Banfield PET HOSPITAL

Anesthesia and Analgesia

for the Veterinary Practitioner: Canine and Feline

Banfield PET HOSPITAL

Asa status

Status	ASA classification	Examples
I	Healthy pet, no disease	Elective OVH or castration
II	Mild systemic disease or localized disease	Healthy geriatric pet, mild anemia or obesity
III (fair)	Moderate systemic disease limiting activity but not life-threatening	Mitral valve insufficiency, collapsing trachea, poorly controlled diabetes
IV (poor)	Severe systemic disease; incapacitating; life-threatening; not expected to live without surgery	Hemoabdomen from splenic rupture, severe traumatic pneumothorax, organ failure
V (grave)	Moribund; not expected to live >24 hours, with or without surgery	Multi-organ failure, severe shock, terminal malignancy

Determine the pet ASA status

- **History**
- **Clinical Pathology Data**
- **Physical Exam**

I –II
- There is little to no increase in risk

III – V
- Discuss increased risk with the client
- Maximize preanesthetic medical management
- Cancel or refer procedure as clinically indicated

CLINICAL ESSENTIAL

The attending veterinarian chooses protocols and determines specific drug dosages

Emergency drug dosing

Drug		Low dose	High dose
Atropine 0.54 mg/mL		0.02 mg/kg	0.04 mg/kg
Dexamethasone SP 4 mg/mL		1 mg/kg	4 mg/kg
Diphenhydramine 50 mg/mL		2.2 mg/kg	N/A
Dopamine 40 mg/mL		2.5 **mcg**/kg/min	10 **mcg**/kg/min
Epinephrine 1 mg/mL		0.01 mg/kg	0.2 mg/kg intratracheal (IT)
Glycopyrrolate 0.2 mg/mL		0.005 mg/kg	0.01 mg/kg
Lidocaine bolus 20 mg/mL	**Canine**	2 mg/kg	4 mg/kg
	Feline	0.2 mg/kg	N/A
Amiodarone 50 mg/mL		5 mg/kg	N/A
Reversal agents			
Atipamezole 5 mg/mL		100 mcg/kg	Equal to amount of dexmedetomidine administered if dose was higher than 10 **mcg**/kg
Butorphanol 10 mg/mL		0.05 mg/kg	0.1 mg/kg
Flumazenil 0.1 mg/mL		0.01 mg/kg	Repeat every hour if needed
Naloxone 0.4 mg/mL		0.04 mg/kg	N/A

Reversal agents may also reverse analgesic properties. Ensure patient analgesic needs are met

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Book 3 | 2nd Edition

ISBN # 978-0-9743262-8-3

Preface

- Individual state practice act requirements and DEA regulations must be met or exceeded in all instances.
- Review Medical Quality Standards. Meet or exceed all Clinical Essentials.

State regulations

- 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 policies and procedures.
- The doctor must ensure compliance with state regulations regarding:
  - Handling and administration of controlled substances
  - Intubation of pets
  - Anesthetic monitoring
  - Drug administration documentation
  - Which hospital associates can legally perform dental prophylaxis and all other medical procedures
  - Off-label usage of medications

This publication may contain information that is not within the current FDA-approved labeling for several products for companion animals.

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Protocols

Abbreviations

ABCB1	updated name for MDR gene
ACVIM	American College of Veterinary Internal Medicine
ALP	alkaline phosphatase
ALT	alanine aminotransferase
ASA	American Society of Anesthesiologists
bpm	beats per minute or breaths per minute, depending on context
BUN	blood urea nitrogen
CNS	central nervous system
CRI	constant rate infusion
DKT	dexmedetomidine, ketamine, torbutrol
ECG	electrocardiogram
$EtCO_2$	end-tidal carbon dioxide
GI	gastrointestinal
GDV	gastric dilatation volvulus
MAP	mean arterial pressure
MDR	multi-drug resistant
NRB	non-rebreathing
NSAID	nonsteroidal anti-inflammatory
OVH	ovariohysterectomy
SpO_2	peripheral capillary oxygen saturation
TPR	temperature, pulse, respiration

Introduction

Protocols have been developed from an evaluation of the current literature and the consensus of board-certified veterinary specialists (anesthesiology and internal medicine). Protocols are never meant to be followed blindly and the anesthesia team remains responsible for making decisions in the best interest of the patient.

Examples:

- If a protocol calls for cefazolin but the patient is allergic to cephalosporins, administer a different antibiotic
- If a protocol utilizes acepromazine, but the patient is undergoing medical therapy for a portosystemic shunt, administer a different premedication

Why do we need different protocols for different patients if the goals of anesthesia (analgesia, unconsciousness and muscle relaxation) are the same for all?

Healthy patients have the highest requirements (in mg/kg) for drugs especially if they are very nervous or very active. These patients usually have increased physiologic reserve in organ and cardiac function. Remember that an unremarkable physical examination does not preclude the presence of underlying pathology. The *Medial Quality Standards* chapter includes examples of potential genetic or breed-associated conditions, which may impact anesthetic decision making.

Generally, consider the need to reduce drugs or drug dosages for older, sicker patients or substitute a drug with fewer side effects depending on disease and American Society of Anesthesiologists (ASA) status.

Considerations for all patients

- Premedication should be appropriate for the patient (see specific protocols) and given 30 minutes before induction (route dependent on medication).
- Wait 30 minutes to allow premedications to take full effect before induction, unless patient status dictates otherwise.
- Premedications are generally administered to provide anxiolysis (e.g., tranquilizers and sedatives) and preemptive analgesia.
- Repeat physical exam and temperature, pulse, respiration (TPR) prior to induction. If any part of TPR has changed significantly and raises concern, stop and reevaluate the patient.
- Complete Anesthetic Machine Checklist prior to each anesthetic procedure.
- Plan analgesic protocol and implement as appropriate for each patient.
- Use of reversal agents should be made on an individual patient basis. See Induction, Monitoring and Recovery chapter for details.

Abdominal

What is different about this patient?

There are multiple clinical scenarios where abdominal surgery may be performed with a variety of comorbidities:

- Abdominal mass removal
- Cystic calculi
- Gastric dilatation volvulus (GDV)
- Gastrointestinal (GI) foreign body
- Hepatic biopsy
- Pyometra

Depending on the underlying etiology, patients may require a large number of stabilizing procedures before becoming anesthetic candidates (*e.g.*, GDV), or may be hemodynamically stable with a relatively unremarkable physical examination (*e.g.*, cystic calculi removal).

A range of analgesic requirements may exist and analgesic plans should be individualized to each patient. Certain conditions may be associated with nausea or vomiting, so the addition of antiemetics (*e.g.*, maropitant) should be considered when medically indicated.

Elevated hepatic enzymes (ALT and ALP) may be seen in many of these patients, so close attention should be paid to potential indicators of hepatic dysfunction and supportive measures be proactively prepared.

Examples

Hepatic dysfunction	Intervention
Hypoglycemia	Dextrose CRI
Hypoalbuminemia	Colloid support
Coagulopathy	Vitamin K or transfusion therapy

Premedication

Drug	Dose		Route
Hydromorphone	**Canine**	0.05–0.2 mg/kg	IM, SC
	Feline	0.05–0.1 mg/kg	
Midazolam	0.1–0.3 mg/kg		
OR			
Methadone	0.25 mg/kg		IV
+/- Midazolam	0.05 mg/kg		
OR if there is a history of vomiting:			
Midazolam	0.1–0.3 mg/kg		IM, SC
Buprenorphine	0.01–0.02 mg/kg		IM, IV

- Provide antiemetic support (maropitant) if vomiting
- Consider if additional analgesic therapy is warranted based on:
  - Signalment
  - Physical examination
  - Anesthetic indication
  - Surgical intervention planned

Additional analgesic therapy

Drug	Dose		Route
Hydromorphone	0.05–0.1 mg/kg		IM, IV, SC
Buprenorphine	0.01–0.02 mg/kg		IM, IV
Buprenorphine – long acting	**Feline**	0.24 mg/kg	**SC only**
Methadone	0.1–0.4 mg/kg		IM, IV
Buprenorphine – Transdermal	**Feline**	1 tube	Transdermal

Induction and intubation

Drug	Dose	Route
Propofol	1.0 mg/kg slowly over 15 seconds Increments of 0.5 mg/kg over 15 seconds until intubation	IV
OR		
Alfaxalone	0.5 mg/kg slowly over 30 seconds Increments of 0.5 mg/kg until smooth transition to intubation and inhalant	IV

- Preoxegenate based on patient tolerance and clinical stability

- **Induce with lowest possible dose of propofol**
  - **May cause apnea if given rapidly**
- **Bradycardia, hypotension and respiratory depression may develop after rapid administration**

Transition phase

Post-induction inhalant rates

Inhalant	Rates	Miscellaneous
Oxygen	50–100 mL/kg/minute (rebreathing)	For first 15 minutes after induction
	150–300 mL/kg/minute (non-rebreathing (NRB))	
Sevoflurane	3% for 3 minutes	Large dogs may need higher rates

- Monitor anesthetic depth and oxygenation closely

Anesthetic maintenance

Drugs	Rates
Oxygen	20–30 mL/kg/minute (rebreathing)
	200 mL/kg/minute (average rate, NRB)
Sevoflurane	1–4% to effect with oxygen

- Prevent/treat hypothermia associated with a large, open abdomen (see *Induction, Monitoring and Recovery* chapter for details)
- Be prepared to adjust oxygen flow rates in response to patient clinical parameters
- Amount of sevoflurane will vary with patient health, analgesic therapy and local blocks used
- If 4% or more sevoflurane is required:
  - Check the anesthesia system for leaks
  - Ensure appropriate analgesia
  - Consider:
    - Inadequate premedication
    - Improper endotracheal intubation, etc.
      - See Equipment chapter for more details

Perioperative anesthetic support

Intravenous Fluids		Rate	Miscellaneous
Crystalloids	**Canine**	5 mL/kg/hour	Consider avoiding lactate in patients with hepatic disease
	Feline	3 mL/kg/hour	
Colloids	**Canine**	20 mL/kg/day OR Bolus of 5 mL/kg	If medically indicated
	Feline	20 mL/kg/day OR Bolus of 2.5 mL/kg	

Anticholinergics

Drug	Dose	Route
Atropine	0.02–0.04 mg/kg	IV
Glycopyrrolate	0.005–0.01 mg/kg	IV

- Depending on preanesthetic blood glucose (BG) readings, BG may need to be checked intraoperatively and postoperatively
- IV dextrose infusion at 2.5–5% may be utilized to support BG in the hypoglycemic patient
- Intraoperative analgesia as indicated by patient clinical status
  - See *The Individualized Anesthesia and Analgesia Plan* chapter for details
- Anticholinergics as clinically indicated for bradycardia accompanied by hypotension

Local blocks and antibiotics

Local Block	
Line block for abdominal incision	Lidocaine (2 mg/kg) OR Bupivacaine (1.5 mg/kg)
Antibiotics	
As medically indicated	See *Medical Quality Standards* chapter

- Dilute local anesthetic as needed to obtain adequate volume for administration
  - Pay attention to maximum cumulative doses
- Perform blocks once patient is under general anesthesia and the first of 3 sterile skin preps has been performed

Anesthetic recovery

Parameter	Range
Normothermic	Temp 100–102.5° F
Normotensive	MAP 80–100 mm Hg
Oxygenating normally on room air	SpO_2 95–100%
Sternal recumbency	
Pain controlled	Pain score <2

- If recovery is slow, recheck BG concentrations

Postoperative care and pain management

Drug	Dose		Route
OPIOID			
Buprenorphine	**Canine**	0.005–0.02 mg/kg	IM
	Feline	0.01–0.02 mg/kg	IM, Transmucosal
Buprenorphine – long acting	**Feline**	0.24 mg/kg (dose on lean body weight)	**SC only**
Hydromorphone	**Canine**	0.01–0.2 mg/kg	SC, IM
		0.005 mg/kg	IV every 2–4 hours
	Feline	0.05–0.1 mg/kg	SC, IM
		0.05 mg/kg	IV every 2–6 hours
Fentanyl	See *Appendix* chapter for details		IV as CRI
Methadone	0.1–0.4 mg/kg		IM, IV
Buprenorphine – Transdermal	**Feline**	1 tube (dose on lean body weight)	Transdermal

- Opioids are most commonly used
  - Avoid NSAIDs with all gastrointestinal surgeries
- Adequate pain management must follow through postoperative period and facilitates anesthetic recovery
- Consider premedication utilized when choosing postoperative analgesics
- Pain scores of 2 and greater should be treated with analgesic medications
- Watch for potential hyperthermia in cats with opioid therapy
- Do not confuse pain with dysphoria, refer to *Induction, Monitoring and Recovery* chapter for details

Analgesia to go home

Drug	Dosage		Route
Tramadol*	**Canine**	5 mg/kg	PO, every 6 hours
	Feline	2–4 mg/kg	
OR			
Buprenorphine	**Feline**	0.01–0.02 mg/kg	Transmucosal, every 8 hours

* Oral tramadol has not been shown to be effective postoperatively in dogs.

- Use opioid as appropriate for health status
- Avoid NSAIDs when possible

Notes

Brachycephalic

What is different about this patient?

Most brachycephalic patients, either canine or feline, have difficulty breathing when awake. Small nares, elongated soft palates and hypoplastic tracheas create a very abnormal upper airway.

Some breeds (e.g., Pugs and Bulldogs) are more likely to be obese, which further exacerbates breathing problems

- Stress increases respiratory rate and can cause serious complications such as hyperthermia or respiratory collapse

Brachycephalic patients (Bulldogs in particular) may not be good candidates for procedures using sedation; general anesthesia may be safer for them. See *Sedation and Immobilization* chapter for more information.

Anticipated problems

- Preoperative airway obstruction after premedication
- Difficulty visualizing the larynx during intubation
- Prolonged and difficult intubation
- Hypoplastic trachea - smaller ET tube than expected
- Airway obstruction during recovery
- Passive gastric reflux (regurgitation) at any point during sedation/anesthesia/recovery
- Bulldogs have a higher incidence of vomiting and aspiration within 24 hours of anesthesia

All sedatives and anesthetic drugs impair respiratory function by central (neurologic) depression and relaxation of muscles needed for maintaining an airway. Patients must be carefully monitored from premedication through recovery.

Examples

ANY pet with a shortened snout	
Boston Terrier	Boxers
Bulldogs	Himalayan
Lhasa Apso	Persian
Pugs	Shih Tzu

OR

ANY pet with a functional or anatomic abnormality of the larynx, pharynx, esophagus or trachea	
Labrador Retriever with laryngeal paralysis	Shar Pei

Home administered anxiolytics

Drug	Dose		Route
Trazodone	**Canine**	5–15 mg/kg	PO 1hr prior to travel
Gabapentin	**Feline**	50–100 mg/cat	PO 2–3 hrs prior to travel

- Consider giving the first dose the night before along with another dose the morning of the procedure
- Trazodone can cause paradoxical excitement. Trial doses are recommended.

Premedication

Drug	Dose	Route
Butorphanol	0.2–0.4 mg/kg	IM
Midazolam	0.1–0.3 mg/kg	IM

- For procedures that need analgesia, avoid opioids that induce vomiting in the premedication. Supplement with another opioid once the patient is intubated and asleep (45-60minutes after the butorphanol).
- Consider pre-operative thoracic radiographs to evaluate the lungs and heart. These patients can be difficult to auscultate and are prone to aspiration pneumonia. Identifying underlying conditions early increases anesthetic safety.
- Never muzzle or restrict the airway in any brachycephalic patient and use minimum physical restraint necessary
- Anxiolytics may be helpful but should not be used in place of safe patient handling practices
  - Cautious use of acepromazine at low-dose (0.01 mg/kg) may be considered if patients are significantly anxious
  - Patient analgesic needs should be considered
- Use maropitant to reduce the risk of vomiting.
- Other perianesthetic protocols to decrease post-operative GI complications:
  - Famotidine 1mg/kg IV or SQ
  - Metoclopramide 0.5mg/kg SQ
  - Omeprazole 1mg/kg PO
  - If history of regurgitation: 1 week of PPI and metoclopramide
- **Pre-oxygenation for at least 3–5 minutes is very important for these patients if they will tolerate it, but stress should be kept to a minimum.**
- **Once premedicated, these patients should be kept under observation at ALL times**

Induction and intubation

Drug	Dose	Route
Propofol	1.0 mg/kg slowly over 15 seconds Increments of 0.5 mg/kg over 15 seconds until intubation	IV
OR		
Alfaxalone	0.5 mg/kg slowly over 30 seconds Increments of 0.5 mg/kg until smooth transition to intubation and inhalant	IV

- Preoxygenate based on patient tolerance and clinical stability
- Continue to provide oxygen between intubation attempts if applicable
- **Induce with lowest possible dose of propofol or alfaxalone**
  - **May cause apnea if given rapidly**
- **Bradycardia, hypotension and respiratory depression may develop after rapid administration**
- It is important to have a range of endotracheal tube sizes available in the case of a hypoplastic trachea
- The average Bulldog may take a 6.5 mm tube (approximate size), instead of the 9 mm tube one might anticipate based on body size
- The DVM should evaluate the soft palate, saccules and search for other abnormalities (tonsilar hypertrophy) just prior to intubation

Transition phase

Post-induction inhalant rates

Inhalant	Rates	Miscellaneous
Oxygen	50–100 mL/kg/minute (rebreathing)	For first 15 minutes after induction
	150–300 mL/kg/minute (NRB)	
Sevoflurane	3% for 3 minutes	Large dogs may need higher rates

- Monitor anesthetic depth and oxygenation closely

Anesthetic maintenance

Drugs	Rates
Oxygen	20–30 mL/kg/minute (rebreathing)
	200 mL/kg/minute (average rate, NRB)
Sevoflurane	1–4% to effect with oxygen

- Once intubated these patients usually do well due to upper airway bypass **(until extubation)**
- Be prepared to adjust oxygen flow rates in response to patient clinical parameters
- Amount of sevoflurane will vary with patient health, analgesic therapy and local blocks used
- If 4% or more sevoflurane is required:
  - Check the anesthesia system for leaks
  - Ensure appropriate analgesia
  - Consider:
    - Inadequate premedication
    - Improper endotracheal intubation, etc.
      - See Equipment chapter for more details
- Inspect the pharynx frequently for reflux

Notes

Perioperative anesthetic support

Intravenous fluids	Rate		Miscellaneous
Crystalloids	**Canine**	5 mL/kg/hour	Higher fluid rates may be needed if patient is not adequately hydrated when anesthesia begins
	Feline	3 mL/kg/hour	

Anticholinergics		
Drug	**Dose**	**Route**
Atropine	0.02–0.04 mg/kg	IV
Glycopyrrolate	0.005–0.01 mg/kg	IV

- **Brachycephalic patients may have high vagal tone with profound respiratory sinus arrhythmias and may benefit from anticholinergic therapy**
- Intraoperative analgesia as indicated by patient clinical status
  - See *The Individualized Anesthesia and Analgesia Plan* chapter for details

Local blocks and antibiotics

Local block	
As medically indicated	Pay attention to maximum cumulative doses
Antibiotics	
As medically indicated	See *Medical Quality Standards* chapter

- Dilute local anesthetic as needed to obtain adequate volume for administration
- Perform blocks once patient is under general anesthesia and the first of 3 sterile skin preps has been performed

Anesthetic recovery

Parameter	Range
Normothermic	Temp 100–102.5° F
Normotensive	MAP 80–100 mm Hg
Oxygenating normally on room air	SpO_2 95–100%
Sternal recumbency	
Pain controlled	Pain score <2

- **Extubation should be as late as possible and oxygen should be provided until the patient can maintain normal SpO_2 without assistance**
  - **It is not unusual to allow the patient to sit in sternal, moving his/her head around with the endotracheal tube still in place**
- Extubate when the patient starts chewing on the tube; continue to monitor closely after extubation (and provide oxygen as necessary) until normal SpO_2 readings are sustained
- Since the airway is so compromised, even a small amount of edema caused by intubation can be catastrophic
  - Neosynephrine nasal drops (one drop per nostril and one on the soft palate) may help with swollen, edematous nasal and soft palate mucosae
- **Reintubation may be necessary if serious respiratory distress occurs after extubation**
  - Have propofol, a laryngoscope, and clean endotrachel tubes available
- Consider supplemental O_2 via mask/flow-by/oxygen cage/nasal oxygen tubes
  - An example procedure for placement of nasal oxygen is provided in the *Respiratory Compromise* protocol
  - Flow-by O_2 support is inefficient and should only be utilized if the patient will not calmly tolerate the mask
- Do not rush recovery
  - Can provide butorphanol 0.1 mg/kg IV, 10 minutes prior to discontinuing anesthesia to promote a quiet recovery and reduce coughing

Postoperative care and pain management

Drug	Dose		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	SC (initial dose)
Meloxicam	**Canine**	0.2 mg/kg	SC (initial dose)
Robenacoxib	**Feline**	2 mg/kg	SC (initial dose)
OPIOID			
Butorphanol	0.2–0.4 mg/kg		IM
Buprenorphine	**Canine**	0.005–0.02 mg/kg	IM
	Feline	0.01–0.02 mg/kg	IM, Transmucosal
Buprenorphine – long acting	**Feline**	0.24 mg/kg (dose on lean body weight)	**SC only**
Hydromorphone	**Canine**	0.01–0.2 mg/kg	SC, IM
		0.005 mg/kg	IV every 2–4 hours
	Feline	0.05–0.1 mg/kg	SC, IM
		0.05 mg/kg	IV every 2–6 hours
Fentanyl	See *Appendix* chapter for details		IV as CRI
Methadone	0.1–0.4 mg/kg		IM, IV
Buprenorphine – Transdermal	**Feline**	1 tube	Transdermal

- NSAIDs and/or opioids are most commonly used as indicated for patient analgesia
- Adequate pain management must follow through postoperative period and facilitates anesthetic recovery
- Consider premedication utilized when choosing postoperative analgesics
- Pain scores of 2 and greater should be treated with analgesic medications
- Watch for potential hyperthermia in cats with opioid therapy
- Do not confuse pain with dysphoria
  - Refer to *Induction, Monitoring and Recovery* chapter for details

Note: For dogs already on an NSAID, do not change to a different NSAID without observing the recommended number of half-lives. Maintain on the same NSAID or use an analgesic with a different mechanism of action (*e.g.*, opioid or tramadol). See *The Individualized Anesthesia and Analgesia Plan* chapter for details.

- Only use NSAID if patient is well-hydrated, has received intraoperative fluids and is not hypotensive or bleeding

Analgesia to go home

Drug	Dosage		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	PO once daily or divided into 2 doses for 3–5 days
Meloxicam	**Canine**	0.1 mg/kg	PO, every 24 hours
Robenacoxib	**Feline**	1 mg/kg	PO once daily for a maximum of 3 **total** doses over 3 days. Do not exceed 1 dose per day.
OPIOID			
Tramadol*	**Canine**	5 mg/kg	PO, every 6 hours
	Feline	2–4 mg/kg	
Buprenorphine	**Feline**	0.01–0.02 mg/kg	Transmucosal, every 8 hours

*Oral tramadol has not been shown to be effective postoperatively in dogs.

- NSAID and/or opioid as appropriate for health status
- **Dispense the same NSAID that was utilized postoperatively**

Notes

Caesarean section

What is different about this patient?

Patients that require a caesarean section (C-section) may be hemodynamically stable and have a relatively unremarkable physical examination. Conversely, patients may be critically ill with complications of pregnancy/delivery and may require significant medical stabilization before proceeding to general anesthesia.

Respiratory compromise may occur when patients with a large, gravid uterus are placed in dorsal recumbency. It is recommended, when possible, to perform abdominal imaging preoperatively to help determine treatment plan and management. This may also allow a determination of fetal number and viability.

Large volumes of fluid and/or blood may potentially be lost with a C-section and replacement needs should be anticipated. Additionally, the use of certain drugs should be avoided in a pregnant patient:

- Acepromazine
- Ketamine
- Benzodiazepines (midazolam, zolazepam)
- Alpha-2 agonists (dexmedetomidine)

Additional considerations:

- It is important to minimize fetal exposure to inhalant anesthetic agents. However, the surgeon should wait 10 - 15 minutes post-induction to remove fetuses from the uterus, to allow for metabolism and redistribution of injectable agents.
- Preloading with a fluid bolus may help avoid hypotension, which occurs when puppies/kittens are delivered. Begin fluid bolus as indicated per patient when abdomen is incised.
- Prevent/treat hypothermia associated with a large, open abdomen (see *Induction, Monitoring and Recovery* chapter for details).

Premedication

Drug	Dose	Route
Butorphanol	0.2–0.4 mg/kg	IM, SC
OR		
Methadone	0.2 mg/kg	IM, IV

- Premedication analgesia may not be required for very quiet or depressed patients
  - May be given IV after puppies/kittens are removed if medically indicated based on stability and response to anesthesia and surgery
- As much patient preparation as possible should occur before induction and may include:
  - Gathering all drugs and supplies needed for resuscitation
  - Calculating and filling syringes for line blocks
  - Collecting supplies and medications anticipated for CRIs (e.g., dobutamine, etc.)
  - Clipping and initial cleaning of surgical fields
- Preoxygenate based on patient tolerance, to help avoid maternal and fetal hypoxia
- Consider the use of maropitant for visceral pain, nausea and faster return to eating post-operatively.

Notes

Induction and intubation

Drug	Dose	Route
Propofol	1.0 mg/kg slowly over 15 seconds	IV
	Increments of 0.5 mg/kg over 15 seconds until intubation	
OR		
Alfaxalone	1–4 mg/kg incrementally over 60 seconds until intubation can be achieved	IV

- Alfaxalone may be associated with better neonatal vitality upon delivery and in the immediate post-operative period

- **Induce with lowest possible dose of induction agent**
  - **Both propofol and alfaxalone may cause apnea if given rapidly**
- **Bradycardia, hypotension and respiratory depression may develop after rapid administration of propofol or alfaxalone**

Transition phase

Post-induction inhalant rates

Inhalant	Rates	Miscellaneous
Oxygen	50–100 mL/kg/minute (rebreathing)	For first 15 minutes after induction
	150–300 mL/kg/minute (NRB)	
Sevoflurane	3% for 3 minutes	Large dogs may need higher rates

- **Be prepared to perform manual ventilation**
- Monitor anesthetic depth and oxygenation closely

Anesthetic maintenance

Drugs	Rates
Oxygen	20–30 mL/kg/minute (rebreathing)
	200 mL/kg/minute (average rate, NRB)
Sevoflurane	1–4% to effect with oxygen

- Be prepared to adjust oxygen flow rates in response to patient clinical parameters
- Amount of sevoflurane will vary with patient health, analgesic therapy and local blocks used
- If 4% or more sevoflurane is required:
  - Check the anesthesia system for leaks
  - Ensure appropriate analgesia
  - Consider:
    - Inadequate premedication
    - Improper endotracheal intubation, etc.
      - *See Equipment* chapter for more details
- Inspect the caudal pharynx frequently for reflux
  - To decrease chances of passive gastric reflux, do not position the patient head down during surgery

Notes

Perioperative anesthetic support

Intravenous Fluids	Rate		Miscellaneous
Crystalloids	**Canine**	5 mL/kg/hour	Higher fluid rates may be needed if patient is not adequately hydrated when anesthesia begins
	Feline	3 mL/kg/hour	

Anticholinergics		
Drug	**Dose**	**Route**
Atropine	0.02–0.04 mg/kg	IV
Glycopyrrolate	0.005–0.01 mg/kg	IV

- Watch for significant changes in heart rate throughout the procedure, beginning with premedication administration
- Intraoperative analgesia as indicated by patient clinical status
  - *See The Individualized Anesthesia and Analgesia Plan* chapter for details
- Anticholinergics as clinically indicated for bradycardia accompanied by hypotension

Notes

Local blocks and antibiotics

Local Block	
Awake, sedated, epidural block of morphine and lidocaine	PF Morphine 0.1 mg/kg PF Lidocaine 3 mg/kg Max Volume 6 mL
OR	
Line blocks for abdominal incision	Reduced dose of lidocaine OR bupivacaine (see below)
Antibiotics	
If medically indicated, cefazolin is recommended	See *Medical Quality Standards* chapter

- **Reduce lidocaine/bupivacaine dosage by 50–75%**
- Dilute local anesthetic as needed to obtain adequate volume for administration
  - Pay attention to maximum cumulative doses — decrease as described
- Perform blocks once patient is under general anesthesia and the first of 3 sterile skin preps has been performed
- If unable to perform an awake epidural block, perform presurgical line blocks once anesthetized and a postsurgical epidural opioid block.

