

Mews Flash: Update on Cat Anesthesia and Analgesia

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Cat Facts

- Often nervous or fractious
 - Increased circulating catecholamines = Increased dose of anesthetic drugs required
- Small body size
 - May be difficult to dose, to fit to monitoring & anesthetic equipment & to keep warm
- Species-specific drug metabolism
 - May not metabolize drugs the same as dogs do (eg, NSAIDs)
- Species-specific response to drugs
 - May respond differently than dogs do (eg, opioids)

These differences add to the fact that cats are at higher risk than dogs for anesthesia-related deaths (risk factor of 0.11% vs 0.05%, respectively, in healthy patients; Brodbelt Vet J. 2009;182(2):152-61).

Anesthesia

Anesthesia can be divided into 4 separate (but continuous) and equally important phases: Preanesthesia, induction, maintenance and recovery.

Preanesthesia

As with other species, appropriate diagnostics and stabilization should occur prior to anesthesia and premedications should be administered to improve the safety of anesthesia by allowing a decrease in the dosages of induction and maintenance drugs and by providing preemptive analgesia.

Preoperative drugs or drug classes and key points:

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| Opioids | Analgesia, reversible, minimal adverse effects |
| Alpha-2 Agonists | Analgesia, reversible, titratable sedation; increased cardiac work |
| Acepromazine | Light to moderate sedation, long duration; not reversible |
| Benzodiazepines | Very safe but not much sedation |

Cat specific information on premedications

- Full opioid agonists (bind to mu and kappa) receptors provide the most profound analgesia but are more likely to cause excitement in cats than in other species. This class of opioids may be used alone for premedication in some dogs but is almost always combined with a sedative in cats.
- Buprenorphine and butorphanol are unlikely to cause excitement but also don't provide analgesia as profound as that provided by the full agonists.
- Butorphanol only lasts about 90 minutes in the cat (Lascelles BD, Roberston SA. AJVR 2004;65(8):1085-1089); buprenorphine lasts 4-8 hours (Steagall PV, et al. J Vet Intern Med. 2014;28(3):762-70).
- Transmucosally administered buprenorphine (this is just the regular buprenorphine applied on the oral mucosa at the standard dose) is a great way to allow owners to provide analgesia for cats at home. Buprenorphine serum concentration after administration by this route was once thought to be equal to serum concentration after IV administration but this was because of sampling. In that study, blood from the jugular vein was analyzed for drug concentration. If a drug is administered for absorption from the oral mucosa, the highest concentration is in the jugular vein (Hedges AR, et al. J Vet Pharm Therap 2014;37(2):145-150). So this route is still good, just not as brilliant as we thought it was. **TIP:** Increase the dose for OTM administration to 0.03-0.05 mg/kg BID-TID.
- Opioids (primarily full agonists) can cause hyperthermia in cats (Posner LP, et al. VAA 2010;37(1):35-43). The hyperthermia is usually mild and self-limiting but body temperature should be monitored postoperatively and any cat that seems agitated in recovery should be checked for hyperthermia.

- Simbadol is buprenorphine in a higher concentration than regular buprenorphine that is FDA-approved for cats. It is labeled for subcutaneous administration (regular buprenorphine is very poorly absorbed after SQ administration) that provides analgesia for 24-hours. It is a DEA Class III drug, just like regular buprenorphine (which is not FDA-approved in animals).
- Dexmedetomidine (specifically Dexdomitor) is one of the few drugs FDA-approved for use in cats. This is one of my favorite drugs – provides sedation AND analgesia and the effects are reversible!

Induction

Induction should occur rapidly & smoothly with drugs dosed 'to effect'.

Induction Drugs and Key Points

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| Propofol | ADV: Easy to titrate to effect and cleared by multiple routes; DISADV: Dose-dependent cardiovascular & respiratory depression. |
| Alfaxalone | Similar to propofol for both advantages and disadvantages. Can be administered IM but volume is large. |
| Ketamine | ADV: Minimal to no change in cardiovascular or respiratory function in patients with healthy hearts; DISADV: Cleared in part unchanged by the kidney – especially in cats. |
| Telazol | Similar to ketamine/benzodiazepine; very potent. |
| Etomidate | ADV: No cardiovascular changes – safest drug for patients with cardiovascular disease; DISADV: Causes muscle tremors, dysphoria, vocalization if sedation isn't adequate. |
| Inhalants | Not ideal for use as a routine induction drug. Causes dose-dependent cardiovascular and respiratory depression. |

