ANESTHESIA FOR PATIENTS WITH COMORBIDITIES

ACVAA
FOUNDED IN 1975

AMERICAN COLLEGE OF VETERINARY ANESTHESIA AND ANALGESIA

SAGE VETERINARY CENTERS

ETHOS VETERINARY HEALTH

ODETTE O, DVM, DACVAA

SPECIAL THANKS...

OBJECTIVES

1. It is possible to safely anesthetize patients with comorbidities

2. Understand anesthetic options available

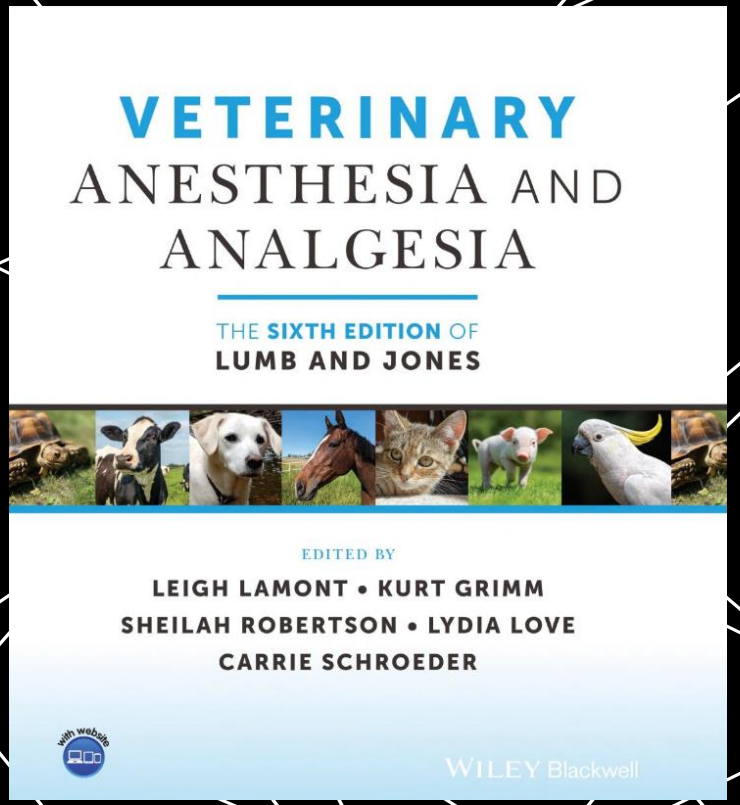
3. Recognize importance of vigilant monitoring! (including specific parameters certain disease processes)

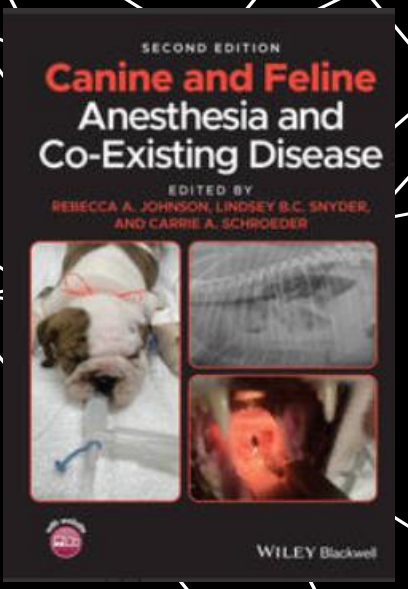
4. Know the anesthetic concerns and how best to prevent and manage potential complications...

5. Modulate safe(r) approaches to management of these patients

ADDITIONAL RESOURCES

- Lumb and Jones' Veterinary Anesthesia and Analgesia, 6th edition
- Canine and Feline Anesthesia & Co-Existing Disease, 2nd edition
- AAHA 2024 Fluid Management Guidelines





AMERICAN SOCIETY OF ANESTHESIOLOGISTS RISK ASSESSMENT

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

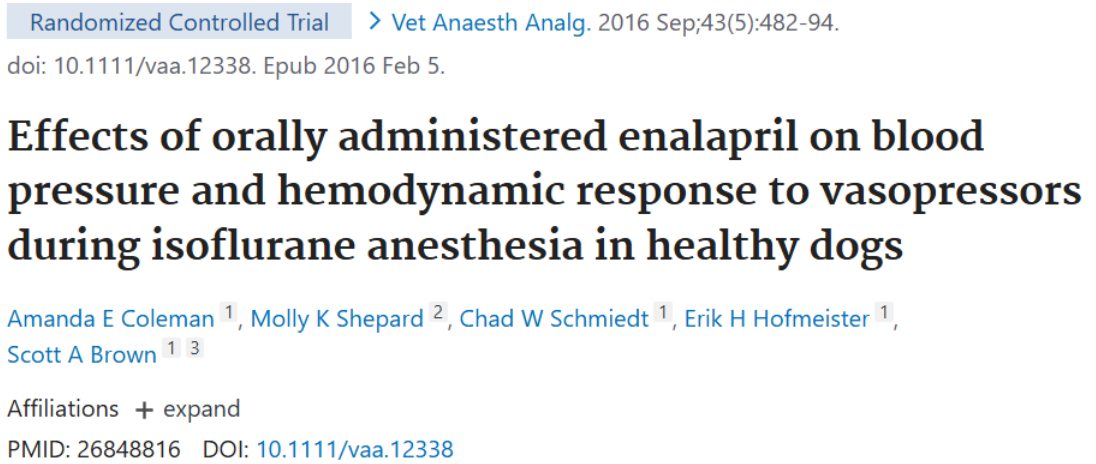
ANESTHESIA FOR PATIENTS WITH CARDIOVASCULAR DISEASE

ANESTHESIA FOR PATIENTS WITH CVS DISEASE: PATIENT ASSESSMENT

- Hx.
  - Medications, cough?, sleeping?
  - GIVE pimobendan, HOLD ACE-inhibitors 12-24h pre-anes

Workup – within a week of planned procedure, if possible!

- Thoracic radiographs
  - 3v
- ECG
- BP
- Lab data: CBC/Chem/lytes



Randomized Controlled Trial > Vet Anaesth Analg. 2016 Sep;43(5):482-94.

doi: 10.1111/vaa.12338. Epub 2016 Feb 5.

Effects of orally administered enalapril on blood pressure and hemodynamic response to vasopressors during isoflurane anesthesia in healthy dogs

Amanda E Coleman [1], Molly K Shepard [2], Chad W Schmiedt [1], Erik H Hofmeister [1], Scott A Brown [1 3]

Affiliations + expand

PMID: 26848816 DOI: 10.1111/vaa.12338

ANESTHESIA FOR PATIENTS WITH CVS DISEASE: PREMEDS

Multi-modal approach!

Pre-premed?

- Gabapentin 5-10 mg/kg + trazodone 3-5 mg/kg q8h

Premeds

- Opioids!
- Benzodiazepenes

In more advanced cases of disease, AVOID:

- Acepromazine – decreases in preload/afterload → IVF bolus
- Alpha-2 agonists – increased afterload, sig decreased CO

ANESTHESIA FOR PATIENTS WITH CVS DISEASE: INDUCTION AGENTS

Favorable CV effects with reasonable use of:

- Propofol
- Alfaxalone
- (Etomidate)
- Opioid-benzo (+/- lidocaine)

Questionable/cautious use of:

- Ketamine/tiletamine
  - Induction doses cause sympathomimetic effects and may potentiate existing arrhythmias

ANESTHESIA FOR PATIENTS WITH CVS DISEASE: MAINTENANCE

Inhalants (isoflurane/sevoflurane) in 100% O2

- Advantages
  - Monitoring
  - Controlled ventilation
- Disadvantages
  - Dose-dependent decreases in BP and CO + SVR

Inhalant-decreasing strategies:

- Analgesic bolus or CRIs (opioid, lidocaine, ketamine)
- Locoregional blockade

ANESTHESIA FOR PATIENTS WITH CVS DISEASE: MONITORING

- Pulse oximetry
- Blood pressure
  - Oscillometric vs Doppler – both!
- End-tidal CO2
- Electrocardiogram
- Temperature

ANESTHESIA FOR PATIENTS WITH CVS DISEASE: PATIENT SUPPORT

Patient pre-oxygenation

- Mask, max flow O2, 3-5 min directly to IND

Fluid therapy

- Compensated cardiac disease
  - 3-5 mL/kg/h of BES
- Hx of non-compensated cardiac disease
  - 2-3 mL/kg/h of BES

