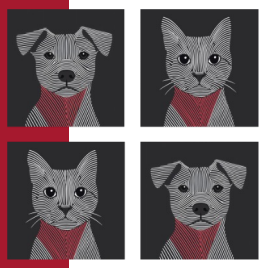
"Deep Breaths: Anesthesia Wins, Woes, and What We Did Next"



*Kelly Zammiello, LVT & Sarah Moriarty, CVT*

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## The "Perfect" Anesthesia…

- Was your patient breathing on their own?
- Did you have to use any interventions?
  - Did they recover uneventfully?
    - Were they normothermic?
  - Did they have a smooth induction?
    - Were their vitals stable?

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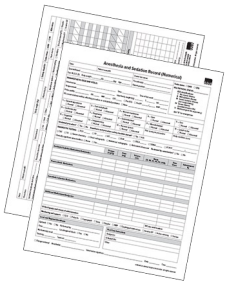
## The Wins: What Went Right?

- Thorough pre-anesthesia assessment
- Appropriate drug protocols
- Effective monitoring & documentation
- Recognize early warning signs of anesthetic instability
- Clear communication with your DVM
- Smooth recovery management



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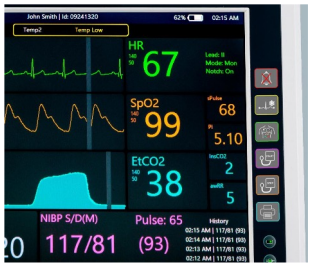
## Monitoring Wins:

**Essential Monitoring Tools**

- ECG
- Pulse Oximeter
- Capnography - ETCO2
- Blood Pressure
  - Non-invasive (doppler, oscillometric)
  - Invasive (arterial catheter)
- Temperature
- Respiratory Rate & Effort

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## Common Anesthesia Woes:

- Hypotension
- Hypertension
- Bradycardia
- Tachycardia
- Hypoventilation/ Apnea
- Hypothermia
- Delayed/Rough Recovery

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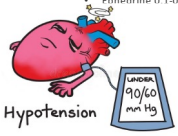
## Hypotension: How Do We Fix It?

- Confirm your blood pressure reading
  - Grab a second modality - doppler, invasive, non-invasive blood pressure
- Assess anesthesthetic depth
  - Jaw tone, palpebral reflex, response to stimuli, eye position, monitoring tools.
- Reduce your inhalant
  - ISOFLURANE VS SEVOFLURANE
- Administer a crystalloid bolus - 3-10mL/kg/10-15 min.
- Administer anticholinergic drugs
  - Glycopyrrolate: 0.005-0.01mg/kg IV
  - Atropine 0.02mg/kg IV

- Notify DVM promptly if interventions are needed
- Adding in pressure support such as inotropes and vasopressors
  - Dopamine CRI 3-10 mcg/kg/min
  - Dobutamine CRI 1-10 mcg/kg/min
  - Norepinephrine 0.1-0.8 mcg/kg/min
  - Vasopressin 0.8U/kg IV
  - Ephedrine 0.1-0.25mg/kg IV

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## What is our blood pressure formula?

Blood Pressure = Cardiac Output (CO) X Systemic Vascular Resistance (SVR)

** This means blood pressure is determined by the volume of blood pumped by the heart per minute and the resistance of the blood vessels. **

Blood pressure can drop due to...

- ↓ Heart Rate
- ↓ Stroke Volume
- ↓ Systemic Vascular Resistance
- Or any combination of the three

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## Bradycardia & Tachycardia

**Common Causes: Bradycardia**

- Excessive anesthetic depth
- Opioids
- Alpha-2 agonists
- Vagal stimulation (ocular pressure, traction, abdominal manipulation)
- Increased cranial pressure or intra abdominal pressure
- Hyperkalemia
- Severe hypoxemia

**Common Causes: Tachycardia**

- Light anesthetic plane
- Pain
- Hypotension
- Hypovolemia
- Hypercapnia
- Hypoxemia
- Anticholinergic administration
- Sepsis
- Arrhythmias

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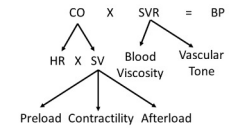
## Bradycardia & Tachycardia - Why It matters?