Cat specific information on induction drugs

- Propofol may cause Heinz bodies with repeat administration (meaning repeated over several days) and was once thought to be a limiting factor for propofol. However, the same thing happens with repeat dosages of ketamine (Bley CR, et al. JAVMA 2007;231(9):1347-53). Turns out it is probably just a cat response, maybe not so much a propofol problem.
- Propofol can be safely used in cats with hepatic lipidosis (Posner LP, et al. JAVMA 2008;232(12):1841-3), even though propofol itself is a lipid.
- The preservative in propofol (Propoflo28) is NOT toxic to cats (Taylor PM, et al. J Feline Med Surg 2012;14(8):516-26). This type of propofol is preferred to the old propofol because the preservative allows the bottle to be used for 28 days after opening whereas the old propofol without a preservative could only be used for 6 hours after opening. This propofol CAN BE USED IN CATS! It isn't FDA approve in cats, but most drugs aren't ☹.
- Alfaxalone is labeled for IM administration in cats in some countries outside the US. A low dose (0.5-1.0 mg/kg) combined with an opioid is appropriate for sedation in geriatric or compromised cats (not very sedating in healthy cats) but the IM label dose (10 mg/kg) is a HUGE volume and can cause dramatic hyperreactivity with prolonged recovery (Grubb et al. J Fel Med Surg 2013;15(10):858-865).
- Inhalant induction (mask or chamber induction) is a risk factor for anesthesia-related death and should NOT be the routine method of anesthesia induction (Brodbelt Vet J. 2009;182(2):152-61).

After induction comes intubation. Cat specific information on intubation:

- Intubate carefully.
- Apply a drop of lidocaine on each arytenoid. Cats are more prone than dogs to laryngospasm. The lidocaine reduces the likelihood of laryngospasm. Alternatively, or additionally, titrate a small dose of induction drug – laryngospasm is often related to inadequate anesthetic depth for intubation.
- Inserting an endotracheal tube was a risk factor for anesthesia-related death in cats (Brodbelt Vet J. 2009;182(2):152-61) – but it isn't the tube that is a risk factor, it is poor intubation technique that is a risk factor.
- Disconnect patients from breathing systems before repositioning them – especially cats. The twisting of

the tube in the trachea as the patient is repositioned can cause tracheal damage.

- Don't use a rigid mouth gag for intubation (or for dentistry, or anything else) in cats. These mouth gags cause excessive opening of the mouth which can cause occlusion of the maxillary artery, which is the main source of blood supply to the retina and brain in cats (Martin-Flores M, et al. Vet J 2014;200:60-64). Occlusion of this artery secondary to mouth gag use has been linked to blindness and neurologic dysfunction, which was profound enough to warrant euthanasia in some cats (Stiles J, et al. Vet J 2012; 2012;193(2): 367-73).

Maintenance

Maintenance is not only about anesthetic drug delivery but also about analgesia, monitoring and support.

- As with other species, inhalant anesthetic drugs are commonly used for procedures lasting > 30 mins.
 - Isoflurane, sevoflurane, desflurane
 - Easily cleared from the body, minimal metabolism, easy to change anesthetic depth
 - Dose-dependent cardiovascular and respiratory depression
- Injectable drugs are also commonly used in cats for short procedures. These are often administered IM since really small cat veins can make IV injection difficult. Common protocols include:
 - Ketamine + an opioid + an alpha-2 agonist
 - Telazol + an opioid + an alpha-2 agonist

Analgesia

To decrease the dose-dependent impact on cardiovascular and respiratory function, keep the inhalant DOSE LOW! The best way to do that is to use analgesia. Analgesic drugs/techniques commonly used during the maintenance phase of anesthesia include:

- Boluses of opioids or alpha-2 agonists
- Local anesthetic blocks
- Constant rate infusions (opioids, ketamine, alpha-2 agonists, combinations; lidocaine is controversial in cats)

Monitoring

- Anesthesia causes depression of ALL organ systems
 - CNS, cardiovascular & respiratory depression most immediately life threatening so our monitoring is focused on these systems
- Monitor the basics
 - MM color, CRT, jaw tone, body temperature, etc...
- Use electronic monitoring equipment