ANESTHESIA FOR PATIENTS WITH CVS DISEASE: BLOOD PRESSURE MGT

CO = HR X SV

MAP = CO x SVR

MAP > 60 mmHg: normal, healthy, young pts

- Doppler BP ≥ 90 mmHg
  - SAP in canine patients

MAP > 80 mmHg: geriatric, renal, hypertensive pts

- Or ideally, within 20 mmHg of awake BP if possible

ANESTHESIA FOR PATIENTS WITH CVS DISEASE: BLOOD PRESSURE MGT

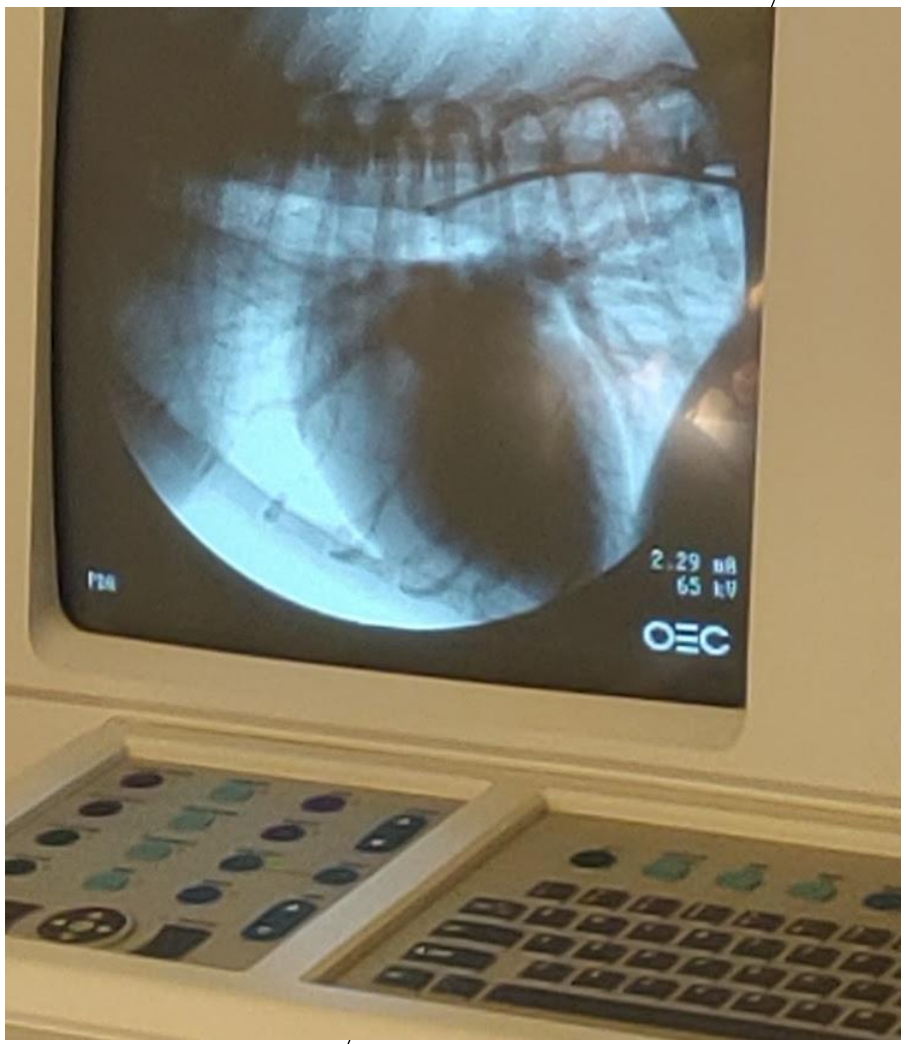
1. Decrease inhalant use!
   - Opioids!, locoregional blocks
2. Check patient HR
   - Anticholinergic use (atropine or glycopyrrolate PRN)
3. Fluid therapy
   - Caution in CVS patients, but consider loss and replacement PRN
4. Positive inotropes
   - Dopamine, dobutamine CRIs
5. Pressors
   - Ephedrine, phenylephrine, vasopressin, NE

ANESTHESIA FOR PATIENTS WITH CVS DISEASE: RECOVERY

Monitor & Record SpO2 and BP until awake

Considerations:

- O2 supplementation?
- NSAID use?
- Fluid volume overload: monitor + furosemide PRN



ANESTHESIA FOR PATIENTS WITH RENAL DISEASE

ANESTHESIA FOR PATIENTS WITH RENAL DISEASE

Kidney Functions

- Filtration
- Reabsorption
- Secretion

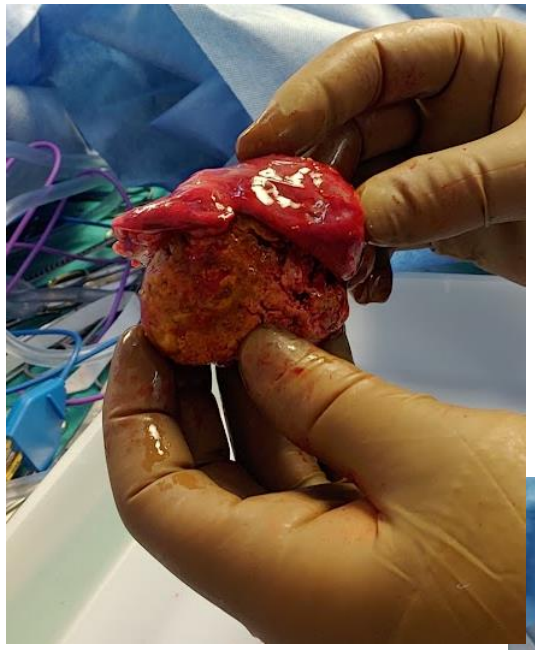
Renal Blood Flow (RBF)

- Receives ≈ 25% CO
- autoregulated in MAP range of 80-180 mmHg
- ALL anesthetics are likely to affect RBF

ANESTHESIA FOR PATIENTS WITH RENAL DISEASE

Patient Problems

- Azotemia
  - ≥ 75% nephron loss for persistent azotemia
    - Signs of renal insufficiency: U/A, PCV, PU/PD
  - Δ BBB → ↑ drug penetration into CNS
- Acidosis
  - can↑ fraction of unbound drug



ANESTHESIA FOR PATIENTS WITH RENAL DISEASE

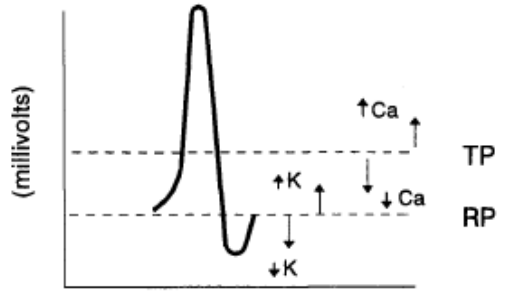


Fig. 39.1. Relationships between extracellular concentrations of potassium (K^+) and calcium (Ca^{2+}) and the resting potential (RP) and threshold potential (TP). An action potential is generated when there is sufficient depolarization to reach the TP. Increased extracellular potassium will result in raised (less negative) RP, whereas increased extracellular calcium will result in raised TP.

Lumb and Jones Vet AA, 6th ed

Electrolyte abnormalities

- Hyperkalemia (>5.5 – 6 mEq/L)
  - Postpone anesthesia
  - Tx.: Ca^{++}; BES (better than 0.9% saline) +/- glucose, insulin, bicarbonate
  - What would your ECG look like? (≈ 8 mEq/L)

Dehydration/Anorexia

- Anemia
  - Via bone marrow suppression, GI blood loss (ulceration), ↓ RBC lifespan, ↓ erythropoeitin production
  - Transfuse pRBC (cats <18%, dogs <20%)
- Hypertension

ANESTHESIA FOR PATIENTS WITH RENAL DISEASE

Chronic Renal Failure

- May be hyperkalemic, azotemic, acidemic, dehydrated, GI/oral ulceration, anemic, hypertensive, poor body condition

Urethral Obstruction

- Concerns: hyperkalemic, azotemic, acidemic
    - Cats may also be hypocalcemic, hyponatremic, and hyperglycemic

Ruptured Urinary Bladder

- Hyperkalemic, hyponatremic, hypochloremic, acidotic

ANESTHESIA FOR PATIENTS WITH RENAL DISEASE

STRESS-FREE!

Stress → catecholamine release →↓RBF, ↓GFR → ↓ urine production

- Also, release of aldosterone, renin, and vasopressin (contributing further to these issues)

ANESTHESIA FOR PATIENTS WITH RENAL DISEASE

Preanesthetic medication

- Goals: ↓ anxiety without ↓ MAP, RBF
- Opioid + benzodiazepine (best option)
- Acepromazine?: NO, likely to cause hypotension. Alpha-2 agonists?: No, likely to decrease CO → decreased renal perfusion

Induction

- Propofol
- Etomidate
- Thiobarbiturates
- AVOID ketamine in cats
- Box/Mask? NO! Stressful!!

ANESTHESIA FOR PATIENTS WITH RENAL DISEASE

Maintenance: Inhalant Anesthesia

- GOAL: minimize inhalant use
  - ↓ CO, vasodilation → hypotension
- Isoflurane
  - Preferred inhalant?
- Sevoflurane
  - Breakdown into nephrotoxic inorganic fluoride
  - Compound A: nephrotoxic breakdown produce of sevoflurane degraded by CO2 absorbents
    - Avoid low fresh gas flows which would increase the concentration of Compound A

ANESTHESIA FOR PATIENTS WITH RENAL DISEASE

Anesthetic Monitoring:

- End-tidal CO2
- Pulse oximetry
- Arterial blood-gas & electrolyte analysis
- Arterial blood pressure
- ECG

ANESTHESIA FOR PATIENTS WITH RENAL DISEASE

Fluid therapy

- BES
- 5 ml/kg/h
  - If normal protein and CV status

Blood pressure

- MAP $\geq$ 80 mmHg
- Fluid support
- + inotrope
  - Dobutamine, dopamine

Ventilation

- Mild hyperventilation. WHY?
- ETCO2 $\approx$ 35 mmHg

ANESTHESIA FOR PATIENTS WITH RENAL DISEASE

Anesthetic Monitoring:

- End-tidal CO2
- Pulse oximetry
- Arterial blood-gas & electrolyte analysis
- Arterial blood pressure
- ECG

ANESTHESIA FOR PATIENTS WITH RENAL DISEASE

Post-operative care

- Avoid or dose-reduce nephrotoxic drugs
  - NSAID
  - Aminoglycoside antibiotics
- +/- urinary catheter placement
  - 0.5-1 ml/kg/h urinary output (dogs)

ANESTHESIA FOR PATIENTS WITH RENAL DISEASE

Correct hydration status PRIOR to anesthetic episode and maintain immediately post

Minimize stress to avoid catecholamine release

Maintain MAP $\geq$ 80 mmHg

Avoid or dose-reduce nephrotoxic drugs

ANESTHESIA FOR PATIENTS WITH ENDOCRINE DISEASE

- Diabetes mellitus
- Hyperadrenocorticism (Cushing’s Disease)
- Hypoadrenocorticism (Addison’s Disease)
- Hyperthyroidism
- Hypothyroidism

ANESTHESIA FOR PATIENTS WITH DIABETES MELLITUS

Common endocrinopathy of dogs (type I) & cats (type II)

GOAL: stabilized patients to anesthesia, i.e. DKA increases risk!

Related concerns:

- Neuropathy – ANS and peripheral
- Vascular endothelial damage
- Renal perfusion, proteinuria
- Osmotic diuresis
- Hypertension – up to 46% of diabetic dogs!

