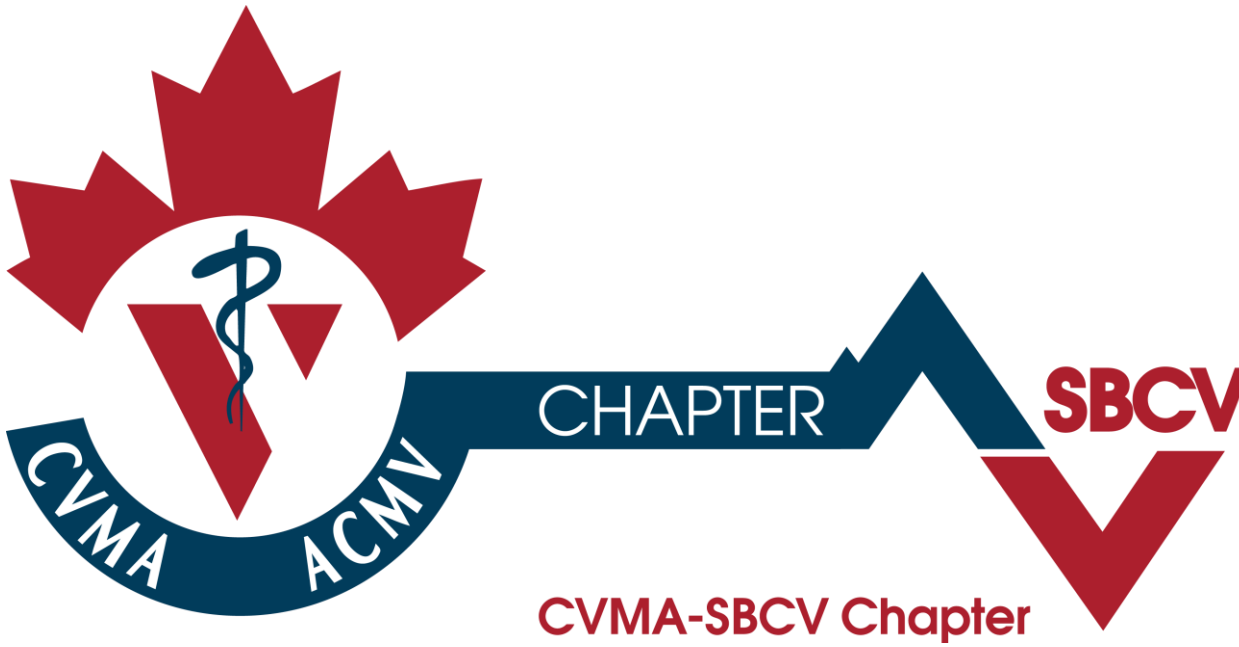
Patient risks & preparation for a successful sedation or anesthetic event

Odette O, DVM, DACVAA

ACVAA
FOUNDED IN 1975

American College of Veterinary Anesthesia and Analgesia

Acknowledgements



Objectives:

- Sedation versus general anesthetic: what are the considerations?
- What are the risks (literally) of sedation &/or anesthesia?
- Optimize patient preparation prior to sedation/anesthesia whenever possible!
- Be prepared: Who? What? Where? When? Why?
- Troubleshooting a rough recovery…

Sedation vs Anesthesia

- ↑ risk of mortality seen with increasing ASA status
  - Importance of patient evaluation and stabilization PRIOR to commencement of procedure
  - Identify risk factors and monitor carefully
- Largest proportion of deaths in post-procedure period
  - Continued patient monitoring & support vital

Why Sedate?

- Diagnostic Imaging
  - Radiographs, CT, U/S
- Biopsies
- Small wound repair
- Bandaging

Benefits of Sedation

- Convenience
- Faster recovery times
  - Reversible options
- ↓ $
- ↑ margin of safety

General Anesthesia

- Reversible unconsciousness
- Amnesia
- Analgesia
- Muscle relaxation
- Perform a procedure
  - w/o suffering
  - Safety
    - Patient
    - Veterinary Care Provider(s)

General Anesthesia: ASA Risk

ASA CLASSIFICATION	DESCRIPTION	EXAMPLES
I	Normal, healthy patient	Healthy young patient presenting for spay/neuter
II	Patient with mild systemic disease	Cutaneous mass removal; uncomplicated orthopedic procedures, well-controlled diabetic or managed asthmatic requiring procedure that may or may not be related to disease
III	Patient with severe systemic disease	Cardiac dysfunction, early renal disease, poorly controlled diabetes mellitus (patient may require procedure possibly unrelated to disease itself), mild anemia
IV	Patient with severe disease that is a constant threat to life	Hemoabdomen, sepsis, intestinal foreign body with potential for bowel rupture, hypovolemic shock, anemia
V	Moribund patient who is not expected to survive	Massive trauma, hemoabdomen with cardiac abnormalities, multi-organ dysfunction, GI

General Anesthesia Definitions

- Multi-modal approach
  - DO NOT "mask down" (canine/feline) patients!
    - Patient & occupational safety concerns
- MAC (minimum alveolar concentration)

= amount of inhalant needed for 50% of patients non-responsive to supramaximal stimulus

  - Isoflurane: ≈ 1.3% canine, ≈1.6% feline
  - Sevoflurane: ≈ 2.3% canine, ≈ 3% feline
  - allows estimate of amount inhalant required
    - factors: procedure, patient pre-med response, inhalant

General Anesthesia: Stages

Stage	Observational signs	Physiologic Parameters
I	Voluntary Mvt, excitement, struggle	Tachycardia, hypertension, breath-holding, U/F, catecholamine release
II	Delerium/Involuntary Mvt, excitement	Tachycardia, hypertension, hyperventilation, continued catechol rel
III (light, medium, deep)	Surgical anesthesia	↓ HR, RR, muscle relaxation
IV	Extreme (CNS) depression	Shock → Death

GA: Advantages

- Minimal calculations needed
- Inhalant effective in every species we encounter
- Predictable effects on most patients, with MAC similar across many species
- Recovery
  - negligible metabolism required
  - hepatic/renal status of patient does not change recovery time from inhalant
  - recovery via alveolar ventilation
  - not prolonged despite length of procedure

GA: Disadvantages

- Potential for adverse effects:
  - hypoventilation, hypoxemia, hypotension, hypothermia
  - Note: some of these side effects may also be seen with procedural sedation, but likely ↓ magnitude
- Additional $$$
  - IVC, fluid tx, ETT, consumables ($ETCO_2$, soda lime, etc.)
- Procedural sedation: may or may not be safer, but lower $...

Anesthesia-Related Mortality

DOGS

- 5/10 000 (0.05%)
- ↑ age
- nonelective sx
- Pre-anes PE not performed/recorded
- Hct outside RR
- Underweight
  - 15x >

CATS

- 11/10 000 (0.11%)
- ↑ age
- nonelective sx
- SpO2 not monitored/recorded
- ↑ body weight
  - NOTE: not BCS

from Mathews et al. JAVMA 2017

The Data: GA M&M

- The risk of death: the Confidential Enquiry into Perioperative Small Animal Fatalities
  - DC Brodbelt et al. Veterinary Anaesthesia and Analgesia, 2008, 35, 365–373
    - 117 (GP & referral) practices in the UK, 98 036 dogs, 79 178 cats
    - Sedation AND General Anesthesia

MORTALITY (%)	ASA I, II (Healthy)	ASA III-V (Sick)	Post-op mortality rate
Dogs	0.05	1.33	47
Cats	0.11	1.4	61

The Data: GA M&M

- Canine anaesthetic death in Spain: a multicenter prospective cohort study of 2012 cases
  - L Gil & J I Redondo Veterinary Anaesthesia and Analgesia, 2013, 40, e57–e67
- Risk of anaesthetic mortality in dogs and cats: an observational cohort study of 3546 cases
  - C Bille et al. Veterinary Anaesthesia and Analgesia, 2012, 39, 59–68

MORTALITY (%)	Spain (n = 2012)	France (n = 3546)
Overall	1.29	1.35
ASA I-II	0.33	0.12
ASA III-V	4.06	4.77

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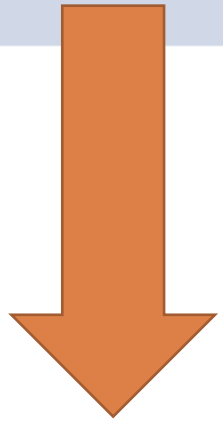


Breaking it down… (Bille et al.)

Main factor related to anesthetic death = poor health status!

- ↑ anesthetic risk with ASA classification
- > ASA III: 4.77%
  - ASA III: 2.9%
  - ASA IV: 7.58%
  - ASA V: 17.33%

What can WE do better?

- Bille et al., VAA (2012 & 2014)
- 1. Emphasize pre-anesthetic medical mgt whenever possible
  - Improve patient's ASA status BEFORE
- 2. Anesthetic Plan:
  - premedication
  - IV induction agent
  - inhalant maintenance
- Monitor & Record: pre, during, post!
- When? Recovery period

Preparing the Patient

- Depends on a number of factors:
  - patient history
  - current health status
  - procedure

- Complete history + thorough PE key to success, plan lab data based on this info!

Preparing the Patient

- Individualize an assessment and workup plan
  - Is the patient low risk or high?
    - Presenting complaint?
    - Co-morbitities?
  - Do specific modifications to the sedation/anesthetic plan need to be formulated?
    - Staffing
    - Equipment

Patient Prep: Fear Free Approach

- www.fearfreepets.com
- Benefits:
  - Increased standard of patient care
  - Staff satisfaction
  - Business model

Patient Prep: Minimum data

- ALL patients:
- QATS = quick assessment tests
  - PCV/TP
  - BG
  - Azo
- Plus,
  - TPR
  - BP
  - Pain score

Patient Prep: Considerations

- History
  - PU/PD → (CBC)/Chem/UA
- Presenting complaint
  - Pale mm, petichiae → CBC
- Physical Exam
  - Cardiac arrhythmia, pulse defs → ECG
- Procedure
  - Hemorrhage risk → current PCV/TP

Preparing the patient

- Patient set-up list
  - ALWAYS have a full GA setup ready!
  - Does patient need:
    - IVC?
    - Fluid tx ahead or after?
    - Which monitors?
  - Drugs/fluids/top-ups calculated
    - MAXIMUM doses

Fasting the Patient

- Pre-procedure fasting is recommended for scheduled elective cases
  - Fasting duration depends on:
    - gastric emptying time
    - type of diet
  - These factors can vary widely from one individual to another
  - Bottom line: No absolute time that decreases the risk of regurgitation and aspiration!