Notes

Anesthetic recovery

Parameter	Range
Normothermic	Temp 100–102.5° F
Normotensive	MAP 80–100 mm Hg
Oxygenating normally on room air	SpO_2 95–100%
Sternal recumbency	
Pain controlled	Pain score <2

Resuscitation of pups/kits:

- Provide warmth and gentle stimulation
- Provide supplemental oxygen
- If spontaneous respiration is not occurring:
  - Consider intubation, depending on size
  - Administer oxygen
  - If dam was given opioid prior to delivery, apply one drop of naloxone sublingually to each pup or kit
  - **DO NOT administer doxapram**
  - **DO NOT swing/sling pups or kits**
  - Gentle suction of nose, mouth and airways may be performed
- Place pups/kits with dam as soon as complete recovery is attained
  - Ensure patient is fully recovered before leaving pups/kits unattended

Postoperative care and pain management

Drug	Dose		Route
Buprenorphine	**Canine**	0.005–0.02 mg/kg	IM
	Feline	0.01–0.02 mg/kg	IM, Transmucosal

- Opioids are most commonly used
  - Avoid NSAIDs when possible
- Adequate pain management must follow through postoperative period and facilitates anesthetic recovery
- Consider premedication utilized when choosing postoperative analgesics
- Pain scores of 2 and greater should be treated with analgesic medications
- Do not confuse pain with dysphoria
  - Refer to *Induction, Monitoring and Recovery* chapter for details

Analgesia to go home

Drug	Dosage		Route
Tramadol*	**Canine**	5 mg/kg	PO, every 6 hours
	Feline	2–4 mg/kg	
OR			
Buprenorphine	**Feline**	0.01–0.02 mg/kg	Transmucosal, every 8 hours

*Oral tramadol has not been shown to be effective postoperatively in dogs.

- Use opioid as appropriate for health status
- Avoid NSAIDs when possible

Cardiac

What is different about this patient?

Patients with cardiac disease are at an increased risk for clinical decompensation, fluid overload and potentially cardiac arrhythmias with anesthesia. Remember that the presence or absence of a murmur does not equate to clinical cardiac disease.

Patients with known or suspected congenital cardiac disease (*e.g.*, patent ductus arteriosus, ventricular septal defect, pulmonic stenosis) that has not been corrected should not undergo general anesthesia due to high potential risks. If anesthesia cannot be avoided and referral is not an option, consider the *Cardiac* protocol.

Patients with known but stable cardiac disease should be thoroughly assessed prior to anesthesia (*e.g.*, thoracic radiographs, blood pressure, ECG, minimum data base) to ensure disease is clinically stable. See the *2009 American College of Veterinary Internal Medicine (ACVIM) Consensus Statement on Chronic Valvular Disease* for a discussion on the classification of heart disease and heart failure for details.

Additional considerations:

- Blood pressure may be affected by comorbid conditions (*e.g.*, renal or endocrine disease) so ensure complete clinical picture is obtained prior to anesthesia
- If patients have evidence of clinical decompensation, stabilize medically and reschedule anesthesia. If anesthesia cannot be avoided and referral is not an option, consider the *Cardiac* protocol.
- Complete cardiac work-ups are recommended for all patients with cardiac disease prior to anesthesia:
  - ECG
  - Echocardiogram
  - BP
- Minimum Data Base (MDB) for these patients should include 2 view thoracic radiographs, labwork and urine prior to the procedure

Canine examples	
Breeds with known risk of cardiac arrhythmias ▶ ECG	Doberman Pinscher Boxer
Breeds with increased incidence of mitral valve disease ▶ Thoracic radiographs	King Charles Cavalier Spaniel
Feline considerations	
Potential presence of subclinical cardiac disease (HCM)	See *Physiology* chapter for details

Premedication

Drug	Dose		Route
Midazolam	0.1–0.3 mg/kg		IM, SC
Butorphanol	0.2– 0.4 mg/kg		IM, SC
OR			
Midazolam	0.1–0.2 mg/kg		IM, SC
Hydromorphone	**Canine**	0.05–0.2 mg/kg	IM
	Feline	0.05–0.1 mg/kg	SC

- Consider if additional analgesic therapy is warranted based on:
  - Signalment
  - Anesthetic indication
  - Physical examination
  - Surgical intervention planned
- **If analgesic therapy is warranted, replace butorphanol in the premedication with another opioid listed in Additional Analgesic Therapy**

- **Pay attention to heart rate after premedication administration**
  - **It is expected that heart rate will decrease as the onset of action of premedication is reached**
- **Anesthetic drug choices should be based on the type of cardiac disease**
  - **Ketamine should be avoided in cats with HCM**
  - **Lower dosed opioids and benzodiazepines are usually safe for patients with cardiac disease**

Additional analgesic therapy

Drug	Dose		Route
Buprenorphine	0.01–0.02 mg/kg		IM, IV
Buprenorphine – long acting	**Feline**	0.24 mg/kg (dose on lean body weight)	**SC only**
Buprenorphine – Transdermal	**Feline**	1 tube	Transdermal

- Thoroughly evaluate cardiovascular parameters after premedication administration
- Any worsening or refractory parameter warrants aborting elective procedures

Induction and intubation

Drug	Dose	Route
Propofol	1.0 mg/kg slowly over 15 seconds Increments of 0.5 mg/kg over 15 seconds until intubation	IV
OR		
Alfaxalone	0.5 mg/kg slowly over 30 seconds Increments of 0.5 mg/kg until smooth transition to intubation and inhalant	IV

- **Induce with lowest possible dose of induction agent**
- **Both propofol and alfaxalone may cuase apnea if given rapidly**
- **Bradycardia, hypotension and respiratory depression may develop after rapid administration of propofol or alfaxalone**

Transition phase
Post-induction inhalant rates

Inhalant	Rates	Miscellaneous
Oxygen	50–100 mL/kg/minute (rebreathing)	For first 15 minutes after induction
	150–300 mL/kg/minute (NRB)	
Sevoflurane	3% for 3 minutes	Large dogs may need higher rates

- Monitor anesthetic depth and oxygenation closely

Anesthetic maintenance

Inhalant	Rates
Oxygen	20–30 mL/kg/minute (rebreathing)
	200 mL/kg/minute (average rate, NRB)
Sevoflurane	1–4% to effect with oxygen

- **If lidocaine CRI is utilized for control of arrhythmias, remember to decrease sevoflurane to 0.5–1% when CRI is started**
- Be prepared to adjust oxygen flow rates in response to patient clinical parameters
- Amount of sevoflurane will vary with patient health, analgesic therapy and local blocks used
- If 4% or more sevoflurane is required:
  - Check the anesthesia system for leaks
  - Ensure appropriate analgesia
  - Consider:
    - Inadequate premedication
    - Improper endotracheal intubation, etc.
      - See Equipment chapter for more details

Notes

Perioperative anesthetic support

Intravenous Fluids	Rate		Miscellaneous
Crystalloids	**Canine**	4 mL/kg/hour	Monitor closely for signs of fluid overload
	Feline	2 mL/kg/hour	

Anticholinergics		
Drug	**Dose**	**Route**
Atropine	0.02–0.04 mg/kg	IV
Glycopyrrolate	0.005–0.01 mg/kg	IV

- Fluid rates for patients with cardiac disease are decreased due to concerns of possible fluid overload
  - Monitor patient cardiovascular parameters closely and change fluid rate as indicated
- Intraoperative analgesia as indicated by patient clinical status
  - See *The Individualized Anesthesia and Analgesia Plan* chapter for details
- Anticholinergics as clinically indicated for bradycardia accompanied by hypotension
  - **Use with caution in patients with cardiac disease**
  - If anticholinergics are administered, continuous ECG monitoring for cardiac arrhythmias is critical

Local blocks and antibiotics

Local Block	
As medically indicated	Pay attention to maximum cumulative doses
Antibiotics	
As medically indicated	See *Medical Quality Standards* chapter

- Dilute local anesthetic as needed to obtain adequate volume for administration
- Perform blocks once patient is under general anesthesia and the first of 3 sterile skin preps has been performed

Anesthetic recovery

Parameter	Range
Normothermic	Temp 100–102.5° F
Normotensive	MAP 80–100 mm Hg
Oxygenating normally on room air	SpO_2 95–100%
Sternal recumbency	
Pain controlled	Pain score <2

Postoperative care and pain management

Drug	Dose		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	SC (initial dose)
Meloxicam	**Canine**	0.2 mg/kg	SC (initial dose)
Robenacoxib	**Feline**	2 mg/kg	SC (initial dose)
OPIOID			
Buprenorphine	**Canine**	0.005–0.02 mg/kg	IM
	Feline	0.01–0.02 mg/kg	IM, Transmucosal
Buprenorphine – long acting	**Feline**	0.24 mg/kg (dose on lean body weight)	**SC only**
Hydromorphone	**Canine**	0.01–0.2 mg/kg	SC, IM
		0.005 mg/kg	IV every 2–4 hours
	Feline	0.05–0.1 mg/kg	SC, IM
		0.05 mg/kg	IV every 2–6 hours
Fentanyl	See *Appendix* chapter for details		IV as CRI
Methadone	0.1–0.4 mg/kg		IM, IV
Buprenorphine – Transdermal	**Feline**	1 tube (dose on lean body weight)	Transdermal

- NSAIDs and/or opioids are most commonly used as indicated for patient analgesia
- Adequate pain management must follow through postoperative period and facilitates anesthetic recovery
- Consider premedication utilized when choosing postoperative analgesics
- Pain scores of 2 and greater should be treated with analgesic medications
- Watch for potential hyperthermia in cats with opioid therapy
- Do not confuse pain with dysphoria
  - Refer to *Induction, Monitoring and Recovery* chapter for details

Note: For dogs already on an NSAID, do not change to a different NSAID without observing the recommended number of half-lives. Maintain on the same NSAID or use an analgesic with a different mechanism of action (*e.g.*, opioid or tramadol). See *The Individualized Anesthesia and Analgesia Plan* chapter for details.

- Only use NSAIDs if patient is well-hydrated, has received intraoperative fluids and is not hypotensive or bleeding

Analgesia to go home

Drug	Dosage		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	PO once daily or divided into 2 doses for 3–5 days
Meloxicam	**Canine**	0.1 mg/kg	PO, every 24 hours
Robenacoxib	**Feline**	1 mg/kg	PO once daily for a maximum of 3 **total** doses over 3 days. Do not exceed 1 dose per day.
OPIOID			
Tramadol*	**Canine**	5 mg/kg	PO, every 6 hours
	Feline	2–4 mg/kg	
Buprenorphine	**Feline**	0.01–0.02 mg/kg	Transmucosal, every 8 hours

*Oral tramadol has not been shown to be effective postoperatively in dogs.

- NSAID and/or opioid as appropriate for health status
- **Dispense the same NSAID that was utilized postoperatively**

Notes

Dental prophylaxis

What is different about this patient?

This same protocol for anesthesia and recovery can be used for healthy, elective soft tissue surgery. However, it is important to evaluate the patient for dental prophylaxis very carefully; patients with significant tooth disease may be geriatric or have concurrent disease, which must be taken into account (see other protocols depending on the nature of the concurrent disease). Use the dental prophylaxis protocol in those healthy pets when no concurrent diseases or patient-specific factors impacting anesthesia are present. Healthy geriatric patients undergoing routine dental prophylaxis should be anesthetized using the *Geriatric* protocol.

Dental prophylaxis is considered a **non-sterile** procedure. It has been shown that bacteremia occurs with routine dental prophylaxis, independent of the severity of dental disease. **Performing sterile procedures under the same anesthesia as a dental prophylaxis is not recommended due to concerns of contamination.**

Unique risks to the patient undergoing a dental prophylaxis include:

- Hypothermia
  - Length of time of procedure
  - Potential for fur to become soaked with flushing solution
- Aspiration
  - Potentially large volume of oral flushing solutions
  - Incorrect or incomplete ET cuff inflation
- Thermal burns
  - Potentially saturated fur and prolonged recumbency on warming devices
  - Be especially cautious in older patients/patients with thin body condition

Premedication

Drug	Dose	Route
Midazolam	0.1–0.3 mg/kg	IM, SC
Butorphanol	0.2–0.4 mg/kg	IM, SC
OR		
Acepromazine	0.02–0.05 mg/kg	IM, SC
Butorphanol	0.2–0.4 mg/kg	IM, SC

- **Maximum acepromazine dose of 2 mg in dogs and 1 mg in cats.** Dose should be reduced for Boxers, sighthounds and dogs positive for ABCB1 (MDR1) gene (Collies and others)
  - See *The Individualized Anesthesia and Analgesia Plan* chapter for details
- Midazolam commonly causes excitation in younger, healthy patients

Note: Routine dental prophylaxis (with no extractions and with minimal periodontal disease) is not anticipated to require additional analgesic therapy

Notes

Induction and intubation

Drug	Dose	Route
Propofol	1.0 mg/kg slowly over 15 seconds Increments of 0.5 mg/kg over 15 seconds until intubation	IV
OR		
Alfaxalone	0.5 mg/kg slowly over 30 seconds Increments of 0.5 mg/kg until smooth transition to intubation and inhalant	IV

- **Induce with lowest possible dose of induction agent**
  - **Both propofol and alfaxalone may cuase apnea if given rapidly**
- **Bradycardia, hypotension and respiratory depression may develop after rapid administration of propofol or alfaxalone**

- Ensure appropriate seal on endotracheal cuff due to high volumes of oral flush solution

Transition phase

Post-induction inhalant rates

Inhalant	Rates	Miscellaneous
Oxygen	50–100 mL/kg/minute (rebreathing)	For first 15 minutes after induction
	150–300 mL/kg/minute (NRB)	
Sevoflurane	3% for 3 minutes	Large dogs may need higher rates

- Monitor anesthetic depth and oxygenation closely

Anesthetic maintenance

Drugs	Rates
Oxygen	20–30 mL/kg/minute (rebreathing)
	200 mL/kg/minute (average rate, NRB)
Sevoflurane	1–4% to effect with oxygen

- High volumes of water may be used to rinse and flush the oral cavity during dental prophylaxis
  - Ensure patient fur does not become saturated with water
  - This may predispose to hypothermia and potentially thermal burns (especially if thin body condition)
    - Keep patients as dry as possible
- Be prepared to adjust oxygen flow rates in response to patient clinical parameters
- Amount of sevoflurane will vary with patient health, analgesic therapy and local blocks used
- If 4% or more sevoflurane is required:
  - Check the anesthesia system for leaks
  - Ensure appropriate analgesia
  - Consider:
    - Inadequate premedication
    - Improper endotracheal intubation, etc.
      - See Equipment chapter for more details

Perioperative anesthetic support

Intravenous Fluids	Rate		Miscellaneous
Crystalloids	**Canine**	5 mL/kg/hour	Higher fluid rates may be needed if patient is not adequately hydrated when anesthesia begins
	Feline	3 mL/kg/hour	

Anticholinergics		
Drug	**Dose**	**Route**
Atropine	0.02–0.04 mg/kg	IV
Glycopyrrolate	0.005–0.01 mg/kg	IV

- Intraoperative analgesia as indicated by patient clinical status
  - See *The Individualized Anesthesia and Analgesia Plan* chapter for details
- Anticholinergics as clinically indicated for bradycardia accompanied by hypotension

Local blocks and antibiotics

Local block		
Dental nerve block(s)	Bupivacaine **Canine**	2 mg/kg
	Feline	1.5 mg/kg
	+/- Buprenorphine	**3–5 mcg**/kg
Antibiotics		
As medically indicated	See *Medical Quality Standards* chapter	

- Dilute local anesthetic as needed to obtain adequate volume for administration
  - Pay attention to maximum cumulative doses

Anesthetic recovery

Parameter	Range
Normothermic	Temp 100–102.5° F
Normotensive	MAP 80–100 mm Hg
Oxygenating normally on room air	SpO_2 95–100%
Sternal recumbency	
Pain controlled	Pain score <2

Notes

Postoperative care and pain management

Drug	Dose		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	SC (initial dose)
Meloxicam	**Canine**	0.2 mg/kg	SC (initial dose)
Robenacoxib	**Feline**	2 mg/kg	SC (initial dose)
OPIOID			
Buprenorphine	**Canine**	0.005–0.02 mg/kg	IM
	Feline	0.01–0.02 mg/kg	IM, Transmucosal
Buprenorphine – long acting	**Feline**	0.24 mg/kg (dose on lean body weight)	**SC only**
Hydromorphone	**Canine**	0.01–0.2 mg/kg	SC, IM
		0.005 mg/kg	IV every 2–4 hours
	Feline	0.05–0.1 mg/kg	SC, IM
		0.05 mg/kg	IV every 2–6 hours
Methadone	0.1–0.4 mg/kg		IM, IV
Buprenorphine - Transdermal	**Feline**	1 tube (dose on lean body weight)	Transdermal

- Adequate pain management must follow through postoperative period and facilitates anesthetic recovery
- Consider premedication utilized when choosing postoperative analgesics
- Pain scores of 2 and greater should be treated with analgesic medications
- Watch for potential hyperthermia in cats with opioid therapy
- Do not confuse pain with dysphoria
  - Refer to *Induction, Monitoring and Recovery* chapter for details

Note: For dogs already on an NSAID, do not change to a different NSAID without observing the recommended number of half-lives. Maintain on the same NSAID or use an analgesic with a different mechanism of action (*e.g.*, opioid or tramadol). See *The Individualized Anesthesia and Analgesia Plan* chapter for details.

- Use NSAIDs only if patient is well-hydrated, has received intraoperative fluids and is not hypotensive or bleeding

Analgesia to go home

Drug	Dosage		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	PO once daily or divided into 2 doses for 3–5 days
Meloxicam	**Canine**	0.1 mg/kg	PO, every 24 hours
Robenacoxib	**Feline**	1 mg/kg	PO once daily for a maximum of 3 **total** doses over 3 days. Do not exceed 1 dose per day.
OPIOID			
Tramadol*	**Canine**	5 mg/kg	PO, every 6 hours
	Feline	2–4 mg/kg	
Buprenorphine	**Feline**	0.01–0.02 mg/kg	Transmucosal, every 8 hours

*Oral tramadol has not been shown to be effective postoperatively in dogs.

- NSAIDs and/or opioids are most commonly used as indicated for patient analgesia
  - Analgesic therapy is not anticipated to be necessary for routine dental prophylaxis
  - Extractions may require additional analgesic medication
- NSAID and/or opioid as appropriate for health status
- **Dispense the same NSAID that was utilized postoperatively**

Diabetic (stable)

What is different about this patient?

Stable may be a relative term for a diabetic as changes in routine and stress can cause the patient to destabilize. It is important to try to fit the anesthesia and procedure into the patient's "normal" pattern as much as possible. Goals are to have the patient awake and eating as soon as possible and able to leave the hospital.

This patient should have the normal evening meal and insulin dose at the regular time the night before anesthesia, then proceed with the following recommendations.

- Give half morning feeding and half morning insulin two to three hours prior to anesthesia.
- Schedule anesthesia as early in the day as possible.
- Ensure preoperative bloodwork is relatively normal (BG should be between 150 - 250 mg/dL).
  - If BG is less than 50 or greater than 600 mg/dL do not proceed with anesthesia and institute measures to control BG.
  - IV infusions of 2.5 or 5% dextrose may be used to support BG when levels are less than 100 mg/dL.
  - If BG levels are greater than 300 mg/dL, IV dextrose support is not indicated.
- Consider antiemetic administration prior to premedication to help prevent nausea and vomiting with the shorter than normal fast.

Stable diabetic patients should be discharged from the hospital as quickly as possible after complete recovery. These patients should be able to eat a normal evening meal with a full insulin dose after anesthesia if the procedure was performed early in the day.

Home administered anxiolytics

Drug		Dose	Route
Trazodone	**Canine**	5–15 mg/kg	PO 1 hr prior to travel
Gabapentin	**Feline**	50–100 mg/cat	PO 2–3 hrs prior to travel

- Consider giving the first dose the night before along with another dose the morning of the procedure
- Trazodone can cause paradoxical excitement. Trial doses are recommended.

Premedication

Drug	Dose	Route
Acepromazine	0.02–0.05 mg/kg	IM, SC
Butorphanol	0.2–0.4 mg/kg	IM, SC
OR		
Midazolam	0.1–0.3 mg/kg	IM, SC
Butorphanol	0.2–0.4 mg/kg	IM, SC

- Pre-treatment with maropitant is recommended to improve early return to eating post-operatively
- If patient is very relaxed or elderly, butorphanol alone may be appropriate
- **Maximum acepromazine dose of 2 mg in dogs and 1 mg in cats.** Dose should be reduced for Boxers, sighthounds and dogs positive for ABCB1 (MDR1) gene (Collies and others)
  - See *The Individualized Anesthesia and Analgesia Plan* chapter for details
- Consider if additional analgesic therapy is warranted, based on:
  - Signalment
  - Anesthetic indication
  - Physical examination
  - Surgical intervention planned
- **If analgesic therapy is warranted, replace butorphanol in the premedication with another opioid listed in Additional Analgesic Therapy**

Additional analgesic therapy

Drug	Dose		Route
Hydromorphone	0.05–0.1 mg/kg		IM, SC
Buprenorphine	0.01–0.02 mg/kg		IM, IV
Buprenorphine – long acting	**Feline**	0.24 mg/kg (dose on lean body weight)	**SC only**
Methadone	0.1–0.4 mg/kg		IM, IV
Buprenorphine – Transdermal	**Feline**	1 tube (dose on lean body weight)	Transdermal

Induction and intubation

Drug	Dose	Route
Propofol	1.0 mg/kg slowly over 15 seconds Increments of 0.5 mg/kg over 15 seconds until intubation	IV
OR		
Alfaxalone	0.5 mg/kg slowly over 30 seconds Increments of 0.5 mg/kg until smooth transition to intubation and inhalant	IV

- **Induce with lowest possible dose of induction agent**
  - **Both propofol and alfxalone my cause apnea if given rapidly**
- **Bradycardia, hypotension and respiratory depression may develop after rapid administration of propofol or alfaxalone**

Transition phase

Post-induction inhalant rates

Inhalant	Rates	Miscellaneous
Oxygen	50–100 mL/kg/minute (rebreathing)	For first 15 minutes after induction
	150–300 mL/kg/minute (NRB)	
Sevoflurane	3% for 3 minutes	Large dogs may need higher rates

- Monitor anesthetic depth and oxygenation closely

Anesthetic maintenance

Drugs	Rates
Oxygen	20–30 mL/kg/minute (rebreathing)
	200 mL/kg/minute (average rate, NRB)
Sevoflurane	1–4% to effect with oxygen

- BG should be measured after induction and at 30-minute intervals or more frequently if medically indicated. If glucose is under 100 mg/dL, IV fluids should be supplemented with dextrose at calculated fluid rate. Dextrose administration should be discontinued if BG is greater than 300 mg/dL.
- Be prepared to adjust oxygen flow rates in response to patient clinical parameters
- Amount of sevoflurane will vary with patient health, analgesic therapy and local blocks used
- If 4% or more sevoflurane is required:
  - Check the anesthesia system for leaks
  - Ensure appropriate analgesia
  - Consider:
    - Inadequate premedication
    - Improper endotracheal intubation, etc.
      - See Equipment chapter for more details

Perioperative anesthetic support

Intravenous Fluids	Rate		Miscellaneous
Crystalloids	**Canine**	5 mL/kg/hour	Higher fluid rates may be needed if patient is not adequately hydrated when anesthesia begins
	Feline	3 mL/kg/hour	

Anticholinergics		
Drug	**Dose**	**Route**
Atropine	0.02–0.04 mg/kg	IV
Glycopyrrolate	0.005–0.01 mg/kg	IV

- Intraoperative analgesia as indicated by patient clinical status
  - See *The Individualized Anesthesia and Analgesia Plan* chapter for details
- Anticholinergics as clinically indicated for bradycardia accompanied by hypotension

Notes

Local blocks and antibiotics

Local block	
As medically indicated	Pay attention to maximum cumulative doses
Antibiotics	
As medically indicated	See *Medical Quality Standards* chapter

- Dilute local anesthetic as needed to obtain adequate volume for administration
- Perform blocks once patient is under general anesthesia and the first of 3 sterile skin preps has been performed

Anesthetic recovery

Parameter	Range
Normothermic	Temp 100–102.5° F
Normotensive	MAP 80–100 mm Hg
Oxygenating normally on room air	SpO_2 95–100%
Sternal recumbency	
Pain controlled	Pain score <2

- Patient should be offered a small amount of food as early as possible when fully awake and able to eat **without risk of aspiration**

Postoperative care and pain management

Drug	Dose		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	SC (initial dose)
Meloxicam	**Canine**	0.2 mg/kg	SC (initial dose)
Robenacoxib	**Feline**	2 mg/kg	SC (initial dose)
OPIOID			
Buprenorphine	**Canine**	0.005–0.02 mg/kg	IM
	Feline	0.01–0.02 mg/kg	IM, Transmucosal
Buprenorphine – long acting	**Feline**	0.24 mg/kg (dose on lean body weight)	**SC only**
Hydromorphone	**Canine**	0.01–0.2 mg/kg	SC, IM
		0.005 mg/kg	IV every 2–4 hours
	Feline	0.05–0.1 mg/kg	SC, IM
		0.05 mg/kg	IV every 2–6 hours
Fentanyl	See *Appendix* chapter for details		IV as CRI
Methadone	0.1–0.4 mg/kg		IM, IV
Buprenorphine – Transdermal	**Feline**	1 tube (dose on lean body weight)	Transdermal

- NSAIDs and/or opioids are most commonly used as indicated for patient analgesia
- Adequate pain management must follow through postoperative period and facilitates anesthetic recovery
- Consider premedication utilized when choosing postoperative analgesics
- Pain scores of 2 and greater should be treated with analgesic medications
- Watch for potential hyperthermia in cats with opioid therapy
- Do not confuse pain with dysphoria
  - Refer to *Induction, Monitoring and Recovery* chapter for details

Note: For dogs already on an NSAID, do not change to a different NSAID without observing the recommended number of half-lives. Maintain on the same NSAID or use an analgesic with a different mechanism of action (*e.g.*, opioid or tramadol). See *The Individualized Anesthesia and Analgesia Plan* chapter for details.

- Use NSAIDs only if patient is well-hydrated, has received intraoperative fluids and is not hypotensive or bleeding

Analgesia to go home

Drug	Dosage		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	PO once daily or divided into 2 doses for 3–5 days
Meloxicam	**Canine**	0.1 mg/kg	PO, every 24 hours
Robenacoxib	**Feline**	1 mg/kg	PO once daily for a maximum of 3 **total** doses over 3 days. Do not exceed 1 dose per day.
OPIOID			
Tramadol*	**Canine**	5 mg/kg	PO, every 6 hours
	Feline	2–4 mg/kg	
Buprenorphine	**Feline**	0.01–0.02 mg/kg	Transmucosal, every 8 hours

* Oral tramadol has not been shown to be effective postoperatively in dogs.

- NSAID and/or opioid as appropriate for health status
- **Dispense the same NSAID that was utilized postoperatively**

Notes

Emergency

What is different about this patient?

True emergencies are surgical cases that require immediate anesthesia (within 15 minutes) to save the patient's life. These situations are rare and thus this protocol should be infrequently used

These patients may require intensive preparation to become as stable as possible for anesthesia. Surgical preparation can occur while stabilization is being performed, prior to induction.

- Calculate emergency drug doses and draw up medication.
- Prepare other equipment that may be necessary – chest tubes, tourniquets, etc.
- Place a second IV catheter.
- Prepare anticipated CRIs – dopamine, fentanyl, lidocaine, etc.

If preanesthetic clinical pathology data cannot be obtained due to the urgency of the situation, perform it as the patient is being examined and stabilized. Address life-threatening abnormalities (*e.g.*, hypoglycemia, hyperkalemia).

Some patients may present on emergency with a life-threatening illness (*e.g.*, urethral obstruction, pyometra). It is important to differentiate patients that require **emergency surgery** from patients with **critical illness** that will need anesthesia at some point but **require medical intervention first**. Proceed to anesthesia when these patients have medically stabilized and anesthesia risks have been reduced.

