

## Anesthesia for Geriatric and Compromised Feline Patients

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Lecture Notes

- Outline
  - Anesthetic risk in cats
  - Patient preparation
  - Equipment
  - Monitoring
  - Common comorbidities and anesthetic relevance
- Risk
  - Cats carry higher anesthetic risk than dogs
  - What can we do to reduce this risk?
    - Be knowledgeable about patient factors that increase the risk of complications
      - Patient factors that may increase risk include
        - Temperament
          - Poor temperament can make it difficult to perform a complete physical exam prior to anesthesia
          - Relative drug overdose may occur in attempts to overcome excitement
          - Post-operative monitoring may be limited by staff safety concerns
          - Anxiety/fear can lead to increased sympathetic stimulation
        - Obesity
          - Potential problems include inaccurate drug dosing, inappropriate drug deposition or distribution, prolonged recovery and respiratory compromise
          - Recommendations: Pre-oxygenate, rapid induction and airway capture, lower mg/kg dose or dose on ideal body weight
        - Size
          - Small patient size is associated with increased risk of mortality in cats
        - Coexisting disease
- Patient preparation
  - Pre-anesthetic preparation is important for both stable and critically ill patients
  - Consider need for diagnostic tests, fluids, transfusions, additional medication or medication withdrawal prior to anesthesia
- Equipment considerations
  - Have available a wide variety of endotracheal tube sizes and stylets (to be used CAUTIOUSLY)
  - Laryngoscopes
  - Rebreathing and non-rebreathing circuits (for animals <3 kg)
  - Check all equipment prior to **every** use
  - Warming equipment

- Fluid pumps recommended (drip rates are imprecise)
- Monitoring
  - The importance of anesthetic monitoring increases in patients with decreased physiologic reserve
  - Diligent monitoring helps us quickly recognize common anesthetic complications and decrease morbidity/mortality
  - ECG, blood pressure (Doppler, oscillometric, invasive/direct), capnograph, pulse oximeter, temperature, mucous membrane color, CRT, blood glucose
  - Monitor the equipment in addition to the patient
- Common comorbidities and anesthetic relevance
  - Renal
  - Respiratory
  - Cardiovascular

### Renal Disease

- Pathophysiology relevant to anesthesia
  - Kidneys receive 20-25% of the cardiac output
  - Kidneys are important for maintaining normal fluid and electrolyte balance, red blood cell numbers, calcium homeostasis and drug/toxin elimination
  - Decreased renal function impairs all of these processes
    - Anemia
    - Hyperkalemia
    - Uremia/azotemia
      - Causes CNS depression (can be additive with anesthetic agents), may also alter BBB function (affecting drug action)
    - Metabolic acidosis
    - Nausea
    - Hypertension
    - Volume sensitivity
- Specific anesthetic concerns
  - Anesthesia decreases renal blood flow due to systemic hypotension and renal vasoconstriction
    - Systemic hypotension
      - Secondary to vasodilation as well as decreased cardiac contractility and cardiac output
      - Maintain MAP 70-80 mmHg
        - Fluids, inotropes and vasopressors
          - Phenylephrine, norepinephrine, dobutamine, dopamine
    - Renal vasoconstriction
      - Anesthesia and the stress of surgery cause the release of aldosterone, renin, vasopressin and catecholamines, all of which decrease GFR, renal blood flow, and urine production
  - Avoid volume overload
    - AAHA standard for healthy anesthetized cat = 3 mL/kg/hr
    - Isotonic crystalloid such as LRS or Plasmalyte
    - May need to ↑ or ↓ depending on pre-existing dehydration/azotemia or inability to excrete fluids, respectively