Fasting the Patient

- Commonly recommended fasting times (adults):
  - water NOT withheld
  - 6-12h for solid food
    - dry diets → higher gastric volumes
      - longer to empty the stomach (vs canned diet)
- Abbreviated fasting times (2-4h, wet food)
  - puppies/kittens
  - diabetics

Fasting the Patient

- Savvas et al., 2009
  - 10 hour fast may not have any advantages over a 3 hour fast in preventing gastro-esophageal reflux in patients fed moist food
  - prolonged fasting ↓ gastric content pH (↑acidity) → ↓ esophageal sphincter pressure, potentially ↑ incidence of gastro-esophageal reflux (GER)
- Savvas et al., 2016
- Viskjer & Sjöström, 2017

Regurgitation: Dogs

- Regurgitation and possible esophagitis leading to esophageal stricture or aspiration of gastric contents followed by pneumonia can be potentially fatal consequences of anesthesia
- A large, multi-center retrospective study found the range of post-anesthetic aspiration pneumonia of 0.04-0.26%
  - depending on the institution
  - overall incidence of 1.7 out of 1000 anesthetic events (Ovbey et. al, 2014)

Regurgitation: Dogs

Three anesthetic-specific events relating to the development of aspiration pneumonia:

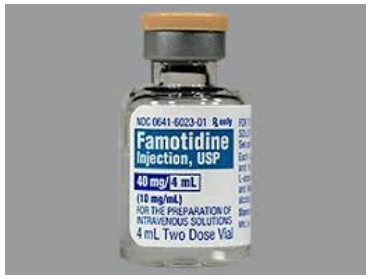
1. hydromorphone given IV specifically at induction
2. use of CRIs containing morphine, lidocaine, ketamine, fentanyl, and/or propfol during anesthesia
3. use of an inotrope or vasopressor during the anesthetic episode

Regurgitation: Dogs

- The risk of developing this type of post-anesthetic complication should not be used as a reason to withhold appropriate analgesia, but instead as a discussion point between veterinary caregiver and client about potential dangers of anesthesia as well as risks and benefits of providing appropriate analgesia!

Regurgitation: Dogs

- Can pharmacological intervention help prevent these anesthetic sequelae?
- Current standards do not recommend preoperative use of gastric acid reducing medications and gastrointestinal motility stimulants in human patients without significant risk for aspiration
  - Clinical efficacy of using these agents for this purpose is low



Regurgitation: Dogs

- In a canine population, a loading dose of 1 mg/kg of metoclopramide followed by a 1 mg/kg/h CRI reduced the risk of developing GER only by 54% in the 52 dogs undergoing orthopedic surgery (Wilson et. al, 2006)
  - Lower dose of this drug was NOT found to be effective
- Cerenia (maropitant) prevents vomiting in premedicated dogs and cats BUT
  - NO statistically significant reduction in the development of GER in dogs (Johnson, 2013)
  - Nausea and injection pain (Martin-Flores, et al., 2016)

Preparing: Logistics

- Checklists are key!
- Pre-use anesthetic machine check
  - For BOTH sedation and anesthesia events
- Location?
  - Can affect amount of sedation required
- Monitors?
  - Which ones?
  - When?

Preparing: equipment

Pre-use Anesthesia Machine Check:

- When? BEFORE EVERY USE!
- Adequate inhalant in vaporizer?
- Pop-off (APL) valve is OPEN?
- Oxygen is connected? Adequate supply available?
- Scavenge is connected?
- Reservoir (rebreathing) bag and breathing system in place?

Preparing: equipment

Pre-use Anesthesia Machine Pressure Check: How?

1. Close pop-off valve
2. Occlude patient end of breathing system
3. Turn on oxygen flowmeter to fill reservoir bag to a pressure of 20 cmH2O
4. Turn off oxygen flowmeter, only “hand-tight”, do NOT overtighten!
5. Hold for 10 seconds

Note: if there is a small leak, turn oxygen flowmeter back on to a maximum of 300 mL O2/min

If leak is greater than 300 mL O2/min, it is unacceptable → troubleshoot or get assistance!

6. Keeping patient end of breathing system occluded, open pop-off valve and squeeze reservoir bag to empty. Watch inspiratory and expiratory unidirectional valves for patency during this time
7. **Remove occlusion from patient end of breathing system LAST!** (This step is done LAST in order to prevent soda lime dust from blowing into patient breathing apparatus)

Recovering the patient

- Recovery plan?
  - Who?
  - What?
  - Where?
  - How?
  - When?

Recovering the Patient: Pain Scores

- Pain Score
  - Which one?
    - *VALIDATED, species-specific*
  - Recommend: Glasgow (short form): canine, feline

- Pain scoring: keys – be consistent!
  - ***Minimum*** times:
    - Baseline
    - Recovery
    - Prior to go home

Recovering the *vocal* patient

Differential Diagnoses?

1. Pain
2. Emergence delirium
3. Dysphoria

Plan?

- Pain meds
- Sedate
- Reverse? probably not…

Recovering the patient

Recovery is a BIG DEAL!

- Statistically the MOST RISKY portion!!
  - Don't minimize supervision & monitoring now
    - Big 3 + T^{o} (see monitoring lecture)
  - IVC should be left in place until patient is awake & stable
  - Extubation?
    - Cats: early! Any "sign of life"
    - Dogs: able to protect their airway: conscious
    - Deflate ETT cuff IMMEDIATELY prior to removing

Key Points for Sleeping Well

- Plan ahead
  - Communicate
  - Calculate
- Prepare accordingly
  - Patient
  - Logistics
    - Staff
    - Equipment
    - Location
    - Time

Questions?

Belly Up to the Bar:

Sedation and Pre-Anesthetic Medications

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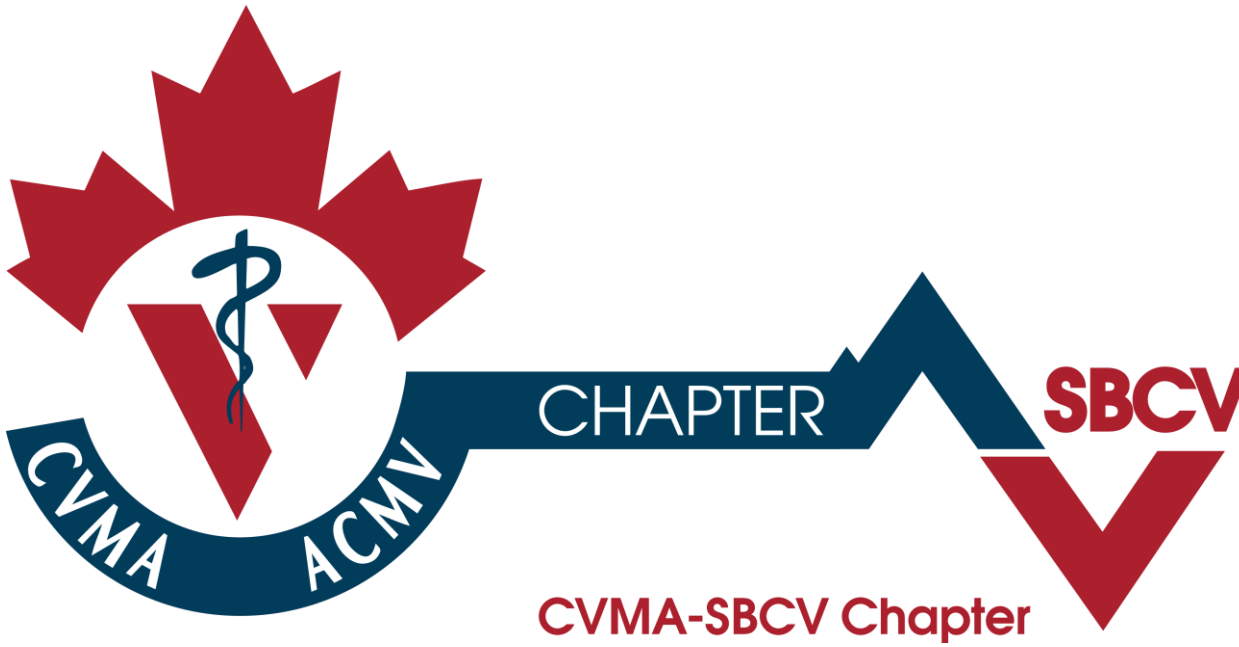

Objectives

- Understand the importance of appropriate sedation/pre-anesthetic medication administration
- Define pre-emptive analgesia and neuroleptanalgesia
- Use a multi-modal approach and know the benefits
- Guide selection of drugs to help manage patients & cases
- AVOID contra-indicated drugs in patients with additional concerns

Why Sedate or Premed?

Sedation

- Convenience
- Faster recovery times
- ↓ $
- ↑ margin of safety
- Safe(er) patient handling

Pre-anesthetic medication "Pre-med"

- ↓ anxiety/stress
- Facilitate handling for IV catheter placement
- ↓ amount of induction agent
- ↓ inhalant needed to perform a procedure
- Pre-emptive analgesia!

Pre-emptive Analgesia

= the provision of analgesic medication(s) before the pain stimulus occurs

- provides more consistent plane of general anesthesia
- less overall analgesic use

Neuroleptanalgesia

- Recommended approach for pre-anesthetic medication

= sedative + opioid

- synergistic effects
  - use less of both drugs with greater effect
  - higher safety margin, lower side effects
  - ↓ stress and provides analgesia

The Sedation/Pre-med Plan: Opioid + Sedative

Opioid

- Pure mu agonists
  - Morphine, hydromorphone, fentanyl
- Others
  - Butorphanol
  - Buprenorphine

Sedative

- Phenothiazine
  - Acepromazine
- Alpha-2 agonist
  - Dexmedetomidine
- Benzodiazepines
  - Midazolam
  - Diazepam

Sedation/Pre-medication

- Administer IM or IV
  - Avoid SQ
    - Many drugs not well taken up
  - IV premeds
    - be mindful not to cause too much stress or risk injury placing an IV catheter
    - reduce the sedative dose
      - more profound and rapid effects
- ALL patients should be monitored closely given
  - respiratory depression, bradycardia, hypotension, vomiting

The Sedatives

- Phenothiazines
  - acepromazine
- Alpha (α)-2 agonists
  - dexmedetomidine
- Benzodiazepines
  - midazolam
  - diazepam

Acepromazine

- Phenothiazine
- MOA: Alpha-1 antagonist, dopamine (D2) antagonist
- Moderate sedation, no analgesia
  - Large margin of safety
  - reliable
- Long acting (4-12h), not reversible
- Hypotension seen
  - Responds well to fluid bolus(es)

Acepromazine

- Additional information:
  - anti-emetic effects
  - anti-histaminic
  - ↓ MAC inhalant ≈ 30%
- Dose: 0.01-0.05 mg/kg
  - (in combination)

Acepromazine

- Caution/Contraindications
  - AVOID in patients who will not tolerate hypotension or fluid boluses
    - renal disease
    - hepatic disease
    - cardiac valvular regurgitative disease
    - risk of hemorrhage and/or coagulation/clotting disorders
  - Residual sedation

Dexmedetomidine

- MoA: Alpha(α)-2 Agonist
- Profound sedation
- Short acting
- Reversible (atipamazole)
  - ONLY IF DONE! DONE! DONE!
- MILD analgesia provided
  - use additional agents for if procedure is painful and/or to ↓ dexmed dose
- Dose: 1-5 mcg/kg IV, 5-10 mcg/kg IM