Examples

Airway obstruction, bilateral pneumothorax	Life-threatening acute hemorrhage

Premedication

Drug	Dose	Route
Midazolam	0.1–0.3 mg/kg	IM, SC
Butorphanol	0.2–0.4 mg/kg	IM, SC

- Consider if additional analgesic therapy is warranted, based on:
  - Signalment
  - Anesthetic indication
  - Physical examination
  - Surgical intervention planned
- **If analgesic therapy is warranted, replace butorphanol in the premedication with another opioid listed in Additional Analgesic Therapy**

Additional analgesic therapy

Drug	Dose		Route
Hydromorphone	0.05–0.1 mg/kg		IM, SC
Buprenorphine	0.01–0.02 mg/kg		IM, IV
Buprenorphine – long acting	**Feline**	0.24 mg/kg (dose on lean body weight)	**SC only**
Methadone	0.1–0.4 mg/kg		IM, IV

Induction and intubation

Drug	Dose	Route
Propofol	1.0 mg/kg slowly over 15 seconds Increments of 0.5 mg/kg over 15 seconds until intubation	IV
OR		
Alfaxalone	0.5 mg/kg slowly over 30 seconds Increments of 0.5 mg/kg until smooth transition to intubation and inhalant	IV

- Preoxygenate if possible, based on patient tolerance and clinical stability

- **Induce with lowest possible dose of induction agent**
  - **Both propofol and alfaxalone may cuase apnea if given rapidly**
- **Bradycardia, hypotension and respiratory depression may develop after rapid administration of propofol or alfaxalone**

Transition phase
Post-induction inhalant rates

Inhalant	Rates	Miscellaneous
Oxygen	50–100 mL/kg/minute (rebreathing)	For first 15 minutes after induction
	150–300 mL/kg/minute (NRB)	
Sevoflurane	3% for 3 minutes	Large dogs may need higher rates

- Monitor anesthetic depth and oxygenation closely

Anesthetic maintenance

Drugs	Rates
Oxygen	20–30 mL/kg/minute (rebreathing)
	200 mL/kg/minute (average rate, NRB)
Sevoflurane	1–4% to effect with oxygen

- Be prepared to adjust oxygen flow rates in response to patient clinical parameters
- Amount of sevoflurane will vary with patient health, analgesic therapy and local blocks used
- If 4% or more sevoflurane is required:
  - Check the anesthesia system for leaks
  - Ensure appropriate analgesia
  - Consider:
    - Inadequate premedication
    - Improper endotracheal intubation, etc.
      - See Equipment chapter for more details

Notes

Perioperative anesthetic support

Intravenous Fluids	Rate		Miscellaneous
Crystalloids	**Canine**	5 mL/kg/hour	Higher fluid rates may be needed if patient is not adequately hydrated when anesthesia begins
	Feline	3 mL/kg/hour	
Colloids	**Canine**	20 mL/kg/day OR Bolus of 5 mL/kg	If medically indicated
	Feline	20 mL/kg/day OR Bolus of 2.5 mL/kg	

Anticholinergics		
Drug	**Dose**	**Route**
Atropine	0.02–0.04 mg/kg	IV
Glycopyrrolate	0.005–0.01 mg/kg	IV

- Treat hypotension and prevent/treat hypothermia as aggressively as possible in the critical patient
- See *Induction, Monitoring and Recovery* chapter for details regarding colloid and transfusion support
- Depending on preanesthetic BG readings, BG may need to be checked intraoperatively and postoperatively. IV dextrose infusion at 2.5–5% may be utilized to support BG in the hypoglycemic patient.
- **If a lidocaine CRI is utilized during surgery, turn the vaporizer down to 0.5–1%**
- Intraoperative analgesia as indicated by patient clinical status
  - See *The Individualized Anesthesia and Analgesia Plan* chapter for details
- Anticholinergics as clinically indicated for bradycardia accompanied by hypotension

Local blocks and antibiotics

Local block	
As medically indicated	Pay attention to maximum cumulative doses
Antibiotics	
As medically indicated	See *Medical Quality Standards* chapter

- Dilute local anesthetic as needed to obtain adequate volume for administration
- Perform blocks once patient is under general anesthesia and the first of 3 sterile skin preps has been performed
- Line blocks may be performed at end of surgery at the time of incision closure

Anesthetic recovery

Parameter	Range
Normothermic	Temp 100–102.5° F
Normotensive	MAP 80–100 mm Hg
Oxygenating normally on room air	SpO_2 95–100%
Sternal recumbency	
Pain controlled	Pain score <2

Postoperative care and pain management

Drug	Dose		Route
OPIOIDS			
Buprenorphine	**Canine**	0.005–0.02 mg/kg	IM
	Feline	0.01–0.02 mg/kg	IM, Transmucosal
Buprenorphine – long acting	**Feline**	0.24 mg/kg (dose on lean body weight)	**SC only**
Hydromorphone	**Canine**	0.01–0.2 mg/kg	SC, IM
		0.005 mg/kg	IV every 2–4 hours
	Feline	0.05–0.1 mg/kg	SC, IM
		0.05 mg/kg	IV every 2–6 hours
Methadone	0.1–0.4 mg/kg		IM, IV
Buprenorphine – Transdermal	**Feline**	1 tube (dose on lean body weight)	Transdermal

- **Critical or unstable patients, or patients that require continuous monitoring, should be referred to an overnight/24-hour facility for continued care**
- Opioids are most commonly used
  - Avoid NSAIDs depending on the emergency, blood pressure stabilization and underlying risks
- Adequate pain management must follow through postoperative period and facilitates anesthetic recovery
- Consider premedication utilized when choosing postoperative analgesics
- Pain scores of 2 and greater should be treated with analgesic medications
- Watch for potential hyperthermia in cats with opioid therapy
- Do not confuse pain with dysphoria
  - Refer to *Induction, Monitoring and Recovery* chapter for details

Analgesia to go home

Drug	Dosage		Route
Tramadol*	**Canine**	5 mg/kg	PO, every 6 hours
	Feline	2–4 mg/kg	
OR			
Buprenorphine	**Feline**	0.01–0.02 mg/kg	Transmucosal, every 8 hours

*Oral tramadol has not been shown to be effective postoperatively in dogs.

- Use opioid as appropriate for health status
- Avoid NSAIDs when possible
- Tailor to the individual patient as clinically indicated

Notes

Geriatric

What is different about this patient?

Geriatric patients are usually considered to be those that have reached 75–80 percent of breed-specific lifespan. An age of 8 years for dogs and 12 years for cats may be a good estimate.

It is important to review the medical history of these patients closely as they may be receiving medications for concurrent diseases or analgesic medication (including NSAIDs) for known or presumptive arthritis. These patients should be scrutinized for concurrent diseases with careful physical examination, clinical pathology evaluation and additional testing if medically indicated.

- **Use the *Geriatric* protocol in those pets where no concurrent disease conditions are identified or suspected.**
  - Geriatric patients undergoing a routine dental prophylaxis should be anesthetized using the *Geriatric* protocol.
- If concurrent disease is identified in a geriatric patient, then the protocol specific to that disease should be utilized.
  - The most common conditions include cardiac, renal and hepatic disease (see specific protocols for details).
- Thoracic radiographs are recommended within 6 months prior to any anesthesia

Complications to consider:

- Increased anxiety
- Arthritis - patients may need additional padding during the procedure, low-stress handling techniques and more support when moving/carrying
- Decreased dose adjustments
- Use of the saphenous vein for IV catheter to decrease stress and handling

Geriatric patients often have significant physiologic decline in most organ functions as well as a decline in neurologic function, leading to less reserve in all vital organs. This means that the patient is less tolerant of anesthesia; all drug dosages (including inhalant anesthesia) must be carefully titrated based on the patient's response.

Examples

Reasonable estimates for geriatric ages	**Canine:** > 8 years (adjust for size/breed)	No concurrent disease
	Feline: >12 years	

Premedication

Drug	Dose	Route
Low dose Acepromazine	0.01 mg/kg	IM
Butorphanol	0.2 mg/kg	IM
OR		
Midazolam	0.1 mg/kg	IM
Butorphanol	0.2–0.4 mg/kg	IM
OR		
Alfaxalone	2 mg/kg	IM (volume limits to small patients only)
Butorphanol	0.2-0.4 mg/kg	IM
OR		
Alfaxalone	2 mg/kg	IM (volume limits to small patients only)
Methadone	0.2 mg/kg	IM

- If the patient is very stressed by the hospital environment or the procedure warrants additional analgesic needs, hydromorphone may replace butorphanol (see dosing below)
  - Alternatively, the opioid may be used alone
- **Maximum acepromazine dose of 2 mg in dogs and 1 mg in cats**
  - Dose should be reduced for Boxers, sighthounds and dogs positive for ABCB1 (MDR1) gene (Collies and others)
    - See *The Individualized Anesthesia and Analgesia Plan* chapter for details
- **If analgesic therapy is warranted, replace butorphanol in the premedication with another opioid listed in Additional Analgesic Therapy**

Additional analgesic therapy

Drug	Dose		Route
Hydromorphone	0.05–0.1 mg/kg		IM, SC
Buprenorphine	0.01–0.02 mg/kg		IM, IV
Buprenorphine – long acting	**Feline**	0.24 mg/kg (done on lean body weight)	**SC only**
Methadone	0.1–0.4 mg/kg		IM, IV
Buprenorphine – Transdermal	**Feline**	1 tube (dose on lean body weight)	Transdermal

Induction and intubation

Drug	Dose	Route
Propofol	1.0 mg/kg slowly over 15 seconds Increments of 0.5 mg/kg over 15 seconds until intubation	IV
OR		
Alfaxalone	0.5 mg/kg slowly over 30 seconds Increments of 0.5 mg/kg until smooth transition to intubation and inhalant	IV

- **Induce with lowest possible dose of propofol**
  - **May cause apnea if given rapidly**
- **Bradycardia, hypotension and respiratory depression may develop after rapid administration**

Transition phase
Post-induction inhalant rates

Inhalant	Rates	Miscellaneous
Oxygen	50–100 mL/kg/minute (rebreathing)	For first 15 minutes after induction
	150–300 mL/kg/minute (NRB)	
Sevoflurane	3% for 3 minutes	Large dogs may need higher rates

- Monitor anesthetic depth and oxygenation closely

Anesthetic maintenance

Inhalant	Rates
Oxygen	20–30 mL/kg/minute (rebreathing)
	200 mL/kg/minute (average rate, NRB)
Sevoflurane	1–4% to effect with oxygen

- **Hypotension should not be tolerated** (*i.e.*, two consecutive low readings should prompt notification of the veterinarian and treatment as directed)
  - **A fluid bolus, usually the first treatment for hypotension, should be used with caution if there is concurrent heart disease**
- Be prepared to adjust oxygen flow rates in response to patient clinical parameters
- Amount of sevoflurane will vary with patient health, analgesic therapy and local blocks used
- If 4% or more sevoflurane is required:
  - Check the anesthesia system for leaks
  - Ensure appropriate analgesia
  - Consider:
    - Inadequate premedication
    - Improper endotracheal intubation, etc.
      - See Equipment chapter for more details

Perioperative anesthetic support

Intravenous Fluids	Rate		Miscellaneous
Crystalloids	**Canine**	5 mL/kg/hour	Higher fluid rates may be needed if patient is not adequately hydrated when anesthesia begins
	Feline	3 mL/kg/hour	

Anticholinergics		
Drug	**Dose**	**Route**
Atropine	0.02–0.04 mg/kg	IV
Glycopyrrolate	0.005–0.01 mg/kg	IV

- **Avoid anticholinergics unless extremely bradycardic, accompanied by hypotension, as geriatric patients may be hypersensitive to anticholinergics**
- Remember that fluid rates and the use of anticholinergics may need to be altered for concurrent disease conditions. See specific protocols for guidelines.
- Intraoperative analgesia as indicated by patient clinical status
  - See *The Individualized Anesthesia and Analgesia Plan* chapter for details

Notes

Local blocks and antibiotics

Local block	
Use whenever possible to lower vaporizer setting required	Pay attention to maximum cumulative doses
Antibiotics	
As medically indicated	See *Medical Quality Standards* chapter

- Dilute local anesthetic as needed to obtain adequate volume for administration
- Perform blocks once patient is under general anesthesia and the first of 3 sterile skin preps has been performed

Notes

Anesthetic recovery

Parameter	Range
Normothermic	Temp 100–102.5° F
Normotensive	MAP 80–100 mm Hg
Oxygenating normally on room air	SpO_2 95–100%
Sternal recumbency	
Pain controlled	Pain score <2

- Careful auscultation of lungs for evidence of pulmonary edema should be performed if additional fluids were required at any time during or after the procedure
- Patients with preexisting arthritis may have difficulty moving around after surgery and may benefit from additional padding and pillows
- Patients with chronic respiratory disease may have SpO_2 levels below and $EtCO_2$ levels above the normal range
  - Upon recovery, SpO_2 levels should return to preoperative levels
- Supplemental oxygen may be of benefit to these patients in the recovery phase and can be provided by mask/flow by/oxygen cage (where available)/instillation of nasal oxygen tubes
  - Note that there are multiple methods described to place nasal oxygen catheters
  - The medical record should contain accurate documentation of the step-by-step procedure utilized
    - An example procedure is provided in the *Respiratory Compromise* protocol
- Recovery may be delayed. Closely monitor for hypothermia and comfort.

Postoperative care and pain management

Drug	Dose		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	SC (initial dose)
Meloxicam	**Canine**	0.2 mg/kg	SC (initial dose)
Robenacoxib	**Feline**	2 mg/kg	SC (initial dose)
OPIOID			
Buprenorphine	**Canine**	0.005–0.02 mg/kg	IM
	Feline	0.01–0.02 mg/kg	IM, Transmucosal
Buprenorphine – long acting	**Feline**	0.24 mg/kg (dose on lean body weight)	**SC only**
Hydromorphone	**Canine**	0.01–0.2 mg/kg	SC, IM
		0.005 mg/kg	IV every 2–4 hours
	Feline	0.05–0.1 mg/kg	SC, IM
		0.05 mg/kg	IV every 2–6 hours
Methadone	0.1–0.4 mg/kg		
Buprenorphine – Transdermal	**Feline**	1 tube (dose on lean body weight)	Transdermal

- NSAIDs and/or opioids are most commonly used as indicated for patient analgesia
- **Consider potential drug interactions**
- Pain management can be the same as for healthy (nongeriatric) patients if renal function (as investigated by preanesthetic minimum data base) is normal
  - If abnormal renal function is present, NSAIDs should not be used
- Adequate pain management must follow through postoperative period and facilitates anesthetic recovery
- Consider premedication utilized when choosing postoperative analgesics
- Pain scores of 2 and greater should be treated with analgesic medications
- Watch for potential hyperthermia in cats with opioid therapy
- Do not confuse pain with dysphoria
  - Refer to *Induction, Monitoring and Recovery* chapter for details

Note: For dogs already on an NSAID, do not change to a different NSAID without observing the recommended number of half-lives. Maintain on the same NSAID or use an analgesic with a different mechanism of action (*e.g.*, opioid or tramadol). See *The Individualized Anesthesia and Analgesia Plan* chapter for details.

- Use NSAIDs only if patient is well-hydrated, has received intraoperative fluids and is not hypotensive or bleeding

Analgesia to go home

Drug	Dosage		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	PO once daily or divided into 2 doses for 3–5 days
Meloxicam	**Canine**	0.1 mg/kg	PO, every 24 hours
Robenacoxib	**Feline**	1 mg/kg	PO once daily for a maximum of 3 **total** doses over 3 days. Do not exceed 1 dose per day.
OPIOID			
Tramadol*	**Canine**	5 mg/kg	PO, every 6 hours
	Feline	2–4 mg/kg	
Buprenorphine	**Feline**	0.01–0.02 mg/kg	Transmucosal, every 8 hours

*Oral tramadol has not been shown to be effective postoperatively in dogs.

- **Dispense the same NSAID that was utilized postoperatively**

Notes

Hands-free radiology

What is different about this patient and procedure?

This protocol should be utilized to help minimize exposure to radiation for hospital associates. The ALARA (as low as reasonably achievable) principles for radiation exposure should be consistently followed and be followed throughout this protocol.

Many drugs and combinations may be used for sedation to get diagnostic radiographs and should be individualized for each patient. Additionally, it is important to preplan radiographic studies to enable maximal utilization of chemical restraint in conjunction with patient positioning tools.

Additional considerations:

- Always consider the safest anesthetic procedure (sedation, immobilization or general anesthesia) for the patient.
- Ensure appropriate monitoring and airway support is provided for every anesthetic procedure.
- Follow all Medical Quality Standards for patient monitoring and recovery during sedation and immobilization procedures.

Examples

Orthopedic injury	Neoplasia staging	Coxofemoral joint assessment

Home administered anxiolytics

Drug	Dose		Route
Trazodone	**Canine**	5–15 mg/kg	PO 1hr prior to travel
Gabapentin	**Feline**	50–100 mg/cat	PO 2–3 hrs prior to travel

- Consider giving the first dose the night before along with another dose the morning of the procedure
- Trazodone can cause paradoxical excitement. Trial doses are recommended.

Premedication

Drug	Dose		Route
Midazolam	0.1–0.3 mg/kg		IM, SC
Butorphanol	0.2–0.4 mg/kg		
OR			
Acepromazine	0.02–0.05 mg/kg		IM, SC
Butorphanol	0.2–0.4 mg/kg		
OR			
Dexmedetomidine	**Canine**	2–5 **mcg**/kg	IM
Butorphanol		0.2–0.4 mg/kg	
OR			
DKT mixture. See *Appendix* chapter for mixing instructions.	**Feline**	0.035 **mL**/kg	IM

- If patient is immobilized, procedures must be converted to general anesthesia if lasting more than 10 minutes
- Consider a different opioid if patient is painful for any reason.

- As a general rule, try using normal premedication for patients that are not fractious
- Fractious patients may require premedication from the *Stressed/Fractious Patient* protocol
  - See *Stressed/Fractious Patient* protocol for details and dosages
- **Maximum acepromazine dose of 2 mg in dogs and 1 mg in cats**
  - Dose should be reduced for Boxers, sighthounds and dogs positive for ABCB1 (MDR1) gene (Collies and others)
    - See *The Individualized Anesthesia and Analgesia Plan* chapter for details
- If patient is immobilized, procedures must be converted to general anesthesia if lasting more than 10 minutes
- Consider a different opioid if patient is painful for any reason

Induction and intubation

Drug	Dose	Route
Propofol	1.0 mg/kg slowly over 15 seconds Increments of 0.5 mg/kg over 15 seconds until intubation	IV
OR		
Alfaxalone	0.5 mg/kg slowly over 30 seconds Increments of 0.5 mg/kg until smooth transition to intubation and inhalant	IV

- Propofol can provide an ultra-short (<5–10 minutes) duration of deeper sedation if additional sedation is needed
  - An IV catheter is required to administer propofol or IV alfaxalone
- Hospital teams should be prepared to intubate and administer supplemental oxygen when medically indicated

- **Bradycardia, hypotension and respiratory depression may develop after rapid administration**
  - **May cause apnea if given rapidly**

- Intubation and inhalant anesthesia are required for immobilization procedures lasting longer than 10 minutes

Maintenance/monitoring

- Monitoring equipment should always be available and used as much as possible
- Almost all animals will tolerate a blood pressure cuff and pulse oximeter while sedated
- Oxygen, laryngoscopes and endotracheal tubes should also be available
- **Use of dexmedetomidine requires flow-by oxygen and pulse oximeter monitoring**

Caution: Dexmedetomidine may cause significant bradycardia (heart rate below 50 bpm). The severity is related to dose (the higher the dose, the higher MAP and the lower the heart rate) and tends to be more severe in dogs than cats. This is a REFLEX bradycardia in response to peripheral vasoconstriction and baroreceptor-mediated decrease in heart rate and SHOULD NOT be treated with an anticholinergic drug. However, at lower doses of dexmedetomidine (less than 5 **mcg/kg**) and also when the vasoconstrictor response starts to diminish (approximately 30 minutes to one hour post-administration), the central sympatholytic effect is in effect, resulting in bradycardia AND hypotension. When bradycardia is associated with hypotension in patients administered dexmedetomidine, it is appropriate to administer an anticholinergic drug.

Support

- IV fluids should not be required for radiographic studies in healthy patients
- Fluid therapy (type and rate) should be individualized to each patient based on physical examination, hydration status and clinical pathology evaluation

Local block and antibiotic

- Not applicable to hands-free radiology

Anesthetic recovery

Parameter	Range
Normothermic	Temp 100–102.5° F
Normotensive	MAP 80–100 mm Hg
Oxygenating normally on room air	SpO_2 95–100%
Sternal recumbency	
Pain controlled	Pain score <2

- Monitoring requirements for sedation/immobilization/general anesthesia procedures as described
  - See *Medical Quality Standards* chapter for details

Postoperative care and pain management

- As medically indicated

Notes

Obese (stable)

What is different about this patient?

Obese patients are those with a body weight 20 – 30 percent or more above ideal. For optimal patient safety in elective procedures, postpone general anesthesia and institute a directed weight loss program. General anesthesia should be then pursued when ideal body weight has been reached.

If there is a need to proceed to anesthesia with an obese patient, drug doses and IV fluid rates should be calculated on lean body weight. Body fat stores do not add to the metabolic fate of medications. This involves a degree of estimating as to what lean body weight should be. Previous medical history with body weight and body condition score may be helpful in determining accurate estimates. If in doubt, underestimate what the patient's weight should be — additional drugs can always be given if administered doses appear ineffective.

Additional considerations:

- Intramuscular and IV injections should be considered. Larger amounts of SC fat lead to variable drug absorption with SC injections. Lumbar injections are likely to only reach the SC space in obese animals.
- Estimated lean body weight should be used to determine endotracheal tube size, size of the rebreathing circuit and bag, tidal volume to be delivered and may influence the size of IV catheter chosen for the patient.
  - Premedication, induction agents, maintenance and analgesic medications should have doses calculated on estimated lean body weight.
- Obesity will have a major impact on the patient's ability to ventilate adequately, especially when placed in dorsal recumbency. Monitor oxygenation closely and be ready to assist ventilation.
- Complications to consider:
  - Passive gastric reflux/regurgitation
  - Hypoxemia
  - Hyperthermia
  - Upper airway obstruction when not intubated
  - Difficulty identifying landmarks and placing IV catheters
  - Hypoventilation especially when the head is tilted lower

Premedication

Drug	Dose	Route
Midazolam	0.1–0.3 mg/kg	IM, SC
Butorphanol	0.2–0.4 mg/kg	
OR		
Acepromazine	0.02–0.05 mg/kg	IM, SC
Butorphanol	0.2–0.4 mg/kg	

- Provide flow-by oxygen prior to induction (preoxygenate for 5 minutes prior if patient will tolerate)
- **Maximum acepromazine dose of 2 mg in dogs and 1 mg in cats**
  - Dose should be reduced for Boxers, sighthounds and dogs positive for ABCB1 (MDR1) gene (Collies and others)
    - See *The Individualized Anesthesia and Analgesia Plan* chapter for details
- Consider if additional analgesic therapy is warranted, based on:
  - Signalment
  - Anesthetic indication
  - Physical examination
  - Surgical intervention planned
- **If analgesic therapy is warranted, replace butorphanol in the premedication with another opioid listed in Additional Analgesic Therapy**

Additional analgesic therapy

Drug	Dose		Route
Hydromorphone	0.05–0.1 mg/kg		IM, SC
Buprenorphine	0.01–0.02 mg/kg		IM, IV
Buprenorphine – long acting	**Feline**	0.24 mg/kg (dose on lean body weight)	**SC only**
Buprenorphine – Transdermal	**Feline**	1 tube (dose on lean body weight)	Transdermal
Methadone	0.1–0.4 mg/kg		IM, IV

Induction and intubation

Drug	Dose	Route
Propofol	1.0 mg/kg slowly over 15 seconds Increments of 0.5 mg/kg over 15 seconds until intubation	IV
OR		
Alfaxalone	0.5 mg/kg slowly over 30 seconds Increments of 0.5 mg/kg until smooth transition to intubation and inhalant	IV

- **Induce with lowest possible dose of induction agent**
  - **Both propofol and alfaxalone may cuase apnea if given rapidly**
- **Bradycardia, hypotension and respiratory depression may develop after rapid administration of propofol or alfaxalone**

Transition phase

Post-induction inhalant rates

Inhalant	Rates	Miscellaneous
Oxygen	50–100 mL/kg/minute (rebreathing)	For first 15 minutes after induction
	150–300 mL/kg/minute (NRB)	
Sevoflurane	3% for 3 minutes	Large dogs may need higher rates

- Monitor anesthetic depth and oxygenation closely

Anesthetic maintenance

Inhalant	Rates
Oxygen	20–30 mL/kg/minute (rebreathing)
	200 mL/kg/minute (average rate, NRB)
Sevoflurane	1–4% to effect with oxygen

- Remember that obesity will have a major impact on the patient's ability to ventilate adequately, especially when placed in dorsal recumbency
  - Monitor oxygenation closely and be ready to assist ventilation
- **Obese patients may have ineffective cooling mechanisms and may be prone to hyperthermia**
  - **Monitor temperatures closely**
- Be prepared to adjust oxygen flow rates in response to patient clinical parameters
- Amount of sevoflurane will vary with patient health, analgesic therapy and local blocks used
- If 4% or more sevoflurane is required:
  - Check the anesthesia system for leaks
  - Ensure appropriate analgesia
  - Consider:
    - Inadequate premedication
    - Improper endotracheal intubation, etc.
      - See Equipment chapter for more details

Perioperative anesthetic support

Intravenous Fluids	Rate		Miscellaneous
Crystalloids	**Canine**	5 mL/kg/hour	Higher fluid rates may be needed if patient is not adequately hydrated when anesthesia begins
	Feline	3 mL/kg/hour	

Anticholinergics		
Drug	**Dose**	**Route**
Atropine	0.02–0.04 mg/kg	IV
Glycopyrrolate	0.005–0.01 mg/kg	IV

- **Calculate fluid rates based on lean body weight**
- Intraoperative analgesia as indicated by patient clinical status
  - See *The Individualized Anesthesia and Analgesia Plan* chapter for details
- Anticholinergics as clinically indicated for bradycardia accompanied by hypotension

Notes

Local blocks and antibiotics

Local block	
As medically indicated	Pay attention to maximum cumulative doses
Antibiotics	
As medically indicated	See *Medical Quality Standards* chapter

- Dilute local anesthetic as needed to obtain adequate volume for administration
- Perform blocks once patient is under general anesthesia and the first of 3 sterile skin preps has been performed

Anesthetic recovery

Parameter	Range
Normothermic	Temp 100–102.5° F
Normotensive	MAP 80–100 mm Hg
Oxygenating normally on room air	SpO_2 95–100%
Sternal recumbency	
Pain controlled	Pain score <2

- If drugs have been carefully administered in minimal dosages, recovery of the obese patient should be fairly rapid
- Obese patients may not ventilate well; place them in sternal recumbency and give oxygen by facemask until they are able to maintain saturation (SpO_2 above 95%) by themselves and temperature is above 100 ° F
- Extremely obese patients might have difficulty righting themselves if they fall into lateral recumbency
  - Ensure complete visual observation until patient is mobile

Postoperative care and pain management

Drug	Dose		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	SC (initial dose)
Meloxicam	**Canine**	0.2 mg/kg	SC (initial dose)
Robenacoxib	**Feline**	2 mg/kg	SC (initial dose)
OPIOID			
Buprenorphine	**Canine**	0.005–0.02 mg/kg	IM
	Feline	0.01–0.02 mg/kg	IM, Transmucosal
Buprenorphine – long acting	**Feline**	0.24 mg/kg (dose on lean body weight)	**SC only**
Hydromorphone	**Canine**	0.01–0.2 mg/kg	SC, IM
		0.005 mg/kg	IV every 2–4 hours
	Feline	0.05–0.1 mg/kg	SC, IM
		0.05 mg/kg	IV every 2–6 hours
Fentanyl	See *Appendix* chapter for details		IV as CRI
Methadone	0.1–0.4 mg/kg		IM, IV
Buprenorphine – Transdermal	**Feline**	1 tube (dose on lean body weight)	Transdermal

- NSAIDs and/or opioids are most commonly used as indicated for patient analgesia
- Adequate pain management must follow through postoperative period and facilitates anesthetic recovery
- Consider premedication when choosing postoperative analgesics
- Pain scores of 2 and greater should be treated with analgesic medications
- Watch for potential hyperthermia in cats with opioid therapy
- Do not confuse pain with dysphoria
  - Refer to *Induction, Monitoring and Recovery* chapter for details

Note: For dogs already on an NSAID, do not change to a different NSAID without observing the recommended number of half-lives. Maintain on the same NSAID or use an analgesic with a different mechanism of action (*e.g.*, opioid or tramadol). See *The Individualized Anesthesia and Analgesia Plan* chapter for details.