Monitors and cat specific concerns

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| ECG | Can be hard to detect the small complexes. Increase the amplitude. |
| Blood pressure - oscillometric | Can be hard to get a reading. Blood pressure is the same as in the dog, but the really small vessels are hard to detect. |
| Blood pressure - Doppler | Usually the best way to get a blood pressure reading in really small patients. Systolic blood pressure as determined by the Doppler may be closer to MAP than SAP in cats (Caulkett et al. Vet Surg 1998;27:370-377). For patient safety, assume it as systolic and carefully assess the cat. Treat if necessary. |
| SpO ₂ | Great! But cats very likely to get cold (small body size) and hypothermia-mediated vasoconstriction decreases likelihood of getting a reading. |
| ET CO ₂ | Sidestream may provide average rather than true end-tidal reading in patients with small tidal volumes and high respiratory rate |

Support – if it isn't right – FIX IT!

- Hypotension (MAP < 60 mmHg)
 - Decrease the vaporizer setting.
 - Give a bolus of crystalloids or colloids
 - Utilize positive inotropic drugs.
 - CAT TIP: Be careful with fluids!
 - Administration of fluids was listed as a risk factor for anesthesia-related death (Brodbeck Vet J. 2009;182(2):152-61). But it isn't the fluid that kill cats – it's the amount of fluid that kills cats!
 - Calculate – and administer – the volume of fluids very carefully. Best to draw up the desired amount in a syringe or small chamber (like a buretrol) vs trying to deliver a small volume from a fluid bag.
- Hypoventilation (ETCO₂ > 45-50 mmHg)
 - Occurs more often than we think
 - Has many causes
 - Breathe for the patient!
- Hypothermia
 - Prevent: decrease anesthesia time, etc...
 - ACTIVELY WARM the patient!!!
 - CAT TIP: Cats are very likely to be hypothermic. Hypothermia can lead to:
 - PROLONGED RECOVERY from anesthesia
 - Impaired metabolism (adds to prolonged recovery)
 - Decreased need for anesthetics
 - Immune system depression
 - Coagulation dysfunction, sludging of blood
 - Decreased cardiac contractility, arrhythmias
 - Increased oxygen consumption (shivering)
 - Respiratory impairment
 - Etc...
 - Be aggressive with warming
 - Prevention easier than rewarming
 - Temperature starts dropping AT INDUCTION
 - Forced air blanket most effective
 - Warm patient's environment
 - Surgery room, recovery cage, etc...
 - Use warm fluids, warm scrub solution (and MINIMAL scrub solution), warm lavage solution, etc...
 - MINIMIZE ANESTHESIA TIME

Recovery

- Most unexpected anesthetic deaths occur in recovery.
- Monitoring and support should continue as long as the patient needs that level of care.
- MAKE SURE CATS ARE WARM!!
- Pain and dysphoria needs to be addressed. A rough recovery is NOT acceptable. Think pain first and re-dose the opioids – but take the body temperature first and make sure the cat is not hypothermic. May need to include a sedative. Alpha-2 agonists are excellent because they provide both sedation AND analgesia.
- NSAIDs in cats? Cats have pain of inflammation! But we do have to dose NSAIDs carefully. Both meloxicam and robenacoxib are approved for preoperative use in cats. Cats seem to be more likely than dogs to suffer NSAID-related adverse effects so administration of NSAIDs postoperatively, after turning off the inhalant so hypotension is unlikely, is also a good option.

Common Anesthetic Protocol EXAMPLES

Healthy cat (American Society of Anesthesiologists [ASA] I-II) inhalant drug based protocol

- Preanesthesia: 0.1mg/kg hydromorphone OR 0.2-0.3 mg/kg morphine IM PLUS 10-15 microg/kg of dexmedetomidine OR 0.03-0.05 mg/kg acepromazine IM. Start NSAIDs now if appropriate.
- Induction: Any of the injectable drugs are good choices
- Maintenance: Isoflurane, sevoflurane or desflurane administered to effect; provide analgesia appropriate for the procedure (local blocks, CRI, etc...); monitor and support
- Recovery: Sedation and analgesia as indicated by the procedure and patient. Commonly, administer another bolus of the opioid used for premedication +/- sedation if the patient is stressed or excited. Administer Simbadol and dispense transmucosal buprenorphine. Start or continue NSAIDs.