**Cardiac Output = Heart Rate X Stroke Volume**




* CO = cardiac output; SVR = systemic vascular resistance; BP = blood pressure; HR = heart rate; SV = stroke volume

Bradycardia: HR too low

- ↓ Cardiac output
- ↓ Blood pressure
- ↓ Organ perfusion
- Risk of arrest

Tachycardia: HR too high

- Increases myocardial oxygen demand
- Reduced diastolic filling time
- Can worsen hypotension
- Risk of arrhythmias

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## Bradycardia & Tachycardia

**Bradycardia - Assessment**

- Check BP cuff
- Asses AX depth
- Reduce inhalant if deep
- Address hypothermia
- Ensure oxygenation
- Treat if hypotensive

**Interventions May Include:**

- Decrease AX depth
- Anticholinergic administration
- Reverse alpha-2's if appropriate (atipamezole)
- Begin CPR if decompensating (follow RECOVER guidelines)

**Tachycardia - Assessment**

- Check BP cuff
- Assess AX depth
- Check ETCO2
- Evaluate sx stimulation
- Assess fluid status

**Interventions May Include:**

- Increase AX depth
- Provide additional analgesia
- IV fluid bolus
- Correct ventilation
- Treat underlying arrhythmia

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## When should we NOT treat bradycardia?

- When our patient's BP is normal
- Expected drug effects (such as dexmedetomidine)

Treat the patient - not just the number on your monitor.

Would you treat this canine patient's bradycardia?


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## Bradycardia & Tachycardia: Putting It All Together…

| Heart Rate | Blood Pressure | Likely Cause | Action |
|---|---|---|---|
| Low HR | Low BP | Excess Depth | Reduce Inhalant |
| Low HR | Normal BP | Drug Effect | Monitor |
| Hight HR | Low BP | Hypovolemia | Fluids |
| High HR | Normal BP | Pain/Light | Analgesia |

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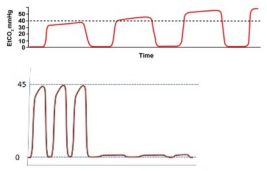
## Hypoventilation/Apnea

- Normal ETCO2 in dogs/cats = 35-45 mmHg
- Hypoventilation = increase in ETCO2
- Apnea = low to zero ETCO2







Troubleshooting Hypercapnia/Hypoventilation:

- Assess anesthetic depth (too deep?)
- Check CO2 absorbent/granules (soda lime/sodasorb)
- Check for an obstruction/occlusion

Troubleshooting Hypocapnia/Apnea:

- Assess anesthetic depth (too light/deep?)
- Assess cardiac output (Blood Pressure, Pulse Ox)
- Check for obstruction/occlusion or a disconnection
- Check ETT positioning
- Check body temperature

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## Hypoventilation/Apnea: Interventions

Hypoventilation/Hypercapnia

- Initiate IPPV - especially if ETCO2 over 55 mmHg
- Increase 02 flow rate (especially if soda lime exhausted)
- Decrease body temperature if hyperthermic (turn off heat support)
- Decrease anesthetic depth if too deep
- Check flutter valves for sticking (usually will see increase in inspiratory CO2)

Apnea/Hypocapnia

- Initiate IPPV
- Adjust anesthetic depth accordingly
- Initiate heat support or add heat support if hypothermic
- Give BP support if hypotensive
- Doxapram (Dopram)? - not recommended under anesthesia

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## Hypothermia

- Normal temperature = 100°F-102.5°F
- Important for cardiac function, metabolism, normal enzyme activity, nerve conduction, and hemostasis
- The most common anesthetic complication of dogs and cats
  - 40-97% of patients
- 75% of heat loss occurs from the body surface and the remainder is lost from the respiratory tract
  - Convection, Conduction, Evaporation, Radiation
- Greatest rate of heat loss occurs after induction and during the first 20 minutes of anesthesia

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## Hypothermia - Why It Matters?