- Use NSAIDs only if patient is well-hydrated, has received intraoperative fluids and is not hypotensive or bleeding

Analgesia to go home

Drug	Dosage		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	PO once daily or divided into 2 doses for 3–5 days
Meloxicam	**Canine**	0.1 mg/kg	PO, every 24 hours
Robenacoxib	**Feline**	1 mg/kg	PO once daily for a maximum of 3 **total** doses over 3 days. Do not exceed 1 dose per day.
OPIOID			
Tramadol*	**Canine**	5 mg/kg	PO, every 6 hours
	Feline	2–4 mg/kg	
Buprenorphine	**Feline**	0.01–0.02 mg/kg	Transmucosal, every 8 hours

*Oral tramadol has not been shown to be effective postoperatively in dogs

- NSAID and/or opioid as appropriate for health status
- **Dispense the same NSAID that was utilized postoperatively**

Notes

Orthopedic

What is different about this patient?

The unique aspects of orthopedic surgery include the use of perioperative antibiotics and the anticipation of more significant analgesic requirements. Anesthesia teams should pay close attention to signs of pain (see *The Individualized Anesthesia and Analgesia Plan* chapter for details) throughout hospitalization and be prepared to intervene when medically indicated.

Additional considerations:

- **Ensure patient has not received corticosteroids prior to the procedure as these could impact postoperative NSAID therapy.**
- Ensure that if NSAIDs have been given preoperatively, type, dose and duration of therapy are known.
  - Do not combine different NSAIDs and wait appropriate half-life if changing NSAIDs.

Premedication

Drug	Dose		Route
Acepromazine	0.02–0.05 mg/kg		IM, SC
Hydromorphone	**Canine**	0.05–0.2 mg/kg	
	Feline	0.05–0.1 mg/kg	
OR			
Midazolam	0.1–0.3 mg/kg		IM, SC
Hydromorphone	**Canine**	0.05–0.2 mg/kg	
	Feline	0.05–0.1 mg/kg	

- See *The Individualized Anesthesia and Analgesia Plan* chapter for details
- Consider if additional analgesic therapy is warranted based on:
  - Signalment
  - Anesthetic indication
  - Physical examination
  - Surgical intervention planned
- **If additional analgesic therapy is warranted, consider one of the listed options**

Additional analgesic therapy

Drug	Dose		Route
Hydromorphone	0.05–0.1 mg/kg		IM, SC
Buprenorphine	0.01–0.02 mg/kg		IM, IV
Buprenorphine – long acting	**Feline**	0.24 mg/kg (dose on lean body weight)	**SC only**
Methadone	0.1–0.4 mg/kg		IM, IV
Buprenorphine – Transdermal	**Feline**	1 tube (dose on lean body weight)	Transdermal

Induction and intubation

Drug	Dose	Route
Propofol	1.0 mg/kg slowly over 15 seconds Increments of 0.5 mg/kg over 15 seconds until intubation	IV
OR		
Alfaxalone	0.5 mg/kg slowly over 30 seconds Increments of 0.5 mg/kg until smooth transition to intubation and inhalant	IV

- **Induce with lowest possible dose of induction agent**
  - **Both propofol and alfaxalone may cuase apnea if given rapidly**
- **Bradycardia, hypotension and respiratory depression may develop after rapid administration of propofol or alfaxalone**

Transition phase

Post-induction inhalant rates

Inhalant	Rates	Miscellaneous
Oxygen	50–100 mL/kg/minute (rebreathing)	For first 15 minutes after induction
	150–300 mL/kg/minute (NRB)	
Sevoflurane	3% for 3 minutes	Large dogs may need higher rates

- Monitor anesthetic depth and oxygenation closely

Anesthetic maintenance

	Rates
Oxygen	20–30 mL/kg/minute (rebreathing)
	200 mL/kg/minute (average rate, NRB)
Sevoflurane	1–4% to effect with oxygen

- Be prepared to adjust oxygen flow rates in response to patient clinical parameters
- Amount of sevoflurane will vary with patient health, analgesic therapy and local blocks used
- If 4% or more sevoflurane is required:
  - Check the anesthesia system for leaks
  - Ensure appropriate analgesia
  - Consider:
    - Inadequate premedication
    - Improper endotracheal intubation, etc.

Notes

Perioperative anesthetic support

Intravenous Fluids	Rate		Miscellaneous
Crystalloids	**Canine**	5 mL/kg/hour	Higher fluid rates may be needed if patient is not adequately hydrated when anesthesia begins
	Feline	3 mL/kg/hour	

Anticholinergics		
Drug	**Dose**	**Route**
Atropine	0.02–0.04 mg/kg	IV
Glycopyrrolate	0.005–0.01 mg/kg	IV

- Intraoperative analgesia as indicated by patient clinical status
  - See *The Individualized Anesthesia and Analgesia Plan* chapter for details
- Anticholinergics as clinically indicated for bradycardia accompanied by hypotension

Notes

Local blocks and antibiotics

Local block and/or epidurals	
As medically indicated	Pay attention to maximum cumulative doses
Liposomal bupivacaine (Nocita)	FDA approved for canine CCL surgery
Antibiotics	
Cefazolin 22 mg/kg over 3–5 minutes at induction	IV Repeat every 90 minutes until skin closure is complete

- For more local and regional analgesia options see *The Individualized Anesthesia and Analgesia Plan* chapter
- Dilute local anesthetic as needed to obtain adequate volume for administration
- Perform blocks once patient is under general anesthesia and the first of 3 sterile skin preps has been performed

Anesthetic recovery

Parameter	Range
Normothermic	Temp 100–102.5° F
Normotensive	MAP 80–100 mm Hg
Oxygenating normally on room air	SpO_2 95–100%
Sternal recumbency	
Pain controlled	Pain score <2

Postoperative care and pain management

Drug	Dose		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	SC (initial dose)
Meloxicam	**Canine**	0.2 mg/kg	SC (initial dose)
Robenacoxib	**Feline**	2 mg/kg	SC (initial dose)
OPIOID			
Hydromorphone	**Canine**	0.01–0.2 mg/kg	SC, IM
		0.005 mg/kg	IV every 2–4 hours
	Feline	0.05–0.1 mg/kg	SC, IM
		0.05 mg/kg	IV every 2–6 hours
Fentanyl	See *Appendix* chapter for details		IV as CRI
HLK	See *Appendix* chapter for details		IV as CRI
Methadone	0.1–0.4 mg/kg		IM, IV
Buprenorphine - Transdermal	**Feline**	1 tube (dose on lean body weight)	Transdermal

- NSAIDs and/or opioids are most commonly used as indicated for patient analgesia
- Adequate pain management must follow through postoperative period and facilitates anesthetic recovery
- Consider premedication utilized when choosing postoperative analgesics
- Pain scores of 2 and greater should be treated with analgesic medications
- Watch for potential hyperthermia in cats with opioid therapy
- Do not confuse pain with dysphoria.
  - Refer to *Induction, Monitoring and Recovery* chapter for details

Note: For dogs already on an NSAID, do not change to a different NSAID without observing the recommended number of half-lives. Maintain on the same NSAID or use an analgesic with a different mechanism of action (*e.g.*, opioid or tramadol). See *The Individualized Anesthesia and Analgesia Plan* chapter for details.

- Use NSAIDs only if patient is well-hydrated, has received intraoperative fluids and is not hypotensive or bleeding

Analgesia to Go Home

Drug	Dosage		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	PO once daily or divided into 2 doses for 3–5 days
Meloxicam	**Canine**	0.1 mg/kg	PO, every 24 hours
Robenacoxib	**Feline**	1 mg/kg	PO once daily for a maximum of 3 **total** doses over 3 days. Do not exceed 1 dose per day.
OPIOID			
Tramadol	**Canine**	5 mg/kg	PO, every 6 hours
	Feline	2–4 mg/kg	
Buprenorphine	**Feline**	0.01–0.02 mg/kg	Transmucosal, every 8 hours
Fentanyl patch	Follow dosing chart		Transdermal

- Hospital teams are reminded that if analgesic needs cannot be met with multimodal analgesia, referral to an overnight (24-hour) facility for additional care is warranted and should be recommended
- NSAID and/or opioid as appropriate for health status
- **Dispense the same NSAID that was utilized postoperatively**

Pediatric (under 16 weeks of age)

What is different about this patient?

Pediatric patients are those less than 16 weeks of age. These patients may pose several additional risks associated with anesthesia, and their size, physiology and ability to thermoregulate should always be considered prior to, during and after any anesthetic procedure.

Additional considerations for pediatric patients:

- May not be as competent to metabolize drugs as adults
- May not thermoregulate well and have little body fat
- Are dependent on higher heart rates to maintain cardiac output
- May be smaller, making changes in anesthetic depth happen faster
- May be harder to monitor, place catheters, intubate, etc.

Ideally, postpone any elective procedure until a patient is over 16 weeks of age and the risks of anesthetizing a pediatric patient can be avoided. If anesthesia cannot be postponed and referral is not an option, consider the *Pediatric* protocol. **Do not fast weaned puppies and kittens for longer than two to three hours before anesthesia.**

General puppy and kitten information (compared to adult animals):

Physical parameter	Pediatric value/comparison to adult value
Heart rate	200 + bpm
Respiratory rate	15–35 bpm
Blood pressure	Decreased
BUN	
Cardiac stroke volume	
Peripheral vascular resistance	
Urine specific gravity	
Cardiac output	Increased
Risk of: ■ Dehydration ■ Hypoglycemia ■ Hypothermia	

Age	Physical Parameter	Normal puppy/kitten value
<2 weeks	Temperature	96–97° F
3 weeks	Total white blood cell count	Decreased compared to adults
<4 weeks	Albumin*	Decreased compared to adults
4 weeks	Temperature	100° F
<6 weeks	Urine color	Colorless
<7 weeks	Packed cell volume	27%
8 weeks	Albumin	Normal adult value

*Puppies and kittens may have greater sensitivity to highly protein-bound medications

Premedication

Drug	Dose	Route
Midazolam	0.1–0.3 mg/kg	IM
Butorphanol	0.2–0.4 mg/kg	
PLUS		
Glycopyrrolate	0.01 mg/kg	IM
OR		
Atropine	0.02–0.04 mg/kg	May be used in place of glycopyrrolate in case of back orders

- **Remember that cardiac output depends primarily on cardiac rate in pediatric patients because of decreased stroke volume**
- Consider preemptive warming post premedication due to increased risk for hypothermia

Notes

Induction and intubation

Drug	Dose	Route
Propofol	1.0 mg/kg slowly over 15 seconds Increments of 0.5 mg/kg over 15 seconds until intubation	IV
OR		
Alfaxalone	0.5 mg/kg slowly over 30 seconds Increments of 0.5 mg/kg until smooth transition to intubation and inhalant	IV

- **Intubation may be difficult in small patients**
  - **Extreme care must be taken to avoid laryngeal trauma, which may induce swelling**

- **Induce with lowest possible dose of induction agent**
  - **Both propofol and alfaxalone may cause apnea if given rapidly**
- **Bradycardia, hypotension and respiratory depression may develop after rapid administration of propofol or alfaxalone**

Transition phase

Post-induction inhalant rates

Inhalant	Rates	Miscellaneous
Oxygen	50–100 mL/kg/minute (rebreathing)	For first 15 minutes after induction
	150–300 mL/kg/minute (NRB)	
Sevoflurane	3% for 3 minutes	Large puppies may need higher rates

- Monitor anesthetic depth and oxygenation closely

Anesthetic maintenance

Inhalant	Rates
Oxygen	20–30 mL/kg/minute (rebreathing)
	200 mL/kg/minute (average rate, NRB)
Sevoflurane	1–4% to effect with oxygen

- Bradycardia is defined as a heart rate under 150 bpm and should be addressed immediately as cardiac output depends primarily on heart rate in pediatric patients
- Hypothermia may be of particular concern in pediatric patients
- High respiratory rates, which are normal to meet the higher oxygen demand of puppies and kittens, will result in rapid changes in anesthetic depth
  - Extra care in continuous monitoring must be taken to keep the patient at the appropriate depth of anesthesia
- High metabolic rates also mean that pediatric patients are frequently hypercapnic
  - Intermittent positive pressure ventilation may be needed to prevent hypoventilation and atelectasis
    - Airway pressures should not exceed 15 cm H_20 since lung compliance should be very good in young patients
- Hypoglycemia can occur in young patients especially if inadvertently fasted for longer than one to two hours
  - BG should be checked after induction (so that dextrose can be added to IV fluids if needed) and at 30-minute intervals during the procedure and at recovery
- Be prepared to adjust oxygen flow rates in response to patient clinical parameters
- Amount of sevoflurane will vary with patient health, analgesic therapy and local blocks used
- If 4% or more sevoflurane is required:
  - Check the anesthesia system for leaks
  - Ensure appropriate analgesia
  - Consider:
    - Inadequate premedication
    - Improper endotracheal intubation, etc.
      - See Equipment chapter for more details

Perioperative anesthetic support

Intravenous Fluids	Rate		Miscellaneous
Crystalloids	**Puppies**	5 mL/kg/hour	Higher fluid rates may be needed if patient is not adequately hydrated when anesthesia begins
	Kittens	3 mL/kg/hour	

Anticholinergics		
Drug	**Dose**	**Route**
Atropine	0.02–0.04 mg/kg	IV
Glycopyrrolate	0.005–0.01 mg/kg	IV

- Intraoperative analgesia as indicated by patient clinical status
  - See *The Individualized Anesthesia and Analgesia Plan* chapter for details
- Anticholinergics as clinically indicated for bradycardia accompanied by hypotension

Local blocks and antibiotics

Local Block	
As medically indicated	Pay attention to maximum cumulative doses
Antibiotics	
As medically indicated	See *Medical Quality Standards* chapter

- Dilute local anesthetic as needed to obtain adequate volume for administration
- Perform blocks once patient is under general anesthesia and the first of 3 sterile skin preps has been performed

Anesthetic recovery

Parameter	Range
Normothermic	Temp 100–102.5° F
Normotensive	MAP 80–100 mm Hg
Oxygenating normally on room air	SpO_2 95–100%
Sternal recumbency	
Pain controlled	Pain score <2

- Pediatric patients should recover fairly quickly if proper attention has been paid to prevent hypothermia, hypoglycemia and hypoventilation
- It is also important to feed pediatric patients as early as possible, once they are able to eat without risk of regurgitation or aspiration

Postoperative care and pain management

Drug	Dose		Route
OPIOID			
Buprenorphine	**Puppies**	0.005–0.02 mg/kg	IM
	Kittens	0.01–0.02 mg/kg	Transmucosal

- Opioids are most commonly used
- Adequate pain management must follow through postoperative period and facilitates anesthetic recovery
- Consider premedication utilized when choosing postoperative analgesics
- Pain scores of 2 and greater should be treated with analgesic medications
- Do not confuse pain with dysphoria
  - Refer to *Induction, Monitoring and Recovery* chapter for details

Analgesia to go home

Drug	Dosage		Route
NSAID			
Carprofen	**Puppies**	4 mg/kg	PO once daily or divided into 2 doses for 3 - 5 days
OPIOID			
Buprenorphine	**Kittens**	0.01–0.02 mg/kg	Transmucosal, every 8 hours

- NSAID and/or opioid as appropriate for health status
  - Carprofen label indicates approved for use on puppies >6 weeks of age
  - Use NSAID only if patient is well-hydrated, has received intraoperative fluids and is not hypotensive or bleeding

Notes

Renal/post-renal (urinary/urethral obstruction)

What is different about this patient?

Acid-base and electrolyte status in these patients may be severely abnormal, which can result in cardiac arrest. Additionally, neurologic status may be markedly depressed from abnormal acid-base status and uremia. Most medication dosages should be on the lower end of the dosage range due to concerns regarding drug metabolism and excretion.

Preanesthetic assessment is essential and **potassium should be less than 6.0 mEql/L** before it is considered safe to anesthetize the patient. Preanesthetic ECG is also important. If abnormal ECG tracing is observed, hyperkalemia may be present and pose a great risk for proceeding with anesthesia. Normal ECG and sinus rhythm do NOT equate to normokalemia. Evaluation of potassium should still be performed to guide the administration of IV fluids as medically indicated before proceeding.

Considerations for initial stabilization:

- Determine physical status and address fluid, acid-base and electrolyte imbalances.
- Address patient analgesic requirements.
- Place sterile urinary catheter with **minimal urethral trauma.**
- Decompressive cystocentesis may facilitate urinary catheterization:
  - Decreases intravesicular, intrarenal and urethral pressures
  - Improves patient comfort
  - Allows collection of unadultered urine sample
  - Sterile urinary catheterization should follow cystocentesis.

Examples

Urethral obstruction	Chronic renal disease
Acute renal injury	Presence of ureteroliths

Premedication

Drug	Dose	Route
Midazolam	0.1–0.3 mg/kg	IM, SC
Butorphanol	0.2–0.4 mg/kg	IM, SC
OR (if chemical restraint required for obstructed cats)		
Alfaxalone	2 mg/kg	IM (wait 10 minutes before attempting IV catheter)
Butorphanol	0.2 mg/kg	
Atropine	0.02 mg/kg	

- Consider giving atropine (0.2–0.4 mg/kg) IM if HR is under 120 bpm (feline).
- Consider if additional analgesic therapy is warranted, based on:
  - Signalment
  - Anesthetic indication
  - Physical examination
  - Surgical intervention planned
- **If analgesic therapy is warranted, replace butorphanol in the premedication with another opioid listed in Additional Analgesic Therapy**
- Recommend maropitant SQ to promote rapid return to eating after recovery.

Additional Analgesic Therapy

Drug	Dose		Route
Hydromorphone	0.05–0.1 mg/kg		IM, SC
Buprenorphine	0.01–0.02 mg/kg		IM, IV
Buprenorphine – long acting	**Feline**	0.24 mg/kg (dose on lean body weight)	**SC only**
Methadone	0.1–0.4 mg/kg		IM, IV
Buprenorphine – Transdermal	**Feline**	1 tube (dose on lean body weight)	Transdermal

Induction and intubation

Drug	Dose	Route
Propofol	1.0 mg/kg slowly over 15 seconds Increments of 0.5 mg/kg over 15 seconds until intubation	IV
OR		
Alfaxalone	0.5 mg/kg slowly over 30 seconds Increments of 0.5 mg/kg until smooth transition to intubation and inhalant	IV

- **Induce with lowest possible dose of induction agent**
  - **Both propofol and alfaxalone may cuase apnea if given rapidly**
- **Bradycardia, hypotension and respiratory depression may develop after rapid administration of propofol or alfaxalone**

Transition phase

Post-induction inhalant rates

Inhalant	Rates	Miscellaneous
Oxygen	50–100 mL/kg/minute (rebreathing)	For first 15 minutes after induction
	150–300 mL/kg/minute (NRB)	
Sevoflurane	3% for 3 minutes	Large dogs may need higher rates

- Monitor anesthetic depth and oxygenation closely
- May not need inhalant anesthetic for urethral obstruction

Anesthetic maintenance

Drugs	Rates
Oxygen	20–30 mL/kg/minute (rebreathing)
	200 mL/kg/minute (average rate, NRB)
Sevoflurane	1–4% to effect with oxygen

- Be cautious with vaporizer settings
  - Sick patients may require a vaporizer setting of 1% or less for maintenance
  - **If the patient is hypothermic prior to anesthesia, anesthetic requirements will be decreased**
  - Pay close attention to the ECG and heart rate in these patients
- **Hypotension cannot be tolerated and must be treated promptly and aggressively as hypotension will exacerbate renal function**
- Be prepared to adjust oxygen flow rates in response to patient clinical parameters
- Amount of sevoflurane will vary with patient health, analgesic therapy and local blocks used
- If 4% or more sevoflurane is required:
  - Check the anesthesia system for leaks
  - Ensure appropriate analgesia
  - Consider:
    - Inadequate premedication
    - Improper endotracheal intubation, etc.
      - See Equipment chapter for more details

Perioperative Anesthetic Support

Intravenous Fluids	Rate		Miscellaneous
Crystalloids	**Canine**	5 mL/kg/hour	Higher fluid rates may be needed if patient is not adequately hydrated when anesthesia begins
	Feline	3 mL/kg/hour	
Colloids	**Canine**	20 mL/kg/day OR Bolus of 5 mL/kg	If medically indicated
	Feline	20 mL/kg/day OR Bolus of 2.5 mL/kg	

Perfusion Support			
Drug	**Dose**		**Route**
Dobutamine	**Canine**	1–10 **mcg**/kg/minute	IV CRI if medically indicated
	Feline	1–10 **mcg**/kg/minute	

Anticholinergics		
Drug	**Dose**	**Route**
Atropine	0.02–0.04 mg/kg	IV
Glycopyrrolate	0.005–0.01 mg/kg	IV

- Monitor fluid input and urine output closely and evaluate frequently for signs of over hydration
  - Consider measuring patient ins and outs to best individualize fluid therapy
- Additional support to assist and maintain renal perfusion with colloids and dobutamine CRIs may be indicated
- Intraoperative analgesia as indicated by patient clinical status
  - See *The Individualized Anesthesia and Analgesia Plan* chapter for details

Local blocks and antibiotics

Local Block	
Consider caudal epidural block for patients with urethral obstruction	Use bupivacaine or PF lidocaine
Antibiotics	
As medically indicated	See *Medical Quality Standards* chapter

- See *The Individualized Anesthesia and Analgesia Plan* chapter for details
- Pay attention to maximum cumulative dosages of local anesthetics
- Perform blocks once patient is under general anesthesia and the first of 3 sterile skin preps has been performed

Notes

Anesthetic recovery

Parameter	Range
Normothermic	Temp 100–102.5° F
Normotensive	MAP 80–100 mm Hg
Oxygenating normally on room air	SpO_2 95–100%
Sternal recumbency	
Pain controlled	Pain score <2

- Throughout recovery, continue to monitor fluid input and urine output
- Frequently assess hydration and blood pressure to determine needs for ongoing fluid therapy
- Patients may be slow to recover and good support is essential
- Supportive measures include:
  - Provide heat as necessary
  - Monitor temperature and ECG continuously
  - Administer IV fluids as medically indicated and recheck electrolytes every 2 hours until normal
  - Supplement with SQ fluids before discharge. Consider administration of SQ fluids the next day for continued fluid support

Notes

Postoperative care and pain management

Drug	Dose		Route
OPIOID			
Buprenorphine	Canine	0.005–0.02 mg/kg	IM
	Feline	0.01–0.02 mg/kg	IM, Transmucosal
Buprenorphine – long acting	Feline	0.24 mg/kg (dose on lean body weight)	SC only
Hydromorphone	Canine	0.01–0.2 mg/kg	SC, IM
		0.005 mg/kg	IV, every 2–4 hours
	Feline	0.05–0.1 mg/kg	SC, IM
		0.05 mg/kg	IV, every 2–6 hours
Methadone	0.1–0.4 mg/kg		IM, IV
Buprenorphine – Transdermal	Feline	1 tube (dose on lean body weight)	Transdermal

- **Avoid NSAIDs in patients with renal disease**
- Adequate pain management must follow through postoperative period and facilitates anesthetic recovery
- Opioids are most commonly used
- Consider premedication utilized when choosing postoperative analgesics
- Watch for potential hyperthermia in cats with opioid therapy
- Pain scores of 2 and greater should be treated with analgesic medications

Analgesia to go home

Drug	Dosage		Route
OPIOID			
Tramadol*	**Canine**	5 mg/kg	PO, every 6 hours
	Feline	2–4 mg/kg	
Buprenorphine	**Feline**	0.01–0.02 mg/kg	Transmucosal, every 8 hours

*Oral tramadol has not been shown to be effective postoperatively in dogs

- Opioid as appropriate for health status

Notes

Respiratory compromise

What is different about this patient?

Patients with respiratory compromise may decompensate rapidly and quickly become critically hypoxemic. Stabilize as much as possible prior to any procedure and continually monitor patient oxygenation. Control and manage the airway not only under anesthesia but throughout the recovery phase.

Additional considerations:

- Anesthetic and analgesic agents tend to depress respiration and administration of these agents could result in worsening of patient status and potentially be fatal.
- Be aware of risks and monitor closely — **always be ready to intervene with assisted ventilation.**
  - See *Induction, Monitoring and Recovery* chapter for details on hypoventilation/hypoxemia.

Examples

Chronic Conditions	Acute Respiratory Distress
Collapsing trachea	Pleural effusion
Asthma	Diaphragmatic hernia

Home administered anxiolytics

Drug		Dose	Route
Trazodone	**Canine**	5–15 mg/kg	PO 1hr prior to travel
Gabapentin	**Feline**	50–100 mg/cat	PO 2-3 hrs prior to travel

- Consider giving the first dose the night before along with another dose the morning of the procedure
- Trazodone can cause paradoxical excitement. Trial doses are recommended.

Premedication

Drug	Dose	Route
Midazolam	0.1–0.3 mg/kg	IM, SC
Butorphanol	0.2–0.4 mg/kg	

- **Preoxygenate based on patient tolerance and clinical stability**
- Consider if additional analgesic therapy is warranted, based on:
  - Signalment
  - Anesthetic indication
  - Physical examination
  - Surgical intervention planned
- **If analgesic therapy is warranted, replace butorphanol in the premedication with another opioid listed in Additional Analgesic Therapy**

Additional analgesic therapy

Drug	Dose		Route
Hydromorphone	0.05–0.1 mg/kg		IM, SC
Buprenorphine	0.01–0.02 mg/kg		IM, IV
Buprenorphine – long acting	**Feline**	0.24 mg/kg (dose on lean body weight)	**SC only**
Methadone	0.1–0.4 mg/kg		IM, IV
Buprenorphine – Transdermal	**Feline**	1 tube (dose on lean body weight)	Transdermal

Induction and intubation

Drug	Dose	Route
Propofol	1.0 mg/kg slowly over 15 seconds Increments of 0.5 mg/kg over 15 seconds until intubation	IV
OR		
Alfaxalone	0.5 mg/kg slowly over 30 seconds Increments of 0.5 mg/kg until smooth transition to intubation and inhalant	IV

- Take extra caution with intubation in patients with preexisting tracheal disease
  - The presence of an ET tube may irritate tracheal mucosa, causing coughing and inflammation, exacerbating clinical signs
  - **Intubate as quickly and as gently as possible**

- **Induce with lowest possible dose of induction agent**
  - **Both propofol and alfaxalone may cuase apnea if given rapidly**
- **Bradycardia, hypotension and respiratory depression may develop after rapid administration of propofol or alfaxalone**

Transition phase

Post-induction inhalant rates

Inhalant	Rates	Miscellaneous
Oxygen	50–100 mL/kg/minute (rebreathing)	For first 15 minutes after induction
	150–300 mL/kg/minute (NRB)	
Sevoflurane	3% for 3 minutes	Large dogs may need higher rates

- **Be prepared to perform manual ventilation**
  - **Closely watch the manometer to ensure pressures do not exceed 12–15 cm H_2O as lung compliance may be reduced**
- Monitor anesthetic depth and oxygenation closely

Anesthetic maintenance

Inhalant	Rates
Oxygen	20–30 mL/kg/minute (rebreathing)
	200 mL/kg/minute (average rate, NRB)
Sevoflurane	1–4% to effect with oxygen

- Be prepared to adjust oxygen flow rates in response to patient clinical parameters
- Amount of sevoflurane will vary with patient health, analgesic therapy and local blocks used
- If 4% or more sevoflurane is required:
  - Check the anesthesia system for leaks
  - Ensure appropriate analgesia
  - Consider:
    - Inadequate premedication
    - Improper endotracheal intubation, etc.
      - See Equipment chapter for more details

Notes

Perioperative anesthetic support

Intravenous Fluids	Rate		Miscellaneous
Crystalloids	Canine	5 mL/kg/hour	Higher fluid rates may be needed if patient is not adequately hydrated when anesthesia begins
	Feline	3 mL/kg/hour	

Anticholinergics		
Drug	**Dose**	**Route**
Atropine	0.02–0.04 mg/kg	IV
Glycopyrrolate	0.005–0.01 mg/kg	IV

- Intraoperative analgesia as indicated by patient clinical status
  - See *The Individualized Anesthesia and Analgesia Plan* chapter for details
- Anticholinergics as clinically indicated for bradycardia accompanied by hypotension
  - Patients with respiratory disease may have increased vagal tone, resulting in bradycardia and may benefit from anticholinergic administration

Notes

Local blocks and antibiotics

Local Block	
As medically indicated	Pay attention to maximum cumulative doses
Antibiotics	
As medically indicated	See *Medical Quality Standards* chapter

- Dilute local anesthetic as needed to obtain adequate volume for administration
- Perform blocks once patient is under general anesthesia and the first of 3 sterile skin preps has been performed

Anesthetic recovery

Parameter	Range
Normothermic	Temp 100–102.5° F
Normotensive	MAP 80–100 mm Hg
Oxygenating normally on room air	SpO_2 95–100%
Sternal recumbency	
Pain controlled	Pain score <2

- Patients with chronic respiratory disease may have SpO_2 levels below and $EtCO_2$ levels above the normal range
  - Upon recovery, SpO_2 levels should return to preoperative levels
- Supplemental oxygen may be of benefit to these patients in the recovery phase and can be provided by flow by/mask/oxygen cage (where available)/instillation of nasal oxygen tubes
  - Flow-by O_2 support is inefficient and should only be utilized if the patient will not calmly tolerate the mask

- There are multiple methods described to place nasal oxygen catheters
  - One optional method for placement is provided on the following page
  - The medical record should contain accurate documentation of the step-by-step procedure utilized

For Collapsing Trachea:

- Administer butorphanol 0.2 mg/kg IM 10 minutes before discontinuing anesthesia to prevent coughing
  - Allow slow return to consciousness
  - Extubate early, at first sign of swallow
  - If urgent reintubation is required, next attempt should take place over 20–30 minutes, moving 1–2 cm at a time
  - Deliver oxygen by face mask until the patient can hold their head up

Method for nasal oxygen tube placement

1. Instill one to two drops of lidocaine into each nostril if needed, based on patient level of consciousness and tolerance.
2. Premeasure and mark an appropriately sized red rubber catheter from the end of the nose to the medial canthus. A tape butterfly may be placed at the mark to assist with securing the tube.
3. Coat the end of the catheter with a small amount of water soluble lubricant.
4. Aiming medially and dorsally, advance the tube into the nose to the level of the mark on the tube.
5. Secure the tube under the alar fold (when possible, based on patient anatomy).
6. Using suture, staple or tissue glue, secure the tube as close as possible to end of nostril.
7. Provide additional attachments on midline of muzzle and at top of head.
8. Attach end of red rubber tube to oxygen line.
9. Administering oxygen at 100 mL/kg/min unilaterally should increase FiO_2 to 37%.
10. If needed, place an Elizabethan collar or similar device to prevent patient dislodgement of tube.

