0.37 mL	0.74 mL
42	18.90	0.38 mL	0.76 mL
43	19.35	0.39 mL	0.77 mL
44	19.80	0.40 mL	0.79 mL
45	20.25	0.41 mL	0.81 mL
46	20.70	0.41 mL	0.83 mL
47	21.15	0.42 mL	0.85 mL
48	21.60	0.43 mL	0.86 mL
49	22.05	0.44 mL	0.88 mL
50	22.50	0.45 mL	0.90 mL

Pet weight		mL to administer	
lbs	kg	0.2 mg/kg	0.4 mg/kg
51	22.95	0.46 mL	0.92 mL
52	23.40	0.47 mL	0.94 mL
53	23.85	0.48 mL	0.95 mL
54	24.30	0.49 mL	0.97 mL
55	24.75	0.50 mL	0.99 mL
56	25.20	0.50 mL	1.01 mL
57	25.65	0.51 mL	1.03 mL
58	26.10	0.52 mL	1.04 mL
59	26.55	0.53 mL	1.06 mL
60	27.00	0.54 mL	1.08 mL
61	27.45	0.55 mL	1.10 mL
62	27.90	0.56 mL	1.12 mL
63	28.35	0.57 mL	1.13 mL
64	28.80	0.58 mL	1.15 mL
65	29.25	0.59 mL	1.17 mL
66	29.70	0.59 mL	1.19 mL
67	30.15	0.60 mL	1.21 mL
68	30.60	0.61 mL	1.22 mL
69	31.05	0.62 mL	1.24 mL
70	31.50	0.63 mL	1.26 mL
71	31.95	0.64 mL	1.28 mL
72	32.40	0.65 mL	1.30 mL
73	32.85	0.66 mL	1.31 mL
74	33.30	0.67 mL	1.33 mL
75	33.75	0.68 mL	1.35 mL
76	34.20	0.68 mL	1.37 mL
77	34.65	0.69 mL	1.39 mL
78	35.10	0.70 mL	1.40 mL
79	35.55	0.71 mL	1.42 mL
80	36.00	0.72 mL	1.44 mL
81	36.45	0.73 mL	1.46 mL
82	36.90	0.74 mL	1.48 mL
83	37.35	0.75 mL	1.49 mL
84	37.80	0.76 mL	1.51 mL
85	38.25	0.77 mL	1.53 mL
86	38.70	0.77 mL	1.55 mL
87	39.15	0.78 mL	1.57 mL
88	39.60	0.79 mL	1.58 mL
89	40.05	0.80 mL	1.60 mL
90	40.50	0.81 mL	1.62 mL
91	40.95	0.82 mL	1.64 mL
92	41.40	0.83 mL	1.66 mL
93	41.85	0.84 mL	1.67 mL
94	42.30	0.85 mL	1.69 mL
95	42.75	0.86 mL	1.71 mL
96	43.20	0.86 mL	1.73 mL
97	43.65	0.87 mL	1.75 mL
98	44.10	0.88 mL	1.76 mL
99	44.55	0.89 mL	1.78 mL
100	45.00	0.90 mL	1.80 mL

Carprofen (Rimadyl®) Injectable
50 mg/mL

DOSE:
Dogs: 4 mg/kg SC

Pet weight		mL to administer
lbs	kg	4 mg/kg
1	0.45	0.04 mL
2	0.90	0.07 mL
3	1.35	0.11 mL
4	1.80	0.14 mL
5	2.25	0.18 mL
6	2.70	0.22 mL
7	3.15	0.25 mL
8	3.60	0.29 mL
9	4.05	0.32 mL
10	4.50	0.36 mL
11	4.95	0.40 mL
12	5.40	0.43 mL
13	5.85	0.47 mL
14	6.30	0.50 mL
15	6.75	0.54 mL
16	7.20	0.58 mL
17	7.65	0.61 mL
18	8.10	0.65 mL
19	8.55	0.68 mL
20	9.00	0.72 mL
21	9.45	0.76 mL
22	9.90	0.79 mL
23	10.35	0.83 mL
24	10.80	0.86 mL
25	11.25	0.90 mL
26	11.70	0.94 mL
27	12.15	0.97 mL
28	12.60	1.01 mL
29	13.05	1.04 mL
30	13.50	1.08 mL
31	13.95	1.12 mL
32	14.40	1.15 mL
33	14.85	1.19 mL
34	15.30	1.22 mL
35	15.75	1.26 mL
36	16.20	1.30 mL
37	16.65	1.33 mL
38	17.10	1.37 mL
39	17.55	1.40 mL
40	18.00	1.44 mL
41	18.45	1.48 mL
42	18.90	1.51 mL
43	19.35	1.55 mL
44	19.80	1.58 mL
45	20.25	1.62 mL
46	20.70	1.66 mL
47	21.15	1.69 mL
48	21.60	1.73 mL
49	22.05	1.76 mL
50	22.50	1.80 mL

Pet weight		mL to administer
lbs	kg	4 mg/kg
51	22.95	1.84 mL
52	23.40	1.87 mL
53	23.85	1.91 mL
54	24.30	1.94 mL
55	24.75	1.98 mL
56	25.20	2.02 mL
57	25.65	2.05 mL
58	26.10	2.09 mL
59	26.55	2.12 mL
60	27.00	2.16 mL
61	27.45	2.20 mL
62	27.90	2.23 mL
63	28.35	2.27 mL
64	28.80	2.30 mL
65	29.25	2.34 mL
66	29.70	2.38 mL
67	30.15	2.41 mL
68	30.60	2.45 mL
69	31.05	2.48 mL
70	31.50	2.52 mL
71	31.95	2.56 mL
72	32.40	2.59 mL
73	32.85	2.63 mL
74	33.30	2.66 mL
75	33.75	2.70 mL
76	34.20	2.74 mL
77	34.65	2.77 mL
78	35.10	2.81 mL
79	35.55	2.84 mL
80	36.00	2.88 mL
81	36.45	2.92 mL
82	36.90	2.95 mL
83	37.35	2.99 mL
84	37.80	3.02 mL
85	38.25	3.06 mL
86	38.70	3.10 mL
87	39.15	3.13 mL
88	39.60	3.17 mL
89	40.05	3.20 mL
90	40.50	3.24 mL
91	40.95	3.28 mL
92	41.40	3.31 mL
93	41.85	3.35 mL
94	42.30	3.38 mL
95	42.75	3.42 mL
96	43.20	3.46 mL
97	43.65	3.49 mL
98	44.10	3.53 mL
99	44.55	3.56 mL
100	45.00	3.60 mL

Dexamethasone sp

4 mg/mL - CPR

DOSE: 4.4 mg/kg IV

Pet weight		mL to administer
lbs	kg	4.4 mg/kg
1	0.45	0.50 mL
2	0.90	0.99 mL
3	1.35	1.49 mL
4	1.80	1.98 mL
5	2.25	2.48 mL
6	2.70	2.97 mL
7	3.15	3.47 mL
8	3.60	3.96 mL
9	4.05	4.46 mL
10	4.50	4.95 mL
11	4.95	5.45 mL
12	5.40	5.94 mL
13	5.85	6.44 mL
14	6.30	6.93 mL
15	6.75	7.43 mL
16	7.20	7.92 mL
17	7.65	8.42 mL
18	8.10	8.91 mL
19	8.55	9.41 mL
20	9.00	9.90 mL
21	9.45	10.40 mL
22	9.90	10.89 mL
23	10.35	11.39 mL
24	10.80	11.88 mL
25	11.25	12.38 mL
26	11.70	12.87 mL
27	12.15	13.37 mL
28	12.60	13.86 mL
29	13.05	14.36 mL
30	13.50	14.85 mL
31	13.95	15.35 mL
32	14.40	15.84 mL
33	14.85	16.34 mL
34	15.30	16.83 mL
35	15.75	17.33 mL
36	16.20	17.82 mL
37	16.65	18.32 mL
38	17.10	18.81 mL
39	17.55	19.31 mL
40	18.00	19.80 mL
41	18.45	20.30 mL
42	18.90	20.79 mL
43	19.35	21.29 mL
44	19.80	21.78 mL
45	20.25	22.28 mL
46	20.70	22.77 mL
47	21.15	23.27 mL
48	21.60	23.76 mL
49	22.05	24.26 mL
50	22.50	24.75 mL

Pet weight		mL to administer
lbs	kg	4.4 mg/kg
51	22.95	25.25 mL
52	23.40	25.74 mL
53	23.85	26.24 mL
54	24.30	26.73 mL
55	24.75	27.23 mL
56	25.20	27.72 mL
57	25.65	28.22 mL
58	26.10	28.71 mL
59	26.55	29.21 mL
60	27.00	29.70 mL
61	27.45	30.20 mL
62	27.90	30.69 mL
63	28.35	31.19 mL
64	28.80	31.68 mL
65	29.25	32.18 mL
66	29.70	32.67 mL
67	30.15	33.17 mL
68	30.60	33.66 mL
69	31.05	34.16 mL
70	31.50	34.65 mL
71	31.95	35.15 mL
72	32.40	35.64 mL
73	32.85	36.14 mL
74	33.30	36.63 mL
75	33.75	37.13 mL
76	34.20	37.62 mL
77	34.65	38.12 mL
78	35.10	38.61 mL
79	35.55	39.11 mL
80	36.00	39.60 mL
81	36.45	40.10 mL
82	36.90	40.59 mL
83	37.35	41.09 mL
84	37.80	41.58 mL
85	38.25	42.08 mL
86	38.70	42.57 mL
87	39.15	43.07 mL
88	39.60	43.56 mL
89	40.05	44.06 mL
90	40.50	44.55 mL
91	40.95	45.05 mL
92	41.40	45.54 mL
93	41.85	46.04 mL
94	42.30	46.53 mL
95	42.75	47.03 mL
96	43.20	47.52 mL
97	43.65	48.02 mL
98	44.10	48.51 mL
99	44.55	49.01 mL
100	45.00	49.50 mL

Dexmedetomidine (Dexdomitor®) and Atipamezole (Antisedan®) 0.5 mg/mL

DOSE: Dogs: 0.005 - 0.02 mg/kg IM for immobilization

- Atipamezole (Antisedan®) is used to reverse dexmedetomidine as necessary.
- To reverse dexmedetomidine (Dexdomitor®), give IM an equal volume of atipamezole as the amount of dexmedetomidine administered mL per mL. The concentration of atipamezole is 10x that of dexmedetomidine as atipamezole is 5 mg/mL vs dexmedetomidine's 0.5 mg/mL.

Pet weight		mL to administer	
lbs	kg	0.005 mg/kg	0.02 mg/kg
1	0.45	0.005 mL	0.02 mL
2	0.90	0.01 mL	0.04 mL
3	1.35	0.01 mL	0.05 mL
4	1.80	0.02 mL	0.07 mL
5	2.25	0.02 mL	0.09 mL
6	2.70	0.03 mL	0.11 mL
7	3.15	0.03 mL	0.13 mL
8	3.60	0.04 mL	0.14 mL
9	4.05	0.04 mL	0.16 mL
10	4.50	0.05 mL	0.18 mL
11	4.95	0.05 mL	0.20 mL
12	5.40	0.05 mL	0.22 mL
13	5.85	0.06 mL	0.23 mL
14	6.30	0.06 mL	0.25 mL
15	6.75	0.07 mL	0.27 mL
16	7.20	0.07 mL	0.29 mL
17	7.65	0.08 mL	0.31 mL
18	8.10	0.08 mL	0.32 mL
19	8.55	0.09 mL	0.34 mL
20	9.00	0.09 mL	0.36 mL
21	9.45	0.09 mL	0.38 mL
22	9.90	0.10 mL	0.40 mL
23	10.35	0.10 mL	0.41 mL
24	10.80	0.11 mL	0.43 mL
25	11.25	0.11 mL	0.45 mL
26	11.70	0.12 mL	0.47 mL
27	12.15	0.12 mL	0.49 mL
28	12.60	0.13 mL	0.50 mL
29	13.05	0.13 mL	0.52 mL
30	13.50	0.14 mL	0.54 mL
31	13.95	0.14 mL	0.56 mL
32	14.40	0.14 mL	0.58 mL
33	14.85	0.15 mL	0.59 mL
34	15.30	0.15 mL	0.61 mL
35	15.75	0.16 mL	0.63 mL
36	16.20	0.16 mL	0.65 mL
37	16.65	0.17 mL	0.67 mL
38	17.10	0.17 mL	0.68 mL
39	17.55	0.18 mL	0.70 mL
40	18.00	0.18 mL	0.72 mL
41	18.45	0.18 mL	0.74 mL
42	18.90	0.19 mL	0.76 mL
43	19.35	0.19 mL	0.77 mL
44	19.80	0.20 mL	0.79 mL
45	20.25	0.20 mL	0.81 mL
46	20.70	0.21 mL	0.83 mL
47	21.15	0.21 mL	0.85 mL
48	21.60	0.22 mL	0.86 mL
49	22.05	0.22 mL	0.88 mL
50	22.50	0.23 mL	0.90 mL

Pet weight		mL to administer	
lbs	kg	0.005 mg/kg	0.02 mg/kg
51	22.95	0.23 mL	0.92 mL
52	23.40	0.23 mL	0.94 mL
53	23.85	0.24 mL	0.95 mL
54	24.30	0.24 mL	0.97 mL
55	24.75	0.25 mL	0.99 mL
56	25.20	0.25 mL	1.01 mL
57	25.65	0.26 mL	1.03 mL
58	26.10	0.26 mL	1.04 mL
59	26.55	0.27 mL	1.06 mL
60	27.00	0.27 mL	1.08 mL
61	27.45	0.27 mL	1.10 mL
62	27.90	0.28 mL	1.12 mL
63	28.35	0.28 mL	1.13 mL
64	28.80	0.29 mL	1.15 mL
65	29.25	0.29 mL	1.17 mL
66	29.70	0.30 mL	1.19 mL
67	30.15	0.30 mL	1.21 mL
68	30.60	0.31 mL	1.22 mL
69	31.05	0.31 mL	1.24 mL
70	31.50	0.32 mL	1.26 mL
71	31.95	0.32 mL	1.28 mL
72	32.40	0.32 mL	1.30 mL
73	32.85	0.33 mL	1.31 mL
74	33.30	0.33 mL	1.33 mL
75	33.75	0.34 mL	1.35 mL
76	34.20	0.34 mL	1.37 mL
77	34.65	0.35 mL	1.39 mL
78	35.10	0.35 mL	1.40 mL
79	35.55	0.36 mL	1.42 mL
80	36.00	0.36 mL	1.44 mL
81	36.45	0.36 mL	1.46 mL
82	36.90	0.37 mL	1.48 mL
83	37.35	0.37 mL	1.49 mL
84	37.80	0.38 mL	1.51 mL
85	38.25	0.38 mL	1.53 mL
86	38.70	0.39 mL	1.55 mL
87	39.15	0.39 mL	1.57 mL
88	39.60	0.40 mL	1.58 mL
89	40.05	0.40 mL	1.60 mL
90	40.50	0.41 mL	1.62 mL
91	40.95	0.41 mL	1.64 mL
92	41.40	0.41 mL	1.66 mL
93	41.85	0.42 mL	1.67 mL
94	42.30	0.42 mL	1.69 mL
95	42.75	0.43 mL	1.71 mL
96	43.20	0.43 mL	1.73 mL
97	43.65	0.44 mL	1.75 mL
98	44.10	0.44 mL	1.76 mL
99	44.55	0.45 mL	1.78 mL
100	45.00	0.45 mL	1.80 mL

Diphenhydramine
50 mg/mL

DOSE: 2.2 mg/kg for anesthesia protocols

• Maximum single dose is 50 mg.