Dexmedetomidine

- CV effects
  - Initial profound peripheral vasoconstriction, reflex bradycardia
  - ↓ cardiac output up to 30-50% (even at low doses)
  - AVOID anti-cholinergic drugs (atropine, glyco) while hypertensive & bradycardic → ↓ cardiac index
    - If patient stable, benign neglect or partial reversal
  - First- or second-degree atrioventricular block can occur

Dexmedetomidine

- Caution/Contraindications
  - AVOID in patients who will not tolerate:
    - bradycardia, hypertension, or decreased cardiac output/poor perfusion
    - i.e. renal disease, hepatic disease, cardiac disease
    - NOTE: ↑ blood pressure via intense vasoconstriction ≠ good perfusion!
    - Hyperglycemia (i.e. diabetics)
  - Not recommended in pregnant animals

Benzodiazepines

- MoA: enhances inhibitory neurotransmitter GABA at the GABAa receptor
  - Sedation and muscle relaxation
  - No analgesia
- Minimal CV effects
- Balanced plan
- Reversible (flumazenil)
  - Caution reversing patients with a seizure history in case you need to re-administer this class of drugs

Benzodiazepines

- Midazolam
  - water-soluble formulation
  - IM or IV @ 0.1 – 0.4 mg/kg
- Diazepam
  - propylene glycol-containing solution for solubility
  - IV only @ 0.1 – 0.4 mg/kg

Benzodiazepines

- Caution: LEAST predictable sedative
  - Young, healthy dogs and cats → disinhibited
    - excitement and/or aggression
    - select your patient & dose carefully!
- Controlled substance
- No analgesia
- Flumazenil (reversal) $$$

The Opioids

- Pure mu (μ) agonists
  - morphine, hydromorphone, oxymorphone, methadone, fentanyl, fentanil-friends
- Kappa (κ) agonist, mu (μ) antagonist
  - butorphanol
- Partial mu (μ) agonist
  - buprenorphine

Opioids: Pure Mu Agonists

- MoA: MOR at dorsal horn of SC and brain

- Morphine (4-6h): 0.3-1 mg/kg
- Hydromorphone, oxymorphone (2-4h): 0.05-0.2 mg/kg
- Fentanyl (10-15 min): 2-20 mcg/kg/h
  - fentanil-friends (very short)
- Methadone (2-4h): 0.2-0.5 mg/kg

Opioids: Pure Mu Agonists

- Amongst the most important in our toolbox for pain management!
  - Excellent analgesia
  - Dose-related decrease in other drugs
- Cardiovascular system: minimal effects
- Reversible (competitive, non-selective)
  - Opioid antagonist such as naloxone or naltrexone
  - DoA ≈ 2h
  - Emergencies only!

Opioids: Pure Mu Agonists

Side effects

- Hypoventilation, panting, constipation, vagally-induced bradycardia
- Dysphoria
- Caution: morphine (quick IV) histamine release → hypotension +/- reflex tachycardia
  - AVOID (IV fast) in patients with hypotension, hypovolemia, hemorrhage, mast cell tumor (?)
  - MIMIMIZE risk via IM for your pre-med and/or diluting the morphine and giving it IV ***slow***

Opioids: Butorphanol

- MoA: kappa agonist, mu antagonist
- Short-acting opioid
  - Sedation
    - ≈ 90-120 min
  - ***Mild*** analgesia
    - ≈ 60 min
- Dose: 0.2-0.4 mg/kg
- EXCELLENT choice
  - procedural sedations: radiographs, U/S
  - Brief, minimally painful events

Opioids: Butorphanol

- Ceiling effect
  - Analgesia
  - Respiratory depression
- NOT appropriate for severe pain
  - Orthopedics
  - Abdominal surgeries
  - Major trauma

Opioids: Buprenorphine

- MoA: partial mu agonists, kappa antagonist
- Long-acting drug (4-8h)
- Mild to moderate analgesia
- Dose: 10 – 30 mcg/kg (0.01-0.03 mg/kg)
- SLOW onset of action, ≈30 min
- Route of admin alters onset, duration, and magnitude of analgesia → IV route preferred!
- AVOID SQ*

*Stegall et al., *Pharmacokinetic and pharmacodynamic modelling of intravenous, intramuscular and subcutaneous buprenorphine in conscious cats*. Vet Anaesth Analg. 2013 Jan;40(1):83-95. REGULAR formulation

Opioids: Buprenorphine

- Poorly reversible!
  - Binds the opioid receptor very tightly and only exerts partial effects
  - Reversal with an opioid antagonist (naloxone, naltrexone) or deciding to change over to pure mu agonist will be very difficult
- Cats:
  - Can give oral-transmucosal (OTM) in cats POST-OP
  - alkaline salivary pH ≈ drug pKa
- Dogs:
  - $$$ (large)
  - Mild levels of pain only
  - NO OTM effectiveness

Opioids: Buprenorphine

- Vetergesic Multidose
  - Burprenorphine 0.3 mg/mL, Cats, IM, Ceva Animal Health
- Simbadol™
  - Extended-release formulation 1.8 mg/mL, cats only, 0.24 mg/kg SQ, USA, Zoetis
  - 24h pain relief w each SQ injection
    - May repeat up to 3x
- In Canada:
  - Buprenorphine (human use)
  - Liposomal encapsulation (?)

J. vet. Pharmacol. Therap. doi: 10.1111/jvp.12357

Pharmacokinetics of liposomal encapsulated buprenorphine suspension following subcutaneous administration to cats

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Johnson, R.J., Kerr, C.L., Enouri, S.S., Modi, P., Lascelles, B.D.X., del Castillo, J.R.E. Pharmacokinetics of liposomal encapsulated buprenorphine suspension following subcutaneous administration to cats. *J. vet. Pharmacol. Therap.* doi: 10.1111/jvp.12357.

We investigated the effects of liposome encapsulation at prolonging the systemic exposure of buprenorphine following subcutaneous administration in

Feline Drug-Related Hyperthermia

- Multi-factorial, moderate, self-limiting hyperthermia (106F, 5h)
- Hydromorphone, morphine, butorphanol, buprenorphine, ketamine
- Maximum temperature seems to be inversely proportional to cat temperature at extubation
- NO morbidity resulting from the hyperthermia has been reported

Posner, 2007 & 2010

Premed Adjuncts: Anticholinergics

- Anti-cholinergics
  - Atropine and glycopyrrolate
  - Only “as needed” (PRN)
  - NOT recommended as part of regular protocols
  - Considerations for use:
    - high vagal tone
      - chronic vomiting, brachycephalic
    - pediatric patient
      - neonates are dependent on heart rate instead of contractility to maintain blood pressure

Premed Adjuncts: Anticholinergics

- Glycopyrrolate
  - Longer duration of action (≈ 30 min)
  - Does NOT increase sedation, can't cross BBB
  - 0.005 – 0.01 mg/kg
- Atropine
  - Shorter duration of action (≈ 5-10 min)
  - Used in urgent/emergent situations
  - 0.02 – 0.04 mg/kg

*Anti-cholinergics to mitigate to bradycardia alone seen with dexmedetomidine administration not recommended (Congdon, 2013)

Premed Adjuncts: Maropitant

- Cerenia® (maropitant)
  - Very effective antiemetic
  - NO sig analgesic effects at clinical doses
  - Prevent vomiting associated with pre-meds & PONV
    - Must give 1h prior to pre-meds to achieve these effects
    - Note: prevention of vomiting NOT found to ↓ GER in canines
      - Precautions for passive regurgitation and possible aspiration should still be in plan (Johnson, 2013)
  - 1 mg/kg IV or SQ

Premed Adjuncts: NSAIDS

An anti-inflammatory drug should be a part of ***every*** anesthetic protocol unless there is a specific contra-indication

- Onset time ≈ 1h
- NSAIDs can be given
  - ahead of an anesthetic procedure (i.e. at time of premed)
  - after anesthetic recovery
- Recommend:
  - 2 options/clinic
  - parenteral + oral formulations preferred

Premed Adjuncts: NSAIDS

- Patient blood pressure & volume status must be normalized!
- Concerns:
  - dehydration/hypotension
  - hemorrhage
  - renal dz
- Options:
  - correct ahead of administration
  - reduced dose administration
  - avoid completely

Premed Adjuncts: NSAIDS

- Absolute contra-indications:
  - GI upset and/or ulceration
  - significant renal/hepatic disease
  - clotting/coagulation disorders
  - concurrent use of steroids or another NSAID
  - systemic MCT disease
- AVOID NSAID in these cases!
  - locoregional blocks
  - opioids
  - additional hospitalization

Pre-PreMeds: Fear Free Pets

Many methods ↓ Fear, Anxiety, Stress (FAS)

www.fearfreepets.com

- Trazodone
  - 3-5 (up to 10) mg/kg PO q8h
- Gabapentin
  - 10-20 mg/kg PO q 8h
- Must be administered BEFORE FAS levels high
  - Recommend dosing night before, then morning of drop-off
- Melatonin
  - 0.1 mg/kg
  - (0.5-3 mg/cat, 1-6 mg/dog)

*caution when patients are already on other behavioral mod meds!

Summary

- Nothing in anesthesia and analgesia is absolute, this is as much art as it is science!
- There may be multiple appropriate choices, especially if the patient is healthy
- Goal is to avoid specific CONTRAINDICATIONS when selecting patient protocol whenever possible
- Most anesthetic cases can be performed successfully at your practice
  - Recognize potential areas of concern ahead
  - Proper preparation and planning
- Consult or referral of a case to an Anesthesiologist may also be an option
  - if specific work-up, monitoring, or post-procedure care needed

Questions?