ANESTHESIA FOR PATIENTS WITH DIABETES MELLITUS: PATIENT PREP

GOAL: minimize hyperglycemia and AVOID hypoglycemia

Prior to anesthesia:

- PE, neuro + ophtho exams
- Labs: BG, UA (glu, ket, prot), e-lytes, ABG, PCV/TP, lactate

Insulin?:

- https://www.aaha.org/resources/2018-aaha-diabetes-management-guideline-for-dogs-and-cats/tips-and-tricks-for-anesthetizing-diabetic-dogs-and-cats/
- Human guideline: miss 1 meal, give 50% of long-term insulin a.m.
- Cats: similar approach due to long-lasting insulin use, feed small wet meal
- Dogs: no well-established guideline, intermed insulins, consider:
  - 50% insulin + small wet-food meal

ANESTHESIA FOR PATIENTS WITH DIABETES MELLITUS: BG MANAGEMENT

GOAL: minimize hyperglycemia and AVOID hypoglycemia

- Schedule case early in the day with goal of returning to schedule ASAP!
- Check BGs often and adjust PRN (q30-60 m) thru recovery
- BG > 200 mg/dL (11.1 mmol/L)
  - Regular insulin 0.25-0.5 U/kg IV or CRI 0.0025 -0.005 U/kg/h
  - Intermediate insulin (patient's usual) 50% dose SQ
- BG < 100 mg/dL (5.6 mmol/L): 2.5-5% dextrose suppl +/- KCl

ANESTHESIA FOR PATIENTS WITH DIABETES MELLITUS: MEDICATIONS

GOAL: minimize hyperglycemia and AVOID hypoglycemia

- Pre-op IV fluids (BES)
- Gastro-protectants +/- prokinetic tx
- Premeds: opioid + sedative
  - (-) Dexmed inhibits insulin rel fr pancreas → hyperglycemia
- Induction: propofol, alfaxalone
  - (-) Ketamine at induction doses causes sympathomimetic resp
- Maintenance: inhalant vs TIVA (or PIVA)
- Locoregional anesthesia/analgesia
- Monitoring: standard + BG q 30-60 min

ANESTHESIA FOR PATIENTS WITH HYPERADRENOCORTICISM

HAC is 2nd most common endocrinopathy seen in middle-old dogs

Who?: Poodles, Terriers, Beagles, Dachshunds; females overrepresented

Patient Prep

- PE; CBC/Chem/UA, endocrine, ABG; BP (50-86% hypertensive)

Disease-related concerns:

- Hypoventilation: organomegaly/obesity, decreased FRC → resp acidosis
- Elevated PTE risk: Hct elevation, vessel compromise, hypercoaguability
- Renal dysf/N: elevated cortisol, ADH inhibition (deH), hypertension

ANESTHESIA FOR PATIENTS WITH HYPERADRENOCORTICISM: ANESTHETIC MANAGEMENT

GOAL: minimize anesthesia time and recumbency

- Pre-op IV fluids (BES)
- Premeds: opioid + sedative
- Induction: propofol, alfaxalone
  - (-) Ketamine at induction doses causes sympathomimetic resp
- Maintenance: inhalant with IPPV
  - Manage hypotension! (2018 ACVIM hypertension guidelines)
- Locoregional anesthesia/analgesia
- Monitoring: standard (SpO2, ETCO2, BP, ECG, T)
- Recovery: hypoventilation! Flowby O2 if SpO2 < 95%!

Journal of Veterinary Internal Medicine Open Access

J Vet Intern Med. 2018 Oct 24;32(6):1803–1822. doi: 10.1111/jvim.15331

ACVIM consensus statement: Guidelines for the identification, evaluation, and management of systemic hypertension in dogs and cats

VETERINARY QUARTERLY
2023, VOL. 43, NO. 1, 1–11
https://doi.org/10.1080/01652176.2023.2234436

Comparative cardiac macroscopic and microscopic study in cats with hyperthyroidism vs. cats with hypertrophic cardiomyopathy

Izabela Janus[a], Agnieszka Noszczyk-Nowak[b], Joanna Bubak[a], Massimiliano Tursi[c], Cristina Vercelli[c] and Marcin Nowak[a]

ANESTHESIA FOR PATIENTS WITH HYPERTHYROIDISM

The most common endocrinopathy in cats older than 8 y/o!

Patient Prep

- PE; CBC/Chem/lytes (w SDMA) + UA
  - ALT + AlkP elevation in approx. 75% of hyperthyroid cats
  - Hypernatremia, hypokalemia, and hypercalcemia seen commonly
- Full cardiac workup; BP (hypertension 17-87%)

Disease-related concerns:

- HCM; myocardial irritability + arrhythmias
- Renal dysf/N
- Hypercoaguability - postoperative antithrombotic treatment (?)

ANESTHESIA FOR PATIENTS WITH HYPERTHYROIDISM

GOAL: protect cardiac function & perfusion (avoid hypotension!)

- Give methimazole at regular times up to anesthesia
- Premeds: opioid + sedative
- Induction: propofol, alfaxalone
  - (-) Ketamine at induction doses causes sympathomimetic resp
- Maintenance: inhalant
  - Manage hypotension! (2018 ACVIM hypertension guidelines)
- Locoregional anesthesia/analgesia
- Monitoring: standard (SpO2, ETCO2, BP, ECG, T)
- Recovery: support O2 needs (SpO2 > 95%!) monitor 48h for acute thyrotoxicosis

ANESTHESIA FOR PATIENTS WITH HEPATIC DISEASE

ANESTHESIA FOR PATIENTS WITH HEPATIC DISEASE: LIVER FUNCTIONS

Drug metabolism

- Detoxification

Gluconeogenesis

Protein synthesis

- Albumin
- Coagulation factors

Extramedullary hematopoiesis

Large functional reserve and capable of regeneration

- Insufficiency UNCOMMON → needs chronic/recurrent injury

ANESTHESIA FOR PATIENTS WITH HEPATIC DISEASE: LABORATORY FINDINGS

- ↓
  - Albumin
  - BUN
  - Glucose
  - Cholesterol
- Coagulopathies (↑ PT, PTT, fibrinogen)
- ↑ bile acids (pre-,postprandial)
- +/- ↑ALT, GGT, Alk-P

ANESTHESIA FOR PATIENTS WITH HEPATIC DISEASE

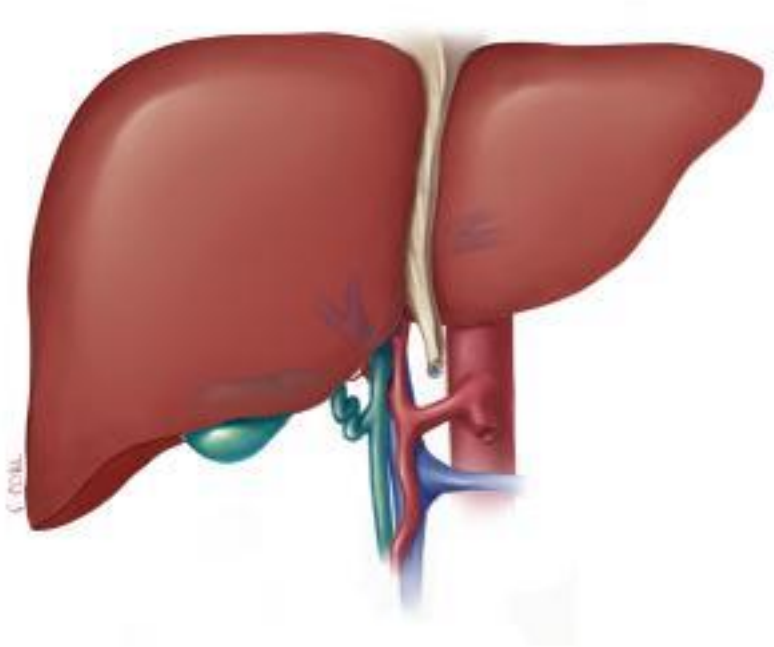
Hepatic dysfunction	Bilirubin	ALT/AST	ALP	Causes
Pre-hepatic	↑ unconjugated fraction	Normal	Normal	Hemolysis, bilirubin overload from whole blood
Intrahepatic (hepatocellular)	↑ conjugated fraction	Markedly ↑	Normal to slightly ↑	Infection, drugs, sepsis, hypoxemia, cirrhosis, lipidosis, neoplasia
Posthepatic (cholestatic)	↑conjugated fraction	Normal to slightly ↑	Marked ↑	Stones, sepsis, pancreatitis

Courtesy Dr. Lisa Ebner

ANESTHESIA FOR PATIENTS WITH HEPATIC DISEASE

Clinical signs of hepatic disease:

- Ascites
- Depression
- Seizures
- Hepatic encephalopathy
- Anorexia
- Weight loss
- Icterus/jaundice



ANESTHESIA FOR PATIENTS WITH HEPATIC DISEASE: CASES NEEDING GA

- Portosystemic vascular malformations
- Acquired PSS
- Hepatic lipidosis
- Cholangiohepatitis (liths, mucocele)
- Hepatotoxins
  - Chronic administration of drugs such as: phenobarbital, NSAIDs, steroids, acetaminophen
  - may need anesthesia for other reasons

ANESTHESIA FOR PATIENTS WITH HEPATIC DISEASE: PREMEDS

Sedative

- AVOID:
  - Acepromazine – hypotension, inhibition of platelet-aggregation
  - Alpha-2 agonist - Δ plasma glucose, peripheral blood flow alterations
- USE:
  - Benzodiazepine–diazepam or midazolam (0.1-0.2 mg/kg)
  - Minimal CV depression
  - CAUTION: patients with hepatic encephalopathy

Opioids are good

ANESTHESIA FOR PATIENTS WITH HEPATIC DISEASE: INDUCTION

Propofol

- Rapid distribution and metabolism via glucuronidation and extrahepatic clearance (lung)

Etomidate

- Short duration of action
- Rapid redistribution
- Hepatic microsomal enzymes, plasma esterases

Dissociative Anesthetics

- Tiletamine, ketamine (duration of action tiletamine > ketamine)
- Acceptable if no seizure history

ANESTHESIA FOR PATIENTS WITH HEPATIC DISEASE: INHALANT MAINTENANCE

Isoflurane

- ↑ hepatic blood flow
- 0.2 % metabolized
- Less CV depression than halothane → better CO → better perfusion

Sevoflurane

- 2-5% metabolized
- Possibly reduces portal vein blood flow and O2 delivery more than isoflurane

ANESTHESIA FOR PATIENTS WITH HEPATIC DISEASE: ANESTHETIC MONITORING

- End-tidal CO2
- Pulse oximetry
- Arterial blood-gas analysis
- Arterial blood pressure
  - MAP > 60 mmHg
- +/- ECG
- Central Venous Pressure (CVP)
  - Often hypoproteinemic
  - Hydration status

ANESTHESIA FOR PATIENTS WITH HEPATIC DISEASE: OTHER CONSIDERATIONS

Maintain T

- ↓ metabolism by liver during hypothermia

Blood glucose

- Check, recheck, & treat hypoglycemia PRN
- 2.5 – 5% Dextrose in crystalloid

Hypoproteinemia

- Albumin ≤ 1.5 g/dL
- ↓ plasma oncotic P
  - pulmonary edema with fluid administration
  - Hypotension
  - Tx. : Plasma transfusion (up to 20 mL/kg)
    Hetastarch (10-20 mL/kg)
    Albumin (canine) @ 2.5-5 mL/kg