Pet weight		mL to administer
lbs	kg	
1	0.45	0.02 mL
2	0.90	0.04 mL
3	1.35	0.06 mL
4	1.80	0.08 mL
5	2.25	0.10 mL
6	2.70	0.12 mL
7	3.15	0.14 mL
8	3.60	0.16 mL
9	4.05	0.18 mL
10	4.50	0.20 mL
11	4.95	0.22 mL
12	5.40	0.24 mL
13	5.85	0.26 mL
14	6.30	0.28 mL
15	6.75	0.30 mL
16	7.20	0.32 mL
17	7.65	0.34 mL
18	8.10	0.36 mL
19	8.55	0.38 mL
20	9.00	0.40 mL
21	9.45	0.42 mL
22	9.90	0.44 mL
23	10.35	0.46 mL
24	10.80	0.48 mL
25	11.25	0.50 mL
26	11.70	0.51 mL
27	12.15	0.53 mL
28	12.60	0.55 mL
29	13.05	0.57 mL
30	13.50	0.59 mL
31	13.95	0.61 mL
32	14.40	0.63 mL
33	14.85	0.65 mL
34	15.30	0.67 mL
35	15.75	0.69 mL
36	16.20	0.71 mL
37	16.65	0.73 mL
38	17.10	0.75 mL
39	17.55	0.77 mL
40	18.00	0.79 mL
41	18.45	0.81 mL
42	18.90	0.83 mL
43	19.35	0.85 mL
44	19.80	0.87 mL
45	20.25	0.89 mL
46	20.70	0.91 mL
47	21.15	0.93 mL
48	21.60	0.95 mL
49	22.05	0.97 mL
50	22.50	0.99 mL
50+	>22.5	1.00 mL

DKT—Dexmedetomidine (Dexdomitor®), Ketamine, Butorphanol (Torbugesic®)

DOSE: 0.065 mL/kg for healthy fractious cats, 0.035 mL/kg for ill fractious cats

- Dexmedetomidine (Dexdomitor®), ketamine, butorphanol (Torbugesic®) (DKT) is made by adding 1 mL of dexmedetomidine (0.5 mg/mL), 1 mL of ketamine (100 mg/mL) and 1 mL of butorphanol (10 mg/mL) into a sterile vial.
- The mixture is stable for up to two months at room temperature. Be sure to label the container appropriately as DKT.
- Atipamezole (Antisedan®) is used to reverse dexmedetomidine as necessary.
- To reverse DKT 0.035 mL/kg (ill patients), give 0.012 mL/kg atipamezole IM (1/3 volume of DKT used); to reverse DKT 0.065 mL/kg (healthy patients), give 0.021 mL/kg atipamezole IM (1/3 volume of DKT used; repeat in 10 minutes if needed.)

Pet weight		mL of DKT to administer (ill patients)	mL of atipamezole for reversal
lbs	kg	0.035 mL/kg	0.012 mL/kg
1	0.45	0.02 mL	0.01 mL
2	0.90	0.03 mL	0.01 mL
3	1.35	0.05 mL	0.02 mL
4	1.80	0.06 mL	0.02 mL
5	2.25	0.08 mL	0.03 mL
6	2.70	0.09 mL	0.03 mL
7	3.15	0.11 mL	0.04 mL
8	3.60	0.13 mL	0.04 mL
9	4.05	0.14 mL	0.05 mL
10	4.50	0.16 mL	0.05 mL
11	4.95	0.17 mL	0.06 mL
12	5.40	0.19 mL	0.06 mL
13	5.85	0.20 mL	0.07 mL
14	6.30	0.22 mL	0.08 mL
15	6.75	0.24 mL	0.08 mL
16	7.20	0.25 mL	0.09 mL
17	7.65	0.27 mL	0.09 mL
18	8.10	0.28 mL	0.10 mL
19	8.55	0.30 mL	0.10 mL
20	9.00	0.32 mL	0.11 mL
21	9.45	0.33 mL	0.11 mL
22	9.90	0.35 mL	0.12 mL
23	10.35	0.36 mL	0.12 mL
24	10.80	0.38 mL	0.13 mL
25	11.25	0.39 mL	0.14 mL
26	11.70	0.41 mL	0.14 mL
27	12.15	0.43 mL	0.15 mL
28	12.60	0.44 mL	0.15 mL
29	13.05	0.46 mL	0.16 mL
30	13.50	0.47 mL	0.16 mL

Pet weight		mL of DKT to administer (healthy patients)	mL of atipamazole for reversal
lbs	kg	0.065 mL/kg	0.021 mL/kg
1	0.45	0.03 mL	0.01 mL
2	0.90	0.06 mL	0.02 mL
3	1.35	0.09 mL	0.03 mL
4	1.80	0.12 mL	0.04 mL
5	2.25	0.15 mL	0.05 mL
6	2.70	0.18 mL	0.06 mL
7	3.15	0.20 mL	0.07 mL
8	3.60	0.23 mL	0.08 mL
9	4.05	0.26 mL	0.09 mL
10	4.50	0.29 mL	0.09 mL
11	4.95	0.32 mL	0.10 mL
12	5.40	0.35 mL	0.11 mL
13	5.85	0.38 mL	0.12 mL
14	6.30	0.41 mL	0.13 mL
15	6.75	0.44 mL	0.14 mL
16	7.20	0.47 mL	0.15 mL
17	7.65	0.50 mL	0.16 mL
18	8.10	0.53 mL	0.17 mL
19	8.55	0.56 mL	0.18 mL
20	9.00	0.59 mL	0.19 mL
21	9.45	0.61 mL	0.20 mL
22	9.90	0.64 mL	0.21 mL
23	10.35	0.67 mL	0.22 mL
24	10.80	0.70 mL	0.23 mL
25	11.25	0.73 mL	0.24 mL
26	11.70	0.76 mL	0.25 mL
27	12.15	0.79 mL	0.26 mL
28	12.60	0.82 mL	0.26 mL
29	13.05	0.85 mL	0.27 mL
30	13.50	0.88 mL	0.28 mL

Dobutamine

25 mg dobutamine in 1 liter normal saline for IV drip (0.025 mg/mL)

DOSE: 1 - 5 µg/kg/min

Pet weight		mL/hr to administer	
lbs	kg	1 µg/kg/min	5 µg/kg/min
1	0.45	1 mL/hr	5 mL/hr
2	0.90	2 mL/hr	11 mL/hr
3	1.35	3 mL/hr	16 mL/hr
4	1.80	4 mL/hr	22 mL/hr
5	2.25	5 mL/hr	27 mL/hr
6	2.70	6 mL/hr	32 mL/hr
7	3.15	8 mL/hr	38 mL/hr
8	3.60	9 mL/hr	43 mL/hr
9	4.05	10 mL/hr	49 mL/hr
10	4.50	11 mL/hr	54 mL/hr
11	4.95	12 mL/hr	59 mL/hr
12	5.40	13 mL/hr	65 mL/hr
13	5.85	14 mL/hr	70 mL/hr
14	6.30	15 mL/hr	76 mL/hr
15	6.75	16 mL/hr	81 mL/hr
16	7.20	17 mL/hr	86 mL/hr
17	7.65	18 mL/hr	92 mL/hr
18	8.10	19 mL/hr	97 mL/hr
19	8.55	21 mL/hr	103 mL/hr
20	9.00	22 mL/hr	108 mL/hr
21	9.45	23 mL/hr	113 mL/hr
22	9.90	24 mL/hr	119 mL/hr
23	10.35	25 mL/hr	124 mL/hr
24	10.80	26 mL/hr	130 mL/hr
25	11.25	27 mL/hr	135 mL/hr
26	11.70	28 mL/hr	140 mL/hr
27	12.15	29 mL/hr	146 mL/hr
28	12.60	30 mL/hr	151 mL/hr
29	13.05	31 mL/hr	157 mL/hr
30	13.50	32 mL/hr	162 mL/hr
31	13.95	33 mL/hr	167 mL/hr
32	14.40	35 mL/hr	173 mL/hr
33	14.85	36 mL/hr	178 mL/hr
34	15.30	37 mL/hr	184 mL/hr
35	15.75	38 mL/hr	189 mL/hr
36	16.20	39 mL/hr	194 mL/hr
37	16.65	40 mL/hr	200 mL/hr
38	17.10	41 mL/hr	205 mL/hr
39	17.55	42 mL/hr	211 mL/hr
40	18.00	43 mL/hr	216 mL/hr
41	18.45	44 mL/hr	221 mL/hr
42	18.90	45 mL/hr	227 mL/hr
43	19.35	46 mL/hr	232 mL/hr
44	19.80	48 mL/hr	238 mL/hr
45	20.25	49 mL/hr	243 mL/hr
46	20.70	50 mL/hr	248 mL/hr
47	21.15	51 mL/hr	254 mL/hr
48	21.60	52 mL/hr	259 mL/hr
49	22.05	53 mL/hr	265 mL/hr
50	22.50	54 mL/hr	270 mL/hr

Pet weight		mL/hr to administer	
lbs	kg	1 µg/kg/min	5 µg/kg/min
51	22.95	55 mL/hr	275 mL/hr
52	23.40	56 mL/hr	281 mL/hr
53	23.85	57 mL/hr	286 mL/hr
54	24.30	58 mL/hr	292 mL/hr
55	24.75	59 mL/hr	297 mL/hr
56	25.20	60 mL/hr	302 mL/hr
57	25.65	62 mL/hr	308 mL/hr
58	26.10	63 mL/hr	313 mL/hr
59	26.55	64 mL/hr	319 mL/hr
60	27.00	65 mL/hr	324 mL/hr
61	27.45	66 mL/hr	329 mL/hr
62	27.90	67 mL/hr	335 mL/hr
63	28.35	68 mL/hr	340 mL/hr
64	28.80	69 mL/hr	346 mL/hr
65	29.25	70 mL/hr	351 mL/hr
66	29.70	71 mL/hr	356 mL/hr
67	30.15	72 mL/hr	362 mL/hr
68	30.60	73 mL/hr	367 mL/hr
69	31.05	75 mL/hr	373 mL/hr
70	31.50	76 mL/hr	378 mL/hr
71	31.95	77 mL/hr	383 mL/hr
72	32.40	78 mL/hr	389 mL/hr
73	32.85	79 mL/hr	394 mL/hr
74	33.30	80 mL/hr	400 mL/hr
75	33.75	81 mL/hr	405 mL/hr
76	34.20	82 mL/hr	410 mL/hr
77	34.65	83 mL/hr	416 mL/hr
78	35.10	84 mL/hr	421 mL/hr
79	35.55	85 mL/hr	427 mL/hr
80	36.00	86 mL/hr	432 mL/hr
81	36.45	87 mL/hr	437 mL/hr
82	36.90	89 mL/hr	443 mL/hr
83	37.35	90 mL/hr	448 mL/hr
84	37.80	91 mL/hr	454 mL/hr
85	38.25	92 mL/hr	459 mL/hr
86	38.70	93 mL/hr	464 mL/hr
87	39.15	94 mL/hr	470 mL/hr
88	39.60	95 mL/hr	475 mL/hr
89	40.05	96 mL/hr	481 mL/hr
90	40.50	97 mL/hr	486 mL/hr
91	40.95	98 mL/hr	491 mL/hr
92	41.40	99 mL/hr	497 mL/hr
93	41.85	100 mL/hr	502 mL/hr
94	42.30	102 mL/hr	508 mL/hr
95	42.75	103 mL/hr	513 mL/hr
96	43.20	104 mL/hr	518 mL/hr
97	43.65	105 mL/hr	524 mL/hr
98	44.10	106 mL/hr	529 mL/hr
99	44.55	107 mL/hr	535 mL/hr
100	45.00	108 mL/hr	540 mL/hr

Ephedrine
5 mg/mL—AEMP

DOSE: 0.1-0.2 mg/kg for anesthesia

- Monitoring and Protocol.
- Limit to three doses – start at low end.
- Stock solution is 50 mg/ml (0.1 ml stock solution added to 0.9 ml of sterile saline = 5 mg/ml solution).