Healthy cat (ASA I-II) injectable drug based protocol

- Preanesthesia: Any opioid at the appropriate dose PLUS 10 microg/kg dexmedetomidine PLUS 5-10 mg/kg ketamine all combined in the same syringe and administered IM. Start NSAIDs now if appropriate. Telazol protocols are also commonly used.
- Induction: The ketamine (or Telazol) in the combination listed above is the induction drug, if the patient is deeply sedated but not asleep, a bolus of any of the injectable drugs are good choices
- Maintenance: The ketamine (or Telazol) in the combination listed above can be the maintenance drug for SHORT (eg, castration) procedures. If the anesthesia is inadequate or the procedure is prolonged, more ketamine can be administered IM or IV or an inhalant can be used. Isoflurane, sevoflurane or desflurane administered to effect; provide analgesia appropriate for the procedure (local blocks, CRI, etc...); monitor and support
- Recovery: Sedation and analgesia as indicated by the procedure and patient. Commonly, administer another bolus of the opioid used for premedication +/- sedation if the patient is stressed or excited. Start or continue NSAIDs +/- Simbadol and/or transmucosal buprenorphine.
- This is the protocol commonly called 'kitty magic' and a common formula is 0.1-0.2 MLS/4.5 kg cat of each of these drugs: dexmedetomidine, buprenorphine and ketamine. The drugs are combined in the same syringe and administered IM (decrease the dose by about 25% for IV administration). Use the low-end dosing for deep sedation and the high end for anesthesia.

ASA III cat

- Preanesthesia: 0.1 mg/kg hydromorphone OR 0.1-0.2 mg/kg morphine IM. Opioids aren't particularly sedating in cats so probably need to add 0.2 mg/kg diazepam or midazolam (if very calm cat), 1-5 microg/kg dexmedetomidine or 0.01-0.02 mg/kg acepromazine IM (if anxious or stressed but not in cats with hepatic disease – may not be able to metabolize drug) or 0.5-1.0 mg/kg alfaxalone (if really sick cat)
- Induction: Any of the injectable drugs are good choices. Propofol or alfaxalone would be ideal because they can most easily be titrated 'to effect'.
- Maintenance: Isoflurane, sevoflurane or desflurane administered to effect; provide analgesia appropriate for the procedure (local blocks, CRI, etc...); monitor and support
- Recovery: Sedation and analgesia as indicated by the procedure and patient. Commonly, administer another bolus of the opioid used for premedication +/- sedation if the patient is stressed or excited. Continue support and monitoring for at least several hours. Start NSAIDs, if appropriate. Also Simbadol and/or transmucosal buprenorphine, if appropriate.

ASA IV-V cat

- Preanesthesia: The patient should have a catheter in place and should be on IV fluids as part of stabilization. Administer 2-5 microg/kg fentanyl through the catheter. IF NO CATHETER, try 0.2 mg/kg butorphanol (not great analgesia but decent sedation in sick cats) PLUS 0.2 mg/kg diazepam or midazolam.
- Induction: Any of the injectable drugs are good choices and should be administered within 1-5 minutes of the premed fentanyl bolus. Can also administer 0.2 mg/kg diazepam or midazolam to decrease dose of induction

drug. Some patients are sick enough that they can be intubated with the opioid and benzodiazepine alone. If not, propofol or alfaxalone would be ideal because they can most easily be titrated 'to effect'.

- Maintenance: Isoflurane, sevoflurane or desflurane administered to effect – LOW DOSE; provide analgesia appropriate for the procedure (local blocks, CRI, etc...); monitor and support
- Recovery: Analgesia as indicated by the procedure and patient. Continue support and monitoring for as long as it takes to insure that the patient is stable. NSAIDs are generally not used in this category of patients because of the potential for NSAIDs to exacerbate disease effects (eg, renal compromise, GI ulceration, etc...). Simbadol or transmucosal buprenorphine may be appropriate.

NOTE ON TRAMADOL: Tramadol appears to be more effective in cats than dogs but it TASTES BAD. I prefer to use buprenorphine for both acute and chronic pain since we have more proof of efficacy with buprenorphine.