ANESTHESIA FOR PATIENTS WITH HEPATIC DISEASE: SUMMARY

- Start medical management for hepatic encephalopathy PRIOR to surgery
- Check coagulation profile (PT, PTT) +/- VCM (TEC)
- Use short-acting and reversible drugs
- Monitor hydration, blood glucose, and plasma protein concentrations
- Hypotension and bradycardia (vasovagal reflex) may occur with biliary tree manipulation. Consider anticholinergic (atropine or glycopyrrolate) in the anesthestic plan
- Be prepared for postoperative complications
    - Seizures, prolonged recovery
- Potential for thromboembolic complications

ANESTHESIA FOR PATIENTS WITH CNS DISEASE

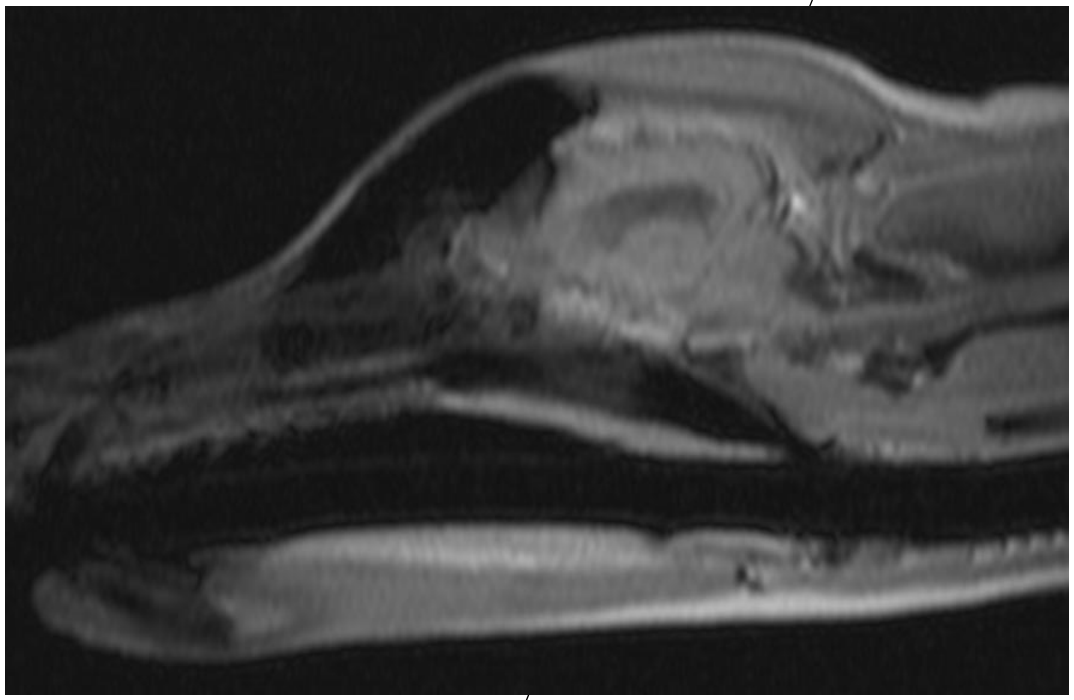
ANESTHESIA FOR PATIENTS WITH CNS DISEASE

Blood supply controlled by autoregulatory mechanisms

- Normal, awake patients

Factors altering cerebral blood flow (CBF)

- Arterial oxygenation
- CO2 partial pressure (PaCO2)
- Mean arterial pressure (MAP)
- Venous outflow



ANESTHESIA FOR PATIENTS WITH CNS DISEASE

Cranial vault is NONCOMPLIANT

- ↑ intracranial volume → ↑ ICP
  - Intracranial masses
  - Trauma
  - Deranged autoregulation
- Potenitally result in
  - Cerebral ischemia
  - Brain herniation

ANESTHESIA FOR PATIENTS WITH CNS DISEASE

- ✖ **Manage Intracranial Pressure!**
  - ✚ AVOID elevated ICP in patients w/ CNS dz
  - ✚ AVOID ↓ venous drainage from the head
  - ✖ Head-down position
  - ✖ Jugular vein occlusion
    - ✶ NO jeck leash
    - ✶ NO jugular venipuncture
    - ✶ NO jugular catheter

ANESTHESIA FOR PATIENTS WITH CNS DISEASE: ANESTHETIC DRUGS

Preanesthetic Medication (sedative) Options

- Acepromazine
  - Historically suspected to ↑ seizure activity, but more recent data suggests NO potentiation
- Alpha-2 agonists
  - NO ↑ ICP in healthy horses and dogs
  - Ok to use for sedation but avoid head droop
- Benzodiazepenes
  - Anticonvulsant activity

ANESTHESIA FOR PATIENTS WITH CNS DISEASE: ANESTHETIC DRUGS

Opioids

- Minimal direct effect on CBF and ICP
- Indirect ↑ CSF pressure via ↑ $PaCO_2$ secondary to hypoventilation

Induction Agents

- Barbiturates (Thiopental)
- Propofol
- Propofol is preferred over barbiturates due to availability and its rapid metabolism → faster recovery
- Ketamine?
- Etomidate?

ANESTHESIA FOR PATIENTS WITH CNS DISEASE: ANESTHETIC DRUGS

Maintenance

- Isoflurane
- Sevoflurane

Amount?

- **MAC or less**
  - Isoflurane 1.2%
  - Sevoflurane 2.3%

ANESTHESIA FOR PATIENTS WITH CNS DISEASE: MONITORING &VITAL PARAMETERS

- ETCO2 30-35 mmHg at all time
- SpO2 > 95%
- MAP 60-140 mmHg
- +/- ECG
- Judicious IV fluids 3-5 mL/kg/h – but consider needs of patient

ANESTHESIA FOR PATIENTS WITH CNS DISEASE: SUMMARY

Patient Management

- Avoid ↑ ICP via ELEVATED head positioning
- NO jugular occlusion, or vomiting (use maropitant ahead of time!)

Anesthetic Management

- Maintain MAP ≥ 60 mmHg + ETCO2 30-35mmHg for CBF autoregulation
- GOALS
  - keep inhalant LOW
  - Avoid hypoxemia and hypercapnia
    - IPPV until AWAKE (recovery period still dangerous!)
- Judicious use of fluid therapy

ANESTHESIA FOR PATIENTS WITH CNS DISEASE: THE CUSHING'S RESPONSE

Rapid DEcompensation under anesthesia

↑ ICP along with ↑ systemic blood pressure

- Attempt to maintain adequate cerebral perfusion pressure

(CPP = MAP - ICP)

Cushing's Triad

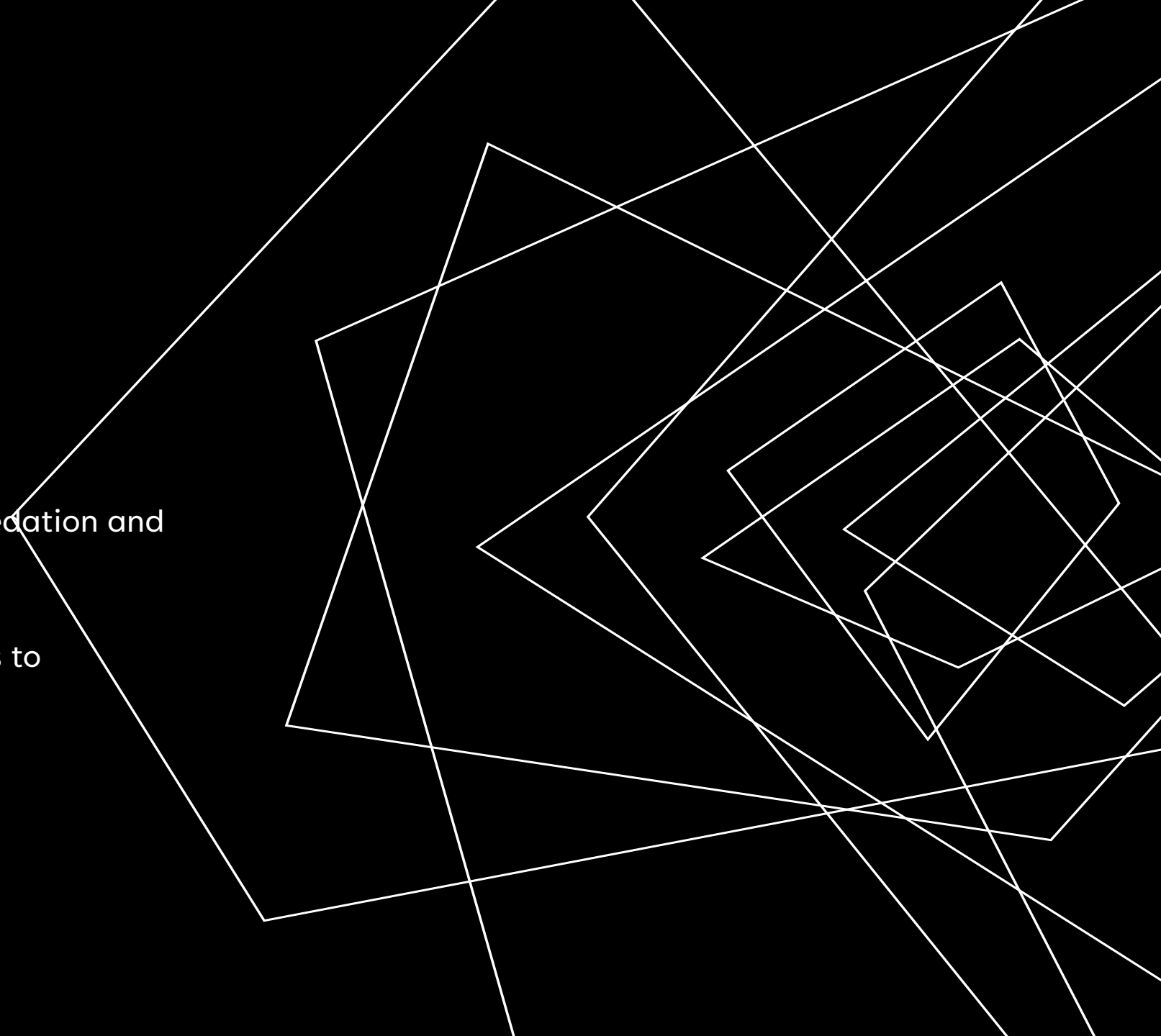
1. ↑ arterial blood pressure
2. Irregular breathing
3. Bradycardia (reflex)

Treatment: mannitol 0.5-1g/kg or hypertonic saline 4 mL/kg!