Pet weight		mL to administer	
lbs	kg	0.1 mg/kg	0.2 mg/kg
1	0.45	0.01 mL	0.02 mL
2	0.90	0.02 mL	0.04 mL
3	1.35	0.03 mL	0.05 mL
4	1.80	0.04 mL	0.07 mL
5	2.25	0.05 mL	0.09 mL
6	2.70	0.05 mL	0.11 mL
7	3.15	0.06 mL	0.13 mL
8	3.60	0.07 mL	0.14 mL
9	4.05	0.08 mL	0.16 mL
10	4.50	0.09 mL	0.18 mL
11	4.95	0.10 mL	0.20 mL
12	5.40	0.11 mL	0.22 mL
13	5.85	0.12 mL	0.23 mL
14	6.30	0.13 mL	0.25 mL
15	6.75	0.14 mL	0.27 mL
16	7.20	0.14 mL	0.29 mL
17	7.65	0.15 mL	0.31 mL
18	8.10	0.16 mL	0.32 mL
19	8.55	0.17 mL	0.34 mL
20	9.00	0.18 mL	0.36 mL
21	9.45	0.19 mL	0.38 mL
22	9.90	0.20 mL	0.40 mL
23	10.35	0.21 mL	0.41 mL
24	10.80	0.22 mL	0.43 mL
25	11.25	0.23 mL	0.45 mL
26	11.70	0.23 mL	0.47 mL
27	12.15	0.24 mL	0.49 mL
28	12.60	0.25 mL	0.50 mL
29	13.05	0.26 mL	0.52 mL
30	13.50	0.27 mL	0.54 mL
31	13.95	0.28 mL	0.56 mL
32	14.40	0.29 mL	0.58 mL
33	14.85	0.30 mL	0.59 mL
34	15.30	0.31 mL	0.61 mL
35	15.75	0.32 mL	0.63 mL
36	16.20	0.32 mL	0.65 mL
37	16.65	0.33 mL	0.67 mL
38	17.10	0.34 mL	0.68 mL
39	17.55	0.35 mL	0.70 mL
40	18.00	0.36 mL	0.72 mL
41	18.45	0.37 mL	0.74 mL
42	18.90	0.38 mL	0.76 mL
43	19.35	0.39 mL	0.77 mL
44	19.80	0.40 mL	0.79 mL
45	20.25	0.41 mL	0.81 mL
46	20.70	0.41 mL	0.83 mL
47	21.15	0.42 mL	0.85 mL
48	21.60	0.43 mL	0.86 mL
49	22.05	0.44 mL	0.88 mL
50	22.50	0.45 mL	0.90 mL

Pet weight		mL to administer	
lbs	kg	0.1 mg/kg	0.2 mg/kg
51	22.95	0.46 mL	0.92 mL
52	23.40	0.47 mL	0.94 mL
53	23.85	0.48 mL	0.95 mL
54	24.30	0.49 mL	0.97 mL
55	24.75	0.50 mL	0.99 mL
56	25.20	0.50 mL	1.01 mL
57	25.65	0.51 mL	1.03 mL
58	26.10	0.52 mL	1.04 mL
59	26.55	0.53 mL	1.06 mL
60	27.00	0.54 mL	1.08 mL
61	27.45	0.55 mL	1.10 mL
62	27.90	0.56 mL	1.12 mL
63	28.35	0.57 mL	1.13 mL
64	28.80	0.58 mL	1.15 mL
65	29.25	0.59 mL	1.17 mL
66	29.70	0.59 mL	1.19 mL
67	30.15	0.60 mL	1.21 mL
68	30.60	0.61 mL	1.22 mL
69	31.05	0.62 mL	1.24 mL
70	31.50	0.63 mL	1.26 mL
71	31.95	0.64 mL	1.28 mL
72	32.40	0.65 mL	1.30 mL
73	32.85	0.66 mL	1.31 mL
74	33.30	0.67 mL	1.33 mL
75	33.75	0.68 mL	1.35 mL
76	34.20	0.68 mL	1.37 mL
77	34.65	0.69 mL	1.39 mL
78	35.10	0.70 mL	1.40 mL
79	35.55	0.71 mL	1.42 mL
80	36.00	0.72 mL	1.44 mL
81	36.45	0.73 mL	1.46 mL
82	36.90	0.74 mL	1.48 mL
83	37.35	0.75 mL	1.49 mL
84	37.80	0.76 mL	1.51 mL
85	38.25	0.77 mL	1.53 mL
86	38.70	0.77 mL	1.55 mL
87	39.15	0.78 mL	1.57 mL
88	39.60	0.79 mL	1.58 mL
89	40.05	0.80 mL	1.60 mL
90	40.50	0.81 mL	1.62 mL
91	40.95	0.82 mL	1.64 mL
92	41.40	0.83 mL	1.66 mL
93	41.85	0.84 mL	1.67 mL
94	42.30	0.85 mL	1.69 mL
95	42.75	0.86 mL	1.71 mL
96	43.20	0.86 mL	1.73 mL
97	43.65	0.87 mL	1.75 mL
98	44.10	0.88 mL	1.76 mL
99	44.55	0.89 mL	1.78 mL
100	45.00	0.90 mL	1.80 mL

Epinephrine
1:1,000 = 1 mg/mL—CPR

LOW DOSE: 0.01 - 0.02 mg/kg IV
HIGH DOSE: 0.1 - 0.2 mg/kg IV for cardiopulmonary resuscitation

Pet weight		Low dose		High dose
lbs	kg	0.01 mg/kg	0.02 mg/kg	0.2 mg/kg
1	0.45	0.005 mL	0.01 mL	0.09 mL
2	0.90	0.01 mL	0.02 mL	0.18 mL
3	1.35	0.01 mL	0.03 mL	0.27 mL
4	1.80	0.02 mL	0.04 mL	0.36 mL
5	2.25	0.02 mL	0.05 mL	0.45 mL
6	2.70	0.03 mL	0.05 mL	0.54 mL
7	3.15	0.03 mL	0.06 mL	0.63 mL
8	3.60	0.04 mL	0.07 mL	0.72 mL
9	4.05	0.04 mL	0.08 mL	0.81 mL
10	4.50	0.05 mL	0.09 mL	0.90 mL
11	4.95	0.05 mL	0.10 mL	0.99 mL
12	5.40	0.05 mL	0.11 mL	1.08 mL
13	5.85	0.06 mL	0.12 mL	1.17 mL
14	6.30	0.06 mL	0.13 mL	1.26 mL
15	6.75	0.07 mL	0.14 mL	1.35 mL
16	7.20	0.07 mL	0.14 mL	1.44 mL
17	7.65	0.08 mL	0.15 mL	1.53 mL
18	8.10	0.08 mL	0.16 mL	1.62 mL
19	8.55	0.09 mL	0.17 mL	1.71 mL
20	9.00	0.09 mL	0.18 mL	1.80 mL
21	9.45	0.09 mL	0.19 mL	1.89 mL
22	9.90	0.10 mL	0.20 mL	1.98 mL
23	10.35	0.10 mL	0.21 mL	2.07 mL
24	10.80	0.11 mL	0.22 mL	2.16 mL
25	11.25	0.11 mL	0.23 mL	2.25 mL
26	11.70	0.12 mL	0.23 mL	2.34 mL
27	12.15	0.12 mL	0.24 mL	2.43 mL
28	12.60	0.13 mL	0.25 mL	2.52 mL
29	13.05	0.13 mL	0.26 mL	2.61 mL
30	13.50	0.14 mL	0.27 mL	2.70 mL
31	13.95	0.14 mL	0.28 mL	2.79 mL
32	14.40	0.14 mL	0.29 mL	2.88 mL
33	14.85	0.15 mL	0.30 mL	2.97 mL
34	15.30	0.15 mL	0.31 mL	3.06 mL
35	15.75	0.16 mL	0.32 mL	3.15 mL
36	16.20	0.16 mL	0.32 mL	3.24 mL
37	16.65	0.17 mL	0.33 mL	3.33 mL
38	17.10	0.17 mL	0.34 mL	3.42 mL
39	17.55	0.18 mL	0.35 mL	3.51 mL
40	18.00	0.18 mL	0.36 mL	3.60 mL
41	18.45	0.18 mL	0.37 mL	3.69 mL
42	18.90	0.19 mL	0.38 mL	3.78 mL
43	19.35	0.19 mL	0.39 mL	3.87 mL
44	19.80	0.20 mL	0.40 mL	3.96 mL
45	20.25	0.20 mL	0.41 mL	4.05 mL
46	20.70	0.21 mL	0.41 mL	4.14 mL
47	21.15	0.21 mL	0.42 mL	4.23 mL
48	21.60	0.22 mL	0.43 mL	4.32 mL
49	22.05	0.22 mL	0.44 mL	4.41 mL
50	22.50	0.23 mL	0.45 mL	4.50 mL

Epinephrine, cont'd
1:1,000 = 1 mg/mL—CPR

LOW DOSE: 0.01 - 0.02 mg/kg IV
HIGH DOSE: 0.1 - 0.2 mg/kg IV for cardiopulmonary resuscitation

Pet weight		Low dose		High dose
lbs	kg	0.01 mg/kg	0.02 mg/kg	0.2 mg/kg
51	22.95	0.23 mL	0.46 mL	4.59 mL
52	23.40	0.23 mL	0.47 mL	4.68 mL
53	23.85	0.24 mL	0.48 mL	4.77 mL
54	24.30	0.24 mL	0.49 mL	4.86 mL
55	24.75	0.25 mL	0.50 mL	4.95 mL
56	25.20	0.25 mL	0.50 mL	5.04 mL
57	25.65	0.26 mL	0.51 mL	5.13 mL
58	26.10	0.26 mL	0.52 mL	5.22 mL
59	26.55	0.27 mL	0.53 mL	5.31 mL
60	27.00	0.27 mL	0.54 mL	5.40 mL
61	27.45	0.27 mL	0.55 mL	5.49 mL
62	27.90	0.28 mL	0.56 mL	5.58 mL
63	28.35	0.28 mL	0.57 mL	5.67 mL
64	28.80	0.29 mL	0.58 mL	5.76 mL
65	29.25	0.29 mL	0.59 mL	5.85 mL
66	29.70	0.30 mL	0.59 mL	5.94 mL
67	30.15	0.30 mL	0.60 mL	6.03 mL
68	30.60	0.31 mL	0.61 mL	6.12 mL
69	31.05	0.31 mL	0.62 mL	6.21 mL
70	31.50	0.32 mL	0.63 mL	6.30 mL
71	31.95	0.32 mL	0.64 mL	6.39 mL
72	32.40	0.32 mL	0.65 mL	6.48 mL
73	32.85	0.33 mL	0.66 mL	6.57 mL
74	33.30	0.33 mL	0.67 mL	6.66 mL
75	33.75	0.34 mL	0.68 mL	6.75 mL
76	34.20	0.34 mL	0.68 mL	6.84 mL
77	34.65	0.35 mL	0.69 mL	6.93 mL
78	35.10	0.35 mL	0.70 mL	7.02 mL
79	35.55	0.36 mL	0.71 mL	7.11 mL
80	36.00	0.36 mL	0.72 mL	7.20 mL
81	36.45	0.36 mL	0.73 mL	7.29 mL
82	36.90	0.37 mL	0.74 mL	7.38 mL
83	37.35	0.37 mL	0.75 mL	7.47 mL
84	37.80	0.38 mL	0.76 mL	7.56 mL
85	38.25	0.38 mL	0.77 mL	7.65 mL
86	38.70	0.39 mL	0.77 mL	7.74 mL
87	39.15	0.39 mL	0.78 mL	7.83 mL
88	39.60	0.40 mL	0.79 mL	7.92 mL
89	40.05	0.40 mL	0.80 mL	8.01 mL
90	40.50	0.41 mL	0.81 mL	8.10 mL
91	40.95	0.41 mL	0.82 mL	8.19 mL
92	41.40	0.41 mL	0.83 mL	8.28 mL
93	41.85	0.42 mL	0.84 mL	8.37 mL
94	42.30	0.42 mL	0.85 mL	8.46 mL
95	42.75	0.43 mL	0.86 mL	8.55 mL
96	43.20	0.43 mL	0.86 mL	8.64 mL
97	43.65	0.44 mL	0.87 mL	8.73 mL
98	44.10	0.44 mL	0.88 mL	8.82 mL
99	44.55	0.45 mL	0.89 mL	8.91 mL
100	45.00	0.45 mL	0.90 mL	9.00 mL

Fentanyl Injectable

0.05 mg/mL

DOSE: 0.003 mg/kg IV loading dose. Must be followed by 0.02 - 0.06 µg/kg/min constant rate infusion (CRI)—refer to CRI mixing instructions, page 21.