Postoperative care and pain management

Drug	Dose		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	SC (initial dose)
Meloxicam	**Canine**	0.2 mg/kg	SC (initial dose)
Robenacoxib	**Feline**	2 mg/kg	SC (initial dose)
OPIOID			
Butorphanol	0.2–0.4 mg/kg		IM
Buprenorphine	**Canine**	0.005–0.02 mg/kg	IM
	Feline	0.01–0.02 mg/kg	IM, Transmucosal
Buprenorphine – long acting	**Feline**	0.24 mg/kg (dose on lean body weight)	**SC only**
Hydromorphone	**Canine**	0.01–0.2 mg/kg	SC, IM
		0.005 mg/kg	IV every 2–4 hours
	Feline	0.05–0.1 mg/kg	SC, IM
		0.05 mg/kg	IV every 2–6 hours
Fentanyl	See *Appendix* chapter for details		IV as CRI
Methadone	0.1–0.4 mg/kg		IM, IV
Buprenorphine - Transdermal	**Feline**	1 tube (dose on lean body weight)	Transdermal

- NSAIDs and/or opioids are most commonly used as indicated for patient analgesia
- Adequate pain management must follow through postoperative period and facilitates anesthetic recovery
- Consider premedication utilized when choosing postoperative analgesics
- Pain scores of 2 and greater should be treated with analgesic medications
- Watch for potential hyperthermia in cats with opioid therapy
- Do not confuse pain with dysphoria
  - Refer to *Induction, Monitoring and Recovery* chapter for details

Note: For dogs already on an NSAID, do not change to a different NSAID without observing the recommended number of half-lives. Maintain on the same NSAID or use an analgesic with a different mechanism of action (*e.g.*, opioid or tramadol). See *The Individualized Anesthesia and Analgesia Plan* chapter for details.

- Use NSAIDs only if patient is well-hydrated, has received intraoperative fluids and is not hypotensive or bleeding

Analgesia to go home

Drug	Dosage		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	PO once daily or divided into 2 doses for 3–5 days
Meloxicam	**Canine**	0.1 mg/kg	PO, every 24 hours
Robenacoxib	**Feline**	1 mg/kg	PO once daily for a maximum of 3 **total** doses over 3 days. Do not exceed 1 dose per day.
OPIOID			
Tramadol*	**Canine**	5 mg/kg	PO, every 6 hours
	Feline	2–4 mg/kg	
Buprenorphine	**Feline**	0.01–0.02 mg/kg	Transmucosal, every 8 hours

*Oral tramadol has not been shown to be effective postoperatively in dogs

- NSAID and/or opioid as appropriate for health status
- **Dispense the same NSAID that was utilized postoperatively**

Sighthounds

What is different about this patient?

Sighthounds have unique behavioral and physical characteristics that will influence anesthetic and monitoring choices.

- Higher PCV% and lower protein levels which can result in effects of drugs that are highly protein bound
- Low body fat increasing the risk for hypothermia under anesthesia
- Deep chested with a larger chest capacity than other breeds of similar weights
- Greyhounds specifically can appear quiet but can be nervous and develop stress hypertension, hyperthermia and colitis
- Decreased activity in liver metabolism slowing the clearance of some drugs such as propofol
- Pressure injuries occur easily from improper positioning or padding
- Skin is easily lacerated or damaged

To help minimize stress in these patients:

- Schedule procedures early in the day
- Administer premedications upon arrival
- Consider keeping the patient with the owner until medications have taken effect
- Minimize the stay in the hospital

Premedication

Drug	Dose	Route
Butorphanol	0.2 mg/kg	IM
Acepromazine	0.05 mg/kg	
OR		
Butorphanol	0.2 mg/kg IM	IM
Dexmedetomidine	2.5 **mcg**/kg	

- Reduce acepromazine or dexmedetomidine doses in older or quiet patients
- Only using opioids may predispose to dysphoria in recovery
- **If analgesic therapy is warranted, replace butorphanol in the premedication with another opioid listed in Additional Analgesic Therapy**

Additional analgesic therapy

Drug	Dose	Route
Hydromorphone	0.05–0.1 mg/kg	IM, SC
Buprenorphine	0.01–0.02 mg/kg	IM, IV
Methadone	0.1–0.4 mg/kg	IM, IV

Notes

Induction and intubation

Drug	Dose	Route
Propofol	1.0 mg/kg slowly over 15 seconds Increments of 0.5 mg/kg over 15 seconds until intubation	IV
OR		
Alfaxalone	0.5 mg/kg slowly over 30 seconds Increments of 0.5 mg/kg until smooth transition to intubation and inhalant	IV

- **Induce with lowest possible dose of induction agent**
  - **Both propofol and alfaxalone may cuase apnea if given rapidly**
- **Bradycardia, hypotension and respiratory depression may develop after rapid administration of propofol or alfaxalone**

Transition phase

Post-induction inhalant rates

Inhalant	Rates	Miscellaneous
Oxygen	50–100 mL/kg/minute (rebreathing)	For first 15 minutes after induction
	150–300 mL/kg/minute (NRB)	
Sevoflurane	3% for 3 minutes	Large dogs may need higher rates

- Monitor anesthetic depth and oxygenation closely

Anesthetic Maintenance

Drugs	Rates
Oxygen	20–30 mL/kg/minute (rebreathing)
	200 mL/kg/minute (average rate, NRB)
Sevoflurane	1–4% to effect with oxygen

- Be prepared to adjust oxygen flow rates in response to patient clinical parameters
- Amount of sevoflurane will vary with patient health, analgesic therapy and local blocks used
- If 4% or more sevoflurane is required:
  - Check the anesthesia system for leaks
  - Ensure appropriate analgesia
  - Consider:
    - Inadequate premedication
    - Improper endotracheal intubation, etc.
      - See Equipment chapter for more details

Perioperative Anesthetic Support

Fluids	Rate		Miscellaneous
Crystalloids	**Canine**	5 mL/kg/hour	Higher fluid rates may be needed if patient is not adequately hydrated when anesthesia begins

Anticholinergics		
Drug	**Dose**	**Route**
Atropine	0.02–0.04 mg/kg	IV
Glycopyrrolate	0.005–0.01 mg/kg	IV

- Intraoperative analgesia as indicated by patient clinical status
  - See *The Individualized Anesthesia and Analgesia Plan* chapter for details
- Anticholinergics as clinically indicated for bradycardia accompanied by hypotension

Anesthetic recovery

Anesthetic Recovery	Parameter
Normothermic Temp	100–102.5° F
Normotensive MAP	80–100 mm Hg
Oxygenating normally on room air	SpO_2 95–100%
Sternal recumbency	
Pain controlled	Pain score <2

- Anxious and rough recoveries are not uncommon with sighthounds
  - Premedication of acepromazine or dexmedetomidine helps prevent these incidents
  - Can repeat dose of (0.5–1 **mcg**/kg dexmedetomidine if hypertension and bradycardia have resolved

Postoperative Care and Pain Management

Drug	Dose		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	SC (initial dose)
Meloxicam	**Canine**	0.2 mg/kg	SC (initial dose)
OPIOID			
Buprenorphine	**Canine**	0.005–0.02 mg/kg	IM
Hydromorphone	**Canine**	0.01–0.2 mg/kg	SC, IM
		0.005 mg/kg	IV every 2–4 hours
Methadone	0.1–0.4 mg/kg		IM, IV

- NSAIDs and/or opioids are most commonly used as indicated for patient analgesia
- Adequate pain management must follow through postoperative period and facilitates anesthetic recovery
- Consider premedication utilized when choosing postoperative analgesics
- Pain scores of 2 and greater should be treated with analgesic medications
- Watch for potential hyperthermia in cats with opioid therapy
- Do not confuse pain with dysphoria
  - Refer to *Induction, Monitoring and Recovery* chapter for details

Analgesia to go home

Drug	Dosage		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	PO once daily or divided into 2 doses for 3–5 days
Meloxicam	**Canine**	0.1 mg/kg	PO, every 24 hours
OPIOID			
Tramadol*	**Canine**	5 mg/kg	PO, every 6 hours

*Oral tramadol has not been shown to be effective postoperatively in dogs

- NSAID and/or opioid as appropriate for health status
- **Dispense the same NSAID that was utilized postoperatively**

Notes

Notes

Soft tissue (elective)

What is different about this patient?

Elective soft tissue surgery patients would include those with normal organ function as determined by clinical pathology data and unremarkable physical examination results, undergoing planned anesthesia. These patients should have an ASA status of I – II. An age-specific protocol (*Geriatric* or *Pediatric*) should be utilized if applicable.

Premedication and additional analgesic choices should reflect patient requirements and anticipated surgical interventions. As such, a routine ovariohysterectomy with elective gastropexy might be expected to require more analgesic therapy than a routine OVH alone. Always consider the use of multimodal therapy for analgesic needs, including the use of local and regional analgesia. See *The Individualized Analgesia and Anesthesia Plan* chapter for details.

Additional considerations:

- Due to concerns of potential surgical site contamination with bacteremia associated with dental prophylaxis, **sterile soft tissue procedures should not be combined with elective dental prophylaxis.**
- All sterile soft tissue surgeries are to be performed in the surgical suite.

Examples

Castration	Ovariohysterectomy
Mass removal	Laceration repair

Premedication

Drug	Dose	Route
Midazolam	0.1–0.3 mg/kg	IM, SC
Butorphanol	0.2–0.4 mg/kg	
OR		
Acepromazine	0.02–0.05 mg/kg	IM, SC
Butorphanol	0.2–0.4 mg/kg	

- **Maximum acepromazine dose of 2 mg in dogs and 1 mg in cats**
  - Dose should be reduced for Boxers, sighthounds and dogs positive for ABCB1 (MDR1) gene (Collies and others)
  - See *The Individualized Anesthesia and Analgesia Plan* chapter for details
- Consider if additional analgesic therapy is warranted, based on:
  - Signalment
  - Anesthetic indication
  - Physical examination
  - Surgical intervention planned
- **Additional analgesia is warranted. Replace butorphanol with another opioid or provide an additional opioid 30–60 minutes after administration of butorphanol (route dependent).**

Additional Analgesic Therapy

Drug	Dose		Route
Hydromorphone	0.05–0.1 mg/kg		IM, SC
Buprenorphine	0.01–0.02 mg/kg		IM, IV
Buprenorphine – long acting	**Feline**	0.24 mg/kg (dose on leanbody weight)	**SC only**
Methadone	0.1–0.4 mg/kg		IM, IV
Buprenorphine – Transdermal	**Feline**	1 tube (dose on lean body weight)	Transdermal

Induction and intubation

Drug	Dose	Route
Propofol	1.0 mg/kg slowly over 15 seconds Increments of 0.5 mg/kg over 15 seconds until intubation	IV
OR		
Alfaxalone	0.5 mg/kg slowly over 30 seconds Increments of 0.5 mg/kg until smooth transition to intubation and inhalant	IV

- **Induce with lowest possible dose of induction agent**
  - **Both propofol and alfaxalone may cuase apnea if given rapidly**
- **Bradycardia, hypotension and respiratory depression may develop after rapid administration of propofol or alfaxalone**

Transition phase

Post-induction inhalant rates

Inhalant	Rates	Miscellaneous
Oxygen	50–100 mL/kg/minute (rebreathing)	For first 15 minutes after induction
	150–300 mL/kg/minute (NRB)	
Sevoflurane	3% for 3 minutes	Large dogs may need higher rates

- Monitor anesthetic depth and oxygenation closely

Anesthetic Maintenance

Drugs	Rates
Oxygen	20–30 mL/kg/minute (rebreathing)
	200 mL/kg/minute (average rate, NRB)
Sevoflurane	1–4% to effect with oxygen

- Be prepared to adjust oxygen flow rates in response to patient clinical parameters
- Amount of sevoflurane will vary with patient health, analgesic therapy and local blocks used
- If 4% or more sevoflurane is required:
  - Check the anesthesia system for leaks
  - Ensure appropriate analgesia
  - Consider:
    - Inadequate premedication
    - Improper endotracheal intubation, etc.
      - See Equipment chapter for more details

Perioperative Anesthetic Support

Fluids	Rate		Miscellaneous
Crystalloids	**Canine**	5 mL/kg/hour	Higher fluid rates may be needed if patient is not adequately hydrated when anesthesia begins
	Feline	3 mL/kg/hour	

Anticholinergics		
Drug	**Dose**	**Route**
Atropine	0.02–0.04 mg/kg	IV
Glycopyrrolate	0.005–0.01 mg/kg	IV

- Intraoperative analgesia as indicated by patient clinical status
  - See *The Individualized Anesthesia and Analgesia Plan* chapter for details
- Anticholinergics as clinically indicated for bradycardia accompanied by hypotension

Local blocks and antibiotics

Local block	
Required: Intratesticular (castration) and line block (OVH) Strongly Recommended: Field/regional blocks	Lidocaine (2 mg/kg) OR bupivacaine (1.5 mg/kg)
Antibiotics	
Not applicable to healthy patient, elective soft tissue procedures	See *Medical Quality Standards* chapter

- Dilute local anesthetic as needed to obtain adequate volume for administration
  - Pay attention to maximum cumulative doses
- Perform blocks once patient is under general anesthesia and the first of 3 sterile skin preps has been performed

Anesthetic recovery

Parameter	Range
Normothermic	Temp 100–102.5° F
Normotensive	MAP 80–100 mm Hg
Oxygenating normally on room air	SpO_2 95–100%
Sternal recumbency	
Pain controlled	Pain score <2

Postoperative care and pain management

Drug	Dose		Route
NSAID			
Carprofen	Canine	4 mg/kg	SC (initial dose)
Meloxicam	Canine	0.2 mg/kg	SC (initial dose)
Robenacoxib	Feline	2 mg/kg	SC (initial dose)
OPIOID			
Buprenorphine	**Canine**	0.005–0.02 mg/kg	IM
	Feline	0.01–0.02 mg/kg	IM, Transmucosal
Buprenorphine – long acting	**Feline**	0.24 mg/kg (dose on lean body weight)	**SC only**
Hydromorphone	**Canine**	0.01–0.2 mg/kg	SC, IM
		0.005 mg/kg	IV every 2 - 4 hours
	Feline	0.05–0.1 mg/kg	SC, IM
		0.05 mg/kg	IV every 2 - 6 hours
Methadone	0.1–0.4 mg/kg		IM, IV
Buprenorphine – Transdermal	**Feline**	1 tube (dose on lean body weight)	Transdermal

- NSAIDs and/or opioids are most commonly used as indicated for patient analgesia
- Adequate pain management must follow through postoperative period and facilitates anesthetic recovery
- Consider premedication utilized when choosing postoperative analgesics
- Pain scores of 2 and greater should be treated with analgesic medications
- Watch for potential hyperthermia in cats with opioid therapy
- Do not confuse pain with dysphoria
  - Refer to *Induction, Monitoring and Recovery* chapter for details

Note: For dogs already on an NSAID, do not change to a different NSAID without observing the recommended number of half-lives. Maintain on the same NSAID or use an analgesic with a different mechanism of action (*e.g.*, opioid). See *The Individualized Anesthesia and Analgesia Plan* chapter for details.

- Use NSAIDs only if patient is well-hydrated, has received intraoperative fluids and is not hypotensive or bleeding

Analgesia to go home

Drug	Dosage		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	PO once daily or divided into 2 doses for 3 - 5 days
Meloxicam	**Canine**	0.1 mg/kg	PO, every 24 hours
Robenacoxib	**Feline**	1 mg/kg	PO once daily for a maximum of 3 **total** doses over 3 days. Do not exceed 1 dose per day.
OPIOID			
Tramadol*	**Canine**	5 mg/kg	PO, every 6 hours
	Feline	2–4 mg/kg	
Buprenorphine	**Feline**	0.01–0.02 mg/kg	Transmucosal, every 8 hours

* Oral tramadol has not been shown to be effective postoperatively in dogs

- NSAID and/or opioid as appropriate for health status
- **Dispense the same NSAID that was utilized postoperatively**

Stressed/fractious

What is different about this patient?

This patient will have extremely high levels of circulating catecholamines (epinephrine, norepinephrine), which can make the patient prone to sudden cardiovascular collapse (hypotension, cardiac arrhythmias, shock, organ dysfunction), especially when sedatives and anesthetics are added. This is sometimes referred to as a "crash."

Additionally, stressed/fractious patients may be impossible to handle for a physical exam. The presence of serious disease may be masked by this physiologic "fight or flight" state, making these patients prone to crash after sedation or induction when the full extent of underlying disease becomes known.

Always be prepared for this crash.

Considerations before proceeding to chemical restraint:

- Most aggressive behavior is a result of underlying fear or pain.
  - Provide analgesic therapy as medically indicated.
  - It may be in the best interest of the fearful patient to reschedule the procedure and introduce a counterconditioning program.
- If the patient struggles for more than three seconds, release and reposition.
  - If struggling for more than three seconds occurs two to three times, consider chemical restraint or abort the procedure.
  - Remember that less may be more in regards to handling and restraint.

DO NOT USE THE *STRESSED/FRACTIOUS* PET PROTOCOL IF ACEPROMAZINE HAS ALREADY BEEN ADMINISTERED

WHEN POSSIBLE, DO NOT PROCEED WITH THE PROCEDURE AND RESCHEDULE TO HELP MITIGATE STRESS

Mitigation Strategies

- Institute a counterconditioning plan
- Plan ahead for minimal patient handling and utilize rapidly acting medications
- Consider oral sedative administration at home prior to next visit (be cautious of emesis if given with food or treat)

Drug	Dose	
Trazodone	**Canine**	5–15 mg/kg PO 1hr prior to travel If more anxiolytic needed add: Gabapentin 5–20 mg/kg PO 2–3 hrs prior to travel
Gabapentin OR Buprenorphine – injectable	**Feline**	50–100 mg/cat 150 mg/large cats 1hr prior to travel OR 0.03 mg/kg transmucosal, 60–90 minutes prior to travel

- Can give a dose at bedtime and an additional dose in the morning
- Prepare owners for ataxia/sedation in cats
- Paradoxical excitation is uncommon with Trazodone, trial doses are still recommended
- Decrease doses of Trazodone in larger dogs
- **These medications are not to replace the pre-anesthetic protocol. Low-stress handling, minimizing stress and further analgesia +/- sedation are required.**

DO NOT WAIT FOR THE STRESSED/FRACTIOUS PET TO BECOME UNMANAGEABLE BEFORE CHANGING YOUR PLAN

See physical examination of the stressed patient (*Medical Quality Standards* chapter) and stressed/fractious patient physiology (*Physiology* chapter) for additional information.

SPECIAL CONSIDERATIONS FOR THE STRESSED/FRACTIOUS BRACHYCEPHALIC PET

- Stressed/fractious brachycephalic patients provide a unique challenge for both patient and associate safety
- If it is determined that the procedure cannot be completed safely, abort the procedure, stabilize and recover the patient and reschedule the procedure

- **Oxygenation and a protected airway are critical to patient safety**
- Provision of oxygen and tracheal intubation should be provided as quickly as possible and whenever medically indicated

Premedication

Drug	Dose	Route
CANINE		
Tiletamine, Zolazepam	2–4 mg/kg	IM
Butorphanol	0.2–0.4 mg/kg	
OR		
Dexmedetomidine	2–5 **mcg**/kg	IM
Ketamine	1–2 mg/kg	
Butorphanol	0.2–0.4 mg/kg	
OR		
Dexmedetomidine	5–7 **mcg**/kg	IM
Butorphanol	0.2–0.4 mg/kg	
OR		
Alfaxalone	2 mg/kg	IM (volume will limit to small dogs)
Butorphanol	0.2–0.4 mg/kg	

Premedication (continued from previous page)

Drug	Dose	Route
FELINE		
DKT	See *Appendix* chapter for dosing charts	IM
OR		
DKT mixture for oral administration	0.2 mL of each drug for a 5 kg cat Allow 10–15 minutes for effect	Administer orally as the cat is hissing and the mouth is open Consider using open-ended tom cat catheter to assist with administration
OR		
Dexmedetomidine	7–10 **mcg**/kg	IM
Methadone	0.3–0.5 mg/kg	
OR		
Dexmedetomidine	7–10 **mcg**/kg	IM
Hydromorphone	0.05–0.1 mg/kg	
OR		
Dexmedetomidine	7–10 **mcg**/kg IM	IM
Buprenorphine	0.01–0.02 mg/kg	
OR		
Dexmedetomidine	7–10 **mcg**/kg IM	IM
Butorphanol	0.2–0.4 mg/kg	
OR (for geriatric or ill cats)		
Alfaxalone	1–2 mg/kg	IM
Methadone	0.3–0.5 mg/kg	

Premedication (continued from previous page)

OR		
Alfaxalone	2 mg/kg IM (max 10 mg/cat)	IM
Butorphanol	0.2–0.4 mg/kg	

Note: Unique DKT dosing and directions for use in both canines and felines

- Ifaxalone 2 mg/kg IM can be added to above feline protocols to achieve more sedation or as an additional IM injection if sedation is not adequate after 15 minutes
- Perform physical examination if not able to be completed prior to premedication
- Place IV catheter if medically indicated or length of procedure is anticipated to be longer than 10 minutes
- Obtain necessary clinical pathology samples

Induction and intubation

Drug	Dose	Route
Propofol	1.0 mg/kg slowly over 15 seconds Increments of 0.5 mg/kg over 15 seconds until intubation	IV
OR		
Alfaxalone	0.5 mg/kg slowly over 30 seconds Increments of 0.5 mg/kg until smooth transition to intubation and inhalant	IV

- Propofol: Anticipate need for lower dose and **may not be needed** for intubation
- Preoxygenate if possible, based on patient tolerance and clinical stability

- **Induce with lowest possible dose of induction agent**
  - **Both propofol and alfaxalone may cuase apnea if given rapidly**
- **Bradycardia, hypotension and respiratory depression may develop after rapid administration of propofol or alfaxalone**

Transition phase

Post-induction inhalant rates

Inhalant	Rates	Miscellaneous
Oxygen	50–100 mL/kg/minute (rebreathing)	For first 15 minutes after induction
	150–300 mL/kg/minute (NRB)	
Sevoflurane	**1–2% for 3 minutes**	Large dogs may need higher rates

- Monitor anesthetic depth and oxygenation closely

Anesthetic maintenance

Inhalant	Rates
Oxygen	20–30 mL/kg/minute (rebreathing)
	200 mL/kg/minute (average rate, NRB)
Sevoflurane	1–4% to effect with oxygen

- Be prepared to adjust oxygen flow rates in response to patient clinical parameters
- Amount of sevoflurane will vary with patient health, analgesic therapy and local blocks used
- If 4% or more sevoflurane is required:
  - Check the anesthesia system for leaks
  - Ensure appropriate analgesia
  - Consider:
    - Inadequate premedication
    - Improper endotracheal intubation, etc.
      - See Equipment chapter for more details

Perioperative anesthetic support

Fluids	Rate		Miscellaneous
Crystalloids	**Canine**	5 mL/kg/hour	Higher fluid rates may be needed if patient is not adequately hydrated when anesthesia begins
	Feline	3 mL/kg/hour	

Anticholinergics		
Drug	**Dose**	**Route**
Atropine	0.02–0.04 mg/kg	IV
Glycopyrrolate	0.005–0.01 mg/kg	IV

Caution: Dexmedetomidine may cause significant bradycardia (heart rate below 50 bpm). The severity is related to dose (the higher the dose, the higher MAP and the lower the heart rate) and tends to be more severe in dogs than cats. This is a REFLEX bradycardia in response to peripheral vasoconstriction and baroreceptor-mediated decrease in heart rate and SHOULD NOT be treated with an anticholinergic drug. However, at lower doses of dexmedetomidine (less than 5 **mcg**/kg) and also when the vasoconstrictor response starts to diminish (approximately 30 minutes to one hour post-administration), the central sympatholytic effect is in effect, resulting in bradycardia AND hypotension. When bradycardia is associated with hypotension in patients administered dexmedetomidine, it is appropriate to administer an anticholinergic drug.

- Intraoperative analgesia as indicated by patient clinical status
  - See *The Individualized Anesthesia and Analgesia Plan* chapter for details
- Anticholinergics as clinically indicated for bradycardia accompanied by hypotension **(see *Caution* above)**

Local blocks and antibiotics

Local Block	
As medically indicated	Pay attention to maximum cumulative doses
Antibiotics	
As medically indicated	See *Medical Quality Standards* chapter

- Dilute local anesthetic as needed to obtain adequate volume for administration
- Perform blocks once patient is under general anesthesia and the first of 3 sterile skin preps has been performed

Anesthetic recovery

Parameter	Range
Normothermic Temp	100–102.5° F
Normotensive MAP	80–100 mm Hg
Oxygenating normally on room air	SpO_2 95–100%
Sternal recumbency	
Pain controlled	Pain score <2

- The addition of butorphanol or midazolam may assist with recovery from tiletamine, zolazepam in dogs
  - See *The Individualized Anesthesia and Analgesia Plan* chapter for additional details

Postoperative care and pain management

Drug	Dose		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	SC (initial dose)
Meloxicam	**Canine**	0.2 mg/kg	SC (initial dose)
Robenacoxib	**Feline**	2 mg/kg	SC (initial dose)
OPIOID			
Buprenorphine	**Canine**	0.005–0.02 mg/kg	IM
	Feline	0.01–0.02 mg/kg	IM, Transmucosal
Buprenorphine – long acting	**Feline**	0.24 mg/kg (dose on lean body weight)	**SC only**
Hydromorphone	**Canine**	0.01–0.2 mg/kg	SC, IM
		0.005 mg/kg	IV every 2–4 hours
	Feline	0.05–0.1 mg/kg	SC, IM
		0.05 mg/kg	IV every 2–6 hours
Fentanyl	See *Appendix* chapter for details		IV as CRI
Methadone	0.1–0.4 mg/kg		IM, IV
Buprenorphine – Transdermal	**Feline**	1 tube (dose on lean body weight)	Transdermal

- NSAIDs and/or opioids are most commonly used as indicated for patient analgesia
- Adequate pain management must follow through postoperative period and facilitates anesthetic recovery
- Consider premedication utilized when choosing postoperative analgesics
- Pain scores of 2 and greater should be treated with analgesic medications

- Watch for potential hyperthermia in cats with opioid therapy
- Do not confuse pain with dysphoria
  - Refer to *Induction, Monitoring and Recovery* chapter for details

Note: For dogs already on an NSAID, do not change to a different NSAID without observing the recommended number of half-lives. Maintain on the same NSAID or use an analgesic with a different mechanism of action (*e.g.*, opioid or tramadol). See *The Individualized Anesthesia and Analgesia Plan* chapter for details.