- Anemia
  - Decreases oxygen delivery (kidneys have high oxygen demand)
  - Consider transfusions for patients with PCV < 18%
- Hyperkalemia
  - Postpone elective anesthesia if  $K^+ > 6$  mmol/L
- Impact on drug choices
  - Stress/pain/fear cause catecholamine release, leading to a decrease in renal blood flow
    - Use appropriate premedication to minimize stress
  - Nearly all drugs are eliminated by the kidneys, but most are in inactive forms
    - Exceptions
      - Tiletamine and ketamine are excreted in active form in cats
  - Potential prolonged recovery due to impaired drug excretion
    - Keep in mind the issues of nephrotoxicity and delayed clearance are different. The fact that a drug may have delayed clearance in a patient with decreased renal function does not mean the drug is nephrotoxic. A downward dose adjustment or extension of the dosing interval may allow you to use the drug safely.
  - Pre-medication
    - Opioids and benzodiazepines are great choices
      - Minimal effect on cardiovascular function
      - Alfaxalone IM is very helpful for more agitated or aggressive animals
      - Consider anti-emetics (e.g. maropitant)
        - Vomiting exacerbates fluid loss
        - Cats may be nauseated by the combined effects of azotemia and anesthetic/analgesic drugs
    - Avoid
      - NSAIDs
      - Alpha-2 agonists (dexmedetomidine) are controversial due to the associated decrease in cardiac output
      - Acepromazine is controversial due to vasodilation decreasing systemic blood pressure, but it may also cause renal vasodilation
  - Induction agents

Drug	Pro	Con
Propofol	Fast onset, short duration	May cause hypotension
Alfaxalone	Slightly less cardiodepressive than propofol	May cause hypotension, longer duration than propofol
Etomidate	Minimal change in HR and BP	May cause hemolysis --> hemoglobinuria
Ketamine	Provides analgesia, can also help maintain cardiac output in sympathetically intact individuals	Active metabolite is excreted, so keep doses low, can cause catecholamine release (leading to renal vasoconstriction)

- Special monitoring, patient prep and/or interventions
  - Consider early admission for pre-anesthetic fluid therapy and continue into recovery
    - Correct dehydration, optimize fluid status and reduce azotemia prior to anesthesia
    - Pre-op fluids can help put the patient in a mild state of diuresis, with the goal of maintaining urine output
  - Control chronic hypertension prior to non-emergent procedures
    - Withhold enalapril/benazepril prior to anesthesia
      - These drugs may exacerbate hypotension
  - Physical exam
    - Hydration
    - Heart rate and rhythm
    - Mentation
  - Minimum database
    - Blood gas: pH
    - Electrolytes: K<sup>+</sup>, Na<sup>+</sup>, Ca<sup>2+</sup>
    - ECG
    - BUN, creatinine
  - Monitor urine output
    - 0.5-2 mL/kg/hr
    - < 0.5 mL/kg/hr increases risk of AKI
  - Avoid hypotension. Ideally, obtain an awake, unstressed, unседated blood pressure prior to the procedure and maintain MAP close to individual cat's normal

### Respiratory Dysfunction

- Pathophysiology relevant to anesthesia
  - Feline lower airway disease
    - Term for heterogenous group of conditions
      - Also called feline asthma, bronchial asthma, allergic asthma, bronchial disease, and chronic bronchitis
  - Airway narrowing results from
    - Cellular infiltrates
    - Mucus secretion
    - Airway edema
  - Clinical signs include coughing and wheezing
  - Acute bronchoconstriction can exacerbate airflow limitation, leading to severe and life-threatening clinical signs
- Specific anesthetic concerns
  - Stress of handling and hospital environment can precipitate a respiratory crisis
  - Cats may become hypoxemic, leading to decreased oxygen delivery to vital organs
  - Hypoxemia during anesthesia can lead to prolonged recovery due to CNS depression
- Impact on drug choices
  - Minimize stress
    - Consider pre-hospital sedation with gabapentin (100 mg/cat)
    - Use pre-medication to facilitate restraint and IV catheter placement
      - Butorphanol is less respiratory depressive than mu agonist opioids, but are mu agonists acceptable if significant pain is anticipated