Pet weight		mL/hr to administer for CRI		mL to administer for IV loading dose
lbs	kg	0.02 µg/kg/min	0.06 µg/kg/min	0.003 mg/kg
1	0.45	0.45 mL	1.35 mL	0.03 mL
2	0.90	0.90 mL	2.70 mL	0.05 mL
3	1.35	1.35 mL	4.05 mL	0.08 mL
4	1.80	1.80 mL	5.40 mL	0.11 mL
5	2.25	2.25 mL	6.75 mL	0.14 mL
6	2.70	2.70 mL	8.10 mL	0.16 mL
7	3.15	3.15 mL	9.45 mL	0.19 mL
8	3.60	3.60 mL	10.80 mL	0.22 mL
9	4.05	4.05 mL	12.15 mL	0.24 mL
10	4.50	4.50 mL	13.50 mL	0.27 mL
11	4.95	4.95 mL	14.85 mL	0.30 mL
12	5.40	5.40 mL	16.20 mL	0.32 mL
13	5.85	5.85 mL	17.55 mL	0.35 mL
14	6.30	6.30 mL	18.90 mL	0.38 mL
15	6.75	6.75 mL	20.25 mL	0.41 mL
16	7.20	7.20 mL	21.60 mL	0.43 mL
17	7.65	7.65 mL	22.95 mL	0.46 mL
18	8.10	8.10 mL	24.30 mL	0.49 mL
19	8.55	8.55 mL	25.65 mL	0.51 mL
20	9.00	9.00 mL	27.00 mL	0.54 mL
21	9.45	9.45 mL	28.35 mL	0.57 mL
22	9.90	9.90 mL	29.70 mL	0.59 mL
23	10.35	10.35 mL	31.05 mL	0.62 mL
24	10.80	10.80 mL	32.40 mL	0.65 mL
25	11.25	11.25 mL	33.75 mL	0.68 mL
26	11.70	11.70 mL	35.10 mL	0.70 mL
27	12.15	12.15 mL	36.45 mL	0.73 mL
28	12.60	12.60 mL	37.80 mL	0.76 mL
29	13.05	13.05 mL	39.15 mL	0.78 mL
30	13.50	13.50 mL	40.50 mL	0.81 mL
31	13.95	13.95 mL	41.85 mL	0.84 mL
32	14.40	14.40 mL	43.20 mL	0.86 mL
33	14.85	14.85 mL	44.55 mL	0.89 mL
34	15.30	15.30 mL	45.90 mL	0.92 mL
35	15.75	15.75 mL	47.25 mL	0.95 mL
36	16.20	16.20 mL	48.60 mL	0.97 mL
37	16.65	16.65 mL	49.95 mL	1.00 mL
38	17.10	17.10 mL	51.30 mL	1.03 mL
39	17.55	17.55 mL	52.65 mL	1.05 mL
40	18.00	18.00 mL	54.00 mL	1.08 mL
41	18.45	18.45 mL	55.35 mL	1.11 mL
42	18.90	18.90 mL	56.70 mL	1.13 mL
43	19.35	19.35 mL	58.05 mL	1.16 mL
44	19.80	19.80 mL	59.40 mL	1.19 mL
45	20.25	20.25 mL	60.75 mL	1.22 mL
46	20.70	20.70 mL	62.10 mL	1.24 mL
47	21.15	21.15 mL	63.45 mL	1.27 mL
48	21.60	21.60 mL	64.80 mL	1.30 mL
49	22.05	22.05 mL	66.15 mL	1.32 mL
50	22.50	22.50 mL	67.50 mL	1.35 mL

Fentanyl Injectable, cont'd

0.05 mg/mL

DOSE: 0.003 mg/kg IV loading dose. Must be followed by 0.02 - 0.06 µg/kg/min constant rate infusion (CRI)—refer to CRI mixing instructions, page 21.

Pet weight		mL/hr to administer for CRI		mL to administer for IV loading dose
lbs	kg	0.02 µg/kg/min	0.06 µg/kg/min	0.003 mg/kg
51	22.95	22.95 mL	68.85 mL	1.38 mL
52	23.40	23.40 mL	70.20 mL	1.40 mL
53	23.85	23.85 mL	71.55 mL	1.43 mL
54	24.30	24.30 mL	72.90 mL	1.46 mL
55	24.75	24.75 mL	74.25 mL	1.49 mL
56	25.20	25.20 mL	75.60 mL	1.51 mL
57	25.65	25.65 mL	76.95 mL	1.54 mL
58	26.10	26.10 mL	78.30 mL	1.57 mL
59	26.55	26.55 mL	79.65 mL	1.59 mL
60	27.00	27.00 mL	81.00 mL	1.62 mL
61	27.45	27.45 mL	82.35 mL	1.65 mL
62	27.90	27.90 mL	83.70 mL	1.67 mL
63	28.35	28.35 mL	85.05 mL	1.70 mL
64	28.80	28.80 mL	86.40 mL	1.73 mL
65	29.25	29.25 mL	87.75 mL	1.76 mL
66	29.70	29.70 mL	89.10 mL	1.78 mL
67	30.15	30.15 mL	90.45 mL	1.81 mL
68	30.60	30.60 mL	91.80 mL	1.84 mL
69	31.05	31.05 mL	93.15 mL	1.86 mL
70	31.50	31.50 mL	94.50 mL	1.89 mL
71	31.95	31.95 mL	95.85 mL	1.92 mL
72	32.40	32.40 mL	97.20 mL	1.94 mL
73	32.85	32.85 mL	98.55 mL	1.97 mL
74	33.30	33.30 mL	99.90 mL	2.00 mL
75	33.75	33.75 mL	101.25 mL	2.03 mL
76	34.20	34.20 mL	102.60 mL	2.05 mL
77	34.65	34.65 mL	103.95 mL	2.08 mL
78	35.10	35.10 mL	105.30 mL	2.11 mL
79	35.55	35.55 mL	106.65 mL	2.13 mL
80	36.00	36.00 mL	108.00 mL	2.16 mL
81	36.45	36.45 mL	109.35 mL	2.19 mL
82	36.90	36.90 mL	110.70 mL	2.21 mL
83	37.35	37.35 mL	112.05 mL	2.24 mL
84	37.80	37.80 mL	113.40 mL	2.27 mL
85	38.25	38.25 mL	114.75 mL	2.30 mL
86	38.70	38.70 mL	116.10 mL	2.32 mL
87	39.15	39.15 mL	117.45 mL	2.35 mL
88	39.60	39.60 mL	118.80 mL	2.38 mL
89	40.05	40.05 mL	120.15 mL	2.40 mL
90	40.50	40.50 mL	121.50 mL	2.43 mL
91	40.95	40.95 mL	122.85 mL	2.46 mL
92	41.40	41.40 mL	124.20 mL	2.48 mL
93	41.85	41.85 mL	125.55 mL	2.51 mL
94	42.30	42.30 mL	126.90 mL	2.54 mL
95	42.75	42.75 mL	128.25 mL	2.57 mL
96	43.20	43.20 mL	129.60 mL	2.59 mL
97	43.65	43.65 mL	130.95 mL	2.62 mL
98	44.10	44.10 mL	132.30 mL	2.65 mL
99	44.55	44.55 mL	133.65 mL	2.67 mL
100	45.00	45.00 mL	135.00 mL	2.70 mL

Glycopyrrolate
0.2 mg/mL

DOSE: 0.01 mg/kg for Anesthesia Monitoring and Emergency Protocol

• Glycopyrrolate can cause an initial slowing of the heart rate when given IV.

Pet weight		mL to administer
lbs	kg	0.01 mg/kg
1	0.45	0.02 mL
2	0.90	0.05 mL
3	1.35	0.07 mL
4	1.80	0.09 mL
5	2.25	0.11 mL
6	2.70	0.14 mL
7	3.15	0.16 mL
8	3.60	0.18 mL
9	4.05	0.20 mL
10	4.50	0.23 mL
11	4.95	0.25 mL
12	5.40	0.27 mL
13	5.85	0.29 mL
14	6.30	0.32 mL
15	6.75	0.34 mL
16	7.20	0.36 mL
17	7.65	0.38 mL
18	8.10	0.41 mL
19	8.55	0.43 mL
20	9.00	0.45 mL
21	9.45	0.47 mL
22	9.90	0.50 mL
23	10.35	0.52 mL
24	10.80	0.54 mL
25	11.25	0.56 mL
26	11.70	0.59 mL
27	12.15	0.61 mL
28	12.60	0.63 mL
29	13.05	0.65 mL
30	13.50	0.68 mL
31	13.95	0.70 mL
32	14.40	0.72 mL
33	14.85	0.74 mL
34	15.30	0.77 mL
35	15.75	0.79 mL
36	16.20	0.81 mL
37	16.65	0.83 mL
38	17.10	0.86 mL
39	17.55	0.88 mL
40	18.00	0.90 mL
41	18.45	0.92 mL
42	18.90	0.95 mL
43	19.35	0.97 mL
44	19.80	0.99 mL
45	20.25	1.01 mL
46	20.70	1.04 mL
47	21.15	1.06 mL
48	21.60	1.08 mL
49	22.05	1.10 mL
50	22.50	1.13 mL

Pet weight		mL to administer
lbs	kg	0.01 mg/kg
51	22.95	1.15 mL
52	23.40	1.17 mL
53	23.85	1.19 mL
54	24.30	1.22 mL
55	24.75	1.24 mL
56	25.20	1.26 mL
57	25.65	1.28 mL
58	26.10	1.31 mL
59	26.55	1.33 mL
60	27.00	1.35 mL
61	27.45	1.37 mL
62	27.90	1.40 mL
63	28.35	1.42 mL
64	28.80	1.44 mL
65	29.25	1.46 mL
66	29.70	1.49 mL
67	30.15	1.51 mL
68	30.60	1.53 mL
69	31.05	1.55 mL
70	31.50	1.58 mL
71	31.95	1.60 mL
72	32.40	1.62 mL
73	32.85	1.64 mL
74	33.30	1.67 mL
75	33.75	1.69 mL
76	34.20	1.71 mL
77	34.65	1.73 mL
78	35.10	1.76 mL
79	35.55	1.78 mL
80	36.00	1.80 mL
81	36.45	1.82 mL
82	36.90	1.85 mL
83	37.35	1.87 mL
84	37.80	1.89 mL
85	38.25	1.91 mL
86	38.70	1.94 mL
87	39.15	1.96 mL
88	39.60	1.98 mL
89	40.05	2.00 mL
90	40.50	2.03 mL
91	40.95	2.05 mL
92	41.40	2.07 mL
93	41.85	2.09 mL
94	42.30	2.12 mL
95	42.75	2.14 mL
96	43.20	2.16 mL
97	43.65	2.18 mL
98	44.10	2.21 mL
99	44.55	2.23 mL
100	45.00	2.25 mL

Hetastarch

6% in 0.9% Sodium Chloride

DOSE:
Dogs: 5 mL/kg IV bolus up to 20 mL/kg/day
Cats: 2.5 mL/kg IV bolus up to 10 mL/kg/day

Pet weight		mL to administer in cats	mL to administer in dogs
lbs	kg	2.5 ml/kg	5 ml/kg
1	0.45	1.13 mL	2.25 mL
2	0.90	2.25 mL	4.50 mL
3	1.35	3.38 mL	6.75 mL
4	1.80	4.50 mL	9.00 mL
5	2.25	5.63 mL	11.25 mL
6	2.70	6.75 mL	13.50 mL
7	3.15	7.88 mL	15.75 mL
8	3.60	9.00 mL	18.00 mL
9	4.05	10.13 mL	20.25 mL
10	4.50	11.25 mL	22.50 mL
11	4.95	12.38 mL	24.75 mL
12	5.40	13.50 mL	27.00 mL
13	5.85	14.63 mL	29.25 mL
14	6.30	15.75 mL	31.50 mL
15	6.75	16.88 mL	33.75 mL
16	7.20	18.00 mL	36.00 mL
17	7.65	19.13 mL	38.25 mL
18	8.10	20.25 mL	40.50 mL
19	8.55	21.38 mL	42.75 mL
20	9.00	22.50 mL	45.00 mL
21	9.45	23.63 mL	47.25 mL
22	9.90	24.75 mL	49.50 mL
23	10.35	25.88 mL	51.75 mL
24	10.80	27.00 mL	54.00 mL
25	11.25	28.13 mL	56.25 mL
26	11.70		58.50 mL
27	12.15		60.75 mL
28	12.60		63.00 mL
29	13.05		65.25 mL
30	13.50		67.50 mL
31	13.95		69.75 mL
32	14.40		72.00 mL
33	14.85		74.25 mL
34	15.30		76.50 mL
35	15.75		78.75 mL
36	16.20		81.00 mL
37	16.65		83.25 mL
38	17.10		85.50 mL
39	17.55		87.75 mL
40	18.00		90.00 mL
41	18.45		92.25 mL
42	18.90		94.50 mL
43	19.35		96.75 mL
44	19.80		99.0 mL
45	20.25		101 mL
46	20.70		104 mL
47	21.15		106 mL
48	21.60		108 mL
49	22.05		110 mL
50	22.50		113 mL

Pet weight		mL to administer in dogs
lbs	kg	5 ml/kg
51	22.95	115 mL
52	23.40	117 mL
53	23.85	119 mL
54	24.30	122 mL
55	24.75	124 mL
56	25.20	126 mL
57	25.65	128 mL
58	26.10	131 mL
59	26.55	133 mL
60	27.00	135 mL
61	27.45	137 mL
62	27.90	140 mL
63	28.35	142 mL
64	28.80	144 mL
65	29.25	146 mL
66	29.70	149 mL
67	30.15	151 mL
68	30.60	153 mL
69	31.05	155 mL
70	31.50	158 mL
71	31.95	160 mL
72	32.40	162 mL
73	32.85	164 mL
74	33.30	167 mL
75	33.75	169 mL
76	34.20	171 mL
77	34.65	173 mL
78	35.10	176 mL
79	35.55	178 mL
80	36.00	180 mL
81	36.45	182 mL
82	36.90	185 mL
83	37.35	187 mL
84	37.80	189 mL
85	38.25	191 mL
86	38.70	194 mL
87	39.15	196 mL
88	39.60	198 mL
89	40.05	200 mL
90	40.50	203 mL
91	40.95	205 mL
92	41.40	207 mL
93	41.85	209 mL
94	42.30	212 mL
95	42.75	214 mL
96	43.20	216 mL
97	43.65	218 mL
98	44.10	221 mL
99	44.55	223 mL
100	45.00	225 mL