Off to Sleep…

Titrated Sedation & Induction of General Anesthesia

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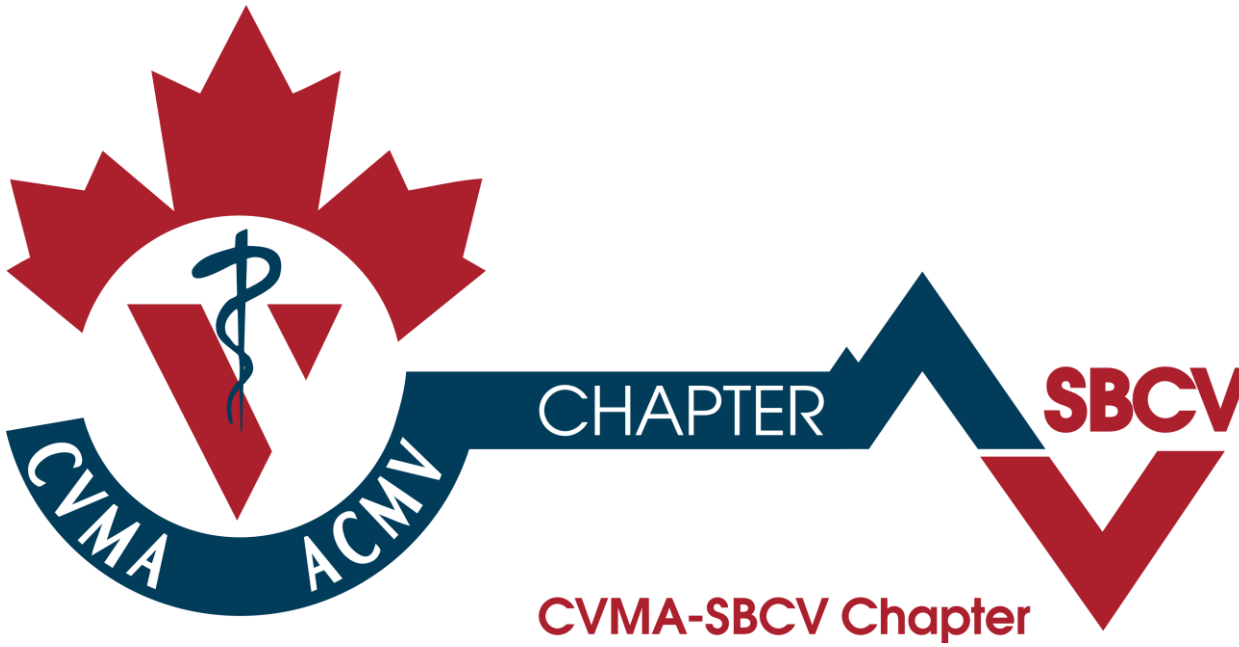
Odette O, DVM, DACVAA

Acknowledgements



Objectives

- Understand why we use induction agents as part of titrated sedation & anesthesia protocols
- Know commonly used induction drugs and their mechanisms of action
- Recognize each drug's effects on major organ systems
- Be familiar with indications and contraindications for use of each induction agent

Titrated Sedation v Anesthesia

- ***Titrated Sedation*** is a state characterized by central depression accompanied by drowsiness and some degree of centrally induced relaxation. The patient is generally unaware of its surroundings but can become aroused and is responsive to noxious stimulation. Sedatives are not recommended by themselves to immobilize a patient during times which painful stimuli are likely to occur.
- ***General anesthesia*** is drug-induced unconsciousness that is characterized by controlled but reversible depression of the CNS and perception. In this state, the patient is not arousable by noxious stimulation. Sensory, motor, and autonomic reflex functions are attenuated to varying degrees, depending upon the specific drug(s) and technique(s) used.

Goals of Titrated Sedation

- Greater control of patient (?)
  - physical vs physiological…
- Muscle relaxation
- Short-lived effects
  - Short procedure time (< 1h total)
- Relatively noncumulative
- Cost-savings

Titrated Sedation Cautions

- IVC!
- Sedation → General Anesthesia
  - Using drugs intended & labelled for ANESTHESIA (not as sedatives!)
  - dose-related resp depression → apnea!
    - ALWAYS BE PREPARED TO INTUBATE & MONITOR CLOSELY!!
  - ↓ABP, ↓ SpO_2
- Noise sensitivity
  - Use as part of a balanced plan (Opioid + sedative 1st)
- Minimal to NO analgesia, NO reversal
- Doses = ¼ to ½ induction dose as boluses (generally)

Titrated Sedation Safety

ALWAYS:

- Oxygen available and administered as flow by
  - Mask +/- diaphragm, HIGH flow rate
- Setup ready to convert to general anesthesia
- Limit procedures to < 1 hr, ideally < 30 min TOTAL
- Monitor & Record!
  - Min: SpO_2, BP, T

Titrated Sedation: Cases

Patients with medical contraindications to commonly used sedatives

- Significant cardiac, renal, hepatic disease
- Short procedures (≤ 20-30 min), limited pain levels
  - FNA
  - Punch biopsy
  - Diagnostic imaging
  - Wound care

Goals of General Anesthesia

- Unconsciousness
- Amnesia
- Analgesia
- Muscle relaxation
- Perform procedure
  - Complex, invasive
  - > 30 min - 1h

Mask/Tank Inductions: AVOID

- ↑↑↑ Staff exposure to inhalant
- ↓↓↓ Ability to monitor patient
- Excitement phase is UGLY
- Deeper plane of anesthesia needed for successful ETT
- BIG MISCONCEPTION that this is a *safer* approach!
- Exception = special species (birds & small mammals)

Why Use Induction Agent?

- Smooth transition from awake to anesthetized
  - I to III
- ↓ amount of inhalant used
- Enables a secure airway
  - Muscle relaxation
  - ETT, NTT, etc.
- These goals are met via use of injectable anesthetic

Pharmacokinetics

How fast will sedation/induction occur?

- Dose of agent
- Route of administration
- Rate of administration
  - Drug factors
    - Lipid solubility, Protein-binding, Molecular weight, Ionization
- Patient factors
  - Premed, acid-base status, serum protein level, -lytes
  - Cardiac output: “vein to brain time”

The *Perfect* Drug

1. Does NOT depend on metabolism for termination of action
2. Provides rapid induction, fast changes in depth, quick recovery
3. Does NOT depress cardiopulmonary function
4. does NOT irritate any tissue
5. ↓ $, stable, nonflammable, nonexplosive
6. does NOT require special equipment for use

What is this MAGICAL agent?

It does not exist! Instead:

- Plan based on patient safety, needs, & logistics
  - Spp, breed, age
  - Physical status
  - Anticipated procedure time
  - Available equipment & personnel
  - Familiarity with technique

Titrated Sedation/GA Agents

Barbiturate Drugs

- thiopental

Non-barbiturate Drugs

- alfaxalone
- dissociative anesthetics
  - ketamine, tiletamine (Telazol)
- etomidate
- propofol & propofol 28

Alfaxalone

Alfaxan®

= alfaxalone + HPCD

- 2-hydroxypropyl-ß-cyclodextrin for solubility
- 10 mL
- 7 d shelf-life (refrigerated)

Alfaxan MultiDose®

= alfaxalone + HPCD + preservatives (ethanol, chlorocresol, benzethonium chloride)

- 10 mL & 20 mL
- 28 d shelf-life (room temp, US only for now)
- Jurox
  - https://www.jurox.com/ca/product/alfaxan

Alfaxalone

- Rapid onset, short-acting
- high therapeutic index (safe)
- No significant analgesia!
- Use as part of a balanced protocol
- INDUCTION agent → always have ETT & monitors ready!
  - Intended and labelled for ANESTHESIA

Alfaxalone

- Classified as a NEUROSTEROID
- Mechanism of Action
  - Drug binding to GABAr increases Cl^- conductance into cell → hyperpolarized post-synaptic membrane → prevents APs & stops impulse transmission
  - Directly enhances GABA-mediated neurodepression at $GABA_A$ receptors
    - Higher doses

Alfaxalone

- *LABELLED* dose
  - Dog ≈ 2 mg/kg
  - Cat ≈ 4 mg/kg
- Significant dose reductions w pre-meds (0.5- 2 mg/kg)
- Benefits
  - Neutral pH (no pain or sloughing)
  - IV or IM administration (NOTE: multidose labelled for IV only!)
  - Good muscle relaxation
  - Non-cumulative

Alfaxalone

Important notes:

- Administer over 60s
  - Top up ¼ dose every 15 sec “to effect”
- Labelled for BOTH dogs & cats
- DOA: 10-25 min (I), top-up q 5-10 min at ¼ dose (TS)
- Noise sensitivity at induction and recovery
  - Recommend use as part of a *balanced* anes plan
  - Alfaxan MultiDose may ppt with midazolam (colleague reports)

Alfaxalone

Major Organ System Effects:

- Respiratory
  - depression, dose-dependent
  - Initial APNEA
- CVS
  - Minimal depression at clinical doses
  - ↑ HR, mild ↓ CO
  - ↓ ABP via vasodilation (↓SVR)
- Fetal depression is dose-dependent

Propofol

Propofol

- Rapinovet™, Diprivan®, etc.
- Dogs and cats
- IV only

PropoFlo™28

- Dogs only
- IV only
- Zoetis
- Induction prior to inhalant (OR) Bolus titrated “sedation”≤ 20 min
- Store at room temp for 28d

Propofol

- Aqueous emulsion
  - Soybean oil, glycerol, egg lecithin (currently on market)
    - Shake well
  - NO preservative → sepsis
    - Discard w/in 6h of opening
  - Painful injection
- Propofol 28 also contains benzyl alcohol and is NOT safe for cats in large quantities
  - NOT labeled for use in cats

Propofol

- Rapid-acting, ultra-short duration
- Relatively noncumulative
- Rapid, complete recovery
- Mechanism of Action
  - Enhances inhibitory effects of GABA at $GABA_A$ receptors
  - Also inhibits N-methyl-D-aspartate (NMDA) receptor
    - minor effect
- NO significant analgesia!

Propofol

- *Labelled* dose
  - Dogs = 4-6.5 mg/kg
  - Cats = 6-8 mg/kg
  - Label use: short-acting anesthetic w rapid onset
    - O_2, airway supplies… be GA ready!
- Significant dose reduction with premeds (1-4 mg/kg)

Important notes:

- Give as a bolus or titrate calc dose over 10-40 s
- DOA < 5 min with single bolus

Propofol

- Benefits:
  - Anticonvulsant
  - Antiemetic
  - Excellent muscle relaxation
- Caution in CATS with daily use!
  - RBC oxidative injury
    - Phenolic compound causes RBC hemolysis with repeated administration and low glucuronide capacity
    - Heinz Body Anemia
  - Rotate use with other induction agents (alfax, ket combo,…)

Propofol

Major Organ System Effects

- Respiratory System
  - Depression, dose- and rate- dependent, apnea
- CVS
  - Little change in HR
  - ↓ABP, ↓CO, ↓SVR
- CNS
  - ↓ CBF, ↓ICP, but ↓MAP too
- Pregnancy: fetal depression, but rapid redistribution and biotransformation

Dissociative Anesthetics

Anesthetic state induced by drugs that interrupt ascending transmission from portions of the brain dealing with conscious and unconscious functions via dissociation of thalamocortic and limbic systems

Dissociative Anesthetics

- Cyclohexamines: ketamine & tiletamine*
  * proprietary formulation Telezol®/Zoletil® (w/zolazepam)
- Highly lipid soluble → "rapid" onset (60-90s)
- IM*, IV, OTM, rectal, nasal, SQ *painful due to acidic pH (3.5)
- Ketalar®
  - Erfa Canada
- Ketamine HCl
  - Sandoz
- Racemic mixture: (+) S-ketamine
  - ↑analgesia, ↑metabolism↓emergence delerium

Ketamine

- Mechanism of action
  - N-methyl-D-aspartate (NMDA) antagonist
    - Prevents glutamate (excitatory nt) from binding
  - Also has affects on Ca+ channel; monoaminergic, and opioid Rs (minor effect)
- Cataleptoid state
  - Eyes open & moving w/o rotation, palpebrals +
  - swallowing reflexes intact
  - ↑ Skeletal muscle tone
    - Minimized with prior use of sedative and/or benzodiazepine

Ketamine

- ANALGESIC!
  - Somatic analgesia
    - Skin and skeletal muscle
  - Dose-dependent – analgesia occurs even at low doses!
    - NOT effective for visceral pain relief
- Important in ***windup*** and ***chronic pain*** tx
  - Brief unless CRI used

Ketamine

Anesthetic Dose Range*

- IM: 5-20 mg/kg
  - Onset time ≈ 10 min
- IV: 2-10 mg/kg
  - Onset time ≈ 45-90 s
- DOA: 10-45 min

*dose varies depending on patient signalment, temperament, and pre-med/ind adjuncts used!