- Leads to bradycardia, decreased cardiac output, hypotension
  - Anticholinergics (Atropine, Glycopyrrolate) are less likely to work
- Asystole or fibrillation can occur closer to 90°F
- Prolonged coagulation times and impaired platelet function leads to increased bleeding
- Metabolism is slowed causing delayed recovery times due to impaired liver function
  - Anesthetic depth increases as temperature decreases if inhalant not lowered
- Apnea, hypercapnia, hypoxia
- Increased post-op infection rates
  - Decreased perfusion and low oxygen in the tissues
  - Impaired immune function
- Shivering can lead to increase O2 demand (hypoxemia) and increased pain

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## Hypothermia - Interventions

- Preventing heat loss is easier than warming up a cold patient!
- Pre-warm during induction
- Avoid cold scrub/alcohol; Warm saline intra-op
- Lower O2 flow rates minimize heat loss from respiratory tract
- Circulating warm water blankets, forced warm air devices
- Blankets and dry towels
- IV fluid warmers
- Plastic wrap or bubble wrap
- Troubleshoot thermometer if sudden heat drop
  - if esophageal could be too far in or could have slipped out
- Can combine multiple modalities!

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## Recovery from Anesthesia

- Most anesthetic-related fatalities occur in recovery
  - 47% of dog, 61% of cat and 64% of rabbit anesthesia-related fatalities
- Rough recovery = vocalization, paddling, head thrashing, disorientation
  - Causes
    - Pain - responsive to human interaction
    - Emergence delirium - unaware of their surroundings, excitement/agitation/restlessness and vocalization
    - Dysphoria - profound state of unease/anxiety/agitation
      - Dogs: agitation, excitement, restlessness, vocalization, disorientation
      - Cats: hallucinatory behavior, open-mouth breathing, agitation, vocalization and pacing
- Temperament and anxiety level prior to anesthesia
- History repeats itself… a rough recovery in the past or rough induction = good chance for dejavu

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## Rough Recovery - Suggestions

- Was there appropriate analgesia for the procedure?
  - Pure mu-opioid vs. Butorphanol
- When was last analgesia?
  - 4-6 hours for most opioids vs CRI
- Was there a sedative given as part of the protocol? When was the last dose?
  - Smaller/Micro doses of sedatives usually sufficient in recovery
    - Acepromazine 0.01 mg/kg or Dexmedetomidine 1-2 mcg/kg
- Is the pet responsive to human interaction?
  - Differentiate pain vs dysphoria
    - If dysphoria - administration of an opioid will have no effect or make it worse
      - Partial reversal with Butorphanol (0.1 mg/kg)
    - If pain - most sedatives have little to no analgesia

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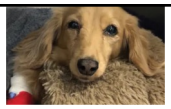
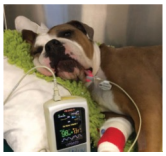
## Rough Recovery - Interventions





- Reversals
  - Flumazenil, Naloxone, Atipamezole
- Partial Reversals
  - Butorphanol
- Consider oral premedications
  - Trazodone, Gabapentin for dogs
  - Trazodone, gabapentin, pregabalin for cats
  - Maropitant
- Having a dedicated recovery area can help
  - Quiet, dimly lit, and maintained at room temperature
  - Soft bedding with extra padding for underweight, arthritic, or non-ambulatory pets
  - Soothing pheromones (Feliway/Adaptil)
- Walking pets before anesthesia or expressing their bladders

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## Prolonged Recovery

- Patient does not respond to stimuli an hour after the end of anesthesia
- Can be caused by physiological depression and/or excessive anesthetic depth
  - Negative Feedback Loop - excessive depth leading to physiological depression, which in turn further increases anesthetic depth
  - Hypothermia decreases drug metabolism
- Can be caused by excessive drug administration
  - Not decreasing doses for an overweight pet
- Other causes: hypoxemia, hypoventilation, hypotension, hypoglycemia, concurrent comorbidities

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## Case Study - "Heidi"

- 3 yr F/S Siberian Husky presented for vomiting, lethargy, fever, abdominal effusion
- Prior abdominal surgery 6 days before presentation
  - SIFBO - Gastrostomy, Enterotomy, and R&A
- AUS confirmed "early" septic abdomen
- Admitted for abdominal exploratory surgery
- Notable pre-op bloodwork:
  - Elevated WBC
  - PCV/TS: 48%/6.8
  - Lactate: 3.81 mmol/L
    - Lactate = by-product of anaerobic glycolysis
    - Increase = inadequate perfusion and oxygenation of cells
    - dehydration, hypovolemia, shock
  - Values >2.5 mmol/L = hyperlactatemia