ANESTHESIA FOR BRACHYCEPHALIC PATIENTS

OBJECTIVES

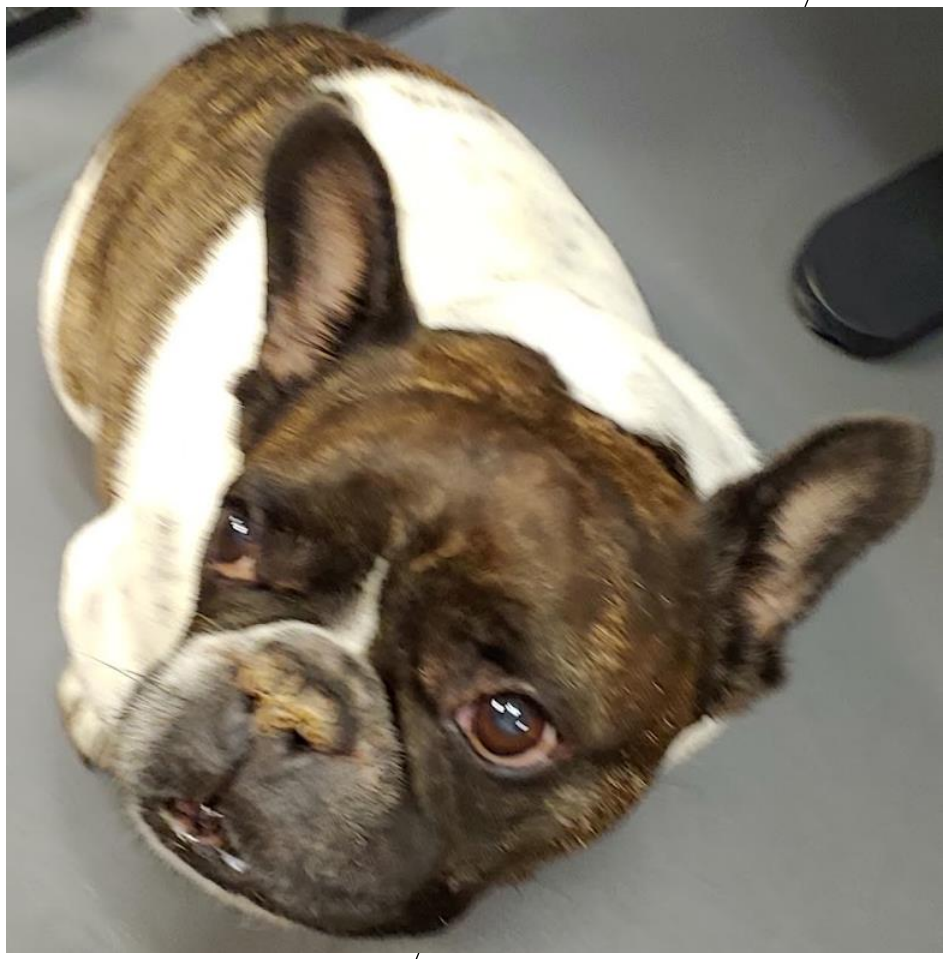
1. Review components of BOAS
2. Discuss concerns for BOAS sedation and anesthesia
3. Modulate safe(r) approaches to management of these patients



COMMONLY AFFECTED BREEDS

- **Bulldogs**
  - English
  - French
- **Pugs**
- **Boston Terriers**

- **Boxers**
- **Shih tzus**



CLIENT EDUCATION

BOAS patients = higher incidence of M & M in peri-op period!

- Sedated and anesthetized procedures

BOAS patients presenting specifically for airway surgery

- Mortality: 2.6- 4% (variable sources)
- Morbidity: Lindsay et al. 23.4% (n = 248)
- English Bulldogs over-represented in one report
- Gruenheid et al.
  - 1.57x more likely to have an intra-anesthetic complication
  - 4.33x more likely to have a post-anesthetic complication

INVITED REVIEW | Open Access

Surgical management of brachycephalic obstructive airway syndrome: An update on options and outcomes

Mandy L. Wallace DVM, MS, DACVS (Small Animal)

First published: 01 July 2024 | https://doi.org/10.1111/vsu.14131

CLINICAL RESEARCH

Comparison of mortality of brachycephalic dogs undergoing partial staphylectomy using conventional incisional, carbon dioxide laser, or bipolar vessel sealing device

Sarah A. Jones DVM, Shawn C. Kennedy DVM, MS, DACVS

First published: 18 July 2023 | https://doi.org/10.1111/vsu.14002 | Citations: 1

CLIENT CONSENT (AN EXTRA FORM!)

Brachycephalic Consent Form

Brachycephalic dogs are considered a high-risk population for hospitalization, anesthesia and/or surgery. Risk factors that can affect outcome and should be discussed include:

1. English or French Bulldog
2. Previous airway surgery
3. If additional surgical procedures are planned during anesthesia for BAS correction (including elective neutering, dermatologic and ophthalmic procedures)
4. Body condition score (assessment of appropriate body weight)
5. Level of respiratory distress at the time of admission to the hospital
6. Body temperate at the time of admission to the hospital
7. Difficult eating including gagging, vomiting, and regurgitation

Authorization for Treatment Checklist

☐ I grant permission for my pet to undergo general anesthesia/sedation/hospitalization.

☐ I am aware that my pet has an increased risk of Brachycephalic Airway Syndrome, and I am aware that BAS increases the risk of complications associated with sedation and anesthesia.

☐ I am aware that if my brachycephalic pet undergoes sedation or general anesthesia the potential complications include partial or complete airway obstruction during recovery and regurgitation/vomiting, which could lead to aspiration pneumonia/respiratory distress.

☐ I am aware that anesthetizing or sedating a brachycephalic animal for any reason can lead to the development of significant complications. In rare circumstances, these complications include prolonged hospitalization in the intensive care unit and temporary tracheostomy tube placement.

☐ I have been well-informed by the attending clinician regarding potential complications associated with brachycephalic airway syndrome.

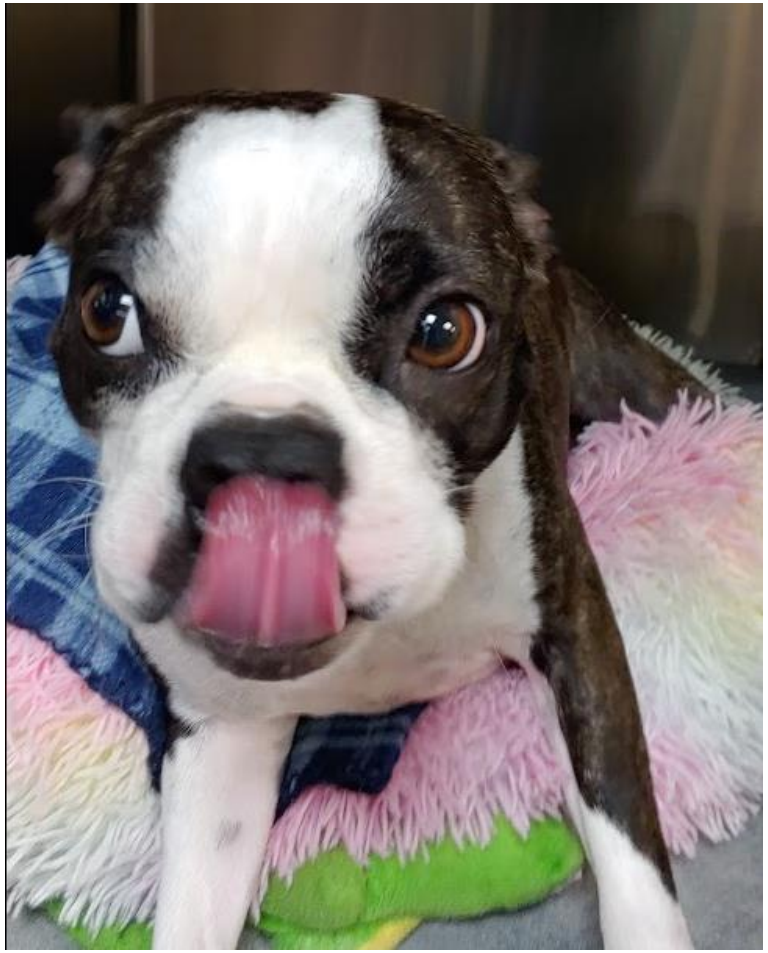
	08-01-2023
Signature	Date

	08-01-2023
Witness	Date

BRACHYCEPHALIC OBSTRUCTIVE AIWAY SYNDROME (BOAS)

- **Stenotic nares**
- **Hypoplastic trachea**
- **Elongated soft palate**
- **+/- everted laryngeal saccules**