- Use NSAIDs only if patient is well-hydrated, has received intraoperative fluids and is not hypotensive or bleeding

Analgesia to go home

Drug	Dosage		Route
NSAID			
Carprofen	**Canine**	4 mg/kg	PO once daily or divided into 2 doses for 3–5 days
Meloxicam	**Canine**	0.1 mg/kg	PO, every 24 hours
Robenacoxib	**Feline**	1 mg/kg	PO once daily for a maximum of 3 **total** doses over 3 days. Do not exceed 1 dose per day.
OPIOID			
Tramadol	**Canine**	5 mg/kg	PO, every 6 hours
	Feline	2–4 mg/kg	
Buprenorphine	**Feline**	0.01–0.02 mg/kg	Transmucosal, every 8 hours

- NSAID and/or opioid as appropriate for health status
- **Dispense the same NSAID that was utilized postoperatively**

Addendum:

Special considerations for surgery:

Ear/Aural Tissue

Induce healthy patients for aural surgery with tiletamine, zolazepam 1–2 mg/kg IV, rather than propofol. Dilute with sterile water to a volume of 1–3 mL and give **slowly to effect** for intubation. Watch closely for signs of patient readiness for intubation as described in the *Induction, Monitoring and Recovery* chapter.

Tiletamine might be helpful with neuropathic pain, which may be present with aural surgery.

These patients may be expected to have more significant analgesic requirements. Consider:

- Wound infusion catheters
- Constant rate infusions (CRIs)
- See *Appendix* chapter for details of advanced analgesic techniques

CNS and Eye/Globe

Carefully consider anesthesia in patients with neurologic disease or head/ocular trauma.

- Intensive stabilization, continuous monitoring and nursing care are likely to be required
- Serial neurologic examinations must be performed
- Consider referral for specialty care

Avoid acepromazine

Maintain EtCO2 between 28–35 for patients with head trauma.

Avoid increasing intracranial pressure:

- Vomiting
- Coughing
- Jugular vein occlusion
- Recumbent position with head lowered
- Medications (*e.g.*, ketamine)

Precalculate doses for mannitol and hypertonic saline for administration in cases of increased intracranial pressure.

Monitor heart rate and blood pressure extremely closely. Bradycardia in conjunction with hypertension may indicate brain herniation (Cushing reflex).

Hyperthyroidism

ECG and echocardiogram are recommended prior to elective anesthesia. If unable to pursue, assume the patient has ventricular hypertrophy when choosing your anesthetic drug and monitoring protocol.

Possible Complications:

- Bradycardia
- Hypotension
- Heart failure
- Hypoglycemia (higher risk if hyperthyoridism is uncontrolled)

Recommend avoiding the use of ketamine, tiletamine/zolazepam, and dexmedetomidine.

Use caution with NSAID administration as renal function is commonly reduced in these patients.

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Notes

CPR Clinical Guidelines

This chapter is comprised of excerpts taken from the Reassessment Campaign on Veterinary Resuscitation (RECOVER) guidelines, published in the *Journal of Veterinary Emergency and Critical Care*, and used with permission from John Wiley and Sons, Inc., publisher.

Note: Information regarding defibrillation therapy and open chest cardiopulmonary resuscitation (CPR) is not included in this text

Abbreviations

ABC	airway, breathing, circulation
ALS	advanced life support
BLS	basic life support
C:V	compression ventilation ratio
CPA	cardiopulmonary arrest
CPR	cardiopulmonary resuscitation
ET	endotracheal
$EtCO_2$	end-tidal carbon dioxide
ECG	electrocardiogram
FiO_2	fraction of inspired oxygen
MAP	mean arterial pressure
$PaCO_2$	partial pressure of arterial carbon dioxide
PaO_2	partial pressure of arterial oxygen
PCA	post cardiac arrest
RECOVER	Reassessment Campaign on Veterinary Resuscitation
ROSC	return of spontaneous circulation
SpO_2	peripheral capillary oxygen saturation
TPR	temperature, pulse, respiration
VF	ventricular fibrillation
VT	ventricular tachycardia

Preparedness and prevention

Equipment

- Equipment and supply inaccessibility or failure has been implicated in delays in initiation of CPR in up to 18 percent of cardiopulmonary arrest (CPA) cases.
- The location, storage and content of resuscitation equipment should be standardized and regularly audited (see *Medical Quality Standards* chapter for essential equipment and medications).

Resuscitation aids

- The presence of cognitive aids (checklists, algorithm charts and dosing charts) has been shown to improve compliance with CPR guidelines.
- Formal training of team members in the use of these aids is crucial for effective utilization during a crisis.
- Availability and clear visibility of charts and other resuscitation aids in areas where CPA may occur (procedure areas, surgery suites) is recommended.

Training

- Adherence to CPR guidelines can only be accomplished if team members receive effective, standardized training and regular opportunities to refresh skills.
- Regardless of the type of technology used for initial training, refresher training at least every six months is recommended to reduce the risk of skill decay.
- Improved learning outcomes have been documented when CPR training culminates in performance testing.
- Regardless of the methods used for initial and refresher training, structured assessment after CPR training is recommended.

Clinical essential

A CPR team is available during normal hours of operation

- In addition to assessment after didactic and psychomotor skills training, structured debriefing after a real resuscitation effort or simulated CPR, allowing participants to review and critique their performance and the performance of the team as a whole, is recommended.
- Open, honest discussion about opportunities for improvement immediately after a CPR attempt can lead to significant enhancement in CPR performance.
- Regardless of the status of the CPR team leader (veterinarian or technician), there is strong evidence that communication and team skills training can improve the effectiveness of a CPR attempt.
- Specific leadership training is recommended for team members who may lead a CPR attempt.
  - Crucial roles of the CPR team leader include:
    - Distributing tasks to other team members
    - Enforcing rules and procedures
- Important leadership behaviors that can improve CPR team performance include:
  - Intermittently summarizing the code to ensure a shared mental model among team members
  - Actively soliciting input from team members to encourage situation awareness and identify issues and ideas from all team members
  - Assigning individual tasks to team members rather than performing them personally to allow better attention to the global status of the code
- Team performance can be enhanced by using focused, clear communication directed at individuals when tasks are assigned and utilization of closed loop communication.
  - Closed loop communication is accomplished by a clear, directed order being given to one team member by another, after which the receiving team member repeats the order back to the requestor to verify the accuracy of the receiver's perception.
- **There is high-level and high-quality supportive evidence in veterinary medicine that anesthesia-related CPAs are associated with increased survival compared to arrests from other causes.**

Basic Life Support (BLS)

It is imperative that BLS is provided immediately upon diagnosis or suspicion of CPA.

Definition

- Recognition of CPA
- Administration of chest compressions
- Airway management and provision of ventilation

Recognition

- It is reasonable to utilize continuous electrocardiogram (ECG) and arterial blood flow monitoring in at-risk pets.
- Continuous end-tidal carbon dioxide ($EtCO_2$) monitoring is recommended in intubated and ventilated at-risk pets.
- Monitored pulse sounds are not a reliable tool for the diagnosis of cardiac arrest, although their disappearance may indicate impending arrest in pets in which the probe was placed prior to CPA.
  - In anesthetized pets, the loss of pulse sounds may be a reasonable indicator of profound hemodynamic deterioration or CPA.
- In anesthetized pets (monitored with an ECG prior to CPA) where physical signs of CPA (unconsciousness, apnea) are not available, ECG alterations may prove helpful as a supporting diagnostic tool for confirmation of CPA.
- Since CPA is a clinical diagnosis, it is essential that the ECG is not regarded as the sole indicator of life or perfusing cardiac rhythm.
- Aggressive administration of CPR in pets suspected of being in CPA is recommended, as the risk of injury due to CPR in pets not in CPA is low.
- When assessing pets that are apneic and unresponsive, a rapid airway, breathing, circulation (ABC) assessment lasting no more than five to 10 seconds is recommended.

Chest compressions

- Chest compressions should be initiated as soon as possible upon recognition of CPA. If multiple rescuers are present, airway and ventilation management should not delay commencement of chest compressions.
  - Ideal chest compressions may achieve a cardiac output of, at most, approximately 25–30 percent of normal.
- **The immediate provision of chest compressions should be the priority.**
- Intubation and ventilation should be attempted as soon as possible, while compressions are being performed.
- Chest compressions should be done in lateral recumbency (either left or right) in both dogs and cat.
- There is strong evidence supporting a recommendation for compression rates of 100–120/minute in cats and dogs

Delivering chest compressions:

- In most large and giant breed dogs: Deliver chest compressions with the hands placed over the widest portion of the chest.
- In narrow, deep chested dogs, such as Greyhounds: Deliver chest compressions with the hands positioned directly over the heart.
- In dogs with barrel-chested conformations, such as English Bulldogs: Consider sternal compressions in dorsal recumbency.
- Cats and small dogs tend to have higher thoracic wall compliance and effective chest compressions can likely be achieved with a one-hand technique with the compressor's fingers wrapped around the sternum at the level of the heart.
  - Consider circumferential compressions rather than lateral compressions.
  - A two-handed technique can also be used.

- There is good evidence to support deep chest compressions of one-third to one-half the width of the thorax in most pets
- It is recommended that full chest wall recoil is allowed between compressions

Ventilation

- Early endotracheal (ET) intubation and provision of ventilation in CPR is likely to be beneficial.
- If equipment and team members are available, rapid intubation of dogs and cats in CPA is recommended.
  - This should be accomplished with the pet in lateral recumbency so chest compressions may be continued during the procedure.
  - Once the ET tube is in place, inflate the cuff so that ventilation and chest compressions can occur simultaneously.

Ventilation rate:

- A ventilation rate of 10 breaths/minute with a tidal volume of 10 mL/kg and a short inspiratory time of one second are recommended.
- For single-rescuer CPR, a compression:ventilation (C:V) ratio of 30:2 in non-intubated dogs is recommended.
  - Perform a series of 30 chest compressions at a rate of 100–120 compressions/minute.
- Deliver two breaths quickly using the mouth-to-snout technique.
- Perform another series of 30 chest compressions.
- Chest compressions should be performed in two-minute cycles without interruption in intubated pets when several rescuers are present.

- Rotate the compressor role after each two-minute cycle of compressions to reduce compressor lean, which may impact chest wall recoil and avoid compromise of compression efficacy due to team member fatigue.
- The use of interposed abdominal compressions in dogs and cats with CPA is reasonable when sufficient team members trained in its use are available.

Advanced life support (ALS)

ALS includes:

- Administration of:
  - Vasopressors
  - Positive inotropes
  - Anticholinergic drugs
- Correction of:
  - Electrolyte disturbances
  - Volume deficits
  - Severe anemia

- **If BLS and ALS are performed promptly, initial return of spontaneous circulation (ROSC) rates may be as high as 50 percent in dogs and cats.**
- The use of low-dose (0.01 mg/kg intravenously (IV) epinephrine administered every three to five minutes early in CPR is recommended.
  - High-dose (0.1 mg/kg IV) epinephrine may be considered after prolonged CPR.
  - In order to minimize underdosing or overdosing during CPR, epinephrine should be administered during *every other* cycle of BLS.
- Routine use of atropine (0.04 mg/kg IV) during CPR in dogs and cats may be considered.
- A precordial thump may have some efficacy for treatment of ventricular fibrillation and/or pulseless ventricular tachycardia.
  - To perform a precordial thump:
    - Ensure the pet is in lateral recumbency.
    - Use a closed fist to sharply strike ("thump") the ribcage over the area of the heart.
- In dogs and cats that have received reversible anesthetic/sedative drugs, administering reversal agents during CPR may be considered.
- Potential risks associated with administration of these drugs are low.

- In refractory ventricular fibrillation/pulseless ventricular tachycardia, consider:
  - Amiodarone (5 mg/kg IV)
  - Lidocaine (2 mg/kg IV)
- IV calcium may be considered in dogs and cats with documented moderate to severe hypocalcemia during CPR.
- Documented hyperkalemia should be treated during CPR.
- Treatment of documented hypokalemia during CPR may be considered.
- The routine use of corticosteroids during CPR is not recommended.
- Administration of 1 mEq/kg of sodium bicarbonate may be considered after prolonged CPA of more than 10–15 minutes.
- For pets in which IV or intraosseous access is not possible, consider the use of the intratracheal route for epinephrine or atropine.
  - Drugs should be diluted with saline or sterile water and administered via a catheter longer than the ET tube.
- Use of a fraction of inspired oxygen (FiO_2) of 21 percent (room air) may be considered.
  - In the absence of arterial blood gas data, the risks of hypoxemia likely outweigh the risks of hyperoxemia and the use of a FiO_2 of 100 percent is reasonable.
- In euvolemic or hypervolemic dogs and cats, routine administration of IV fluids is not recommended.
  - Pets with pre-existing hypovolemia are likely to benefit from increased circulating volume during CPR and administration of IV fluids in these pets is reasonable.

Pets that experience CPA while under general anesthesia should be aggressively resuscitated, as a much higher percentage should be anticipated to survive to discharge compared to the general population

Monitoring

End-tidal carbon dioxide ($EtCO_2$)

- Immediate post-intubation $EtCO_2$ value should not be used for diagnosis of CPA in dogs and cats.
  - Initial values may not be representative of pulmonary perfusion.
    - Subsequent values may be associated with pulmonary perfusion.
  - Multiple high-quality studies support the conclusion that sudden increases in $EtCO_2$ occur rapidly with ROSC (due to increased pulmonary blood flow).
- $EtCO_2$ monitoring is likely a valuable adjunct for verification of correct ET tube placement, in conjunction with:
  - Direct visualization
  - Auscultation
  - Observation of chest excursions
- $EtCO_2$ should not be used as a sole measure of correct ET tube placement.
- Evaluation of the ECG (though susceptible to artifact) during intercycle pauses is recommended to obtain an accurate rhythm diagnosis and guide ALS therapy.
  - Chest compressions should not be stopped during a complete two-minute cycle of CPR to allow ECG interpretation.
  - Pauses in chest compressions to evaluate the ECG rhythm should be minimized.
- There is strong evidence supporting the use of $EtCO_2$ monitoring during CPR as an early indicator of ROSC and as a measure of efficacy of CPR.
  - Potentially allows rescuers to adjust treatment to maximize perfusion

Pulse

- Interruption of chest compressions during CPR specifically to palpate the pulse is not recommended.
- Palpation of the pulse to identify ROSC during intercycle pauses in CPR is reasonable as long as it does not delay resumption of compressions.

Electrolytes

- Routine monitoring of electrolytes, especially during prolonged CPR, may be considered.
- In cases of CPA that are known or suspected to be due to electrolyte derangements, monitoring of electrolytes will help guide therapy and is recommended.

Additional

- Central or mixed venous blood gas analysis to evaluate the effectiveness of CPR may be considered but arterial blood gas analysis during CPR is not recommended.
- Due to the high risk of recurrence, post-resuscitation monitoring should be sufficient to detect impending reoccurrence of CPA and should be sufficient to guide therapy appropriate for the pet's condition.
- There is no clear evidence to delineate between recommendations for continuous monitoring versus intermittent monitoring.
  - Monitoring should be tailored to the individual pet and its circumstances and underlying diseases, especially when determining the intervals for intermittent monitoring.
- There is evidence in support of serial monitoring following ROSC of:
  - Continuous ECG
  - Arterial oxygenation
  - Ventilation
  - Body temperature
  - Blood glucose
  - Systemic (arterial) blood pressure
  - Serial physical exams and neurologic monitoring
- Serial body temperature measurements are recommended to avoid high rewarming rates and hyperthermia.
- **In one veterinary study, 54 percent of pets that achieved ROSC succumbed to another episode of CPA, highlighting the importance of post-cardiac care and monitoring.**

Post-cardiac arrest (PCA) care

Goals of PCA Care

- Target:
  - Normocapnia
  - Normotension to hypertension
  - Avoid hypoxemia and hyperoxemia
  - Normal temperature/mild hypothermia
- Glucocorticoids if refractory hypotension
- Hypertonic saline or mannitol if cerebral edema
- Referral for advanced or 24-hour care to facility with intensive monitoring and advanced therapeutics

- Routine use of large volumes of IV fluids post-arrest is not recommended, except in strongly suspected or confirmed hypovolemia cases.
- Fluid therapy should be adjusted according to criteria customary to veterinary small animal emergency and critical care.
- Fluid therapy should be avoided in pets with evidence of congestive heart failure.
- Use of vasopressor and/or positive inotropic support to reach hemodynamic goals in dogs and cats with persistent hypotension and/or cardiovascular instability is reasonable.
- It is reasonable to assume that hypertension in the immediate PCA period in dogs and cats is beneficial.
- It is reasonable to target normocapnia (arterial carbon dioxide partial pressure ($PaCO_2$) of 32–43 mm Hg in dogs and 26–26 mm Hg in cats) in the PCA period.
  - Serial monitoring of $EtCO_2$ or arterial blood gases is necessary to assure adequacy of ventilation.
- Routine mechanical ventilation in all PCA pets is not recommended.

- It is reasonable to employ manual or mechanical ventilation in the PCA period in pets that:
  - Are hypoventilating
  - Are hypoxemic
  - Require high inspiratory oxygen concentration (FiO_2 equal to or greater than 60 percent) to maintain normoxemia
  - Are at risk of respiratory arrest
- Both hypoxemia and hyperoxemia should be avoided.
- If mild accidental hypothermia is present in the PCA period, it is reasonable to not rapidly rewarm these pets.
  - Mild therapeutic hypothermia should not be initiated if advanced critical care capabilities, including mechanical ventilation, are not available.
- Routine administration of corticosteroids during PCA care is not recommended.
  - Administration of hydrocortisone (1 mg/kg followed by either 1 mg/kg every six hours or an infusion of 0.15 mg/kg/hour and then tapered as the pet's condition allows) to cats or dogs that remain hemodynamically unstable despite administration of fluids and inotropes/pressors during PCA care may be considered. *Equivalent dexamethasone sodium phosphate dosing is roughly 0.5 mg/kg IV.*
- Use of hypertonic saline and mannitol in dogs and cats with neurologic signs consistent with cerebral edema (*e.g.*, coma, cranial nerve deficits, decerebrate postures, abnormal mentation) may be considered.
- Referral of critically ill dogs and cats to facilities with intensive monitoring and advanced therapeutics for PCA care is reasonable.

Clinical essential

Offer referral of critical or unstable pets to owners when appropriate and in the best interest of the pet

Figure 3.1

Cardiopulmonary Resuscitation

Cardiopulmonary Arrest (CPA)

INITIATE BASIC LIFE SUPPORT (BLS)

1 Cycle = 2 Minutes

Chest compressions

100 – 120/minute

Compress 1/3–1/2 of chest width
Do not lean
Allow full recoil of chest in between compressions

2-handed compressions
Suitable for large dogs

1-handed compressions
Suitable for small dogs and cats

Ventilation

10 breaths/minute

Tidal volume = 10 mL/kg
Inspiratory time = 1 second
OR
Mouth to snout ventilation at
C:V of 30:2

Resuscitation bag used to provide ventilation

Evaluate Patient

Change Compressor every 2 minutes

Advanced Life Support

Return of Spontaneous Circulation

Post-CPA Care

For additional information see *RECOVER* guidelines, *CPR* chapter and supporting materials.

Figure 3.2

Advanced Life Support (ALS)

INITIATE

1. **ECG MONITORING**
2. **$EtCO_2$ MONITORING** (where equipment exists)
3. **ENSURE PATENT VASCULAR ACCESS**
4. **ADMINISTER REVERSAL AGENTS** (if appropriate)

DRUG	DOSE	NOTES
Atipamezole (5 mg/mL)	50 **mcg**/kg	Reverses alpha-2 agonists
Flumazenil (0.1 mg/mL)	0.01 mg/kg	Reverses benzodiazepines
Naloxone (0.4 mg/mL)	0.04 mg/kg	Reverses opioids

5. **ADMINISTER PRECORDIAL THUMP**

BEGIN TIMING 2 MINUTE CYCLE

AVOID DISRUPTION TO COMPRESSION/VENTILATION

VASOPRESSOR DRUGS			
DRUG	**DOSE**	**NOTES**	
Epinephrine (1 mg/mL)	0.01 mg/kg	Administer every other cycle Consider 0.1 mg/kg with CPA >10 min	
Atropine (0.54 mg/mL)	0.05 mg/kg	Administer every other cycle with asystole or pulseless electrical activity	
ANTI-ARRHYTHMIC DRUGS			
Amiodarone (50 mg/mL)	5 mg/kg	Used for ventricular fibrillation and ventricular tachycardia	
Lidocaine (20 mg/mL) if amiodarone is not available	**Canine:** 2–8 mg/kg **Feline:** 0.2 mg/kg	Maximum doses:	**Canine:** 8 mg/kg **Feline:** 1 mg/kg

MONITOR

PARAMETER	NOTES
Continuous ECG	Normal sinus rhythm; assess for ROSC
$EtCO_2$	>15 mm Hg indicates good compressions
SpO_2	>90 % breathing room air or 100% O_2
TPR	Ensure monitoring does not impede compressions and ventilation
Blood pressure	MAP >80 mm Hg
Blood glucose	>100 mg/dL
Serial physical and neurologic examinations	

ASSESS

PARAMETER	NOTES
Calcium	Correct if needed
Potassium	Correct if needed
Volume status	Administer fluids if hypovolemic
FiO_2	Inhalant rates of 21 – 100%; adjust based on SpO_2
Acid base status	Consider sodium bicarbonate therapy (1 mEq/kg) if CPA >10 min

Post-Cardiopulmonary Arrest (CPA) Care and Monitoring

PARAMETER	GOAL	NOTES
Ventilation	**Canine:** $PaCO_2$ = 32–43	Manual ventilation for hypoventilating patients; avoid hypercapnia
	Feline: $PaCO_2$ = 26–36	
Blood pressure	Normotension to mild hypertension	
Oxygenation	PaO_2 = 80–100 mm Hg SpO_2 = 94–98%	Avoid hypoxemia and hyperoxemia
Temperature	Normothermia to mild hypothermia	Warm patients slowly
Additional Therapies		
Glucocorticoids	Hydrocortisone (1 mg/kg initial dose)	If refractory hypotension
Hypertonic saline	2–4 mL/kg of 7% solution	For neurologic signs consistent with cerebral edema; monitor volume status and urine output
	OR	
Mannitol	0.5 g/kg IV over 15–20 minutes	
Referral	24-hour care center with advanced critical care capabilities	

Clinical essential

Crash cart containing emergency drugs and equipment is readily available, in a designated place, portable, clearly labeled and appropriately stocked at all times

References and suggested reading for *CPR*:

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Full RECOVER articles are available online with open access at:
www.onlinelibrary.wiley.com/doi/10.1111/vec.2012.22.issue-s1/issuetoc

Job aids, posters and charts are available at the *Veterinary Emergency and Critical Care Society (VECCS)* website:
www.veccs.org/product-category/posters/

APPENDIX

Abbreviations

CRI	constant rate infusion	IPPV	intermittent positive pressure ventilation
ECG	electrocardiography	IM	intramuscular
$EtCO_2$	end-tidal carbon dioxide	IV	intravenous
HLK	hydromorphone, lidocaine, ketamine	MAP	mean arterial pressure
HR	heart rate	SpO_2	saturation of peripheral oxygen

Medication dilution and combination

- Completely label and date all medication dilutions and combinations with the appropriate labels

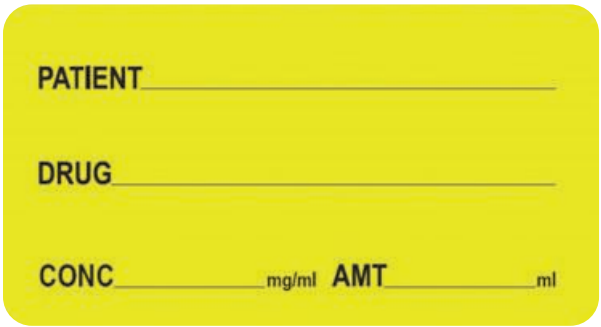
Figure 3.3: Mixed medication label

- Follow local, state and/or federal law for the mixing, storage and disposal of all medications and controlled drugs

- All CRIs:
  - Prepared directly at the time of use
- Dedicated to one patient
  - Discarded immediately when no longer in use
- Completely label and date all syringes with the appropriate label.

For dilution of acepromazine or preparation of DKT:

Figure 3.4: Syringe label



Medication	Dilution		Resultant Solution
Acepromazine	Sterile vial	Mix 27mL sterile water 3 mL (30 mg) acepromazine	1 mg/mL
DKT	Sterile vial	1 mL dexmedetomidine (0.5 mg) 1 mL ketamine (100 mg) 1 mL butorphanol (10 mg)	

- Stability and length of efficacy of diluted or combination medications have only been determined in a limited number of animal species and for a minimal amount of medications[1,2,3]
- Follow the intravenous access requirements for multi-dose vial usage:
  - Use amber-colored glass vials to protect contents from light.
  - Use aseptic technique every time, with every instance of handling.
  - Discard immediately if any signs of gross contamination.
  - Obtain a new, sterile syringe and needle for each use.
  - Discard syringe and needle after each use.

- Except where prohibited by law, it is recommended to:
  - Check all medication vials prior to use to ensure medications are not expired prior to diluting or mixing and to ensure expiration dates will not be exceeded with storage.
  - Keep medications that have been diluted or mixed at room temperature and protect from light.
  - Discard any unused medications (following appropriate laws for disposal) after 28 days.

Advanced analgesic techniques

Introduction

This section provides information on advanced analgesic techniques. Identification and treatment for immediate and post-operative pain are clinical essentials. The decision to utilize advanced techniques should be individualized and only considered when medically indicated in those uncommon situations where pain cannot be controlled.

Hospital teams should recognize that these techniques may require additional supplies (*e.g.*, syringe pump, wound infusion catheters), personnel, and training to perform effectively and safely.

Side effects and complications may occur and intensive monitoring is warranted for all patients that are deemed severely painful. Referral to 24-hour care facilities with advanced capabilities for critical patient care should be considered and offered when medically indicated.