Hydromorphone
2 mg/mL

DOSE: Dogs: 0.05 - 0.2 mg/kg IM, IV, SC for anesthesia; 0.03 - 0.04 mg/kg for epidurals
Cats: 0.05 - 0.1 mg/kg IM, IV, SC for anesthesia

Pet weight		mL to administer		For epidurals	
lbs	kg	0.05 mg/kg	0.2 mg/kg	0.03 mg/kg	0.04 mg/kg
1	0.45	0.01 mL	0.05 mL	0.01 mL	0.01 mL
2	0.90	0.02 mL	0.09 mL	0.01 mL	0.02 mL
3	1.35	0.03 mL	0.14 mL	0.02 mL	0.03 mL
4	1.80	0.05 mL	0.18 mL	0.03 mL	0.04 mL
5	2.25	0.06 mL	0.23 mL	0.03 mL	0.05 mL
6	2.70	0.07 mL	0.27 mL	0.04 mL	0.05 mL
7	3.15	0.08 mL	0.32 mL	0.05 mL	0.06 mL
8	3.60	0.09 mL	0.36 mL	0.05 mL	0.07 mL
9	4.05	0.10 mL	0.41 mL	0.06 mL	0.08 mL
10	4.50	0.11 mL	0.45 mL	0.07 mL	0.09 mL
11	4.95	0.12 mL	0.50 mL	0.07 mL	0.10 mL
12	5.40	0.14 mL	0.54 mL	0.08 mL	0.11 mL
13	5.85	0.15 mL	0.59 mL	0.09 mL	0.12 mL
14	6.30	0.16 mL	0.63 mL	0.09 mL	0.13 mL
15	6.75	0.17 mL	0.68 mL	0.10 mL	0.14 mL
16	7.20	0.18 mL	0.72 mL	0.11 mL	0.14 mL
17	7.65	0.19 mL	0.77 mL	0.11 mL	0.15 mL
18	8.10	0.20 mL	0.81 mL	0.12 mL	0.16 mL
19	8.55	0.21 mL	0.86 mL	0.13 mL	0.17 mL
20	9.00	0.23 mL	0.90 mL	0.14 mL	0.18 mL
21	9.45	0.24 mL	0.95 mL	0.14 mL	0.19 mL
22	9.90	0.25 mL	0.99 mL	0.15 mL	0.20 mL
23	10.35	0.26 mL	1.04 mL	0.16 mL	0.21 mL
24	10.80	0.27 mL	1.08 mL	0.16 mL	0.22 mL
25	11.25	0.28 mL	1.13 mL	0.17 mL	0.23 mL
26	11.70	0.29 mL	1.17 mL	0.18 mL	0.23 mL
27	12.15	0.30 mL	1.22 mL	0.18 mL	0.24 mL
28	12.60	0.32 mL	1.26 mL	0.19 mL	0.25 mL
29	13.05	0.33 mL	1.31 mL	0.20 mL	0.26 mL
30	13.50	0.34 mL	1.35 mL	0.20 mL	0.27 mL
31	13.95	0.35 mL	1.40 mL	0.21 mL	0.28 mL
32	14.40	0.36 mL	1.44 mL	0.22 mL	0.29 mL
33	14.85	0.37 mL	1.49 mL	0.22 mL	0.30 mL
34	15.30	0.38 mL	1.53 mL	0.23 mL	0.31 mL
35	15.75	0.39 mL	1.58 mL	0.24 mL	0.32 mL
36	16.20	0.41 mL	1.62 mL	0.24 mL	0.32 mL
37	16.65	0.42 mL	1.67 mL	0.25 mL	0.33 mL
38	17.10	0.43 mL	1.71 mL	0.26 mL	0.34 mL
39	17.55	0.44 mL	1.76 mL	0.26 mL	0.35 mL
40	18.00	0.45 mL	1.80 mL	0.27 mL	0.36 mL
41	18.45	0.46 mL	1.85 mL	0.28 mL	0.37 mL
42	18.90	0.47 mL	1.89 mL	0.28 mL	0.38 mL
43	19.35	0.48 mL	1.94 mL	0.29 mL	0.39 mL
44	19.80	0.50 mL	1.98 mL	0.30 mL	0.40 mL
45	20.25	0.51 mL	2.03 mL	0.30 mL	0.41 mL
46	20.70	0.52 mL	2.07 mL	0.31 mL	0.41 mL
47	21.15	0.53 mL	2.12 mL	0.32 mL	0.42 mL
48	21.60	0.54 mL	2.16 mL	0.32 mL	0.43 mL
49	22.05	0.55 mL	2.21 mL	0.33 mL	0.44 mL
50	22.50	0.56 mL	2.25 mL	0.34 mL	0.45 mL

Hydromorphone, cont'd
2 mg/mL

DOSE: Dogs: 0.05 - 0.2 mg/kg IM, IV, SC for anesthesia; 0.03 - 0.04 mg/kg for epidurals
Cats: 0.05 - 0.1 mg/kg IM, IV, SC for anesthesia

Pet weight		mL to administer		For epidurals	
lbs	kg	0.05 mg/kg	0.2 mg/kg	0.03 mg/kg	0.04 mg/kg
51	22.95	0.57 mL	2.30 mL	0.34 mL	0.46 mL
52	23.40	0.59 mL	2.34 mL	0.35 mL	0.47 mL
53	23.85	0.60 mL	2.39 mL	0.36 mL	0.48 mL
54	24.30	0.61 mL	2.43 mL	0.36 mL	0.49 mL
55	24.75	0.62 mL	2.48 mL	0.37 mL	0.50 mL
56	25.20	0.63 mL	2.52 mL	0.38 mL	0.50 mL
57	25.65	0.64 mL	2.57 mL	0.38 mL	0.51 mL
58	26.10	0.65 mL	2.61 mL	0.39 mL	0.52 mL
59	26.55	0.66 mL	2.66 mL	0.40 mL	0.53 mL
60	27.00	0.68 mL	2.70 mL	0.41 mL	0.54 mL
61	27.45	0.69 mL	2.75 mL	0.41 mL	0.55 mL
62	27.90	0.70 mL	2.79 mL	0.42 mL	0.56 mL
63	28.35	0.71 mL	2.84 mL	0.43 mL	0.57 mL
64	28.80	0.72 mL	2.88 mL	0.43 mL	0.58 mL
65	29.25	0.73 mL	2.93 mL	0.44 mL	0.59 mL
66	29.70	0.74 mL	2.97 mL	0.45 mL	0.59 mL
67	30.15	0.75 mL	3.02 mL	0.45 mL	0.60 mL
68	30.60	0.77 mL	3.06 mL	0.46 mL	0.61 mL
69	31.05	0.78 mL	3.11 mL	0.47 mL	0.62 mL
70	31.50	0.79 mL	3.15 mL	0.47 mL	0.63 mL
71	31.95	0.80 mL	3.20 mL	0.48 mL	0.64 mL
72	32.40	0.81 mL	3.24 mL	0.49 mL	0.65 mL
73	32.85	0.82 mL	3.29 mL	0.49 mL	0.66 mL
74	33.30	0.83 mL	3.33 mL	0.50 mL	0.67 mL
75	33.75	0.84 mL	3.38 mL	0.51 mL	0.68 mL
76	34.20	0.86 mL	3.42 mL	0.51 mL	0.68 mL
77	34.65	0.87 mL	3.47 mL	0.52 mL	0.69 mL
78	35.10	0.88 mL	3.51 mL	0.53 mL	0.70 mL
79	35.55	0.89 mL	3.56 mL	0.53 mL	0.71 mL
80	36.00	0.90 mL	3.60 mL	0.54 mL	0.72 mL
81	36.45	0.91 mL	3.65 mL	0.55 mL	0.73 mL
82	36.90	0.92 mL	3.69 mL	0.55 mL	0.74 mL
83	37.35	0.93 mL	3.74 mL	0.56 mL	0.75 mL
84	37.80	0.95 mL	3.78 mL	0.57 mL	0.76 mL
85	38.25	0.96 mL	3.83 mL	0.57 mL	0.77 mL
86	38.70	0.97 mL	3.87 mL	0.58 mL	0.77 mL
87	39.15	0.98 mL	3.92 mL	0.59 mL	0.78 mL
88	39.60	0.99 mL	3.96 mL	0.59 mL	0.79 mL
89	40.05	1.00 mL	4.01 mL	0.60 mL	0.80 mL
90	40.50	1.01 mL	4.05 mL	0.61 mL	0.81 mL
91	40.95	1.02 mL	4.10 mL	0.61 mL	0.82 mL
92	41.40	1.04 mL	4.14 mL	0.62 mL	0.83 mL
93	41.85	1.05 mL	4.19 mL	0.63 mL	0.84 mL
94	42.30	1.06 mL	4.23 mL	0.63 mL	0.85 mL
95	42.75	1.07 mL	4.28 mL	0.64 mL	0.86 mL
96	43.20	1.08 mL	4.32 mL	0.65 mL	0.86 mL
97	43.65	1.09 mL	4.37 mL	0.65 mL	0.87 mL
98	44.10	1.10 mL	4.41 mL	0.66 mL	0.88 mL
99	44.55	1.11 mL	4.46 mL	0.67 mL	0.89 mL
100	45.00	1.13 mL	4.50 mL	0.68 mL	0.90 mL

Lidocaine for VPCs

20 mg/mL

DOSE:
Dogs: 1 - 4 mg/kg—administer slowly to effect IV for VPCs.
Cats: 0.25 - 0.5 mg/kg—administer slowly to effect IV for VPCs.

- Note: Can cause bradycardia.
- Lidocaine dose is the same for both AMEP and CPR charts.

Pet weight		Dose for dogs		Dose for cats	
lbs	kg	1 mg/kg	2 mg/kg	0.25 mg/kg	0.5 mg/kg
1	0.45	0.02 mL	0.05 mL	0.01 mL	0.01 mL
2	0.90	0.05 mL	0.09 mL	0.01 mL	0.02 mL
3	1.35	0.07 mL	0.14 mL	0.02 mL	0.03 mL
4	1.80	0.09 mL	0.18 mL	0.02 mL	0.05 mL
5	2.25	0.11 mL	0.23 mL	0.03 mL	0.06 mL
6	2.70	0.14 mL	0.27 mL	0.03 mL	0.07 mL
7	3.15	0.16 mL	0.32 mL	0.04 mL	0.08 mL
8	3.60	0.18 mL	0.36 mL	0.05 mL	0.09 mL
9	4.05	0.20 mL	0.41 mL	0.05 mL	0.10 mL
10	4.50	0.23 mL	0.45 mL	0.06 mL	0.11 mL
11	4.95	0.25 mL	0.50 mL	0.06 mL	0.12 mL
12	5.40	0.27 mL	0.54 mL	0.07 mL	0.14 mL
13	5.85	0.29 mL	0.59 mL	0.07 mL	0.15 mL
14	6.30	0.32 mL	0.63 mL	0.08 mL	0.16 mL
15	6.75	0.34 mL	0.68 mL	0.08 mL	0.17 mL
16	7.20	0.36 mL	0.72 mL	0.09 mL	0.18 mL
17	7.65	0.38 mL	0.77 mL	0.10 mL	0.19 mL
18	8.10	0.41 mL	0.81 mL	0.10 mL	0.20 mL
19	8.55	0.43 mL	0.86 mL	0.11 mL	0.21 mL
20	9.00	0.45 mL	0.90 mL	0.11 mL	0.23 mL
21	9.45	0.47 mL	0.95 mL	0.12 mL	0.24 mL
22	9.90	0.50 mL	0.99 mL	0.12 mL	0.25 mL
23	10.35	0.52 mL	1.04 mL	0.13 mL	0.26 mL
24	10.80	0.54 mL	1.08 mL	0.14 mL	0.27 mL
25	11.25	0.56 mL	1.13 mL	0.14 mL	0.28 mL
26	11.70	0.59 mL	1.17 mL	0.15 mL	0.29 mL
27	12.15	0.61 mL	1.22 mL	0.15 mL	0.30 mL
28	12.60	0.63 mL	1.26 mL	0.16 mL	0.32 mL
29	13.05	0.65 mL	1.31 mL	0.16 mL	0.33 mL
30	13.50	0.68 mL	1.35 mL	0.17 mL	0.34 mL
31	13.95	0.70 mL	1.40 mL		
32	14.40	0.72 mL	1.44 mL		
33	14.85	0.74 mL	1.49 mL		
34	15.30	0.77 mL	1.53 mL		
35	15.75	0.79 mL	1.58 mL		
36	16.20	0.81 mL	1.62 mL		
37	16.65	0.83 mL	1.67 mL		
38	17.10	0.86 mL	1.71 mL		
39	17.55	0.88 mL	1.76 mL		
40	18.00	0.90 mL	1.80 mL		
41	18.45	0.92 mL	1.85 mL		
42	18.90	0.95 mL	1.89 mL		
43	19.35	0.97 mL	1.94 mL		
44	19.80	0.99 mL	1.98 mL		
45	20.25	1.01 mL	2.03 mL		
46	20.70	1.04 mL	2.07 mL		
47	21.15	1.06 mL	2.12 mL		
48	21.60	1.08 mL	2.16 mL		
49	22.05	1.10 mL	2.21 mL		
50	22.50	1.13 mL	2.25 mL		

Lidocaine for VPCs, cont'd

20 mg/mL

DOSE:
Dogs: 1 - 4 mg/kg—administer slowly to effect IV for VPCs.
Cats: 0.25 - 0.5 mg/kg—administer slowly to effect IV for VPCs.