ROMEO



ROMEO

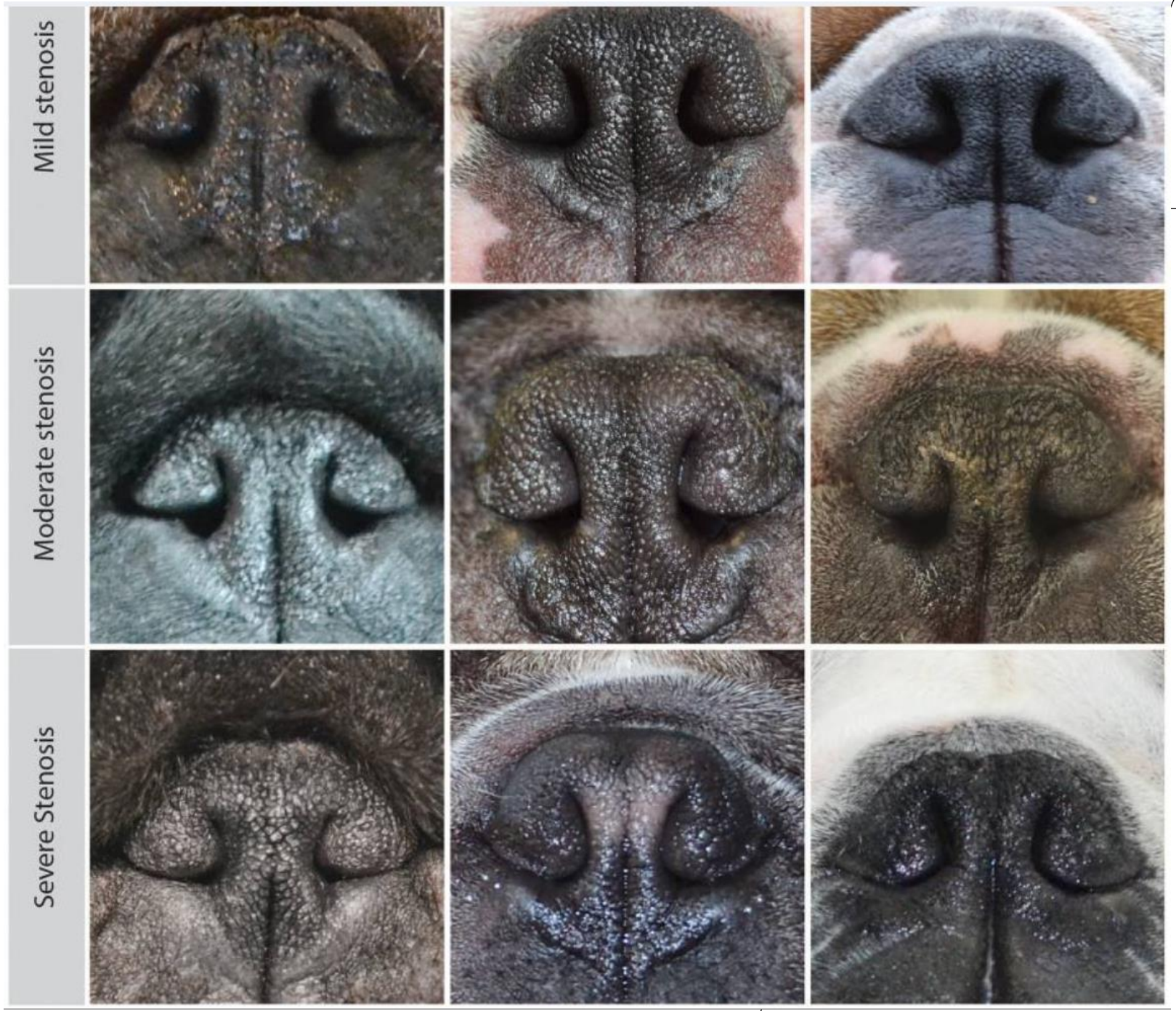
perfect

STENOTIC NARES

Liu NC, Troconis EL, Kalmar L, Price DJ, Wright HE, Adams VJ, Sargan DR, Ladlow JF.

Conformational risk factors of brachycephalic obstructive airway syndrome (BOAS) in pugs, French bulldogs, and bulldogs. PLoS One. 2017 Aug 1;12(8):e0181928. doi: 10.1371/journal.pone.0181928.

PMID: 28763490; PMCID: PMC5538678.



DIFFICULT AIRWAY

- Redundant soft tissue
- Hyperplastic tissues
- Laryngeal collapse
- Tracheal collapse
- Bronchial collapse

CLINICAL SIGNS

- **Increased respiratory noise**
- **Snoring**
- **Stridor**
- **Inspiratory dyspnea**
- **Exercise and/or heat intolerance**
- **Syncope**
- **Cyanosis**
- **Collapse**

GI CONCERNS

- **Gagging, ptyalism, regurgitation, vomiting**
- **Sliding hiatal hernia**
- **Gastritis, esophagitis, GERD**

- **Frenchies > English & Pugs**
- **BOAS regurg incidence: 9.1-34.5%**
  - Reportedly, post-op > pre-op

Significant improvement reported post-BOAS procedure

Fasting and Treatment Recommendations for Dogs and Cats Prior to Anesthesia

It can be confusing to determine what a patient should receive by mouth prior to anesthesia, even if they are healthy. It becomes more complicated when there are pre-existing conditions that require treatment. Use this table to support your recommendations.

Patient Status	Withhold Water for ____ Hr		Withhold Food for ____ Hr				Feed Pâté-Consistency Wet Food	Treatments and Medications				Other
	0*	6–12	1–2	2–4	4–6	6–12		Monitor BG	Chronic Oral Meds†	Anti-emetic,§ Antacid, and Promotility Medications	Insulin	
Healthy	✓				✓				✓			
<8 wks of age or <2 kg	✓		No longer than 1–2 hr				✓ In pre-op period	Before, during, and after induction	✓			Perform as first case of the day
Diabetic	✓			✓			½ meal 2–4 hr prior	Before, during, and after	✓		½ dose given 2–4 hr prior	Perform as the first case of the day
History of, or at risk for, regurgitation		✓				✓	Consider feeding 10%–25% of normal amount 4–6 hr prior to induction		✓	✓		
Emergent		ASAP								✓		Stabilize patient prior to induction

* 0 hr = allow free access to water

† Oral medications may be administered with small amount (1–2 tbs) wet food or pills coated in an edible paste-like material.

§ Anti-emetics are a valid addition to any anesthetic protocol due to the potential for increased patient comfort by decreasing vomiting secondary to pre-anesthetic medications.

Review textbox "Recommendations for Chronic Medications the Day of Anesthesia." Use clinical judgement in healthy patients to determine if giving a small amount of in-hospital treats to facilitate gentle handling or decreasing patient stress would be beneficial prior to anesthesia.

RESPIRATORY CONCERNS

Presentation to hospital may be anywhere from minimally clinical for elective procedure to severe respiratory distress

Concerns for distress and collapse should be considered, despite presentation!

- **Aspiration pneumonia**
- **Negative pressure pulmonary edema (aka post-obstructive)**

CARDIOVASCULAR CONCERNS

- **Increased PaCO2**
- **Elevated Hct, low PaO2, chronic inflammation**
  - hypercoaguability
- **Higher resting BP**
  - Oscillometric baseline
- **Greater vasovagal tone**
  - Bradycardia

OCULAR CONCERNS

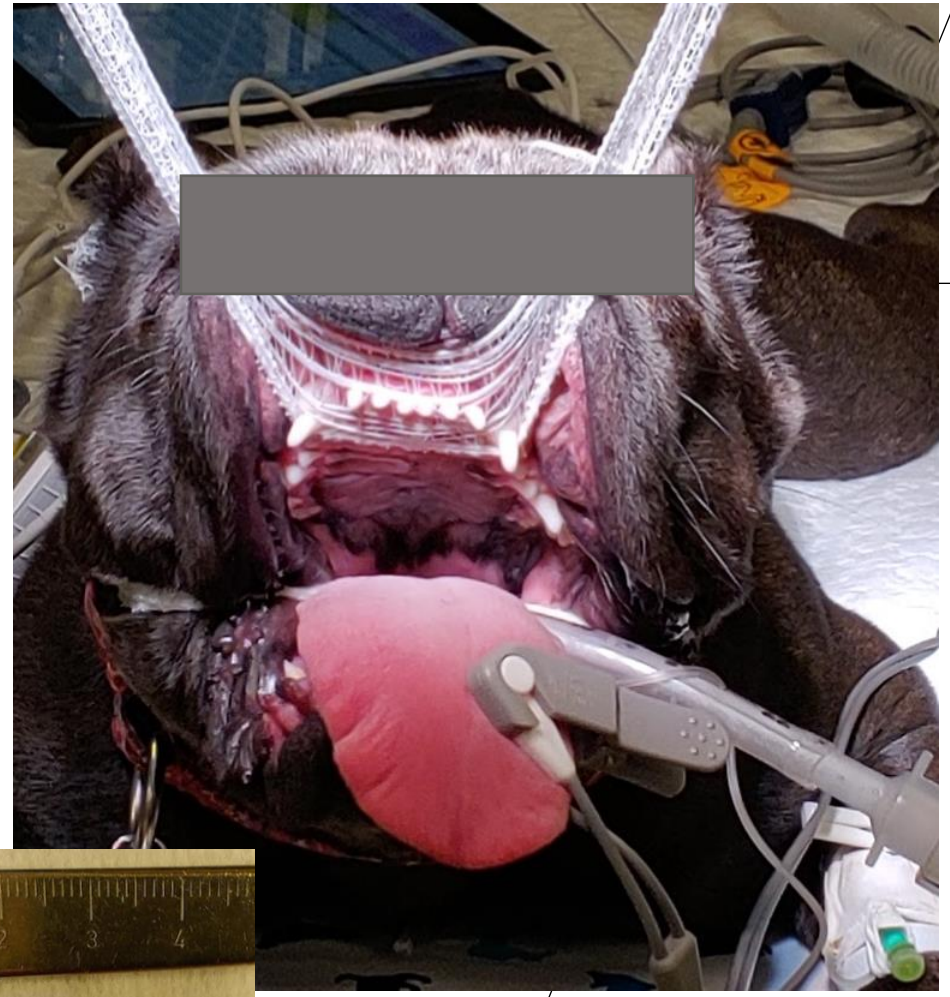
- **Proptosis**
- **Corneal injury**

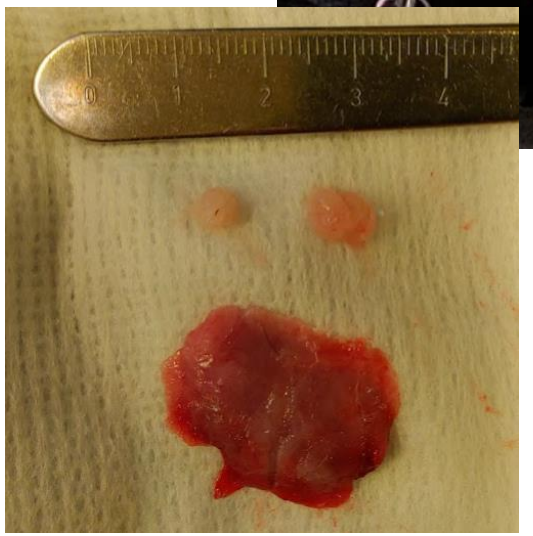
CORRECTIVE PROCEDURES

Reduce undesired clinical signs listed on slides above!

Include:

- **Staphylectomy**
- **Alarplasty**
- **Turbinectomy**
- **Vestibuloplasty**
- **Laryngeal sacculectomy**
- **Tonsillectomy**





BOAS GRADING & INDEX SCALES

Grading System

0: asymptomatic, BOAS-free

1: mild BOAS, the dog shows mild respiratory noise but exercise tolerance is unaffected

2: moderate BOAS, the dog requires medical attention such as weight control and/or surgical intervention

3: severe BOAS, the dog requires immediate surgical intervention

Numeric scale 0-100%

0%: completely asymptomatic

100%: most severe state

OUR BOAS GOALS

- Stress-free and pain-free visit
- O2 supplementation and monitoring thru before, during, and after procedure
- Secure and maintain a patent airway
- Minimize regurg/vomit to prevent aspiration pneumonia
- Slow and quiet recovery
    - Yet, avoid prolonged (excessive) sedation & recumbency

THE APPROACH?