Notes

Constant Rate Infusions (CRIs)

Dexmedetomidine CRI

- Post-operative/recovery/sedative/anxiety treatment if analgesics have been administered and pet is showing signs of stress or anxiety
- Has synergistic effects with opioid analgesics and decreases perioperative stress in dogs
- Provides analgesia through both central and peripheral mechanisms
- Should **not** be considered a "standalone" analgesic
  - Should be used in conjunction with opioid analgesics to take advantage of synergistic effects
- May be used as a treatment option for opioid dysphoria
- May help with neuropathic pain
- Should be administered via syringe or fluid pump

Dose:

› Recommended dose range is 0.5–2.0 **mcg**/kg/hour (canine and feline)
- 1.0 **mcg/kg/hour** is most commonly used

Intra-operative Dexmedetomidine CRI:

0.25 mL (0.125mg) dexmedetomidine in 1.0 L of crystalloid fluids:
Infusion at 10 mL/kg/hour = 1.25 **mcg**/kg/hour
Infusion at 5 mL/kg/hour = 0.63 **mcg**/kg/hour

› Empty the urinary bladder at the end of surgery
› Use additional analgesics (*e.g.*, opioids) since dexmedetomidine is **not** a standalone analgesic
› Have post-op sedation available and ready since patients can be noise sensitive and suddenly rousable

Post-operative Dexmedetomidine CRI:

1.0 mL (0.5 mg) dexmedetomidine in 1.0 L of crystalloid fluids
Infusion at 2.0 mL/kg/hour = 1.0 **mcg**/kg/hour*

2.0 mL (1.0 mg) dexmedetomidine in 1.0 L of crystalloid fluids
Infusion at 2.0 mL/kg/hour = 2.0 **mcg**/kg/hour*

*Patients should be monitored for level of sedation and rousability and infusion rate decreased accordingly

Fentanyl CRI

- Fentanyl is very short acting (approximately 15 minutes) and therefore requires CRI administration.
- Major advantage of a fentanyl CRI is that it allows titration of opioid dosing to pet needs.
- Fentanyl may decrease the inhalant requirements up to approximately 65 percent depending on dose.
  - **It is very important that the inhalant be titrated accordingly to avoid the pet being too deep.**
- Fentanyl should be administered via syringe pump.
- If hydromorphone premedication dose was administered within 2 hours, a fentanyl loading dose is **not** required.
  - If not, then administer a fentanyl loading dose of 3–5 **mcg**/kg slowly over 2 minutes while monitoring pulse/HR via ECG and respiration to rapidly achieve analgesic plasma levels

Heart rate:

- If significant bradycardia is associated with hypotension (MAP <60 mm Hg) then administer an anticholinergic (glycopyrrolate 0.005 mg/kg IV or 0.01 mg/kg IM).
  - Significant bradycardia; less than 50 bpm in medium to large dogs, less than 70–80 bpm in small dogs and cats.

Respiration:

- Monitor saturation of peripheral oxygen (SpO_2) at transition from 100% oxygen to room air at recovery.
  - Provide supplemental O_2 (100 mLs/kg/min) until able to maintain SpO_2 >93–95%.
- End-tidal carbon dioxide ($EtCO_2$) should be monitored and manual or mechanical intermittent positive pressure ventilation (IPPV) provided if $EtCO_2$ is greater than 55 mm Hg, despite titration of inhalant.

Level of sedation:

- Ensure that patient is 'rousable' and can respond to his/her name. If not:
  - May be prone to hypoventilation/hypoxemia, regurgitation/aspiration
    - Lower/stop CRI, assess pulse/HR, respiration, SpO_2 (provide supplemental O_2 if <93%).
    - Partial reversal with butorphanol 0.1 mL (1.0 mg) diluted in 0.9 mLs IV fluid, given in 0.2 mL increments IV

Body temperature:

- If hypothermic, provide active heating

Assessment of pain:

- Adjust CRI based on pain level

Dose:

Loading dose:

3.0 - 5.0 **mcg/kg** IV slowly over 2 minutes, monitor pulse/heart rate (HR) via electrocardiography (ECG) and respiration

CRI:

Intra-op: 5.0–10 **mcg**/kg/hr*
Post-op: 2.0–10 **mcg**/kg/hr*

*The reported analgesic plasma levels of fentanyl in dogs are 1.0 -2.0 ng/mL.

- There may be considerable inter-individual variation in plasma levels and pain threshold for different patients.
- It is imperative that patients be regularly assessed for pain and level of sedation (rousability) in order to titrate the fentanyl CRI to the patient's analgesic needs.

Hydromorphone, Lidocaine, Ketamine (HLK) CRI

- Intra-operative constant rate infusion (CRI) for multimodal analgesia
- Administer via a fluid or syringe pump:
  - Ensure accurate dosing
  - Decrease the chance of inadvertent bolus administration

Intra-operative Dose:

› Infuse at 10 mLs/kg/hour for the first hour then reduce to 5.0 mLs/kg/hr

- **DO NOT BOLUS!**

- Add to 1.0 liter bag of crystalloid fluids (all drug volumes and milligrams can be halved if adding to a 500 mL bag of crystalloids):

Drug	Volume to add (mg)	Infusion dose (1st hour)	Infusion dose (2nd hour)
Hydromorphone (10 mg/mL)	0.2 mLs (2.0mg)	0.02 mg/kg/hr	0.01 mg/kg/hr*
Lidocaine (20 mg/mL)	15 mLs (300mg)	3.0 mg/kg/hr (50 **mcg**/kg/min)	1.5 mg/kg/hr (25 **mcg**/kg/min)
Ketamine (100 mg/mL)	1.2 mLs (120mg)	1.2 mg/kg/hr (20 **mcg**/kg/min)	0.6 mg/kg/hr (10 **mcg**/kg/min)

* Dose of hydromorphone over 4 hours = 0.04 mg/kg

Note: Some patients may require supplemental doses of hydromorphone intra-operatively. It is important to monitor patients for anesthetic requirement (*i.e.*, level of gas anesthetic required and signs of inadequate analgesia such as increased heart rate and blood pressure.

Post-operative Dose:
› Infuse at 2.0 mLs/kg/hour

- **DO NOT BOLUS!**

- Add to 1.0 liter bag of crystalloid fluids:

Drug	Volume to add (mg)	Infusion dose
Hydromorphone (10 mg/mL)	0.5 mLs (5.0 mg)	0.01 mg/kg/hr
Lidocaine (20 mg/mL)	37.5 mLs (750 mg)	1.5 mg/kg/hr (25 **mcg**/kg/min)
Ketamine (100 mg/mL)	0.6 mLs (60 mg)	0.12 mg/kg/hr (2.0 **mcg**/kg/min)

Supplemental Information:

- When patients have significant analgesic requirements, and an HLK CRI is planned, loading doses of medications may be considered prior to induction.
- Remember the caveats for these patients.
- **Lidocaine**
  - Provide loading dose for intra-operative CRI
    - 2.0 mg/kg slowly IV over 2 minutes prior to induction
- **Ketamine**
  - Can be administered after lidocaine and prior to propofol to provide a loading dose for intra-operative CRI
    - 0.5 mg/kg slowly IV
- **Note that the use of these medications may impact (reduce) the amount of induction agent needed to achieve intubation.**

Note: There are multiple formulas that may be used for calculations of CRIs. Examples using a syringe pump or a 250 mL fluid bag for infusion are provided here. See individual chapters and additional content in the *Appendix* for details. It is the attending veterinarian's responsibility to correctly calculate and administer CRIs. Concentrations may need to vary based upon patient size. Pay close attention to fluid administration rates and the potential for fluid overload.

Table 3.1

Medication	Infusion		Resultant Solution
Dexmedetomidine (0.5 mg/mL)	Syringe pump	Mix 30 mL sterile 0.9% NaCl with 0.3 mL (0.15 mg) dexmedetomidine	5 **mcg**/mL
	250 mL bag 0.9% NaCl	Add 2.5 mL (1.25 mg) dexmedetomidine to new, sterile bag	
Dobutamine (12.5 mg/mL)	Syringe pump	Mix 30 mL sterile 0.9% NaCl with 0.03 mL (0.375 mg) dobutamine	12.5 **mcg**/mL
	250 mL bag 0.9% NaCl	Add 0.25 mL (3.125 mg) dobutamine to new, sterile bag	
Dopamine (40 mg/mL)	Syringe pump	Mix 30 mL sterile 0.9% NaCl with 0.03 mL (1.2 mg) dopamine	40 **mcg**/mL
	250 mL bag 0.9% NaCl	Add 0.25 mL (10 mg) dopamine to new, sterile bag	
Fentanyl (0.5 mg/mL)	Syringe pump	Mix 30 mL sterile 0.9% NaCl with 0.15 mL (0.075 mg) fentanyl	2.5 **mcg**/mL
	250 mL bag 0.9% NaCl	Add 1 mL (0.5 mg) fentanyl to new, sterile bag	2 **mcg**/mL
Lidocaine (20 mg/mL) CRI	Syringe pump	Mix 30 mL sterile 0.9% NaCl with 3 mL (60 mg) lidocaine	2 mg/mL
	250 mL bag 0.9% NaCl	Add 12.5 mL (250 mg) lidocaine to new, sterile bag	1 mg/mL

Fentanyl Patch

- Recommended dose is 4 **mcg**/kg/hour (canine)
- In cats, a 25 **mcg**/hour patch is applied resulting in doses ranging from 4–8 **mcg**/kg.
- Analgesia has been associated with plasma concentrations of ~0.6–1.2 ng/mL in dogs and 1.5–1.7 ng/mL in cats which can take up to 24 hours in dogs and 7 hours in cats.[5]
  - There is significant inter-individual variability in plasma concentrations achieved with fentanyl patches, therefore, patients should be assessed for adequate analgesia using the *Colorado Acute Pain Scale*.
- Plans for alternative mu-opioid analgesia should be made until the expected onset of adequate analgesic plasma levels.
  - Buprenorphine (partial mu agonist) and butorphanol (mu antagonist) will antagonize the effects of fentanyl and should not be used concurrently.
  - Hydromorphone or fentanyl CRI are recommended.
- Fentanyl patches should be placed at recovery from general anesthesia to avoid excessive absorption due to external pet warming devices.
- Apply to dorsal/lateral thorax.
  - Consider patient access to licking or ingesting patch when planning site of application.
- Clip hair, wipe excess hair (rolled self-adherent wraps work well), warm with hands, apply.
- Fentanyl patches are typically removed by ~72 hours post application.
- Patches that lift off of the skin should be replaced on a newly prepared area of skin.
- If an animal ingests a patch, it should be monitored for signs of opioid overdosage and naloxone (mu antagonist) should be administered.
- Proper disposal is imperative.

CAUTION! A significant amount of residual fentanyl may still reside in the patch after removal. There is potential for abuse or diversion and inadvertent ingestion has led to fatalities in children. Consider these prior to sending a pet home with a fentanyl patch. In the home environment, proper disposal is imperative. Gloves should be worn while handling.

Wound Infusion Catheters

- Flexible, polypropylene, perforated, indwelling catheters imbedded in or near surgical sites and used to deliver intermittent injections of local anesthetics
- Major advantages:
  - Provide local pain relief
  - Reduce the need for systemic analgesics
  - Faster return of appetite
  - Ambulatory the evening of or morning after surgery
    - Require less nursing care as patients are able to walk outside for elimination needs
- Less parenteral analgesic requirement reduces side effects:
  - Sedation
  - Risk of regurgitation/aspiration
  - Urinary retention
- Clinical investigations of this technique in human medicine have demonstrated:
  - Improved pain control at rest and with activity
  - Decreased opioid requirement
  - Increased patient satisfaction
  - Shorter hospital stay following a variety of surgical procedures
- Studies in animals describe uses for:
  - Ear canal ablation
  - Median sternotomy
  - Lateral thoracotomy
  - Limb amputation
  - Major soft tissue tumor excision:
    - Mastectomy
    - Fibrosarcoma resection in cats

Equipment:

- Butterfly connectors
- Wound infusion catheter (Figures 3.5 and 3.6)
  - The distal tip of the wound infusion catheter is sealed so that liquid exits only from the micropores.
  - The catheters are available with different lengths of micropores to allow for use in a variety of anatomical sites and sizes of pets.
  - A black depth indicator marks a point located ½ inch (1.25 cm) from the first micropore to insure that all micropores are located below the skin.
- Line filter
- Waterproof dressing
- Suture

Positioning and anatomic landmarks:

- Dependent upon site and type of wound

Figure 3.5: Wound infusion catheter

Used with permission from Bonnie L. Hay Kraus, DVM, DACVS, DACVAA

Figure 3.6: Catheter showing micropore locations

Used with permission from Bonnie L. Hay Kraus, DVM, DACVS, DACVAA

Technique:

- Plan for the location of the catheter end/filter/cap.
- Make a stab incision in the skin, insert the catheter tip and pull the catheter tip into the wound bed normograde.
- Insert the catheter with the distal tip in the deepest layer of the closure and then suture in place.
- It is essential that all perforations are below the skin.
- Perform routine wound closure over the catheter.
- Place a purse string suture and finger trap to secure the catheter.
- Suture **both** butterfly connectors to the skin. One should be adjusted to be located close to the exit of the catheter from the skin to help keep it from backing out. Cover with sterile, waterproof dressing and seal the catheter end with a 0.2 micron filter and an injection cap. Add a clear label to the soaker catheter site to avoid confusion with an IV injection cap.

Drugs

- Bupivacaine dosing is 1.5 mg/kg and should be injected 10 - 15 minutes prior to the end of surgery and continued every four to six hours post-operatively. (Figure 3.7)

Figure 3.7

Catheter loaded with calculated bupivacaine dose and priming volume of catheter and filter

Used with permission from Bonnie L. Hay Kraus, DVM, DACVS, DACVAA

- Be sure to add the priming volume and the filter volume to the calculated dose. The priming volume for all sizes of catheters is 0.8 mLs and the filter volume is 1 mLs so this volume needs to be added to the first intra-operative dose.
- For small dogs or cats, the bupivacaine may need to be diluted, otherwise the volume may not be sufficient to reach the entire tissue bed.

Figure 3.8

Examples of Bupivacaine Dosing Calculations

For patients <10 kg

2.5 kg feline
x 1.5 mg/kg
= 3.75 mg
÷ 5 mg/mL
= 0.75 mL. Add 0.75 mL **sterile water** (do not use saline-containing fluids)
= Final volume of 1.5 mL, which is more likely to be a sufficient volume to adequately bathe the wound bed without going above the recommended dose.

For patients >10 kg

5 kg feline
x 1.5 mg/kg
= 7.5 mg
÷ 5 mg/mL
= 1.5 mLs (feline dose)
+ 0.8 mLs (priming volume)
+ 1 mL filter volume
= 3.3 mLs bupivacaine for **first dose only**. Thereafter, each subsequent dose should be the regular calculated dose.

Notes

Points to Remember:

- Bury the catheter in deepest part of wound/incision
- Ensure that all micropores are below the skin
- Secure the catheter with a purse string and finger trap and both plastic tabs
- Administer bupivacaine every four to six hours
- The priming volume for all wound infusion catheters is 0.8 mL and filters are 1 mL
- Maintain catheter for minimum of 24 - 72 hours and up to three to five days
- Infuse with bupivacaine 1.5 mg/kg prior to catheter removal to extend the duration of analgesia
- Assess individual pet for:
  - Fluid accumulation. Decrease infusion volume or increase dosing interval
  - Pain assessment of the pet at regular intervals
  - Tenderness to palpation. Dose more frequently (reaction to injection can be seen when dosing interval is every six hours).
  - Lower opioid doses. Use of wound infusion catheters will lower opioid dose requirements. More signs of opioid dysphoria (or other opioid side effects such as sedation) may be observed if full opioid doses are used.

Dosage Charts

The charts are meant to provide a guideline to dosing calculations and typically list the minimum and maximum dosages for a given medication. It is the responsibility of the providing veterinarian to decide drug dosages for an individual patient and perform accurate calculations.

Acepromazine | 1 mg/mL

Weight (kg)	CANINE		FELINE	
	mLs to administer		mLs to administer	
	Low end 0.005 mg/kg	High end 0.05 mg/kg	Low end 0.01 mg/kg	High end 0.1 mg/kg
0.5	0.00	0.03	0.01	0.05
1	0.01	0.05	0.01	0.10
2	0.01	0.10	0.02	0.20
3	0.02	0.15	0.03	0.30
4	0.02	0.20	0.04	0.40
5	0.03	0.25	0.05	0.50
6	0.03	0.30	0.06	0.60
7	0.04	0.35	0.07	0.70
8	0.04	0.40	0.08	0.80
9	0.05	0.45	0.09	0.90
10	0.05	0.50	0.10	1.00
11	0.06	0.55		
12	0.06	0.60		
13	0.07	0.65		
14	0.07	0.70		
15	0.08	0.75		
16	0.08	0.80		
17	0.09	0.85		
18	0.09	0.90		
19	0.10	0.95		
20	0.10	1.00		
21	0.11	1.05		
22	0.11	1.10		
23	0.12	1.15		
24	0.12	1.20		
25	0.13	1.25		
26	0.13	1.30		
27	0.14	1.35		
28	0.14	1.40		
29	0.15	1.45		
30	0.15	1.50		
31	0.16	1.55		
32	0.16	1.60		
33	0.17	1.65		
34	0.17	1.70		
35	0.18	1.75		
36	0.18	1.80		
37	0.19	1.85		
38	0.19	1.90		
39	0.20	1.95		
40	0.20	2.00		
40 +	0.20	2.00		

MAXIMUM DOSAGE

Canine:
2 mg/dog

Feline:
1 mg/cat

Alfaxalone | 10 mg/mL

Weight (kg)	CANINE/FELINE	
	mLs to administer	
	Low end 1 mg/kg	High end 4 mg/kg
0.5	0.05	0.2
1	0.1	0.4
2	0.2	0.8
3	0.3	1.2
4	0.4	1.6
5	0.5	2.0
6	0.6	2.4
7	0.7	2.8
8	0.8	3.2
9	0.9	3.6
10	1.0	4.0
11	1.1	4.4
12	1.2	4.8
13	1.3	5.2
14	1.4	5.6
15	1.5	6.0
16	1.6	6.4
17	1.7	6.8
18	1.8	7.2
19	1.9	7.6
20	2.0	8.0
21	2.1	8.4
22	2.2	8.8
23	2.3	9.2
24	2.4	9.6
25	2.5	10.0
26	2.6	10.4
27	2.7	10.8
28	2.8	11.2
29	2.9	11.6
30	3.0	12.0
31	3.1	12.4
32	3.2	12.8
33	3.3	13.2
34	3.4	13.6
35	3.5	14.0
36	3.6	14.4
37	3.7	14.8
38	3.8	15.2
39	3.9	15.6
40	4.0	16.0
41	4.1	16.4
42	4.2	16.8
43	4.3	17.2
44	4.4	17.6
45	4.5	18.0
46	4.6	18.4
47	4.7	18.8
48	4.8	19.2
49	4.9	19.6
50	5.0	20.0

SEE DOSING INSTRUCTIONS IN TEXT
Administer only to effect

Atipamezole | 5 mg/mL

Weight (kg)	FELINE	
	mLs to administer	
	Compromised 0.012 mL/kg	Healthy 0.021 mL/kg
0.5	0.01	0.01
1	0.01	0.02
2	0.02	0.04
3	0.04	0.06
4	0.05	0.08
5	0.06	0.11
6	0.07	0.13
7	0.08	0.15
8	0.10	0.17
9	0.11	0.19
10	0.12	0.21
11	0.13	0.23
12	0.14	0.25
13	0.16	0.27

PACKAGE INSERT CONTAINS DETAILED DOSING INSTRUCTIONS

Feline:
Reversal for DKT

Canine:
Reversal of dexmedetomidine

Administer atipamezole IM at equal mL volume to dexmedetomidine administered

Atropine | 0.4 mg/mL (For cardiac support)

Weight (kg)	CANINE/FELINE	
	mLs to administer	
	Low end 0.02 mg/kg	High end 0.04 mg/kg
0.5	0.025	0.05
1	0.05	0.1
2	0.10	0.2
3	0.15	0.3
4	0.20	0.4
5	0.25	0.5
6	0.30	0.6
7	0.35	0.7
8	0.40	0.8
9	0.45	0.9
10	0.50	1.0
11	0.55	1.1
12	0.60	1.2
13	0.65	1.3
14	0.70	1.4
15	0.75	1.5
16	0.80	1.6
17	0.85	1.7
18	0.90	1.8
19	0.95	1.9
20	1.00	2.0
21	1.05	2.1
22	1.10	2.2
23	1.15	2.3
24	1.20	2.4
25	1.25	2.5
26	1.30	2.6
27	1.35	2.7
28	1.40	2.8
29	1.45	2.9
30	1.50	3.0
31	1.55	3.1
32	1.60	3.2
33	1.65	3.3
34	1.70	3.4
35	1.75	3.5
36	1.80	3.6
37	1.85	3.7
38	1.90	3.8
39	1.95	3.9
40	2.00	4.0
41	2.05	4.1
42	2.10	4.2
43	2.15	4.3
44	2.20	4.4
45	2.25	4.5
46	2.30	4.6
47	2.35	4.7
48	2.40	4.8
49	2.45	4.9
50	2.50	5.0

Bupivacaine | 5 mg/mL (For local anesthesia)

Weight (kg)	CANINE		FELINE	
	mLs to administer		mLs to administer	
	Low end 1 mg/kg	Maximum Dose 2 mg/kg	Low end 1 mg/kg	Maximum Dose 1.5 mg/kg
0.5	0.10	0.20	0.10	0.15
1	0.20	0.40	0.20	0.30
2	0.40	0.80	0.40	0.60
3	0.60	1.20	0.60	0.90
4	0.80	1.60	0.80	1.20
5	1.00	2.00	1.00	1.50
6	1.20	2.40	1.20	1.80
7	1.40	2.80	1.40	2.10
8	1.60	3.20	1.60	2.40
9	1.80	3.60	1.80	2.70
10	2.00	4.00	2.00	3.00
11	2.20	4.40	2.20	3.30
12	2.40	4.80	2.40	3.60
13	2.60	5.20	2.60	3.90
14	2.80	5.60		
15	3.00	6.00		
16	3.20	6.40		
17	3.40	6.80		
18	3.60	7.20		
19	3.80	7.60		
20	4.00	8.00		
21	4.20	8.40		
22	4.40	8.80		
23	4.60	9.20		
24	4.80	9.60		
25	5.00	10.00		
26	5.20	10.40		
27	5.40	10.80		
28	5.60	11.20		
29	5.80	11.60		
30	6.00	12.00		
31	6.20	12.40		
32	6.40	12.80		
33	6.60	13.20		
34	6.80	13.60		
35	7.00	14.00		
36	7.20	14.40		
37	7.40	14.80		
38	7.60	15.20		
39	7.80	15.60		
40	8.00	16.00		
41	8.20	16.40		
42	8.40	16.80		
43	8.60	17.20		
44	8.80	17.60		
45	9.00	18.00		
46	9.20	18.40		
47	9.40	18.80		
48	9.60	19.20		
49	9.80	19.60		
50	10.00	20.00		

LOCAL INJECTION GUIDELINES

Canine:
0.5 – 1.0 mL per site

Feline:
0.2 – 0.3 mL per site

Dilute with sterile water if more volume is needed

Buprenorphine | 0.3 mg/mL

Weight (kg)	CANINE		FELINE		
	mLs to administer		mLs to administer		
	Low end 0.005 mg/kg	High end 0.02 mg/kg	Low end 0.01 mg/kg	High end 0.02 mg/kg	Acute pain 0.04 mg/kg
0.5	0.01	0.03	0.02	0.03	0.07
1	0.02	0.07	0.03	0.07	0.13
2	0.03	0.13	0.07	0.13	0.27
3	0.05	0.20	0.10	0.20	0.40
4	0.07	0.27	0.13	0.27	0.53
5	0.08	0.33	0.17	0.33	0.67
6	0.10	0.40	0.20	0.40	0.80
7	0.12	0.47	0.23	0.47	0.93
8	0.13	0.53	0.27	0.53	1.07
9	0.15	0.60	0.30	0.60	1.20
10	0.17	0.67	0.33	0.67	1.33
11	0.18	0.73	0.37	0.73	1.47
12	0.20	0.80	0.40	0.80	1.60
13	0.22	0.87	0.43	0.87	1.73
14	0.23	0.93			
15	0.25	1.00			
16	0.27	1.07			
17	0.28	1.13			
18	0.30	1.20			
19	0.32	1.27			
20	0.33	1.33			
21	0.35	1.40			
22	0.37	1.47			
23	0.38	1.53			
24	0.40	1.60			
25	0.42	1.67			
26	0.43	1.73			
27	0.45	1.80			
28	0.47	1.87			
29	0.48	1.93			
30	0.50	2.00			
31	0.52	2.07			
32	0.53	2.13			
33	0.55	2.20			
34	0.57	2.27			
35	0.58	2.33			
36	0.60	2.40			
37	0.62	2.47			
38	0.63	2.53			
39	0.65	2.60			
40	0.67	2.67			
41	0.68	2.73			
42	0.70	2.80			
43	0.72	2.87			
44	0.73	2.93			
45	0.75	3.00			
46	0.77	3.07			
47	0.78	3.13			
48	0.80	3.20			
49	0.82	3.27			
50	0.83	3.33			

Buprenorphine – long acting | 1.8 mg/mL

Weight (kg)	FELINE mLs to administer 0.24 mg/kg
0.5	0.07
1	0.13
2	0.27
3	0.40
4	0.53
5	0.67
6	0.80
7	0.93
8	1.07
9	1.20
10	1.33
11	1.47
12	1.60
13	1.73

DOSAGE
Dose on lean body weight

Butorphanol | 10 mg/mL (For analgesia)

Weight (kg)	CANINE/FELINE	
	mLs to administer	
	Low end 0.2 mg/kg	High end 0.4 mg/kg
0.5	0.01	0.02
1	0.02	0.04
2	0.04	0.08
3	0.06	0.12
4	0.08	0.16
5	0.10	0.20
6	0.12	0.24
7	0.14	0.28
8	0.16	0.32
9	0.18	0.36
10	0.20	0.40
11	0.22	0.44
12	0.24	0.48
13	0.26	0.52
14	0.28	0.56
15	0.30	0.60
16	0.32	0.64
17	0.34	0.68
18	0.36	0.72
19	0.38	0.76
20	0.40	0.80
21	0.42	0.84
22	0.44	0.88
23	0.46	0.92
24	0.48	0.96
25	0.50	1.00
26	0.52	1.04
27	0.54	1.08
28	0.56	1.12
29	0.58	1.16
30	0.60	1.20
31	0.62	1.24
32	0.64	1.28
33	0.66	1.32
34	0.68	1.36
35	0.70	1.40
36	0.72	1.44
37	0.74	1.48
38	0.76	1.52
39	0.78	1.56
40	0.80	1.60
41	0.82	1.64
42	0.84	1.68
43	0.86	1.72
44	0.88	1.76
45	0.90	1.80
46	0.92	1.84
47	0.94	1.88
48	0.96	1.92
49	0.98	1.96
50	1.00	2.00

Carprofen | 50 mg/mL

Weight (kg)	CANINE	
	mLs to administer	
	Low end 4 mg/kg	High end 4.4 mg/kg
0.5	0.04	0.04
1	0.08	0.09
2	0.16	0.18
3	0.24	0.26
4	0.32	0.35
5	0.40	0.44
6	0.48	0.53
7	0.56	0.62
8	0.64	0.70
9	0.72	0.79
10	0.80	0.88
11	0.88	0.97
12	0.96	1.06
13	1.04	1.14
14	1.12	1.23
15	1.20	1.32
16	1.28	1.41
17	1.36	1.50
18	1.44	1.58
19	1.52	1.67
20	1.60	1.76
21	1.68	1.85
22	1.76	1.94
23	1.84	2.02
24	1.92	2.11
25	2.00	2.20
26	2.08	2.29
27	2.16	2.38
28	2.24	2.46
29	2.32	2.55
30	2.40	2.64
31	2.48	2.73
32	2.56	2.82
33	2.64	2.90
34	2.72	2.99
35	2.80	3.08
36	2.88	3.17
37	2.96	3.26
38	3.04	3.34
39	3.12	3.43
40	3.20	3.52
41	3.28	3.61
42	3.36	3.70
43	3.44	3.78
44	3.52	3.87
45	3.60	3.96
46	3.68	4.05
47	3.76	4.14
48	3.84	4.22
49	3.92	4.31
50	4.00	4.40

Dexamethasone SP 4 mg/mL

Weight (kg)	CANINE/FELINE	
	mLs to administer	
	Low end 0.1 mg/kg	High end 0.4 mg/kg
0.5	0.013	0.05
1	0.025	0.10
2	0.050	0.20
3	0.075	0.30
4	0.100	0.40
5	0.125	0.50
6	0.150	0.60
7	0.175	0.70
8	0.200	0.80
9	0.225	0.90
10	0.250	0.10
11	0.275	0.11
12	0.300	0.12
13	0.325	0.13
14	0.350	0.14
15	0.375	0.15
16	0.400	0.16
17	0.425	0.17
18	0.450	0.18
19	0.475	0.19
20	0.500	0.20
21	0.525	0.21
22	0.550	0.22
23	0.575	0.23
24	0.600	0.24
25	0.625	0.25
26	0.650	0.26
27	0.675	0.27
28	0.700	0.28
29	0.725	0.29
30	0.750	0.30
31	0.775	0.31
32	0.800	0.32
33	0.825	0.33
34	0.850	0.34
35	0.875	0.35
36	0.900	0.36
37	0.925	0.37
38	0.950	0.38
39	0.975	0.39
40	1.000	0.40
41	1.025	0.41
42	1.050	0.42
43	1.075	0.43
44	1.100	0.44
45	1.125	0.45
46	1.150	0.46
47	1.175	0.47
48	1.200	0.48
49	1.225	0.49
50	1.250	0.50