Ketamine

Analgesic Dose Range (IV)

- Loading dose: 0.5-2 mg/kg
- CRI: 2-10 mcg/kg/min
- Setting up a CRI:
  - Syringe-pump
  - Fluid pump: add 120 mg (1.2 mL to 1L bag BES), run at 5 mL/kg/h = 10 mcg/kg/min K. Post-op 2 mL/kg/h = 4 mcg/kg/min
- (-) affects on CVS less common at these doses

Ketamine

Benefits:

- Extremely SAFE!
- Minimal CV & R depression in most patients
- Inhalant (MAC) reduction
  - CV profile improvement
- Effective tool for pain mgt
  - Synergistic w other analgesics
  - Mgt of long-term pain

Ketamine

Organ System Effects (at INDUCTION doses):

- Respiratory
  - Apneustic breathing pattern
    - Breath hold, shallow, irregular
  - ↑ Rf, ↓PaO2
- CVS
  - ↑ HR, ↑ABP, ↑$CMRO_2$, ↓SV
  - May sensitize heart to catecholamine-induced arrhythmias
  - Alone → direct myocardial depression
  - CV stimulation via sympathomimetic effects
  - AVOID induction doses in patients w CV dz
    - including HCM, arrhythmias

Ketamine

- CNS
  - ↑CBF, ↑ABP, ↑ICP, ↓CPP
  - Use with caution ALONE in traumatic brain cases
  - Ketamine-associated seizures
  - But, also neuroprotective…
- Ocular
  - may ↑IOP related to muscle tone

Induction Adjuncts

- These agents are NOT appropriate for use alone, but are commonly used with induction agents for their beneficial effects
- Benzodiazepine Agonists
- Local Anesthetic: Lidocaine

Induction Adjuncts

Benzodiazepines:

- Species differences
  - UNRELIABLE sedative in healthy dogs and cats
  - Excellent in small mammals, swine, birds, neonates, geriatric
- Often combined with
  - Ketamine
  - Propofol
  - Alfaxalone

Induction Adjuncts

Lidocaine:

- Mechanism of action
  - Sodium channel blocker
  - ANALGESIA!
- Routes of administration
  - Topical or IV
- Blunts laryngeal reflexes
- (Loading) dose: 1-2 mg/kg IV slow
  - (+/- CRI at 25-50 mcg/kg/min for analgesia)

Special Inductions:

Opioid-Benzodiazepine:

- VERY debilitated patients
- Minimal CV and respiratory depression
- Provides pre-emptive analgesia
- Both drugs are reversible
- Topical lidocaine helpful
- Select patient CAREFULLY!
- No other injectable agent is used in the protocol

Summary

- Nothing in anesthesia & analgesia is absolute, this is as much art as it is science!
- Multiple appropriate protocol choices exist, especially if the patient is healthy
- Goal: avoid specific CONTRAINDICATIONS when selecting a patient protocol
- Most anesthetic cases can be performed successfully at your practice
  - Recognize potential areas of concern ahead
  - Proper preparation and planning
- Consult with an Anesthesiologist may be considered

Questions?

Stay Safe

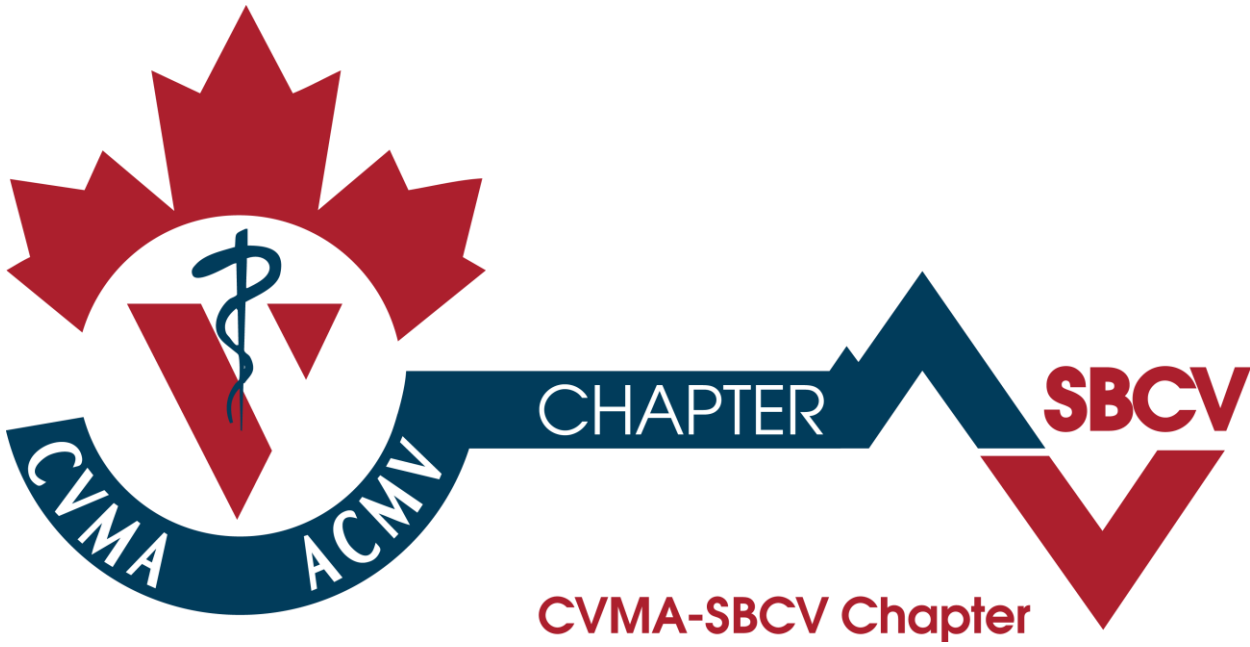
Anesthetic Monitoring & Troubleshooting Common Issues

ACVAA
FOUNDED IN 1975

AMERICAN COLLEGE OF
VETERINARY ANESTHESIA
AND ANALGESIA

Odette O, DVM, DACVAA

Acknowledgements



There are no safe anesthetic agents, there are no safe anesthetic procedures.
There are only safe anesthetists.

—Robert Smith, MD

Objectives

- Recognize the importance of sedation/anesthesia monitoring during and after an event
- Prioritize which monitors to use & what they tell us
- Recognize parameter values that cause concern
- Formulate a framework for managing common anesthetic complications

Goals of Monitoring

- Increase patient safety
- Decrease morbidity and mortality
- Sedation and anesthesia
  - Impossible to avoid cardiovascular and respiratory depression
  - Is it significant?
    - Monitor → respond accordingly
    - Optimize patient status
  - Physiologic changes often requiring support/intervention by veterinary team

Important Resources

- AAHA Anesthesia Monitoring Guidelines 2020
  - https://www.aaha.org/aaha-guidelines/2020-aaha-anesthesia-and-monitoring-guidelines-for-dogs-and-cats/anesthesia-and-monitoring-home/
    - https://www.aaha.org/globalassets/02-guidelines/2020-anesthesia/anesthesia_and_monitoring-guidelines_final.pdf

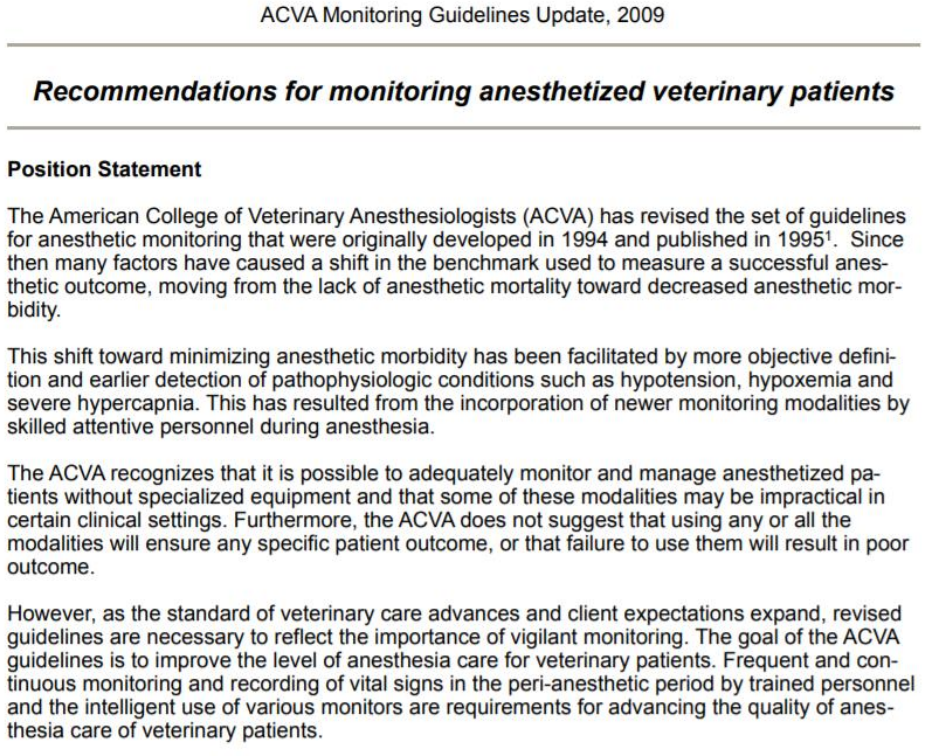

VETERINARY PRACTICE GUIDELINES

2020 AAHA Anesthesia and Monitoring Guidelines for Dogs and Cats*

Tamara Grubb, DVM, PhD, DACVAA†, Jennifer Sager, BS, CVT, VTS (Anesthesia/Analgesia, ECC)†, James S. Gaynor, DVM, MS, DACVAA, DAIPM, CVA, CVPP, Elizabeth Montgomery, DVM, MPH, Judith A. Parker, DVM, DABVP, Heidi Shafford, DVM, PhD, DACVAA, Caitlin Tearney, DVM, DACVAA

Important Resources

- ACVAA SA Monitoring Guidelines
  - https://acvaa.org/veterinarians/guidelines/
  - 2009
  - Update coming soon!