- Combine opioids with benzodiazepine, dexmedetomidine, alfaxalone or acepromazine where appropriate
- Consider terbutaline 0.01 mg/kg IM/SQ
  - Beta receptor agonist
  - Bronchodilator
  - Reduces complications during bronchoscopy/bronchoalveolar lavage
  - 15-30 minute onset
- Volatile inhalants are bronchodilators
- Induction agents

Drug	Pro	Con
Propofol	<ul style="list-style-type: none"> <li>- Fast onset to allow rapid airway capture</li> <li>- Decreases wheezing in both asthmatic and non-asthmatic humans (unknown in cats)</li> </ul>	<ul style="list-style-type: none"> <li>- Causes respiratory depression (related to dose and administration speed)</li> </ul>
Alfaxalone	<ul style="list-style-type: none"> <li>- Slightly less cardiodepressive than Propofol</li> </ul>	<ul style="list-style-type: none"> <li>- Causes respiratory depression</li> <li>- Slower onset and longer duration than Propofol</li> </ul>
Ketamine	<ul style="list-style-type: none"> <li>- Bronchodilator</li> <li>- Analgesic</li> </ul>	<ul style="list-style-type: none"> <li>- Slower onset than propofol</li> <li>- Not reversible</li> </ul>

- Special monitoring, patient prep and/or interventions
  - Maintain patient on asthma medications up to/including the morning of anesthesia
  - Pre-oxygenate (all) patients and continue to provide flow-by O<sub>2</sub> in recovery
    - 3-5 minutes with face mask (preferable) or flow-by if patient will tolerate
    - Appropriate sedation will promote cooperation, but weigh the risk/benefit in stressed animals
  - Ensure adequate depth of anesthesia ***before*** attempting to intubate
  - Consider a supraglottic airway device if procedure permits
  - Be prepared with additional induction agent and intubation supplies should the patient require re-intubation on recovery

### Hypertrophic Cardiomyopathy

- Pathophysiology relevant to anesthesia
  - Common in apparently healthy cats
    - Shelter cats > 6 months old in U.K.
    - Murmur present - 40.8%
    - HCM - 14.7%
    - Congenital heart disease - 0.5%

- Other cardiomyopathy - 0.1%
- Arrhythmias may have more predictive value than murmurs
- Characterized by diffuse or segmental hypertrophy of the left ventricular myocardium with development of cardiomyofiber disarray
- Left ventricular outflow tract obstruction can develop 2<sup>o</sup> to systolic anterior motion of the mitral valve
- Left atrial dilation and mitral valve regurgitation are also common
- Consequences of these phenotypic changes
  - Heart consumes more oxygen because myocardium is performing more work
  - Prone to arrhythmias
  - Sensitive to fluid challenges or overload
- Specific anesthetic concerns
  - In hospital setting, ↑ stress level is reflected by clinically significant ↑ in HR, RR and BP. These changes may cause complications in cats with cardiomyopathy.
  - Development of a safe anesthetic protocol requires an understanding of the type and severity of the patient's cardiovascular disease
    - Sometimes this information is not known at the time of sedation/anesthesia because of the need for sedation to facilitate diagnostics (physical exam, echocardiography, thoracic radiography, blood collection) or the client declines
  - Tachyarrhythmias
    - Especially ventricular
    - Can increase myocardial work and decrease cardiac filling leading to poor cardiac output
    - Pre-medicate to avoid stress-induced tachyarrhythmia
  - Hypoxemia and ischemic myocardial injury
    - Pre-oxygenate
  - Volume overload
    - Consider fluid rate < 3 mL/kg/hr
- Impact on drug choices
  - No single drug provides the optimal balance of sedation/analgesia without cardiac depression
  - Preferred pre-medication
    - Opioids
    - Benzodiazepines
    - Consider gabapentin for pre-hospital sedation
  - Opioids
    - Minimal negative cardiorespiratory effects
    - Can cause vagally-mediated bradycardia
      - Less problematic in cats than dogs due to their propensity for high sympathetic tone in hospital and opioid-induced excitation
    - Minimal sedative effect
    - Consider antimuscarinic agents (atropine, glycopyrrolate) only if opioids cause severe bradycardia that is affecting cardiac output, as we generally want to avoid high heart rates in cats with HCM
  - Benzodiazepines (midazolam, diazepam)
    - Minimal cardiorespiratory suppression
    - Centrally-mediated muscle relaxation and anxiolysis
    - Paradoxical responses are possible