Dexmedetomidine | 0.5 mg/mL

Weight (kg)	CANINE		FELINE	
	mLs to administer		mLs to administer	
	Low end 2 mcg/kg	High end 5 mcg/kg	Low end 5 mcg/kg	High end 10 mcg/kg
0.5	0.00	0.01	0.01	0.01
1	0.00	0.01	0.01	0.02
2	0.01	0.02	0.02	0.04
3	0.01	0.03	0.03	0.06
4	0.02	0.04	0.04	0.08
5	0.02	0.05	0.05	0.10
6	0.02	0.06	0.06	0.12
7	0.03	0.07	0.07	0.14
8	0.03	0.08	0.08	0.16
9	0.04	0.09	0.09	0.18
10	0.04	0.10	0.10	0.20
11	0.04	0.11	0.11	0.22
12	0.05	0.12	0.12	0.24
13	0.05	0.13	0.13	0.26
14	0.06	0.14		
15	0.06	0.15		
16	0.06	0.16		
17	0.07	0.17		
18	0.07	0.18		
19	0.08	0.19		
20	0.08	0.20		
21	0.08	0.21		
22	0.09	0.22		
23	0.09	0.23		
24	0.10	0.24		
25	0.10	0.25		
26	0.10	0.26		
27	0.11	0.27		
28	0.11	0.28		
29	0.12	0.29		
30	0.12	0.30		
31	0.12	0.31		
32	0.13	0.32		
33	0.13	0.33		
34	0.14	0.34		
35	0.14	0.35		
36	0.14	0.36		
37	0.15	0.37		
38	0.15	0.38		
39	0.16	0.39		
40	0.16	0.40		
41	0.16	0.41		
42	0.17	0.42		
43	0.17	0.43		
44	0.18	0.44		
45	0.18	0.45		
46	0.18	0.46		
47	0.19	0.47		
48	0.19	0.48		
49	0.20	0.49		
50	0.20	0.50		

Package insert contains detailed dosing instructions

For reversal, administer atipamezole IM at equal mL volume to dexmedetomidine administered

Usage limited to pets with ASA status I – II

Diphenhydramine | 50 mg/mL

Weight (kg)	CANINE/FELINE	
	mLs to administer	
	Low end 1mg/kg	High end 2.2 mg/kg
0.5	0.01	0.02
1	0.02	0.04
2	0.04	0.09
3	0.06	0.13
4	0.08	0.18
5	0.10	0.22
6	0.12	0.26
7	0.14	0.31
8	0.16	0.35
9	0.18	0.40
10	0.20	0.44
11	0.22	0.48
12	0.24	0.53
13	0.26	0.57
14	0.28	0.62
15	0.30	0.66
16	0.32	0.7
17	0.34	0.75
18	0.36	0.79
19	0.38	0.84
20	0.40	0.88
21	0.42	0.92
22	0.44	0.97
23	0.46	1.00
24	0.48	1.00
25	0.50	
26	0.52	
27	0.54	
28	0.56	
29	0.58	
30	0.60	
31	0.62	
32	0.64	
33	0.66	
34	0.68	
35	0.70	
36	0.72	
37	0.74	
38	0.76	
39	0.78	
40	0.80	
41	0.82	
42	0.84	
43	0.86	
44	0.88	
45	0.90	
46	0.92	
47	0.94	
48	0.96	
49	0.98	
50	1.00	

MAXIMUM DOSE
1 ML (50 MG)

DKT | Dexmedetomidine, Ketamine, Butorphanol

Weight (kg)	FELINE			
	mLs DKT administered	mL atipamezole	mLs DKT administered	mL atipamezole
	Compromised 0.035 mL/kg	Reversal 0.012 mL/kg	Healthy 0.065 mL/kg	Reversal 0.021 mL/kg
0.5	0.02	0.01	0.03	0.01
1	0.04	0.01	0.07	0.02
2	0.07	0.02	0.13	0.04
3	0.11	0.04	0.20	0.06
4	0.14	0.05	0.26	0.08
5	0.18	0.06	0.33	0.11
6	0.21	0.07	0.39	0.13
7	0.25	0.08	0.46	0.15
8	0.28	0.10	0.52	0.17
9	0.32	0.11	0.59	0.19
10	0.35	0.12	0.65	0.21
11	0.39	0.13	0.72	0.23
12	0.42	0.14	0.78	0.25
13	0.46	0.16	0.85	0.27

ATIPAMEZOLE REVERSAL: REPEAT IN 10 MINUTES IF NEEDED

Epinephrine | 1 mg/mL

Weight (kg)	CANINE/FELINE	
	mLs to administer	
	Low end 0.01 mg/kg	High end 0.2 mg/kg (intra-tracheal)
0.5	0.01	0.10
1	0.01	0.20
2	0.02	0.40
3	0.03	0.60
4	0.04	0.80
5	0.05	1.00
6	0.06	1.20
7	0.07	1.40
8	0.08	1.60
9	0.09	1.80
10	0.10	2.00
11	0.11	2.20
12	0.12	2.40
13	0.13	2.60
14	0.14	2.80
15	0.15	3.00
16	0.16	3.20
17	0.17	3.40
18	0.18	3.60
19	0.19	3.80
20	0.20	4.00
21	0.21	4.20
22	0.22	4.40
23	0.23	4.60
24	0.24	4.80
25	0.25	5.00
26	0.26	5.20
27	0.27	5.40
28	0.28	5.60
29	0.29	5.80
30	0.30	6.00
31	0.31	6.20
32	0.32	6.40
33	0.33	6.60
34	0.34	6.80
35	0.35	7.00
36	0.36	7.20
37	0.37	7.40
38	0.38	7.60
39	0.39	7.80
40	0.40	8.00
41	0.41	8.20
42	0.42	8.40
43	0.43	8.60
44	0.44	8.80
45	0.45	9.00
46	0.46	9.20
47	0.47	9.40
48	0.48	9.60
49	0.49	9.80
50	0.50	10.00

Fentanyl | 0.05 mg/mL

Weight (kg)	CANINE/FELINE	
	mLs to administer	
	Low end 3 mcg/kg	High end 5 mcg/kg
0.5	0.03	0.05
1	0.06	0.10
2	0.12	0.20
3	0.18	0.30
4	0.24	0.40
5	0.30	0.50
6	0.36	0.60
7	0.42	0.70
8	0.48	0.80
9	0.54	0.90
10	0.60	1.00
11	0.66	1.10
12	0.72	1.20
13	0.78	1.30
14	0.84	1.40
15	0.90	1.50
16	0.96	1.60
17	1.02	1.70
18	1.08	1.80
19	1.14	1.90
20	1.20	2.00
21	1.26	2.10
22	1.32	2.20
23	1.38	2.30
24	1.44	2.40
25	1.50	2.50
26	1.56	2.60
27	1.62	2.70
28	1.68	2.80
29	1.74	2.90
30	1.80	3.00
31	1.86	3.10
32	1.92	3.20
33	1.98	3.30
34	2.04	3.40
35	2.10	3.50
36	2.16	3.60
37	2.22	3.70
38	2.28	3.80
39	2.34	3.90
40	2.40	4.00
41	2.46	4.10
42	2.52	4.20
43	2.58	4.30
44	2.64	4.40
45	2.70	4.50
46	2.76	4.60
47	2.82	4.70
48	2.88	4.80
49	2.94	4.90
50	3.00	5.00

Flumazenil | 0.1 mg/mL

Weight (kg)	CANINE/FELINE mLs to administer 0.01 mg/kg Repeat every hour if needed
0.5	0.05
1	0.1
2	0.2
3	0.3
4	0.4
5	0.5
6	0.6
7	0.7
8	0.8
9	0.9
10	1.0
11	1.1
12	1.2
13	1.3
14	1.4
15	1.5
16	1.6
17	1.7
18	1.8
19	1.9
20	2.0
21	2.1
22	2.2
23	2.3
24	2.4
25	2.5
26	2.6
27	2.7
28	2.8
29	2.9
30	3.0
31	3.1
32	3.2
33	3.3
34	3.4
35	3.5
36	3.6
37	3.7
38	3.8
39	3.9
40	4.0
41	4.1
42	4.2
43	4.3
44	4.4
45	4.5
46	4.6
47	4.7
48	4.8
49	4.9
50	5.0

Glycopyrrolate | 0.2 mg/mL

Weight (kg)	CANINE/FELINE	
	mLs to administer	
	Low end 0.005 mg/kg	High end 0.01 mg/kg
0.5	0.01	0.03
1	0.03	0.05
2	0.05	0.10
3	0.08	0.15
4	0.10	0.20
5	0.13	0.25
6	0.15	0.30
7	0.18	0.35
8	0.20	0.40
9	0.23	0.45
10	0.25	0.50
11	0.28	0.55
12	0.30	0.60
13	0.33	0.65
14	0.35	0.70
15	0.38	0.75
16	0.40	0.80
17	0.43	0.85
18	0.45	0.90
19	0.48	0.95
20	0.50	1.00
21	0.53	1.05
22	0.55	1.10
23	0.58	1.15
24	0.60	1.20
25	0.63	1.25
26	0.65	1.30
27	0.68	1.35
28	0.70	1.40
29	0.73	1.45
30	0.75	1.50
31	0.78	1.55
32	0.80	1.60
33	0.83	1.65
34	0.85	1.70
35	0.88	1.75
36	0.90	1.80
37	0.93	1.85
38	0.95	1.90
39	0.98	1.95
40	1.00	2.00
41	1.03	2.05
42	1.05	2.10
43	1.08	2.15
44	1.10	2.20
45	1.13	2.25
46	1.15	2.30
47	1.18	2.35
48	1.20	2.40
49	1.23	2.45
50	1.25	2.50

Hydromorphone | 2 mg/mL

Weight (kg)	CANINE		FELINE	
	mLs to administer		mLs to administer	
	Low end 0.05 mg/kg	High end 0.2 mg/kg	Low end 0.05 mg/kg	High end 0.1 mg/kg
0.5	0.01	0.05	0.01	0.03
1	0.03	0.10	0.03	0.05
2	0.05	0.20	0.05	0.10
3	0.08	0.30	0.08	0.15
4	0.10	0.40	0.10	0.20
5	0.13	0.50	0.13	0.25
6	0.15	0.60	0.15	0.30
7	0.18	0.70	0.18	0.35
8	0.20	0.80	0.20	0.40
9	0.23	0.90	0.23	0.45
10	0.25	1.00	0.25	0.50
11	0.28	1.10	0.28	0.55
12	0.30	1.20	0.30	0.60
13	0.33	1.30	0.33	0.65
14	0.35	1.40		
15	0.38	1.50		
16	0.40	1.60		
17	0.43	1.70		
18	0.45	1.80		
19	0.48	1.90		
20	0.50	2.00		
21	0.53	2.10		
22	0.55	2.20		
23	0.58	2.30		
24	0.60	2.40		
25	0.63	2.50		
26	0.65	2.60		
27	0.68	2.70		
28	0.70	2.80		
29	0.73	2.90		
30	0.75	3.00		
31	0.78	3.10		
32	0.80	3.20		
33	0.83	3.30		
34	0.85	3.40		
35	0.88	3.50		
36	0.90	3.60		
37	0.93	3.70		
38	0.95	3.80		
39	0.98	3.90		
40	1.00	4.00		
41	1.03	4.10		
42	1.05	4.20		
43	1.08	4.30		
44	1.10	4.40		
45	1.13	4.50		
46	1.15	4.60		
47	1.18	4.70		
48	1.20	4.80		
49	1.23	4.90		
50	1.25	5.00		

Ketamine

100 mg/mL
(For stressed/fractious canines)

Weight (kg)	CANINE	
	mLs to administer	
	1 mg/kg	2 mg/kg
0.5	0.005	0.01
1	0.01	0.02
2	0.02	0.04
3	0.03	0.06
4	0.04	0.08
5	0.05	0.10
6	0.06	0.12
7	0.07	0.14
8	0.08	0.16
9	0.09	0.18
10	0.10	0.20
11	0.11	0.22
12	0.12	0.24
13	0.13	0.26
14	0.14	0.28
15	0.15	0.30
16	0.16	0.32
17	0.17	0.34
18	0.18	0.36
19	0.19	0.38
20	0.20	0.40
21	0.21	0.42
22	0.22	0.44
23	0.23	0.46
24	0.24	0.48
25	0.25	0.50
26	0.26	0.52
27	0.27	0.54
28	0.28	0.56
29	0.29	0.58
30	0.30	0.60
31	0.31	0.62
32	0.32	0.64
33	0.33	0.66
34	0.34	0.68
35	0.35	0.70
36	0.36	0.72
37	0.37	0.74
38	0.38	0.76
39	0.39	0.78
40	0.40	0.80
41	0.41	0.82
42	0.42	0.84
43	0.43	0.86
44	0.44	0.88
45	0.45	0.90
46	0.46	0.92
47	0.47	0.94
48	0.48	0.96
49	0.49	0.98
50	0.50	1.00

In combination with dexmedetomidine and butorphanol

Lidocaine Bolus

20 mg/mL
(For cardiac arrhythmias)

Weight (kg)	CANINE		FELINE
	mLs to administer		mLs to administer
	Low end 2 mg/kg	High end 4 mg/kg	High end 0.2 mg/kg
0.5	0.05	0.10	0.01
1	0.10	0.20	0.01
2	0.20	0.40	0.02
3	0.30	0.60	0.03
4	0.40	0.80	0.04
5	0.50	1.00	0.05
6	0.60	1.20	0.06
7	0.70	1.40	0.07
8	0.80	1.60	0.08
9	0.90	1.80	0.09
10	1.00	2.00	0.10
11	1.10	2.20	0.11
12	1.20	2.40	0.12
13	1.30	2.60	0.13
14	1.40	2.80	
15	1.50	3.00	
16	1.60	3.20	
17	1.70	3.40	
18	1.80	3.60	
19	1.90	3.80	
20	2.00	4.00	
21	2.10	4.20	
22	2.20	4.40	
23	2.30	4.60	
24	2.40	4.80	
25	2.50	5.00	
26	2.60	5.20	
27	2.70	5.40	
28	2.80	5.60	
29	2.90	5.80	
30	3.00	6.00	
31	3.10	6.20	
32	3.20	6.40	
33	3.30	6.60	
34	3.40	6.80	
35	3.50	7.00	
36	3.60	7.20	
37	3.70	7.40	
38	3.80	7.60	
39	3.90	7.80	
40	4.00	8.00	
41	4.10	8.20	
42	4.20	8.40	
43	4.30	8.60	
44	4.40	8.80	
45	4.50	9.00	
46	4.60	9.20	
47	4.70	9.40	
48	4.80	9.60	
49	4.90	9.80	
50	5.00	10.00	

MAXIMUM DOSAGE

Canine:
8 mg/kg

Feline:
1 mg/kg

Administer slowly over 1 – 2 minutes

Lidocaine | 20 mg/mL (For local anesthesia)

Weight (kg)	CANINE		FELINE	
	mLs to administer		mLs to administer	
	Low end 1 mg/kg	High end 4 mg/kg	Low end 1 mg/kg	High end 2 mg/kg
0.5	0.03	0.10	0.03	0.05
1	0.05	0.20	0.05	0.10
2	0.10	0.40	0.10	0.20
3	0.15	0.60	0.15	0.30
4	0.20	0.80	0.20	0.40
5	0.25	1.00	0.25	0.50
6	0.30	1.20	0.30	0.60
7	0.35	1.40	0.35	0.70
8	0.40	1.60	0.40	0.80
9	0.45	1.80	0.45	0.90
10	0.50	2.00	0.50	1.00
11	0.55	2.20	0.55	1.10
12	0.60	2.40	0.60	1.20
13	0.65	2.60	0.65	1.30
14	0.70	2.80		
15	0.75	3.00		
16	0.80	3.20		
17	0.85	3.40		
18	0.90	3.60		
19	0.95	3.80		
20	1.00	4.00		
21	1.05	4.20		
22	1.10	4.40		
23	1.15	4.60		
24	1.20	4.80		
25	1.25	5.00		
26	1.30	5.20		
27	1.35	5.40		
28	1.40	5.60		
29	1.45	5.80		
30	1.50	6.00		
31	1.55	6.20		
32	1.60	6.40		
33	1.65	6.60		
34	1.70	6.80		
35	1.75	7.00		
36	1.80	7.20		
37	1.85	7.40		
38	1.90	7.60		
39	1.95	7.80		
40	2.00	8.00		
41	2.05	8.20		
42	2.10	8.40		
43	2.15	8.60		
44	2.20	8.80		
45	2.25	9.00		
46	2.30	9.20		
47	2.35	9.40		
48	2.40	9.60		
49	2.45	9.80		
50	2.50	10.00		

MAXIMUM DOSAGE

Canine:
10 mg/kg

Feline:
5 mg/kg

LOCAL INJECTION GUIDELINES

Canine:
0.5 - 1.0 mL per site

Feline:
0.2 - 0.3 mL per site

Dilute with sterile water if more volume is needed

Meloxicam | 5 mg/mL

Weight (kg)	CANINE mLs to administer 0.2 mg/kg	FELINE mLs to administer 0.3 mg/kg
0.5	0.005	0.025
1	0.01	0.05
2	0.02	0.1
3	0.03	0.15
4	0.04	0.2
5	0.05	0.25
6	0.06	0.3
7	0.07	0.35
8	0.08	0.4
9	0.09	0.45
10	0.01	0.5
11	0.11	0.55
12	0.12	0.6
13	0.13	0.65
14	0.14	0.7
15	0.15	0.75
16	0.16	0.8
17	0.17	0.85
18	0.18	0.9
19	0.19	0.95
20	0.2	1
21	0.21	1.05
22	0.22	1.1
23	0.23	1.15
24	0.24	1.2
25	0.25	1.25
26	0.26	1.3
27	0.27	1.35
28	0.28	1.4
29	0.29	1.45
30	0.3	1.5
31	0.31	1.55
32	0.32	1.6
33	0.33	1.65
34	0.34	1.7
35	0.35	1.75
36	0.36	1.8
37	0.37	1.85
38	0.38	1.9
39	0.39	1.95
40	0.4	2
41	0.41	2.05
42	0.42	2.1
43	0.43	2.15
44	0.44	2.2
45	0.45	2.25
46	0.46	2.3
47	0.47	2.35
48	0.48	2.4
49	0.49	2.45
50	0.5	2.5

Methadone | 10mg/mL

Weight (kg)	CANINE/FELINE	
	mLs to administer	
	Low end (0.1 mg/kg)	High end (0.5 mg/kg)
0.5	0.005	0.025
1	0.01	0.05
2	0.02	0.10
3	0.03	0.15
4	0.04	0.20
5	0.05	0.25
6	0.06	0.30
7	0.07	0.35
8	0.08	0.40
9	0.09	0.45
10	0.10	0.50
11	0.11	0.55
12	0.12	0.60
13	0.13	0.65
14	0.14	0.70
15	0.15	0.75
16	0.16	0.80
17	0.17	0.85
18	0.18	0.90
19	0.19	0.95
20	0.20	1.00
21	0.21	1.05
22	0.22	1.10
23	0.23	1.15
24	0.24	1.20
25	0.25	1.25
26	0.26	1.30
27	0.27	1.35
28	0.28	1.40
29	0.29	1.45
30	0.30	1.50
31	0.31	1.55
32	0.32	1.60
33	0.33	1.65
34	0.34	1.70
35	0.35	1.75
36	0.36	1.80
37	0.37	1.85
38	0.38	1.90
39	0.39	1.95
40	0.40	2.00
41	0.41	2.05
42	0.42	2.10
43	0.43	2.15
44	0.44	2.20
45	0.45	2.25
46	0.46	2.30
47	0.47	2.35
48	0.48	2.40
49	0.49	2.45
50	0.50	2.50

Midazolam | 1 mg/mL

Weight (kg)	CANINE/FELINE	
	mLs to administer	
	Low end 0.1 mg/kg	High end 0.3 mg/kg
0.5	0.05	0.15
1	0.10	0.30
2	0.20	0.60
3	0.30	0.90
4	0.40	1.20
5	0.50	1.50
6	0.60	1.80
7	0.70	2.10
8	0.80	2.40
9	0.90	2.70
10	1.00	3.00
11	1.10	3.30
12	1.20	3.60
13	1.30	3.90
14	1.40	4.20
15	1.50	4.50
16	1.60	4.80
17	1.70	5.10
18	1.80	5.40
19	1.90	5.70
20	2.00	6.00
21	2.10	6.30
22	2.20	6.60
23	2.30	6.90
24	2.40	7.20
25	2.50	7.50
26	2.60	7.80
27	2.70	8.10
28	2.80	8.40
29	2.90	8.70
30	3.00	9.00
31	3.10	9.30
32	3.20	9.60
33	3.30	9.90
34	3.40	10.20
35	3.50	10.50
36	3.60	10.80
37	3.70	11.10
38	3.80	11.40
39	3.90	11.70
40	4.00	12.00
41	4.10	12.30
42	4.20	12.60
43	4.30	12.90
44	4.40	13.20
45	4.50	13.50
46	4.60	13.80
47	4.70	14.10
48	4.80	14.40
49	4.90	14.70
50	5.00	15.00

Midazolam | 5 mg/mL

Weight (kg)	CANINE/FELINE	
	mLs to administer	
	Low end 0.1 mg/kg	High end 0.3 mg/kg
0.5	0.01	0.03
1	0.02	0.06
2	0.04	0.12
3	0.06	0.18
4	0.08	0.24
5	0.10	0.30
6	0.12	0.36
7	0.14	0.42
8	0.16	0.48
9	0.18	0.54
10	0.20	0.60
11	0.22	0.66
12	0.24	0.72
13	0.26	0.78
14	0.28	0.84
15	0.30	0.90
16	0.32	0.96
17	0.34	1.02
18	0.36	1.08
19	0.38	1.14
20	0.40	1.20
21	0.42	1.26
22	0.44	1.32
23	0.46	1.38
24	0.48	1.44
25	0.50	1.50
26	0.52	1.56
27	0.54	1.62
28	0.56	1.68
29	0.58	1.74
30	0.60	1.80
31	0.62	1.86
32	0.64	1.92
33	0.66	1.98
34	0.68	2.04
35	0.70	2.10
36	0.72	2.16
37	0.74	2.22
38	0.76	2.28
39	0.78	2.34
40	0.80	2.40
41	0.82	2.46
42	0.84	2.52
43	0.86	2.58
44	0.88	2.64
45	0.90	2.70
46	0.92	2.76
47	0.94	2.82
48	0.96	2.88
49	0.98	2.94
50	1.00	3.00

Naloxone | 0.4 mg/mL

Weight (kg)	CANINE/FELINE mLs to administer 0.04 mg/kg Repeat every hour if needed
0.5	0.05
1	0.1
2	0.2
3	0.3
4	0.4
5	0.5
6	0.6
7	0.7
8	0.8
9	0.9
10	1.0
11	1.1
12	1.2
13	1.3
14	1.4
15	1.5
16	1.6
17	1.7
18	1.8
19	1.9
20	2.0
21	2.1
22	2.2
23	2.3
24	2.4
25	2.5
26	2.6
27	2.7
28	2.8
29	2.9
30	3.0
31	3.1
32	3.2
33	3.3
34	3.4
35	3.5
36	3.6
37	3.7
38	3.8
39	3.9
40	4.0
41	4.1
42	4.2
43	4.3
44	4.4
45	4.5
46	4.6
47	4.7
48	4.8
49	4.9
50	5.0

Propofol | 10 mg/mL

Weight (kg)	CANINE/FELINE	
	mLs to administer	
	Low end 1 mg/kg	High end 8 mg/kg
0.5	0.05	0.40
1	0.10	0.80
2	0.20	1.60
3	0.30	2.40
4	0.40	3.20
5	0.50	4.00
6	0.60	4.80
7	0.70	5.60
8	0.80	6.40
9	0.90	7.20
10	1.00	8.00
11	1.10	8.80
12	1.20	9.60
13	1.30	10.40
14	1.40	11.20
15	1.50	12.00
16	1.60	12.80
17	1.70	13.60
18	1.80	14.40
19	1.90	15.20
20	2.00	16.00
21	2.10	16.80
22	2.20	17.60
23	2.30	18.40
24	2.40	19.20
25	2.50	20.00
26	2.60	20.80
27	2.70	21.60
28	2.80	22.40
29	2.90	23.20
30	3.00	24.00
31	3.10	24.80
32	3.20	25.60
33	3.30	26.40
34	3.40	27.20
35	3.50	28.00
36	3.60	28.80
37	3.70	29.60
38	3.80	30.40
39	3.90	31.20
40	4.00	32.00
41	4.10	32.80
42	4.20	33.60
43	4.30	34.40
44	4.40	35.20
45	4.50	36.00
46	4.60	36.80
47	4.70	37.60
48	4.80	38.40
49	4.90	39.20
50	5.00	40.00

SEE DOSING INSTRUCTIONS IN TEXT
Administer only to effect

Robenacoxib | 20 mg/mL

Weight (kg)	FELINE mLs to administer 2 mg/kg
0.5	0.05
1	0.10
2	0.20
3	0.30
4	0.40
5	0.50
6	0.60
7	0.70
8	0.80
9	0.90
10	1.00
11	1.10
12	1.20
13	1.30

Tiletamine/Zolazepan | 100 mg/mL

Weight (kg)	CANINE/FELINE		
	mLs to administer		
	1 mg/kg	2 mg/kg	4 mg/kg
0.5	0.01	0.01	0.02
1	0.01	0.02	0.04
2	0.02	0.04	0.08
3	0.03	0.06	0.12
4	0.04	0.08	0.16
5	0.05	0.10	0.20
6	0.06	0.12	0.24
7	0.07	0.14	0.28
8	0.08	0.16	0.32
9	0.09	0.18	0.36
10	0.10	0.20	0.40
11	0.11	0.22	0.44
12	0.12	0.24	0.48
13	0.13	0.26	0.52
14	0.14	0.28	0.56
15	0.15	0.30	0.60
16	0.16	0.32	0.64
17	0.17	0.34	0.68
18	0.18	0.36	0.72
19	0.19	0.38	0.76
20	0.20	0.40	0.80
21	0.21	0.42	0.84
22	0.22	0.44	0.88
23	0.23	0.46	0.92
24	0.24	0.48	0.96
25	0.25	0.50	1.00
26	0.26	0.52	1.04
27	0.27	0.54	1.08
28	0.28	0.56	1.12
29	0.29	0.58	1.16
30	0.30	0.60	1.20
31	0.31	0.62	1.24
32	0.32	0.64	1.28
33	0.33	0.66	1.32
34	0.34	0.68	1.36
35	0.35	0.70	1.40
36	0.36	0.72	1.44
37	0.37	0.74	1.48
38	0.38	0.76	1.52
39	0.39	0.78	1.56
40	0.40	0.80	1.60
41	0.41	0.82	1.64
42	0.42	0.84	1.68
43	0.43	0.86	1.72
44	0.44	0.88	1.76
45	0.45	0.90	1.80
46	0.46	0.92	1.84
47	0.47	0.94	1.88
48	0.48	0.96	1.92
49	0.49	0.98	1.96
50	0.50	1.00	2.00

DOSAGE
1–4 mg/kg IM for stressed/fractious canines

DOSAGE
1–2 mg/kg IV for surgical induction

References and suggested reading for *Appendix*:

1. Dodelet-Devillers et al. *Assessment of stability of ketamine-xylazine preparations with or without acepromazine using high performance liquid chromatography-mass spectrometry.* Can J Vet Res. Jan 2016;80(1): 86-89.
2. Taylor BJ, Orr SA, Chapman JL, et al. *Beyond-use dating of extemporaneously compounded ketamine, acepromazine,and xylazine: safety, stability, and efficacy over time.* J Am Assoc Lab Anim Sci. Nov 2009:48(6)718-726.
3. Kwiatkowski JL, Johnson CE, Wagner DS. *Extended stability of intravenous acetaminophen in syringes and opened vials.* Am J Health Syst Pharm. 2012 Nov 2012;69(22):1999-2001.
4. U.S. Pharmacopeial Convention (USP). General Chapter 797. www.usp.org/. Accessed February 15, 2017.
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