ACVA Monitoring Guidelines Update, 2009

Recommendations for monitoring anesthetized veterinary patients

Position Statement

The American College of Veterinary Anesthesiologists (ACVA) has revised the set of guidelines for anesthetic monitoring that were originally developed in 1994 and published in 1995[1]. Since then many factors have caused a shift in the benchmark used to measure a successful anesthetic outcome, moving from the lack of anesthetic mortality toward decreased anesthetic morbidity.

This shift toward minimizing anesthetic morbidity has been facilitated by more objective definition and earlier detection of pathophysiologic conditions such as hypotension, hypoxemia and severe hypercapnia. This has resulted from the incorporation of newer monitoring modalities by skilled attentive personnel during anesthesia.

The ACVA recognizes that it is possible to adequately monitor and manage anesthetized patients without specialized equipment and that some of these modalities may be impractical in certain clinical settings. Furthermore, the ACVA does not suggest that using any or all the modalities will ensure any specific patient outcome, or that failure to use them will result in poor outcome.

However, as the standard of veterinary care advances and client expectations expand, revised guidelines are necessary to reflect the importance of vigilant monitoring. The goal of the ACVA guidelines is to improve the level of anesthesia care for veterinary patients. Frequent and continuous monitoring and recording of vital signs in the peri-anesthetic period by trained personnel and the intelligent use of various monitors are requirements for advancing the quality of anesthesia care of veterinary patients.

Important Resources

- CVBC SA Anesthetic Monitoring
  - http://cvbc.ca/CVBC1/Resources_Contents/Files/Small%20Animal%20Anesthetic%20Monitoring%20Standard%20FINAL%20revised%20(March%201%202019).pdf

College of Veterinarians of British Columbia

Professional Practice Standard: Small Animal Anesthetic Monitoring[1]

Published February 2019, effective March 1, 2019

This College publication describes a mandatory standard of practice. The *Veterinarians Act* in section 52 provides that a failure to comply with a standard may be investigated.

Key Points

- Patient Preparation
- Individualized protocols/plans
- Priorities: Circulation, Ventilation, Oxygenation
- Record Keeping
  - Legal requirements, q 5-10 min written
- Adjust continually based on patient status!

Why Monitor?

- Drugs used:
  - Opioids: butorphanol, buprenorphine, hydromorphone, morphine
  - Sedatives: phenothiazines, alpha-2 agonists
  - Inhalants: isoflurane, sevoflurane
- Compromised CIRCULATION and VENTILATION
  - Monitor patients and support accordingly!
    - Supplemental O_2
    - Fluid therapy

Physical Monitoring

- Observation
- Palpation
- Auscultation
- Important part of monitoring all sedated and anesthetized patients
- Concerns: subjective, limited info

Anesthetic Monitors

- Available
- Affordable
- Invaluable information
- Necessary & integral part of practicing safely

PARAMETER:	MONITOR:	INFORMATION:
Oxygenation	Pulse Oximeter	SpO_2, pulse rate (PR)
Ventilation/Respiration	Capnometer/Capnograph	Respiration rate, $ETCO_2$
Blood Pressure	Doppler w sphygmomanometer, Oscillometeric Direct Arterial Line (invasive)	SAP (systolic arterial pressure) MAP(mean)w calculated SAP,DAP SAP, MAP, DAP (diastolic), PR
Pulse rate	Pulse oximeter, Doppler Oscillometric* ECG	Pulse by pulse, audible info * not real time with oscillo Electrical impulses of heart
Temperature	Thermometer	Rectal or esophageal temperature

The Big 3

The Anesthesia Big 3

1. Pulse Oximeter

2. Capnograph

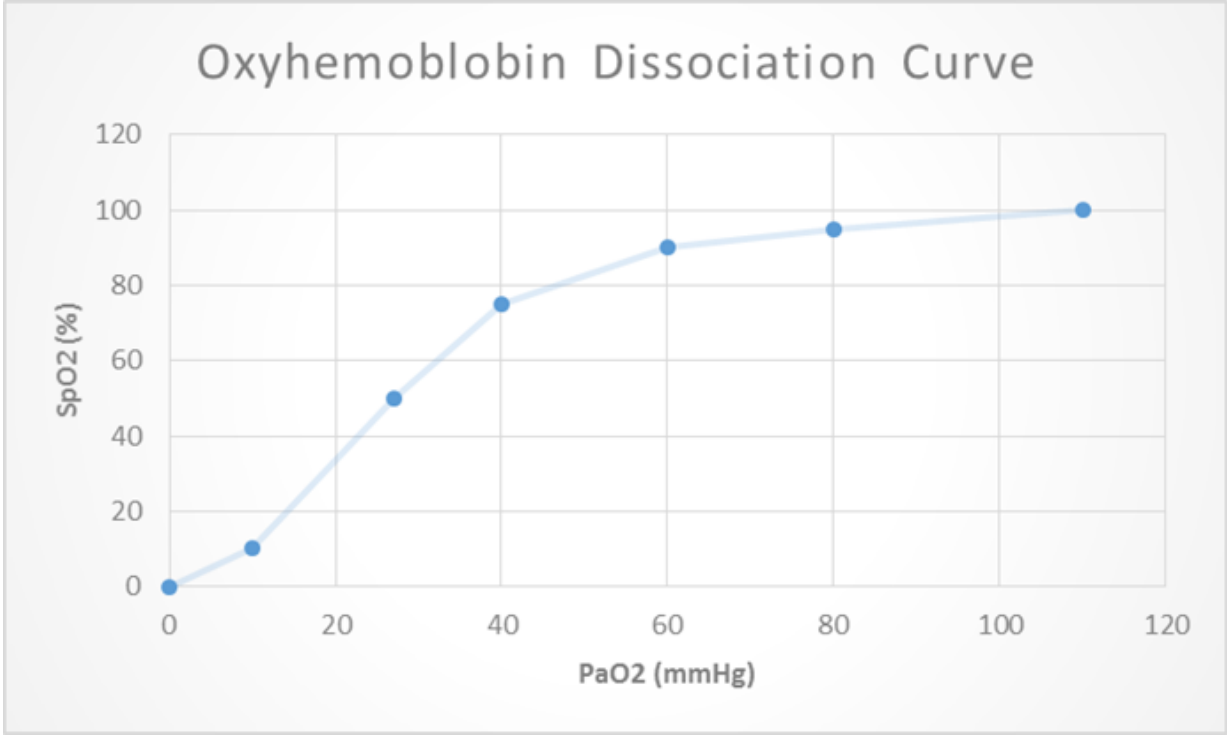
3. Blood Pressure

Pulse Oximetry

- Parameters:
  - Real-time pulse rate (PR)
  - Non-invasive hemoglobin saturation O_2 (SpO_2)
- Normal ranges:
  - SpO_2 > 95%
  - PR: Dogs (>60 bpm), cats (> 120 bpm)
- Advantages:
  - Small, affordable, portable, gives valuable info
  - Noninvasive

Pulse Oximetry

- Sigmoid shape
- FiO_2 21% PaO_2 :
  80-110 mmHg
- FiO_2 100% PaO_2:
  400-500 mmHg
- SpO_2: PaO_2 benchmarks



SpO2 (%)	PaO2 (mmHg)
100	> 100 (up to 500)
95	80
90	60
75	40

Pulse Oximetry: When to use?

- From induction through recovery (GA)/ entire sedation procedure whenever possible!
- Oxygen desaturation events
  - SpO_2 < 95%
  - Please NEVER ignore!
  - Induction: esophageal intubation, endobronchial intubation, oxygen supply problem
  - Maintenance: hypoventilation
  - Recovery: hypoventilation, VQ mismatch

Hypoxemia

= inadequate oxygenation of the blood

- Often seen during the peri-anesthetic period
  - After premedication
  - During induction
  - At recovery
- Monitor: Pulse oximeter
- SpO_2 < 95% is a cause of concern
- ALWAYS TROUBLESHOOT!

Hypoxemia

Is the number real?

- Pulse oximeter that displays a pulse waveform (plethysmograph) most desirable
- Others with light indicator demonstrating appropriate perfusion to area where probe is placed

Hypoxemia

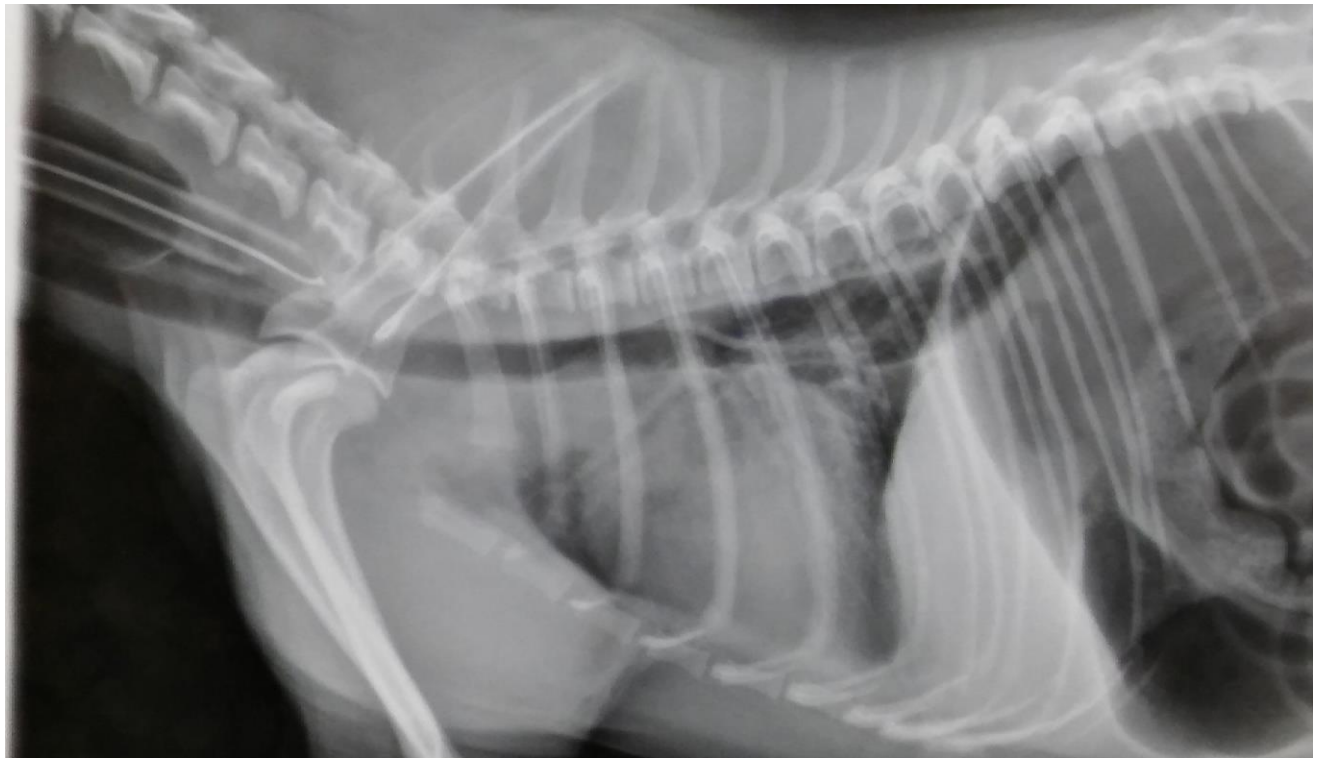
FIVE major causes of hypoxemia during anesthesia:

1. ↓ FiO_2
2. Hypoventilation*
3. V/Q mismatch*
4. R to L shunt
5. Diffusion impairment

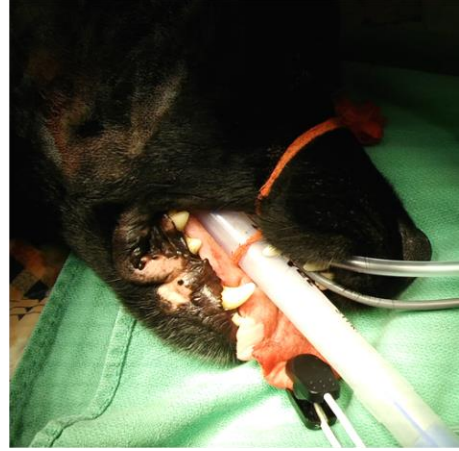
* Commonly seen with sedation/GA

Hypoxemia

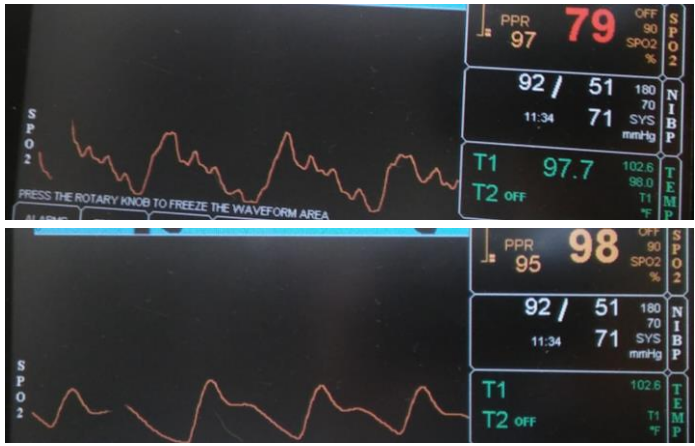
- Induction
  - esophageal intubation
  - endobronchial intubation
  - oxygen supply problem
- Maintenance
  - hypoventilation
- Recovery
  - Hypoventilation
  - VQ mismatch



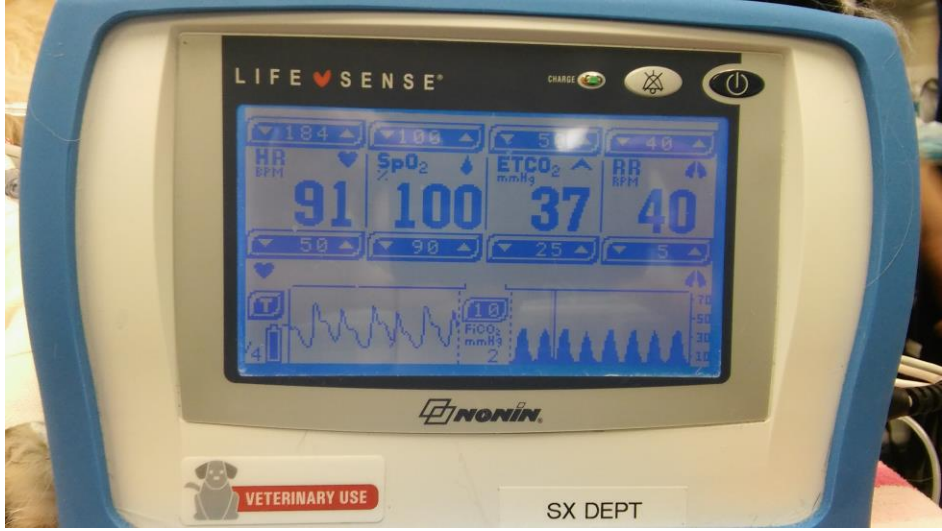
Hypoxemia: Pulse Ox Issues



- Transmittance v reflectance probe
  - Proper placement
    - Well perfused, non-pigmented surface, approp size
  - Avoid light contamination: optical shunting/interference
- Equipment issues
  - Low battery
  - Mismatched probe to unit
  - Electrical interference
- Patient factors that ↓ accuracy:
  - Dense hair coat, pigmented skin, motion/shivering
  - Poor perfusion: vasoactive drugs, hypoTº, hypotension, probe
- AbN hemoglobin: carboxyHb, methoxyHb, anemia



Capnography



- Parameters:
  - Real-time respiratory rate (RR)
  - End-tidal CO_2 ($ETCO_2$)
- Normal ranges:
  - $ETCO_2$ 35-45 mmHg
  - RR: Dogs (≈ 8-20 bpm), cats (≈10-30 bpm)
  - Recall, $V_m = V_t * RR$
- Advantages:
  - Affordable, noninvasive, portable, valuable info

Capnography

- Most sedatives and anesthetics ↓ ventilation
  - Opioids
  - Sedatives (acepromazine, dexmedetomidine)
  - Inhalants
- CO_2 tells us many things about the patient
  - Cellular metabolism
  - Respiration
    - Gas exchange at the alveoli
    - Endotracheal intubation
  - Perfusion/circulation →CARDIAC OUTPUT (CO)!
- $ETCO_2$ closely approximates $PaCO_2$ normally

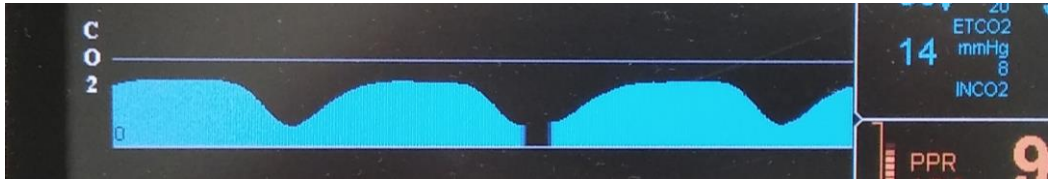
Capnography: When to use?

- From induction (intubation) to recovery (extubation)
- Hypoventilation events
  - $ETCO_2$ > 45 mmHg
    - Common causes: too deep (inhalant), obese, opioid/sed
    - (-): respiratory acidosis
    - You have control!
- Hyperventilation events
  - $ETCO_2$ < 35 mmHg
    - Dilutional effects?
    - Is the patient: light, painful, hot/opioids, acidemic, hypoxemic?

Hypoventilation

- $V_m = V_t * RR$
- Clinically, $ETCO_2$ > 50-55 mmHg
- Management:
  - Do NOT withhold appropriate doses of sedative or opioid due to concerns of hypoventilation!
  - Patient too deep? ↓ inhalant after depth check
  - IPPV supplement – manual or ventilator

"Hypoventilation" Alternative



High INSPIRED CO2

- Inspired CO_2 < 10 mmHg
- Check set-up:
  - exhausted soda lime
  - ↑ dead space (anatomical and/or mechanical)
  - incompetent unidirectional valve in a rebreathing system
  - O_2 flow that is too low in a non-rebreathing system

Hyperventilation

- ↑ RR → $ETCO_2$< 30 mmHg (clinically)
- Possible causes:
  - Light anes depth &/or pain
  - Iatrogenic
  - Hypoxemia
  - Hypercapnia (with light anes plane)
  - Opioids
  - Bronchospasm
- Management directed to underlying cause

- Hyperthermia

"Hyperventilation" Alternatives

Other causes of low $ETCO_2$:

- Patient size: small → dilutional effects of O_2 flow
- Production: cellular metabolism
  - Hypothermia
- Alveolar ventilation
  - CO_2 gradient: $PACO_2 \approx PaCO_2$, $PaCO_2 \approx ETCO_2$ (5 mmHg)
- Perfusion (systemic, pulmonary)
  - $ETCO_2$ = important indicator of CARDIAC OUTPUT!
  - Always manage sudden drops in CO_2 with this 1st
    - Patient status: alive?!? Hemorrhage? BP? Depth?

Blood Pressure Monitoring

- Parameters:
  - Pulse rate (PR)
  - Arterial pressure (SAP, MAP, DAP in mmHg)
- Normal ranges:
  - MAP $\geq$ 60 mmHg: normal, healthy, young pts
    - Doppler BP $\geq$ 90 mmHg
  - MAP > 80 mmHg: geriatric, renal, hypertensive pts
    - Or ideally, within 20 mmHg of awake BP if possible

Blood Pressure Monitoring

- Considered a major vital sign
  - Blood to peripheral tissue beds to carry O_2 and remove CO_2
- Indirectly indicates:
  - Perfusion
  - Circulation
  - Cardiac output
  - No clinically useful CO monitor on market

BP monitoring: Options

- Direct Arterial Line
  - Pros: gold-standard, accuracy, waveform analysis
  - Cons:higher skill level, ↑ equipment, set up time, +/- hemorrhage, hematoma, infection, and/or pain
- Doppler + sphygmomanometer
  - Pros: ↓$, reliable among a large range of pt size, HR, BP; real-time, audible
  - Cons: electrical interference of othr eqpt, ↑ set-up time vs oscillometric, manual inflation of the cuff needed
- Oscillometric device
  - Pros: easy to apply, automated, *can* be very accurate
  - Cons: ↓accuracy: hypotension, hypertension, tachycardia, bradycardia, very small patients

BP Monitoring: When to use?

- Sedation
  - Acepromaine: ↓SVR
  - Dexmedetomidine: ↑ SVR, reflex bradycardia
- General Anesthesia
  - Inhalant: ↓ CO, ↓ SVR
- From start of procedure until …?
  - Patient monitoring should end once the patient has vitals WNL!
    - TPR, BP, SpO_2, +/- $ETCO_2$

BP: Key Factors

The Major Players:

- CO = HR x SV
- MAP = CO x SVR

The Numbers (aka # pressure goals):

- Young, healthy
  - MAP > 60 mmHg
  - Doppler/SAP > 90 mmHg
- Geriatric, renal dz, hypertensive
  - MAP > 80 mmHg
  - SAP > 110 mmHg

Managing Hypotension

1. Decrease inhalant

- Inhalant: ↓ SV and ↓ SVR → ↓ CO & ↓MAP
  - Check depth
    - Eye position, palpebral reflexes, jaw tone
- Plan ahead: multi-modal plan
  - Opioid (pure mu agonist best for mod-sev pain)
  - Other analgesic drugs (possible as CRI)
  - Locoregional anesthesia

Managing Hypotension

2. Heart Rate: is the patient bradycardic?

- HR < 60 bpm (dogs), HR < 120 bpm (cats)
- Anticholinergic administration
  - Glycopyrrolate versus Atropine
  - Dexmedetomidine: HR < 40 bpm (dogs), HR < 80 bpm (cats)
    - AVOID anti-cholinergic drugs if HYPERtensive & bradycardic → ↓ cardiac index (Congon et al. JAVMA, 2011)
    - If patient stable → benign neglect
    - *Give anti-cholinergic if bradycardic **&** HYPOtensive*
    - Atipamazole? (Martin Flores et al. IVECCS, 2016)
- Hypothermia

Managing Hypotension

3. Fluid therapy

- Is it under-hydrated in the face of anesthetic vasodilation?
  - Pre-op PCV/TP?
  - Vasodilating drugs? (i.e. acepromazine, inhalant)
  - Can patient tolerate a fluid bolus (with perhaps additional boluses)?
- Bolus = 5-10 mL/kg (BES crystalloid)
  - < 15 minutes
  - Note: increasing the hourly fluid rate is unlikely to improve hypotension!