- Note: Can cause bradycardia.
- Lidocaine dose is the same for AMEP and CPR charts.

Pet weight		Dose for dogs	
lbs	kg	1 mg/kg	2 mg/kg
51	22.95	1.15 mL	2.30 mL
52	23.40	1.17 mL	2.34 mL
53	23.85	1.19 mL	2.39 mL
54	24.30	1.22 mL	2.43 mL
55	24.75	1.24 mL	2.48 mL
56	25.20	1.26 mL	2.52 mL
57	25.65	1.28 mL	2.57 mL
58	26.10	1.31 mL	2.61 mL
59	26.55	1.33 mL	2.66 mL
60	27.00	1.35 mL	2.70 mL
61	27.45	1.37 mL	2.75 mL
62	27.90	1.40 mL	2.79 mL
63	28.35	1.42 mL	2.84 mL
64	28.80	1.44 mL	2.88 mL
65	29.25	1.46 mL	2.93 mL
66	29.70	1.49 mL	2.97 mL
67	30.15	1.51 mL	3.02 mL
68	30.60	1.53 mL	3.06 mL
69	31.05	1.55 mL	3.11 mL
70	31.50	1.58 mL	3.15 mL
71	31.95	1.60 mL	3.20 mL
72	32.40	1.62 mL	3.24 mL
73	32.85	1.64 mL	3.29 mL
74	33.30	1.67 mL	3.33 mL
75	33.75	1.69 mL	3.38 mL
76	34.20	1.71 mL	3.42 mL
77	34.65	1.73 mL	3.47 mL
78	35.10	1.76 mL	3.51 mL
79	35.55	1.78 mL	3.56 mL
80	36.00	1.80 mL	3.60 mL
81	36.45	1.82 mL	3.65 mL
82	36.90	1.85 mL	3.69 mL
83	37.35	1.87 mL	3.74 mL
84	37.80	1.89 mL	3.78 mL
85	38.25	1.91 mL	3.83 mL
86	38.70	1.94 mL	3.87 mL
87	39.15	1.96 mL	3.92 mL
88	39.60	1.98 mL	3.96 mL
89	40.05	2.00 mL	4.01 mL
90	40.50	2.03 mL	4.05 mL
91	40.95	2.05 mL	4.10 mL
92	41.40	2.07 mL	4.14 mL
93	41.85	2.09 mL	4.19 mL
94	42.30	2.12 mL	4.23 mL
95	42.75	2.14 mL	4.28 mL
96	43.20	2.16 mL	4.32 mL
97	43.65	2.18 mL	4.37 mL
98	44.10	2.21 mL	4.41 mL
99	44.55	2.23 mL	4.46 mL
100	45.00	2.25 mL	4.50 mL

Lidocaine Local Anesthetic Blocks

2% (20 mg/mL)

DOSE: 1 - 2 mg/kg for local blocks; doses are cumulative; do not mix with bupivacaine.

Pet weight		mL to administer	
lbs	kg	1 mg/kg	2 mg/kg
1	0.45	0.02 mL	0.05 mL
2	0.90	0.05 mL	0.09 mL
3	1.35	0.07 mL	0.14 mL
4	1.80	0.09 mL	0.18 mL
5	2.25	0.11 mL	0.23 mL
6	2.70	0.14 mL	0.27 mL
7	3.15	0.16 mL	0.32 mL
8	3.60	0.18 mL	0.36 mL
9	4.05	0.20 mL	0.41 mL
10	4.50	0.23 mL	0.45 mL
11	4.95	0.25 mL	0.50 mL
12	5.40	0.27 mL	0.54 mL
13	5.85	0.29 mL	0.59 mL
14	6.30	0.32 mL	0.63 mL
15	6.75	0.34 mL	0.68 mL
16	7.20	0.36 mL	0.72 mL
17	7.65	0.38 mL	0.77 mL
18	8.10	0.41 mL	0.81 mL
19	8.55	0.43 mL	0.86 mL
20	9.00	0.45 mL	0.90 mL
21	9.45	0.47 mL	0.95 mL
22	9.90	0.50 mL	0.99 mL
23	10.35	0.52 mL	1.04 mL
24	10.80	0.54 mL	1.08 mL
25	11.25	0.56 mL	1.13 mL
26	11.70	0.59 mL	1.17 mL
27	12.15	0.61 mL	1.22 mL
28	12.60	0.63 mL	1.26 mL
29	13.05	0.65 mL	1.31 mL
30	13.50	0.68 mL	1.35 mL
31	13.95	0.70 mL	1.40 mL
32	14.40	0.72 mL	1.44 mL
33	14.85	0.74 mL	1.49 mL
34	15.30	0.77 mL	1.53 mL
35	15.75	0.79 mL	1.58 mL
36	16.20	0.81 mL	1.62 mL
37	16.65	0.83 mL	1.67 mL
38	17.10	0.86 mL	1.71 mL
39	17.55	0.88 mL	1.76 mL
40	18.00	0.90 mL	1.80 mL
41	18.45	0.92 mL	1.85 mL
42	18.90	0.95 mL	1.89 mL
43	19.35	0.97 mL	1.94 mL
44	19.80	0.99 mL	1.98 mL
45	20.25	1.01 mL	2.03 mL
46	20.70	1.04 mL	2.07 mL
47	21.15	1.06 mL	2.12 mL
48	21.60	1.08 mL	2.16 mL
49	22.05	1.10 mL	2.21 mL
50	22.50	1.13 mL	2.25 mL

Pet weight		mL to administer	
lbs	kg	1 mg/kg	2 mg/kg
51	22.95	1.15 mL	2.30 mL
52	23.40	1.17 mL	2.34 mL
53	23.85	1.19 mL	2.39 mL
54	24.30	1.22 mL	2.43 mL
55	24.75	1.24 mL	2.48 mL
56	25.20	1.26 mL	2.52 mL
57	25.65	1.28 mL	2.57 mL
58	26.10	1.31 mL	2.61 mL
59	26.55	1.33 mL	2.66 mL
60	27.00	1.35 mL	2.70 mL
61	27.45	1.37 mL	2.75 mL
62	27.90	1.40 mL	2.79 mL
63	28.35	1.42 mL	2.84 mL
64	28.80	1.44 mL	2.88 mL
65	29.25	1.46 mL	2.93 mL
66	29.70	1.49 mL	2.97 mL
67	30.15	1.51 mL	3.02 mL
68	30.60	1.53 mL	3.06 mL
69	31.05	1.55 mL	3.11 mL
70	31.50	1.58 mL	3.15 mL
71	31.95	1.60 mL	3.20 mL
72	32.40	1.62 mL	3.24 mL
73	32.85	1.64 mL	3.29 mL
74	33.30	1.67 mL	3.33 mL
75	33.75	1.69 mL	3.38 mL
76	34.20	1.71 mL	3.42 mL
77	34.65	1.73 mL	3.47 mL
78	35.10	1.76 mL	3.51 mL
79	35.55	1.78 mL	3.56 mL
80	36.00	1.80 mL	3.60 mL
81	36.45	1.82 mL	3.65 mL
82	36.90	1.85 mL	3.69 mL
83	37.35	1.87 mL	3.74 mL
84	37.80	1.89 mL	3.78 mL
85	38.25	1.91 mL	3.83 mL
86	38.70	1.94 mL	3.87 mL
87	39.15	1.96 mL	3.92 mL
88	39.60	1.98 mL	3.96 mL
89	40.05	2.00 mL	4.01 mL
90	40.50	2.03 mL	4.05 mL
91	40.95	2.05 mL	4.10 mL
92	41.40	2.07 mL	4.14 mL
93	41.85	2.09 mL	4.19 mL
94	42.30	2.12 mL	4.23 mL
95	42.75	2.14 mL	4.28 mL
96	43.20	2.16 mL	4.32 mL
97	43.65	2.18 mL	4.37 mL
98	44.10	2.21 mL	4.41 mL
99	44.55	2.23 mL	4.46 mL
100	45.00	2.25 mL	4.50 mL

Meloxicam Injectable

5 mg/mL

DOSE: 0.1 to 0.2 mg/kg SC as part of declaw protocol in cats. 0.1 to 0.2 mg/kg dose is one-time only.

Pet weight		mL to administer in cats	
lbs	kg	0.1 mg/kg	0.2 mg/kg
1	0.45	0.01 mL	0.02 mL
2	0.90	0.02 mL	0.04 mL
3	1.35	0.03 mL	0.05 mL
4	1.80	0.04 mL	0.07 mL
5	2.25	0.05 mL	0.09 mL
6	2.70	0.05 mL	0.11 mL
7	3.15	0.06 mL	0.13 mL
8	3.60	0.07 mL	0.14 mL
9	4.05	0.08 mL	0.16 mL
10	4.50	0.09 mL	0.18 mL
11	4.95	0.10 mL	0.20 mL
12	5.40	0.11 mL	0.22 mL
13	5.85	0.12 mL	0.23 mL
14	6.30	0.13 mL	0.25 mL
15	6.75	0.14 mL	0.27 mL
16	7.20	0.14 mL	0.29 mL
17	7.65	0.15 mL	0.31 mL
18	8.10	0.16 mL	0.32 mL
19	8.55	0.17 mL	0.34 mL
20	9.00	0.18 mL	0.36 mL
21	9.45	0.19 mL	0.38 mL
22	9.90	0.20 mL	0.40 mL
23	10.35	0.21 mL	0.41 mL
24	10.80	0.22 mL	0.43 mL
25	11.25	0.23 mL	0.45 mL

Midazolam (Canine & Feline)

1 mg/mL

DOSE: 0.1 to 0.2 mg/kg IM
0.1 mg/kg IV for emergency protocol

Pet weight		mL to administer	
lbs	kg	0.1 mg/kg	0.2 mg/kg
1	0.45	0.05 mL	0.09 mL
2	0.90	0.09 mL	0.18 mL
3	1.35	0.14 mL	0.27 mL
4	1.80	0.18 mL	0.36 mL
5	2.25	0.23 mL	0.45 mL
6	2.70	0.27 mL	0.54 mL
7	3.15	0.32 mL	0.63 mL
8	3.60	0.36 mL	0.72 mL
9	4.05	0.41 mL	0.81 mL
10	4.50	0.45 mL	0.90 mL
11	4.95	0.50 mL	0.99 mL
12	5.40	0.54 mL	1.08 mL
13	5.85	0.59 mL	1.17 mL
14	6.30	0.63 mL	1.26 mL
15	6.75	0.68 mL	1.35 mL
16	7.20	0.72 mL	1.44 mL
17	7.65	0.77 mL	1.53 mL
18	8.10	0.81 mL	1.62 mL
19	8.55	0.86 mL	1.71 mL
20	9.00	0.90 mL	1.80 mL
21	9.45	0.95 mL	1.89 mL
22	9.90	0.99 mL	1.98 mL
23	10.35	1.04 mL	2.07 mL
24	10.80	1.08 mL	2.16 mL
25	11.25	1.13 mL	2.25 mL
26	11.70	1.17 mL	2.34 mL
27	12.15	1.22 mL	2.43 mL
28	12.60	1.26 mL	2.52 mL
29	13.05	1.31 mL	2.61 mL
30	13.50	1.35 mL	2.70 mL
31	13.95	1.40 mL	2.79 mL
32	14.40	1.44 mL	2.88 mL
33	14.85	1.49 mL	2.97 mL
34	15.30	1.53 mL	3.06 mL
35	15.75	1.58 mL	3.15 mL
36	16.20	1.62 mL	3.24 mL
37	16.65	1.67 mL	3.33 mL
38	17.10	1.71 mL	3.42 mL
39	17.55	1.76 mL	3.51 mL
40	18.00	1.80 mL	3.60 mL
41	18.45	1.85 mL	3.69 mL
42	18.90	1.89 mL	3.78 mL
43	19.35	1.94 mL	3.87 mL
44	19.80	1.98 mL	3.96 mL
45	20.25	2.03 mL	4.05 mL
46	20.70	2.07 mL	4.14 mL
47	21.15	2.12 mL	4.23 mL
48	21.60	2.16 mL	4.32 mL
49	22.05	2.21 mL	4.41 mL
50	22.50	2.25 mL	4.50 mL

Pet weight		mL to administer	
lbs	kg	0.1 mg/kg	0.2 mg/kg
51	22.95	2.30 mL	4.59 mL
52	23.40	2.34 mL	4.68 mL
53	23.85	2.39 mL	4.77 mL
54	24.30	2.43 mL	4.86 mL
55	24.75	2.48 mL	4.95 mL
56	25.20	2.52 mL	5.04 mL
57	25.65	2.57 mL	5.13 mL
58	26.10	2.61 mL	5.22 mL
59	26.55	2.66 mL	5.31 mL
60	27.00	2.70 mL	5.40 mL
61	27.45	2.75 mL	5.49 mL
62	27.90	2.79 mL	5.58 mL
63	28.35	2.84 mL	5.67 mL
64	28.80	2.88 mL	5.76 mL
65	29.25	2.93 mL	5.85 mL
66	29.70	2.97 mL	5.94 mL
67	30.15	3.02 mL	6.03 mL
68	30.60	3.06 mL	6.12 mL
69	31.05	3.11 mL	6.21 mL
70	31.50	3.15 mL	6.30 mL
71	31.95	3.20 mL	6.39 mL
72	32.40	3.24 mL	6.48 mL
73	32.85	3.29 mL	6.57 mL
74	33.30	3.33 mL	6.66 mL
75	33.75	3.38 mL	6.75 mL
76	34.20	3.42 mL	6.84 mL
77	34.65	3.47 mL	6.93 mL
78	35.10	3.51 mL	7.02 mL
79	35.55	3.56 mL	7.11 mL
80	36.00	3.60 mL	7.20 mL
81	36.45	3.65 mL	7.29 mL
82	36.90	3.69 mL	7.38 mL
83	37.35	3.74 mL	7.47 mL
84	37.80	3.78 mL	7.56 mL
85	38.25	3.83 mL	7.65 mL
86	38.70	3.87 mL	7.74 mL
87	39.15	3.92 mL	7.83 mL
88	39.60	3.96 mL	7.92 mL
89	40.05	4.01 mL	8.01 mL
90	40.50	4.05 mL	8.10 mL
91	40.95	4.10 mL	8.19 mL
92	41.40	4.14 mL	8.28 mL
93	41.85	4.19 mL	8.37 mL
94	42.30	4.23 mL	8.46 mL
95	42.75	4.28 mL	8.55 mL
96	43.20	4.32 mL	8.64 mL
97	43.65	4.37 mL	8.73 mL
98	44.10	4.41 mL	8.82 mL
99	44.55	4.46 mL	8.91 mL
100	45.00	4.50 mL	9.00 mL