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## Case Study - "Heidi"

- Pre-op Vitals - Weight: 26.1 kg, T: 102.1°F, P: 176, R: 28, MM: pink/tacky, CRT: <2 seconds, BP: 144/107 (119)
- Methadone 0.3 mg/kg IV, Maropitant 1 mg/kg IV, Lidocaine 2 mg/kg IV, Midazolam 0.2 mg/kg IV, Propofol to effect (~ 1 mg/kg IV), Cefazolin 22 mg/kg IV q 90 minutes, maintained on O2 and Isoflurane ~ 1.5%
- Fentanyl CRI at 10 mcg/kg/hr and Lidocaine CRI at 30 mcg/kg/min
- Tachycardia noted pre- and immediately post-induction
- 15 minutes post-induction moved into the OR and placed on ventilator


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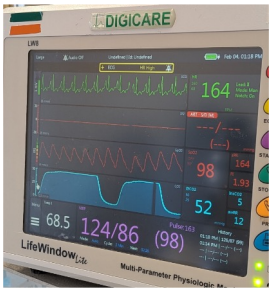
## Case Study - "Heidi"

- Tachycardia persisted in the OR
- Pulse pressure variations on plethysmogram
  - Only seen with IPPV - positive pressure in the thorax decreases preload of the right ventricle thus decreasing stroke volume
  - The greater the variation, more likely to respond to fluid bolus
- Hyperlactatemia, persistent tachycardia, pulse pressure variations - fluid bolus
  - 10 mL/kg crystalloid fluid bolus IV over ~ 15 minutes
  - 15 minutes later HR: 120 and remained in the 120s for the rest of the surgery (R&A)
- Outcome: patient recovered uneventfully and was able to be discharged several days later



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## Case Study - "Fred"

- 12 yr M/N Domestic Shorthair presented for CT Scan Head/Neck and oral/nasal biopsies
  - Chronic rhinitis and suspect right-sided maxillary lesion
- Pre-op vitals - Weight: 7.09 kg, T: 100.1, P: 190, R: 36, MM: pink, CRT: <2 seconds, BP: unable to obtain
- Received oral Maropitant the night before, unsure if O gave him Gabapentin prior to drop-off
- Methadone 0.3 mg/kg IM, Alfaxalone 1 mg/kg IM to facilitate IVC placement
- Pre-op PCV/TS: 40%/7.6
- Alfaxalone 1 mg/kg IV and Midazolam 0.2 mg/kg IV for induction
- Fentanyl CRI 10 mcg/kg/hr and Alfaxalone CRI 0.05 mg/kg/min
- Maintained on O2 and Isoflurane 0.5% - 0%



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## Case Study - "Fred"

- After moving into dental operatory, became bradycardic and hypotensive
  - HR: 120, BP: 76/46 (55)
- Administered Glyopyrrolate 0.01 mg/kg IV
- ~5 minutes later heart rate improved to 140 and blood pressure improved 95/62 (72)
  - HR and BP remained at similar values for the remainder of the procedure
- Outcome: patient recovered uneventfully and was discharged




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## Key Notes

- Preparation prevents most anesthetic complications
- Trends matter more than single numbers
- Early communication saves lives
- Treat your patient – not just the monitor
- Your formula's!
  - Blood Pressure= Cardiac Output (CO) X Systemic Vascular Resistance (SVR)
  - Cardiac Output (CO)= Heart Rate (HR) X Stroke Volume (SV)

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## Any Questions????

Kelly & Sarah's emails
kzammiello@cuvs.org
smoriarty@cuvs.org

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**"Every time we induce anesthesia, we're asking a patient to trust us with their life. They don't know what a capnograph is. They don't know what a MAP should be. They just know they're in our hands…"**

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"Deep Breaths: Anesthesia Wins, Woes, and What We Did Next"

# THANK YOU!!!!!

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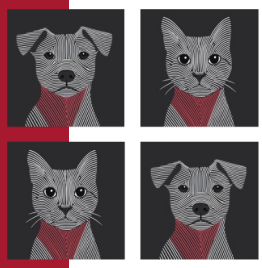

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