In these cases, preparation and specific case management will be more important that the actual anesthetic/analgesic medications used!

Respiratory patient concerns (McDonnell & Kerr 2015):

1. Endotracheal intubation
2. Use of enriched oxygen (i.e. > 30-35% O2)
3. Application of “sighs” (PIP ~ 20–30 cmH2O) thru maint & rec
4. Avoid prolonged recumbency
5. Avoid large volume of IV fluid administration (if possible)

THE PLAN

Patient

Procedure

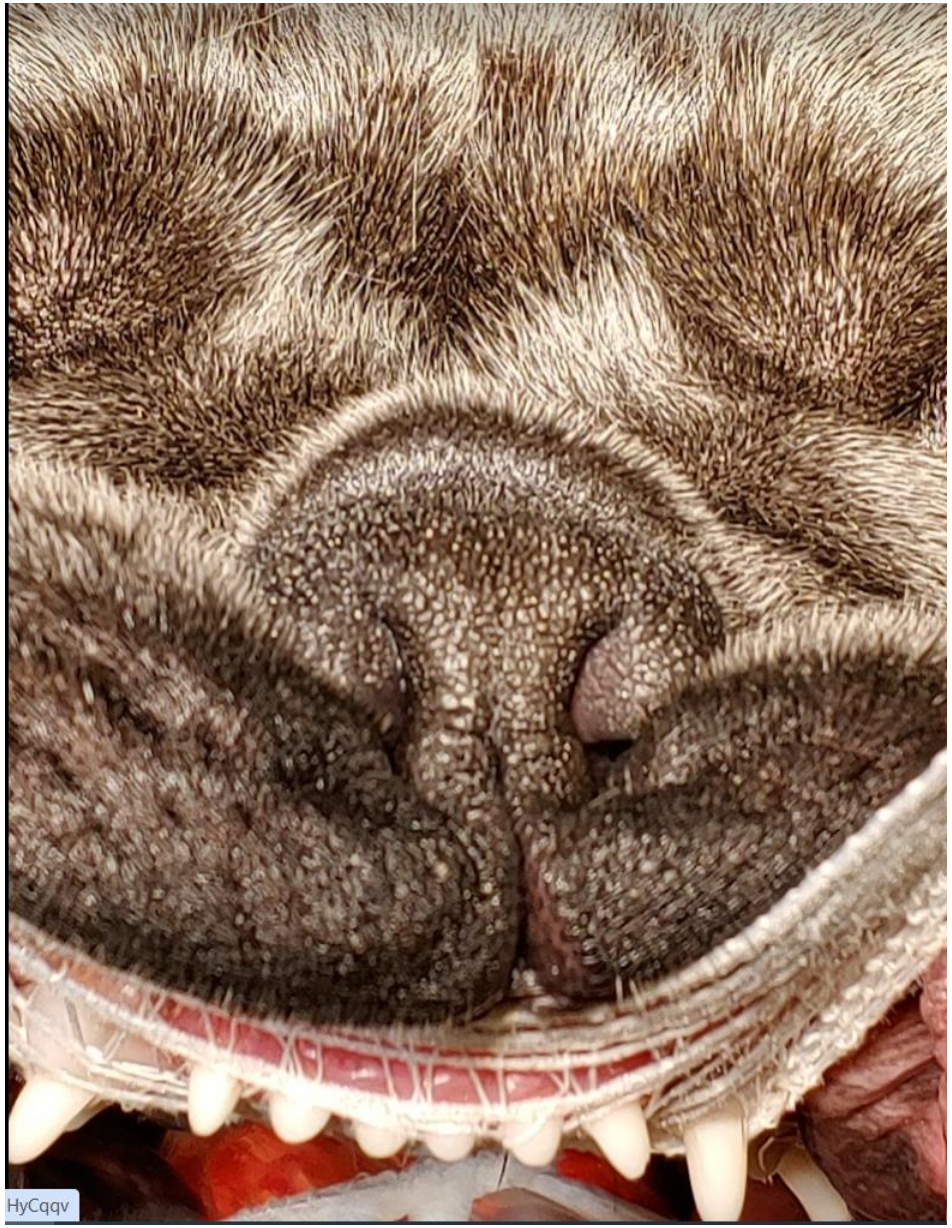
Staff

Nursing care

Monitors

Aftercare

O2



PREANESTHETIC EVALUATION

- History + PE
  - V/regurg?
  - Meds?
  - Exercise tolerance?
- CXR (3v)
  - Radiologist review of ALL images!
- Labs: CBC/Chem/lytes/UA/T4/ABG?
- SpO2 (on room air 1st)

PREANESTHETIC PLANNING

- BOAS consent form!
- IVC placement
- Sedation for safe(r) workup & handling?
  - Case-by-case assessment for type/dose of drugs selected
  - Oral meds
    - Gabapentin 10 mg/kg PO (or rectal, no data)
    - Trazodone 3-5 mg/kg PO (or rectal, 5-10 mg/kg)
  - Injectable
    - Butorphanol: 0.2 mg/kg IV (or IM, V?)
    - Acepromazine 0.01-0.02 mg/kg IV or IM

AVMA Publications

Previous Article Next Article

Editorial Type: Pharmacology

Pharmacokinetics and efficacy of trazodone following rectal administration of a single dose to healthy dogs

Erica M. O'Donnell DVM, Saya A. Press BVSC, MS, Margo J. Karriker PharmD, and Stephanie... View More +

DOI: https://doi.org/10.2460/ajvr.81.9.739

Volume/Issue: Volume 81: Issue 9

Received: 15 Aug 2019 | Accepted: 16 Jan 2020 | Online Publication Date: 01 Sep 2020

PREANESTHETIC PLANNING

Antiemetics?

- Maropitant: 1 mg/kg SQ or IV, 1-2h ahead

Gastroprotectants?

- Famotidine: 0.5 -1 mg/kg IV SLOW
- Pantoprazole: 1 mg/kg IV SLOW

Prokinetics?

- Metoclopramide: 1 mg/kg/d CRI, post-op
  - Avoid in renal dz and hypotension
  - https://www.drugs.com/drug-interactions/metoclopramide-index.html
- Cisapride

Received: 1 August 2018 | Accepted: 5 September 2018
DOI: 10.1111/jvim.15337

Journal of Veterinary Internal Medicine Open Access ACVIM American College of Veterinary Internal Medicine

CONSENSUS STATEMENT

Consensus Statements of the American College of Veterinary Internal Medicine (ACVIM) provide the veterinary community with up-to-date information on the pathophysiology, diagnosis, and treatment of clinically important animal diseases. The ACVIM Board of Regents oversees selection of relevant topics, identification of panel members with the expertise to draft the statements, and other aspects of assuring the integrity of the process. The statements are derived from evidence-based medicine whenever possible and the panel offers interpretive comments when such evidence is inadequate or contradictory. A draft is prepared by the panel, followed by solicitation of input by the ACVIM membership that may be incorporated into the statement. It is then submitted to the *Journal of Veterinary Internal Medicine*, where it is edited before publication. The authors are solely responsible for the content of the statements.

ACVIM consensus statement: Support for rational administration of gastrointestinal protectants to dogs and cats

Stanley L. Marks[1] | Peter H. Kook[2] | Mark G. Papich[3] | M. K. Tolbert[4] | Michael D. Willard[4]

Journal of Veterinary Internal Medicine Open Access

J Vet Intern Med. 2020 Feb 5;34(2):678–683. doi: 10.1111/jvim.15718

Comparative analysis of the effect of IV administered acid suppressants on gastric pH in dogs

Amanda Kuhl [1], Adesola Odunayo [1,✉], Josh Price [1], Silke Hecht [1], Kristen Marshall [1], Joerg Steiner [2], M Katherine Tolbert [2,✉]

Author information Article notes Copyright and License information
PMCID: PMC7096616 PMID: 32020689

ANESTHESIA SETUP

SpO2 in place prior! Masimo RadG or ROOT w transflectance probe

Preoxygenation

- Mask, max O2 flow, 3-5 min directly to IND

Intubation setup

- Laryngoscope +/- tongue depressors
- Lots of tube sizes, cut short
  - Hagen–Poiseuille law, and is estimated by:

    (Resistance ^{8} x viscosity x tube length) / radius^{4}

    Shortest, *widest* tube = least work of breathing (decreased R)
- Sheridan PVC = personal preference, low P high V cuff + integrity

PREANESTHETIC MEDICATION

1st: IVC in place, GA setup ready!

Formula = opioid + sedative

Opioid:

- **Fast/low procedure/pain level**
  - Butorphanol 0.2-0.4 mg/kg q 60-90 m
  - Buprenorphine 10-20 mcg/kg (0.01 -0.02 mg/kg), q 4-6h
- **Long/high procedure/pain level**
  - Methadone 0.1-0.3 mg/kg, q 2-4h
  - Hydromorphone 0.05-0.1 mg/kg, q 2-4h

PREANESTHETIC MEDICATION

Remember: opioid + sedative

Sedative, options:

- **Acepromazine 0.01-0.03 mg/kg**
  - Avoid in patients who won't tolerate hypotension, fluid boluses
- **Dexmedetomidine 0.5 – 3 mcg/kg**
  - Avoid in patients with cardiac, renal, hepatic disease or severe BOAS
- **Midazolam/diazepam 0.1-0.2 mg/kg**

INDUCTION AGENTS

Goals:

- **Rapidly secure an airway w largest possible, short ETT**
- **Avoid apnea (thus multimodal approach!)**

Agents that provide rapid onset + muscle relaxation?