Midazolam (Canine & Feline)

5 mg/mL

DOSE: 0.1 to 0.2 mg/kg IM
0.1 mg/kg IV for emergency protocol

Pet weight		mL to administer	
lbs	kg	0.1 mg/kg	0.2 mg/kg
1	0.45	0.01 mL	0.02 mL
2	0.90	0.02 mL	0.04 mL
3	1.35	0.03 mL	0.05 mL
4	1.80	0.04 mL	0.07 mL
5	2.25	0.05 mL	0.09 mL
6	2.70	0.05 mL	0.11 mL
7	3.15	0.06 mL	0.13 mL
8	3.60	0.07 mL	0.14 mL
9	4.05	0.08 mL	0.16 mL
10	4.50	0.09 mL	0.18 mL
11	4.95	0.10 mL	0.20 mL
12	5.40	0.11 mL	0.22 mL
13	5.85	0.12 mL	0.23 mL
14	6.30	0.13 mL	0.25 mL
15	6.75	0.14 mL	0.27 mL
16	7.20	0.14 mL	0.29 mL
17	7.65	0.15 mL	0.31 mL
18	8.10	0.16 mL	0.32 mL
19	8.55	0.17 mL	0.34 mL
20	9.00	0.18 mL	0.36 mL
21	9.45	0.19 mL	0.38 mL
22	9.90	0.20 mL	0.40 mL
23	10.35	0.21 mL	0.41 mL
24	10.80	0.22 mL	0.43 mL
25	11.25	0.23 mL	0.45 mL
26	11.70	0.23 mL	0.47 mL
27	12.15	0.24 mL	0.49 mL
28	12.60	0.25 mL	0.50 mL
29	13.05	0.26 mL	0.52 mL
30	13.50	0.27 mL	0.54 mL
31	13.95	0.28 mL	0.56 mL
32	14.40	0.29 mL	0.58 mL
33	14.85	0.30 mL	0.59 mL
34	15.30	0.31 mL	0.61 mL
35	15.75	0.32 mL	0.63 mL
36	16.20	0.32 mL	0.65 mL
37	16.65	0.33 mL	0.67 mL
38	17.10	0.34 mL	0.68 mL
39	17.55	0.35 mL	0.70 mL
40	18.00	0.36 mL	0.72 mL
41	18.45	0.37 mL	0.74 mL
42	18.90	0.38 mL	0.76 mL
43	19.35	0.39 mL	0.77 mL
44	19.80	0.40 mL	0.79 mL
45	20.25	0.41 mL	0.81 mL
46	20.70	0.41 mL	0.83 mL
47	21.15	0.42 mL	0.85 mL
48	21.60	0.43 mL	0.86 mL
49	22.05	0.44 mL	0.88 mL
50	22.50	0.45 mL	0.90 mL

Pet weight		mL to administer	
lbs	kg	0.1 mg/kg	0.2 mg/kg
51	22.95	0.46 mL	0.92 mL
52	23.40	0.47 mL	0.94 mL
53	23.85	0.48 mL	0.95 mL
54	24.30	0.49 mL	0.97 mL
55	24.75	0.50 mL	0.99 mL
56	25.20	0.50 mL	1.01 mL
57	25.65	0.51 mL	1.03 mL
58	26.10	0.52 mL	1.04 mL
59	26.55	0.53 mL	1.06 mL
60	27.00	0.54 mL	1.08 mL
61	27.45	0.55 mL	1.10 mL
62	27.90	0.56 mL	1.12 mL
63	28.35	0.57 mL	1.13 mL
64	28.80	0.58 mL	1.15 mL
65	29.25	0.59 mL	1.17 mL
66	29.70	0.59 mL	1.19 mL
67	30.15	0.60 mL	1.21 mL
68	30.60	0.61 mL	1.22 mL
69	31.05	0.62 mL	1.24 mL
70	31.50	0.63 mL	1.26 mL
71	31.95	0.64 mL	1.28 mL
72	32.40	0.65 mL	1.30 mL
73	32.85	0.66 mL	1.31 mL
74	33.30	0.67 mL	1.33 mL
75	33.75	0.68 mL	1.35 mL
76	34.20	0.68 mL	1.37 mL
77	34.65	0.69 mL	1.39 mL
78	35.10	0.70 mL	1.40 mL
79	35.55	0.71 mL	1.42 mL
80	36.00	0.72 mL	1.44 mL
81	36.45	0.73 mL	1.46 mL
82	36.90	0.74 mL	1.48 mL
83	37.35	0.75 mL	1.49 mL
84	37.80	0.76 mL	1.51 mL
85	38.25	0.77 mL	1.53 mL
86	38.70	0.77 mL	1.55 mL
87	39.15	0.78 mL	1.57 mL
88	39.60	0.79 mL	1.58 mL
89	40.05	0.80 mL	1.60 mL
90	40.50	0.81 mL	1.62 mL
91	40.95	0.82 mL	1.64 mL
92	41.40	0.83 mL	1.66 mL
93	41.85	0.84 mL	1.67 mL
94	42.30	0.85 mL	1.69 mL
95	42.75	0.86 mL	1.71 mL
96	43.20	0.86 mL	1.73 mL
97	43.65	0.87 mL	1.75 mL
98	44.10	0.88 mL	1.76 mL
99	44.55	0.89 mL	1.78 mL
100	45.00	0.90 mL	1.80 mL

Midazolam (Exotics)

1 mg/mL

DOSE: 0.2 to 0.4 mg/kg up to 1mg/kg

Pet weight		mL to administer	
lbs	kg	0.2 mg/kg	0.4 mg/kg
1	0.45	0.09 mL	0.18 mL
2	0.90	0.18 mL	0.36 mL
3	1.35	0.27 mL	0.54 mL
4	1.80	0.36 mL	0.72 mL
5	2.25	0.45 mL	0.90 mL
6	2.70	0.54 mL	1.08 mL
7	3.15	0.63 mL	1.26 mL
8	3.60	0.72 mL	1.44 mL
9	4.05	0.81 mL	1.62 mL
10	4.50	0.90 mL	1.80 mL
11	4.95	0.99 mL	1.98 mL
12	5.40	1.08 mL	2.16 mL
13	5.85	1.17 mL	2.34 mL
14	6.30	1.26 mL	2.52 mL
15	6.75	1.35 mL	2.70 mL
16	7.20	1.44 mL	2.88 mL
17	7.65	1.53 mL	3.06 mL
18	8.10	1.62 mL	3.24 mL
19	8.55	1.71 mL	3.42 mL
20	9.00	1.80 mL	3.60 mL
21	9.45	1.89 mL	3.78 mL
22	9.90	1.98 mL	3.96 mL
23	10.35	2.07 mL	4.14 mL
24	10.80	2.16 mL	4.32 mL
25	11.25	2.25 mL	4.50 mL
26	11.70	2.34 mL	4.68 mL
27	12.15	2.43 mL	4.86 mL
28	12.60	2.52 mL	5.04 mL
29	13.05	2.61 mL	5.22 mL
30	13.50	2.70 mL	5.40 mL
31	13.95	2.79 mL	5.58 mL
32	14.40	2.88 mL	5.76 mL
33	14.85	2.97 mL	5.94 mL
34	15.30	3.06 mL	6.12 mL
35	15.75	3.15 mL	6.30 mL
36	16.20	3.24 mL	6.48 mL
37	16.65	3.33 mL	6.66 mL
38	17.10	3.42 mL	6.84 mL
39	17.55	3.51 mL	7.02 mL
40	18.00	3.60 mL	7.20 mL
41	18.45	3.69 mL	7.38 mL
42	18.90	3.78 mL	7.56 mL
43	19.35	3.87 mL	7.74 mL
44	19.80	3.96 mL	7.92 mL
45	20.25	4.05 mL	8.10 mL
46	20.70	4.14 mL	8.28 mL
47	21.15	4.23 mL	8.46 mL
48	21.60	4.32 mL	8.64 mL
49	22.05	4.41 mL	8.82 mL
50	22.50	4.50 mL	9.00 mL

Pet weight		mL to administer	
lbs	kg	0.2 mg/kg	0.4 mg/kg
51	22.95	4.59 mL	9.18 mL
52	23.40	4.68 mL	9.36 mL
53	23.85	4.77 mL	9.54 mL
54	24.30	4.86 mL	9.72 mL
55	24.75	4.95 mL	9.90 mL
56	25.20	5.04 mL	10.08 mL
57	25.65	5.13 mL	10.26 mL
58	26.10	5.22 mL	10.44 mL
59	26.55	5.31 mL	10.62 mL
60	27.00	5.40 mL	10.80 mL
61	27.45	5.49 mL	10.98 mL
62	27.90	5.58 mL	11.16 mL
63	28.35	5.67 mL	11.34 mL
64	28.80	5.76 mL	11.52 mL
65	29.25	5.85 mL	11.70 mL
66	29.70	5.94 mL	11.88 mL
67	30.15	6.03 mL	12.06 mL
68	30.60	6.12 mL	12.24 mL
69	31.05	6.21 mL	12.42 mL
70	31.50	6.30 mL	12.60 mL
71	31.95	6.39 mL	12.78 mL
72	32.40	6.48 mL	12.96 mL
73	32.85	6.57 mL	13.14 mL
74	33.30	6.66 mL	13.32 mL
75	33.75	6.75 mL	13.50 mL
76	34.20	6.84 mL	13.68 mL
77	34.65	6.93 mL	13.86 mL
78	35.10	7.02 mL	14.04 mL
79	35.55	7.11 mL	14.22 mL
80	36.00	7.20 mL	14.40 mL
81	36.45	7.29 mL	14.58 mL
82	36.90	7.38 mL	14.76 mL
83	37.35	7.47 mL	14.94 mL
84	37.80	7.56 mL	15.12 mL
85	38.25	7.65 mL	15.30 mL
86	38.70	7.74 mL	15.48 mL
87	39.15	7.83 mL	15.66 mL
88	39.60	7.92 mL	15.84 mL
89	40.05	8.01 mL	16.02 mL
90	40.50	8.10 mL	16.20 mL
91	40.95	8.19 mL	16.38 mL
92	41.40	8.28 mL	16.56 mL
93	41.85	8.37 mL	16.74 mL
94	42.30	8.46 mL	16.92 mL
95	42.75	8.55 mL	17.10 mL
96	43.20	8.64 mL	17.28 mL
97	43.65	8.73 mL	17.46 mL
98	44.10	8.82 mL	17.64 mL
99	44.55	8.91 mL	17.82 mL
100	45.00	9.00 mL	18.00 mL

Propofol
10 mg/mL

DOSE: 1 - 6 mg/kg IV for immobilization and induction for anesthesia protocols

Pet weight		mL to administer		
lbs	kg	2 mg/kg	4 mg/kg	6 mg/kg
1	0.45	0.09 mL	0.18 mL	0.27 mL
2	0.90	0.18 mL	0.36 mL	0.54 mL
3	1.35	0.27 mL	0.54 mL	0.81 mL
4	1.80	0.36 mL	0.72 mL	1.08 mL
5	2.25	0.45 mL	0.90 mL	1.35 mL
6	2.70	0.54 mL	1.08 mL	1.62 mL
7	3.15	0.63 mL	1.26 mL	1.89 mL
8	3.60	0.72 mL	1.44 mL	2.16 mL
9	4.05	0.81 mL	1.62 mL	2.43 mL
10	4.50	0.90 mL	1.80 mL	2.70 mL
11	4.95	0.99 mL	1.98 mL	2.97 mL
12	5.40	1.08 mL	2.16 mL	3.24 mL
13	5.85	1.17 mL	2.34 mL	3.51 mL
14	6.30	1.26 mL	2.52 mL	3.78 mL
15	6.75	1.35 mL	2.70 mL	4.05 mL
16	7.20	1.44 mL	2.90 mL	4.32 mL
17	7.65	1.53 mL	3.06 mL	4.59 mL
18	8.10	1.62 mL	3.24 mL	4.86 mL
19	8.55	1.71 mL	3.42 mL	5.13 mL
20	9.00	1.80 mL	3.60 mL	5.40 mL
21	9.45	1.89 mL	3.78 mL	5.67 mL
22	9.90	1.98 mL	3.96 mL	5.94 mL
23	10.35	2.07 mL	4.14 mL	6.21 mL
24	10.80	2.16 mL	4.32 mL	6.48 mL
25	11.25	2.25 mL	4.50 mL	6.75 mL
26	11.70	2.34 mL	4.68 mL	7.02 mL
27	12.15	2.43 mL	4.86 mL	7.29 mL
28	12.60	2.52 mL	5.04 mL	7.56 mL
29	13.05	2.61 mL	5.22 mL	7.83 mL
30	13.50	2.70 mL	5.40 mL	8.10 mL
31	13.95	2.79 mL	5.58 mL	8.37 mL
32	14.40	2.88 mL	5.76 mL	8.64 mL
33	14.85	2.97 mL	5.94 mL	8.91 mL
34	15.30	3.06 mL	6.12 mL	9.18 mL
35	15.75	3.15 mL	6.30 mL	9.45 mL
36	16.20	3.24 mL	6.48 mL	9.72 mL
37	16.65	3.33 mL	6.66 mL	9.99 mL
38	17.10	3.42 mL	6.84 mL	10.26 mL
39	17.55	3.51 mL	7.02 mL	10.53 mL
40	18.00	3.60 mL	7.20 mL	10.80 mL
41	18.45	3.69 mL	7.38 mL	11.07 mL
42	18.90	3.78 mL	7.56 mL	11.34 mL
43	19.35	3.87 mL	7.74 mL	11.61 mL
44	19.80	3.96 mL	7.92 mL	11.88 mL
45	20.25	4.05 mL	8.10 mL	12.15 mL
46	20.70	4.14 mL	8.28 mL	12.42 mL
47	21.15	4.23 mL	8.46 mL	12.69 mL
48	21.60	4.32 mL	8.64 mL	12.96 mL
49	22.05	4.41 mL	8.82 mL	13.23 mL
50	22.50	4.50 mL	9.00 mL	13.50 mL