- Acepromazine (avoid)
  - Sedative and anxiolytic effects but no analgesia
  - Decreases systemic vascular resistance due to  $\alpha_1$  antagonism
    - Decreased afterload leads to increased pressure gradient across the left ventricular outflow tract
      - Can predispose to worsened outflow tract obstruction
    - Hypotension can decrease coronary perfusion, leading to myocardial ischemia
- Dexmedetomidine (controversial)
  - Excellent sedation and analgesia
  - Significant cardiovascular depression
  - Decrease in heart rate (may be beneficial)
    - Medetomidine decreased outflow tract obstruction in cats with hypertrophic obstructive cardiomyopathy and SAM (Lamont *et al.* JAVMA 2002)
- Induction agents

Drug	Pro	Con
Alfaxalone	<ul style="list-style-type: none"> <li>- Less cardiodepressive than Propofol</li> <li>- Safe for IM administration in compromised, fractious animals, providing excellent sedation</li> </ul>	<ul style="list-style-type: none"> <li>- May cause hypotension</li> <li>- Longer duration than propofol</li> </ul>
Etomidate	<ul style="list-style-type: none"> <li>- Minimal change in HR, BP or cardiac output</li> </ul>	<ul style="list-style-type: none"> <li>- May cause excitement (best combined with opioid and/or benzodiazepine)</li> </ul>
Propofol	<ul style="list-style-type: none"> <li>- Does not stimulate myocardium</li> <li>- Decreases myocardial O<sub>2</sub> consumption</li> </ul>	<ul style="list-style-type: none"> <li>- May cause hypotension</li> <li>- Decreases coronary blood flow</li> </ul>
Ketamine	<ul style="list-style-type: none"> <li>- Analgesia</li> </ul>	<ul style="list-style-type: none"> <li>- Catecholamine release causes <math>\uparrow</math> HR, BP and myocardial O<sub>2</sub> consumption. Most profound at 5-10 mg/kg</li> <li>- Low doses <i>may</i> be acceptable (1-2 mg/kg), but weigh risk if other agents are available</li> </ul>

- Special monitoring, patient prep and/or interventions
  - Hypotension
    - Consider fluid bolus dependent upon volume status and assessment of cardiac size and function

- Dopamine superior to phenylephrine at improving cardiac output in cats with HCM (Wiese A, AJVR 2012)
- Drugs to withhold
  - Beta blockers (atenolol)
    - Used for heart rate control, increase diastolic filling time
    - Exacerbate bradycardia under anesthesia
    - Consider halving or withholding morning dose depending on stability of chronic rate control
- Anticoagulants (aspirin, clopidogrel)
  - Administered to cats at risk of thromboembolic events
  - Withhold 7 days prior to invasive surgical procedures

### Resources

- Journal of Feline Medicine and Surgery
  - <https://journals.sagepub.com/home/jfm>
- AAFP Guidelines
  - <https://catvets.com/guidelines/practice-guidelines/anesthesia-guidelines>
- Feline Medicine Sedation for Cats with Cardiovascular Disease (A. Wiese)
  - <https://todaysveterinarypractice.com/feline-medicine-sedation-for-cats-with-cardiovascular-disease/>
- Colorado Pain scoring for cats
  - <http://csu-cvmb.colostate.edu/Documents/anesthesia-pain-management-pain-score-feline.pdf>