- Propofol
  - 1-4 mg/kg IV slow
- Alfaxalone
  - 0.5 – 2 mg/kg IV slow

TIPS FOR DIFFICULT AIRWAY

- Use muscle-relaxing induction agent
- Ensure adequate depth
- If a stylet is used, ensure that it does not extend beyond the length of the ETT
- Water-based lubricant improves ETT seal
  - Single-use or dedicated tube to prevent contamination
- Consider IV lidocaine as part of induction protocol
  - 1 mg/kg IV SLOW (30-60s) prior to induction blunts reflex

MAINTENANCE

Isoflurane or sevoflurane in O2

ANESTHETIC MONITORING: BOAS

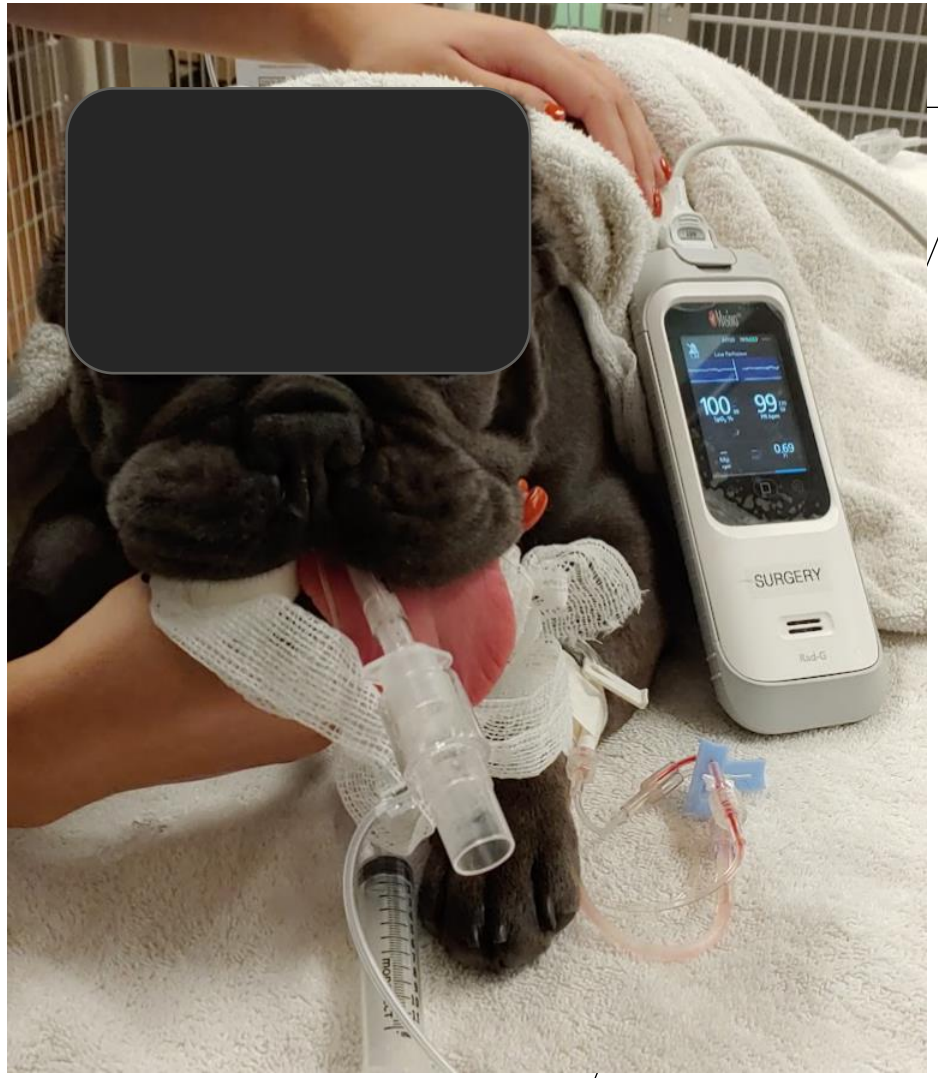
- Pulse oximetry
- End-tidal CO2
- Blood pressure
  - MAP > 60 mmHg – young, healthy
  - MAP > 80 mmHg - comorbidities
- ECG
- +/- Arterial blood-gas analysis

RECOVERY CONCERNS

- Airway obstruction
- Hypoxemia
- Hypercapnia
- Hyperthermia
- Excitement vs excessive sedation
- Pain

RECOVERY ITEMS

- Reintubation supplies
- Laryngoscope, ETT, induction agent
- Supplemental O2
- Monitoring eqpt
  - SpO2, ETCO2, +/- BP



PLAN: DESATURATION AFTER EXTUBATION

- Flowby O2
- Mouth gag use
- Extend neck, avoid pressure on ventral aspect
- Late extubation
- Reversals (?): atipamezole, butorphanol/naloxone...
- Be prepared to reintubate and provide further tx
  - Inflammation:
    - dexSP 0.1 mg/kg IV, gauze-soaked mannitol
  - Nebulization?
  - Temporary palatoplasty?

NEBULIZED EPINEPHRINE

Nebulized Adrenaline in the Postoperative Management of**Brachycephalic** Obstructive Airway Syndrome in a Pug.
Ellis J, Leece EA.
J Am Anim Hosp Assoc. 2017 Mar/Apr;53(2):107-110. doi: 10.5326/JAAHA-MS-6466.
PMID: 28282230

Nebulization of**epinephrine** to reduce the severity of**brachycephalic** obstructive airway syndrome in dogs.
Franklin PH, Liu NC, Ladlow JF.
Vet Surg. 2021 Jan;50(1):62-70. doi: 10.1111/vsu.13523. Epub 2020 Oct 12.
PMID: 33044024

Nebulised adrenaline in the post-operative management of**brachycephalic** obstructive airway syndrome in dogs: short-term outcomes in 90 cases (2014-2020).
Fenner J, Henderson CC, Demetriou JL.
N Z Vet J. 2023 Nov;71(6):329-336. doi: 10.1080/00480169.2023.2248053. Epub 2023 Aug 28.
PMID: 37599560

TEMPORARY PALATOPLASTY


JAVMA

AVMA

Temporary palatopexy procedure for brachycephalic obstructive airway crisis in dogs

Jessica Sun, DVM, DACVECC*


JSAP JOURNAL OF SMALL ANIMAL PRACTICE | BSAVA BRITISH SMALL ANIMAL VETERINARY ASSOCIATION

ORIGINAL ARTICLE

Evaluation of temporary palatopexy to manage brachycephalic obstructive airway syndrome in dogs in respiratory distress

J. A. Sun, J. A. Johnson, T. C. Hallowell

First published: 30 December 2021 | https://doi.org/10.1111/jsap.13453

OPEN ACCESS VIDEO:
https://avmajournals.avma.org/view/journals/javma/aop/javma.24.04.0236/javma.24.04.0236.xml

REFERRAL?

Experience of clinician

Client preference

Referral location, cost, availability

Available patient support

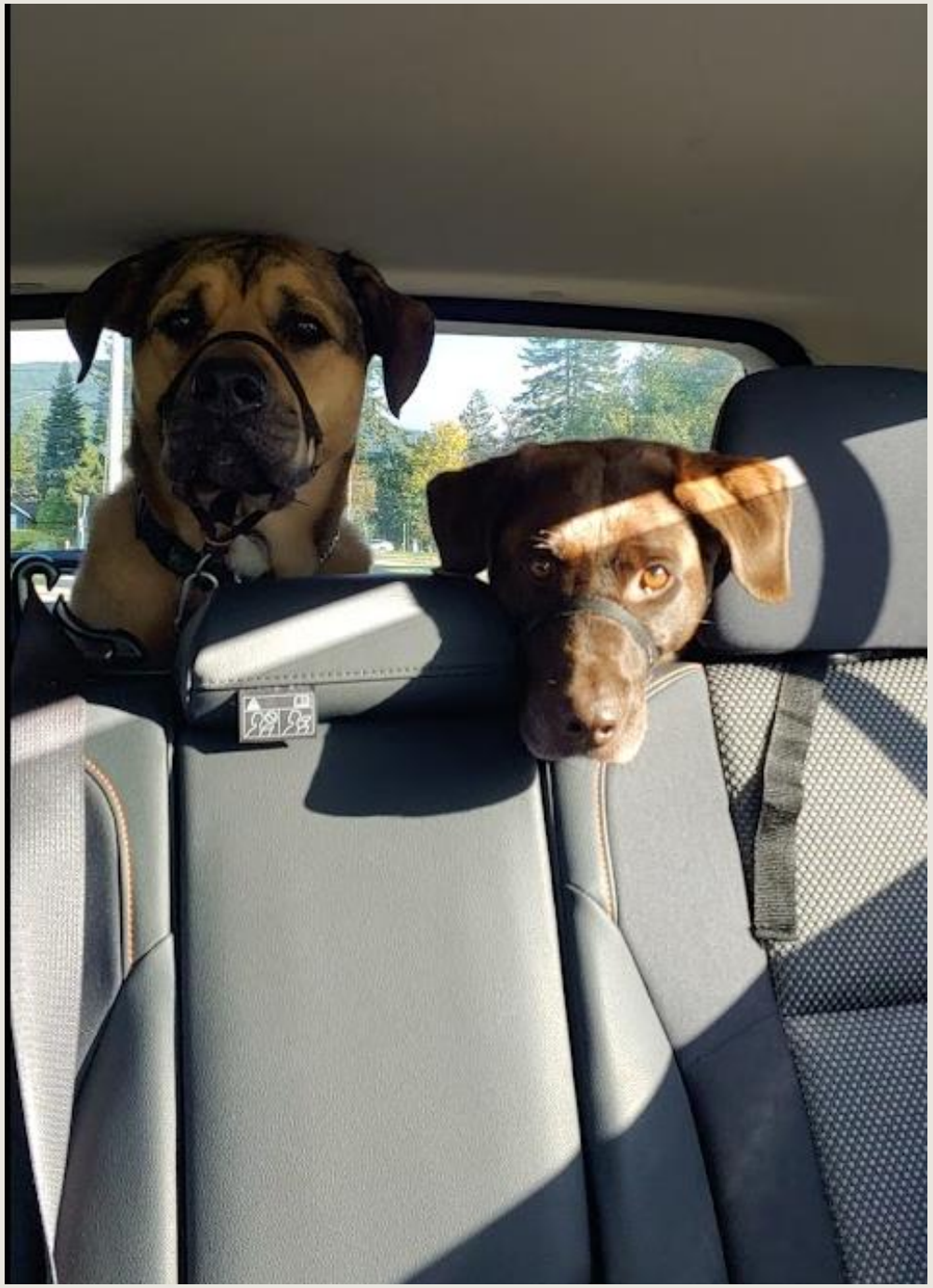
- drugs, monitoring, staff

Procedure to be performed?

Options? acvaa.org

Keep the case, get a consult, refer it...

QUESTIONS?



THANK YOU

Odette O, DVM,DACVAA

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