Pet weight		mL to administer		
lbs	kg	2 mg/kg	4 mg/kg	6 mg/kg
51	22.95	4.59 mL	9.18 mL	13.77 mL
52	23.40	4.68 mL	9.36 mL	14.04 mL
53	23.85	4.77 mL	9.54 mL	14.31 mL
54	24.30	4.86 mL	9.72 mL	14.58 mL
55	24.75	4.95 mL	9.90 mL	14.85 mL
56	25.20	5.04 mL	10.08 mL	15.12 mL
57	25.65	5.13 mL	10.26 mL	15.39 mL
58	26.10	5.22 mL	10.44 mL	15.66 mL
59	26.55	5.31 mL	10.62 mL	15.93 mL
60	27.00	5.40 mL	10.80 mL	16.20 mL
61	27.45	5.49 mL	10.98 mL	16.47 mL
62	27.90	5.58 mL	11.16 mL	16.74 mL
63	28.35	5.67 mL	11.34 mL	17.01 mL
64	28.80	5.76 mL	11.52 mL	17.28 mL
65	29.25	5.85 mL	11.70 mL	17.55 mL
66	29.70	5.94 mL	11.88 mL	17.82 mL
67	30.15	6.03 mL	12.06 mL	18.09 mL
68	30.60	6.12 mL	12.24 mL	18.36 mL
69	31.05	6.21 mL	12.42 mL	18.63 mL
70	31.50	6.30 mL	12.60 mL	18.90 mL
71	31.95	6.39 mL	12.78 mL	19.17 mL
72	32.40	6.48 mL	12.96 mL	19.44 mL
73	32.85	6.57 mL	13.14 mL	19.71 mL
74	33.30	6.66 mL	13.32 mL	19.98 mL
75	33.75	6.75 mL	13.50 mL	20.25 mL
76	34.20	6.84 mL	13.68 mL	20.52 mL
77	34.65	6.93 mL	13.86 mL	20.79 mL
78	35.10	7.02 mL	14.04 mL	21.06 mL
79	35.55	7.11 mL	14.22 mL	21.33 mL
80	36.00	7.20 mL	14.40 mL	21.60 mL
81	36.45	7.29 mL	14.58 mL	21.87 mL
82	36.90	7.38 mL	14.76 mL	22.14 mL
83	37.35	7.47 mL	14.94 mL	22.41 mL
84	37.80	7.56 mL	15.12 mL	22.68 mL
85	38.25	7.65 mL	15.30 mL	22.95 mL
86	38.70	7.74 mL	15.48 mL	23.22 mL
87	39.15	7.83 mL	15.66 mL	23.49 mL
88	39.60	7.92 mL	15.84 mL	23.76 mL
89	40.05	8.01 mL	16.02 mL	24.03 mL
90	40.50	8.10 mL	16.20 mL	24.30 mL
91	40.95	8.19 mL	16.38 mL	24.57 mL
92	41.40	8.28 mL	16.56 mL	24.84 mL
93	41.85	8.37 mL	16.74 mL	25.11 mL
94	42.30	8.46 mL	16.92 mL	25.38 mL
95	42.75	8.55 mL	17.10 mL	25.65 mL
96	43.20	8.64 mL	17.28 mL	25.92 mL
97	43.65	8.73 mL	17.46 mL	26.19 mL
98	44.10	8.82 mL	17.64 mL	26.46 mL
99	44.55	8.91 mL	17.82 mL	26.73 mL
100	45.00	9.00 mL	18.00 mL	27.00 mL

Telazol
100 mg/mL

DOSE: 1 - 4 mg/kg IM for fractious dogs and 1 - 2 mg/kg IV for ear surgery induction

Pet weight		mL to administer			
lbs	kg	1 mg/kg	2 mg/kg	3 mg/kg	4 mg/kg
1	0.45	0.005 mL	0.01 mL	0.01 mL	0.02 mL
2	0.90	0.01 mL	0.02 mL	0.03 mL	0.04 mL
3	1.35	0.01 mL	0.03 mL	0.04 mL	0.05 mL
4	1.80	0.02 mL	0.04 mL	0.05 mL	0.07 mL
5	2.25	0.02 mL	0.05 mL	0.07 mL	0.09 mL
6	2.70	0.03 mL	0.05 mL	0.08 mL	0.11 mL
7	3.15	0.03 mL	0.06 mL	0.09 mL	0.13 mL
8	3.60	0.04 mL	0.07 mL	0.11 mL	0.14 mL
9	4.05	0.04 mL	0.08 mL	0.12 mL	0.16 mL
10	4.50	0.05 mL	0.09 mL	0.14 mL	0.18 mL
11	4.95	0.05 mL	0.10 mL	0.15 mL	0.20 mL
12	5.40	0.05 mL	0.11 mL	0.16 mL	0.22 mL
13	5.85	0.06 mL	0.12 mL	0.18 mL	0.23 mL
14	6.30	0.06 mL	0.13 mL	0.19 mL	0.25 mL
15	6.75	0.07 mL	0.14 mL	0.20 mL	0.27 mL
16	7.20	0.07 mL	0.14 mL	0.22 mL	0.29 mL
17	7.65	0.08 mL	0.15 mL	0.23 mL	0.31 mL
18	8.10	0.08 mL	0.16 mL	0.24 mL	0.32 mL
19	8.55	0.09 mL	0.17 mL	0.26 mL	0.34 mL
20	9.00	0.09 mL	0.18 mL	0.27 mL	0.36 mL
21	9.45	0.09 mL	0.19 mL	0.28 mL	0.38 mL
22	9.90	0.10 mL	0.20 mL	0.30 mL	0.40 mL
23	10.35	0.10 mL	0.21 mL	0.31 mL	0.41 mL
24	10.80	0.11 mL	0.22 mL	0.32 mL	0.43 mL
25	11.25	0.11 mL	0.23 mL	0.34 mL	0.45 mL
26	11.70	0.12 mL	0.23 mL	0.35 mL	0.47 mL
27	12.15	0.12 mL	0.24 mL	0.36 mL	0.49 mL
28	12.60	0.13 mL	0.25 mL	0.38 mL	0.50 mL
29	13.05	0.13 mL	0.26 mL	0.39 mL	0.52 mL
30	13.50	0.14 mL	0.27 mL	0.41 mL	0.54 mL
31	13.95	0.14 mL	0.28 mL	0.42 mL	0.56 mL
32	14.40	0.14 mL	0.29 mL	0.43 mL	0.58 mL
33	14.85	0.15 mL	0.30 mL	0.45 mL	0.59 mL
34	15.30	0.15 mL	0.31 mL	0.46 mL	0.61 mL
35	15.75	0.16 mL	0.32 mL	0.47 mL	0.63 mL
36	16.20	0.16 mL	0.32 mL	0.49 mL	0.65 mL
37	16.65	0.17 mL	0.33 mL	0.50 mL	0.67 mL
38	17.10	0.17 mL	0.34 mL	0.51 mL	0.68 mL
39	17.55	0.18 mL	0.35 mL	0.53 mL	0.70 mL
40	18.00	0.18 mL	0.36 mL	0.54 mL	0.72 mL
41	18.45	0.18 mL	0.37 mL	0.55 mL	0.74 mL
42	18.90	0.19 mL	0.38 mL	0.57 mL	0.76 mL
43	19.35	0.19 mL	0.39 mL	0.58 mL	0.77 mL
44	19.80	0.20 mL	0.40 mL	0.59 mL	0.79 mL
45	20.25	0.20 mL	0.41 mL	0.61 mL	0.81 mL
46	20.70	0.21 mL	0.41 mL	0.62 mL	0.83 mL
47	21.15	0.21 mL	0.42 mL	0.63 mL	0.85 mL
48	21.60	0.22 mL	0.43 mL	0.65 mL	0.86 mL
49	22.05	0.22 mL	0.44 mL	0.66 mL	0.88 mL
50	22.50	0.23 mL	0.45 mL	0.68 mL	0.90 mL

Telazol, cont'd
100 mg/mL

DOSE: 1 to 4 mg/kg IM for fractious dogs and 1 - 2 mg/kg IV for ear surgery induction

Pet weight		mL to administer			
lbs	kg	1 mg/kg	2 mg/kg	3 mg/kg	4 mg/kg
51	22.95	0.23 mL	0.46 mL	0.69 mL	0.92 mL
52	23.40	0.23 mL	0.47 mL	0.70 mL	0.94 mL
53	23.85	0.24 mL	0.48 mL	0.72 mL	0.95 mL
54	24.30	0.24 mL	0.49 mL	0.73 mL	0.97 mL
55	24.75	0.25 mL	0.50 mL	0.74 mL	0.99 mL
56	25.20	0.25 mL	0.50 mL	0.76 mL	1.01 mL
57	25.65	0.26 mL	0.51 mL	0.77 mL	1.03 ml
58	26.10	0.26 mL	0.52 mL	0.78 mL	1.04 mL
59	26.55	0.27 mL	0.53 mL	0.80 mL	1.06 mL
60	27.00	0.27 mL	0.54 mL	0.81 mL	1.08 mL
61	27.45	0.27 mL	0.55 mL	0.82 mL	1.10 mL
62	27.90	0.28 mL	0.56 mL	0.84 mL	1.12 mL
63	28.35	0.28 mL	0.57 mL	0.85 mL	1.13 mL
64	28.80	0.29 mL	0.58 mL	0.86 mL	1.15 mL
65	29.25	0.29 mL	0.59 mL	0.88 mL	1.17 mL
66	29.70	0.30 mL	0.59 mL	0.89 mL	1.19 mL
67	30.15	0.30 mL	0.60 mL	0.90 mL	1.21 mL
68	30.60	0.31 mL	0.61 mL	0.92 mL	1.22 mL
69	31.05	0.31 mL	0.62 mL	0.93 mL	1.24 mL
70	31.50	0.32 mL	0.63 mL	0.95 mL	1.26 mL
71	31.95	0.32 mL	0.64 mL	0.96 mL	1.28 mL
72	32.40	0.32 mL	0.65 mL	0.97 mL	1.30 mL
73	32.85	0.33 mL	0.66 mL	0.99 mL	1.31 mL
74	33.30	0.33 mL	0.67 mL	1.00 mL	1.33 mL
75	33.75	0.34 mL	0.68 mL	1.01 mL	1.35 mL
76	34.20	0.34 mL	0.68 mL	1.03 mL	1.37 mL
77	34.65	0.35 mL	0.69 mL	1.04 mL	1.39 mL
78	35.10	0.35 mL	0.70 mL	1.05 mL	1.40 mL
79	35.55	0.36 mL	0.71 mL	1.07 mL	1.42 mL
80	36.00	0.36 mL	0.72 mL	1.08 mL	1.44 mL
81	36.45	0.36 mL	0.73 mL	1.09 mL	1.46 mL
82	36.90	0.37 mL	0.74 mL	1.11 mL	1.48 mL
83	37.35	0.37 mL	0.75 mL	1.12 mL	1.49 mL
84	37.80	0.38 mL	0.76 mL	1.13 mL	1.51 mL
85	38.25	0.38 mL	0.77 mL	1.15 mL	1.53 mL
86	38.70	0.39 mL	0.77 mL	1.16 mL	1.55 mL
87	39.15	0.39 mL	0.78 mL	1.17 mL	1.57 mL
88	39.60	0.40 mL	0.79 mL	1.19 mL	1.58 mL
89	40.05	0.40 mL	0.80 mL	1.20 mL	1.60 mL
90	40.50	0.41 mL	0.81 mL	1.22 mL	1.62 mL
91	40.95	0.41 mL	0.82 mL	1.23 mL	1.64 mL
92	41.40	0.41 mL	0.83 mL	1.24 mL	1.66 mL
93	41.85	0.42 mL	0.84 mL	1.26 mL	1.67 mL
94	42.30	0.42 mL	0.85 mL	1.27 mL	1.69 mL
95	42.75	0.43 mL	0.86 mL	1.28 mL	1.71 mL
96	43.20	0.43 mL	0.86 mL	1.30 mL	1.73 mL
97	43.65	0.44 mL	0.87 mL	1.31 mL	1.75 mL
98	44.10	0.44 mL	0.88 mL	1.32 mL	1.76 mL
99	44.55	0.45 mL	0.89 mL	1.34 mL	1.78 mL
100	45.00	0.45 mL	0.90 mL	1.35 mL	1.80 mL

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