Managing Hypotension

4. Positive Inotropes

- Dopamine CRI (5-10 mcg/kg/min)
  - Beta agonist → ↑SV
  - Alpha agonist →↑SVR
- Dobutamine CRI
  - Synthetic beta agonist →↑SV
- Proper fluid resuscitation needed prior to start, otherwise tachyarrhythmia

Managing Hypotension

5. Vasopressors

- Shock, significant underlying disease→ significant peripheral vasodilation
- Phenylephrine (2-5 mcg/kg), ephedrine (0.05-0.2 mg/kg), or norepinephrine (0.5-2 mcg/kg/min)
  - ↑ SVR
- Vasopressin (1-4 mU/kg/min)
  - patients with significant acidemia

* Patients with significant hemorrhage and/or needing use of vasopressors = high risk! Need intensive & O/N care!!

Electrocardiogram (ECG)

- Parameters:
  - Cardiac electrical activity
  - HR
    - Canine: 60-160 bpm
    - Feline: 120-220 bpm
- When to use?
  - Normal pts: after the “big 3”: pulse oximeter, capnogram/graph, BP monitor
  - Place in advance of anesthetic induction in patients where cardiac arrhythmia concern
    - i.e., hx cardiac dz, hemoabdomen, GDV, septic shock

Electrocardiogram (ECG)

- Electrical APs → ECG tracing
  - P wave = atrial depolarization
  - QRS complex = ventricular depolarization
  - T wave = ventricular repolarization
- Under abN circumstances, electrical activity ≠ approp cardiac contraction
  - ↓ CO, circulation, perfusion
  - i.e. AV block, VPCs, V tach, etc.
- ECG HR may become unreliable
  - Severe bradycardia or tachycardia
  - A-V block
  - A flutter/ A fib
  - ventricular arrhythmias

Cardiac Arrhythmias

- Source: abnormal cardiac contraction(s)
- Detection: helpful monitors -
  - Pulse oximeter (with waveform)
  - Doppler
  - ECG
- Many and varied! Remote cardio consults available
- Here are a few common anesthesia-related ones:

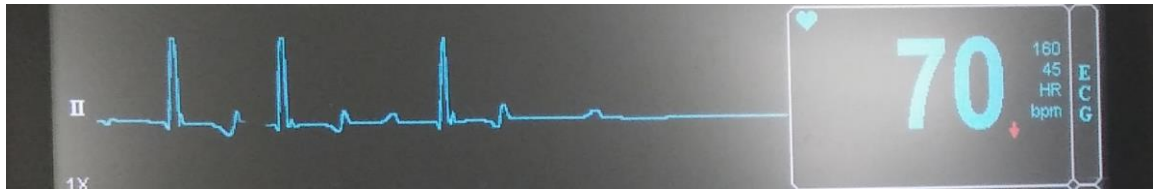
Sinus Bradycardia

- Rate low, rhythm regular
- Dogs < 60 bpm, Cats < 100-120 bpm
  - Dexmed use: Dogs < 40 bpm, Cats < 80 bpm
- Causes:
  - ↑ vagal tone
  - Hypothermia
  - Drugs, esp opioids, dexmedetomidine
- Treatment: anticholinergic
  - Atropine 0.02 – 0.04 mg/kg IV (urgent, emergent)
  - glycopyrrolate 0.005 – 0.01 mg/kg IV (<5m onset)

Sinus Tachycardia

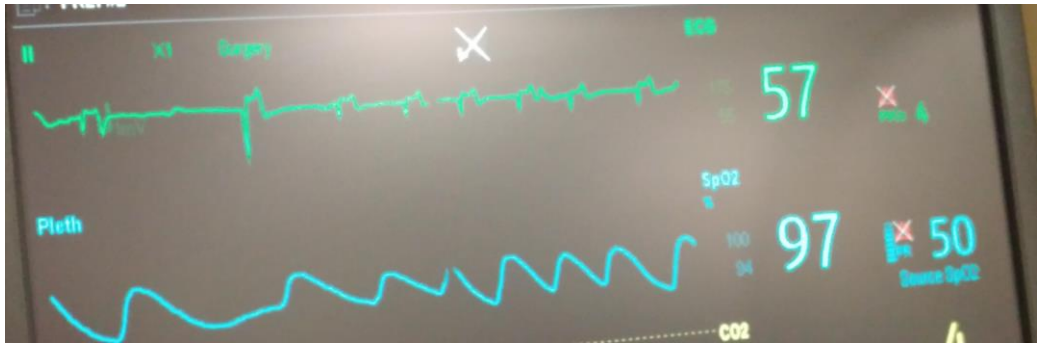
- Rate high, rhythm regular
- Dogs > 140-160 bpm, Cats > 240 bpm
- Causes:
  - Light anesthetic plane
  - pain
  - Shock
  - hypoxemia
  - anemia
  - Iatrogenic
- Treatment
  - Diagnose and address underlying cause

Second-Degree AV Block- Mobitz Type I



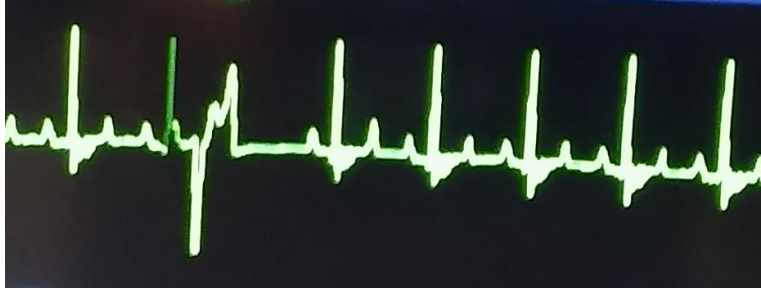
- P waves NOT followed by QRS complex
- P-R interval progressively long→ beat dropped
- Rate: atrial > ventricular
- Cause(s):
  - Normal finding
  - Increased vagal tone: V, ETT, surgical procedure
  - Drugs: opioids, dexmedetomidine
- Treatment:
  - Benign neglect: HR > 60 (dogs), > 100 (cats); MAP > 60 mmHg
  - Anticholingergic: atropine v glycopyrrolate

Ventricular Escape Beat



- Ventricular in origin
  - No P wave ahead of complex
- Looks like VPC but occurs LATE
  - Low intrinsic rate
    - Dogs < 40-60 bpm, Cats < 80-100 bpm
- Treatment:
  - AVOID lidocaine, this beat is protective!
  - Increase intrinsic HR via anticholinergic
    - Atropine v glycopyrrolate

Ventricular Premature Complex (VPC)



- Ventricular origin of cardiac impulse, early
- QRS w/o preceding P wave
- QRS complex = wide, bizarre, EARLY
- Causes:
  - Pain
  - Shock, trauma
  - underlying cardiac dz
  - hypoxemia, anemia
  - GDV, hemoabd
- Treatment
  - Runs w/ ↑ *f*, multi-form, hypotension, pulse def, RonT
  - Lidocaine (2-4 mg/kg), procainamide, esmolol

Ventricular Tachycardia (Vtach)

- Ectopic ventricular foci (wide, bizarre)
- > 3 VPCs in a row
- HR > 160 -180 bpm (dogs)
- VERY BAD! Very, very bad…
- Pulse v no pulse
  - Perfusion poor
- Treatment
  - Lidocaine IV load, CRI
    - 2-4 mg/kg, 50-100 mg/kg/min (use pump)
  - CPR

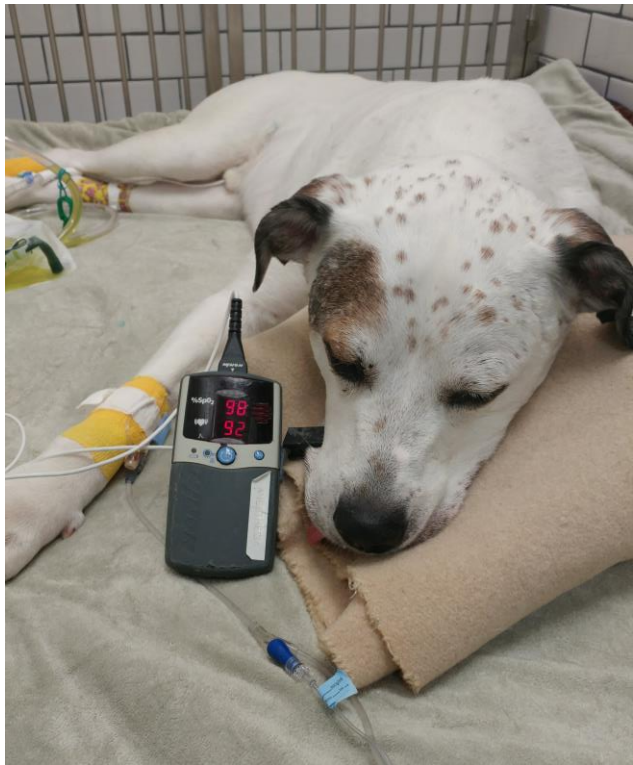
Image from: http://www.vetgo.com/cardio/concepts/concsect.php?sectionkey=5

Temperature

- Temperature monitoring +/- heat support should be provided in all sedated & GA pts
- Hyperthermia
  - ↑ metabolism, ↑ ETCO2, ↑anesthetic drug need
  - T > 108°F → multiple organ failure and death
- Hypothermia
  - T < 96°F: ↑ infection and bleeding risks
  - T < 94°F: prolonged and poor quality recovery
    - ↓ drug metabolism
    - shivering → discomfort, ↑ oxygen consumption

Recovery Monitors?

- > ½ anesthesia mortalities occur in **recovery** period!
  - Within 3h post-op
  - MONITOR until vital signs N, patient alert & ambulatory
    - How long? ≈ 10-30 minutes and RECORD EVERYTHING!
- Pulse Oximeter
  - SpO2, PR
- Respiratory
  - Rate, effort
- Blood Pressure
- Temperature



Summary

- Use monitors regularly for the entire peri-anesthetic period to increase anesthesia safety
- Common complications are managed with the clinical picture provided by patient history, workup, procedure, and monitor data
- Many cases can be managed well in the general practice setting with proper preparation and planning
- Board-certified Anesthesiologists are able help!
  - Phone consults
  - Refer the case

Questions?