Anesthesiology for Veterinary Technicians

Monitoring the Anesthetized Patient
Additional Reading

Anesthesia and Analgesia for Veterinary Technicians  (4th edition)
John a. Thomas, Phillip Lerche
http://evolve.elsevier.com

- Chapter 5: Anesthetic Monitoring
  - Introduction to Monitoring pages 139-140
  - Indicators of Circulation pages 143-146
  - Start at Capillary Refill Time on page 151 and read to page 170
Additional Reading

Lumb & Jones’ Veterinary Anesthesia and Analgesia (4th edition)
William Tranquilli, John Thurmon, Kurt Grimm

- Chapter 19: Monitoring Anesthetized Patients
  - Pages 533-558
Additional Reading

Clinical Textbook for Veterinary Technicians (8th edition)
Joanna M. Bassert, John A. Thomas
http://www.evolve.elsevier.com/Bassert/McCurnin/

- Chapter 29: Veterinary Anesthesia
  - Anesthetic Monitoring Pages 1102-1112
Why should we monitor anesthetized patients?

Monitoring the anesthetized patient allows the veterinary anesthetist to identify problems early, institute treatment promptly, and thus avoid irreversible adverse outcomes.
Goal of Anesthetic Monitoring

The overall goal of monitoring anesthetized animals is to ensure adequate tissue perfusion with oxygenated blood.
How to monitor the anesthetized patient?

- Subjective and objective monitoring of anesthetized patients
  - Subjective monitoring involves using the anesthetist's visual, touch, and auditory senses to assess the patient’s vital signs.
  - Objective monitoring involves the use of monitors to assess the patient’s vital signs.
What parameters should be monitored?

- The American College of Veterinary Anesthesiologists (ACVA) developed a set of guidelines for monitoring anesthetized patients.

- [http://www.acva.org](http://www.acva.org)
ACVA Monitoring Recommendations

- Circulation
- Oxygenation
- Ventilation
- Personnel
- Medical Record
### The Anesthetic Record

- Legal document
- Monitor continuously
- Record every 5 minutes
- Alerts you to trends

<table>
<thead>
<tr>
<th>Time</th>
<th>Drug, Dosage, Route</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00</td>
<td>DEBECOL 25 mg iv/IM</td>
<td>good</td>
</tr>
<tr>
<td></td>
<td>GLYCO 0.025 mg/kg</td>
<td></td>
</tr>
</tbody>
</table>

**Blood Flows**

- LRS

**Induction**

- KET 12.5 mg/kg iv
- DIAZ 0.625 mg/kg

**Meds**

- GLYCO 0.025 mg/kg iv
- NYXO 0.2 mg/kg

**Codes/Remarks**

- CPDSC 5 E 20

**Symbols**

- A: Assisted
- C: Controlled
- D: Diazepam
- M: Mean
- T: Temperature
- P: Pulse

**Recovery Notes**

- Smooth

**Anesthesia Time**

- 1.5 hr
Circulation

- Electrical activity
  - can have electrical activity without mechanical activity (pulseless electrical activity PEA)
- Mechanical activity
  - pulse pressure
  - mean arterial blood pressure
  - central venous pressure
Three forms of cardiac arrest

- Asystole
- Ventricular fibrillation
- Pulseless electrical activity
Electrical Activity

Electrocardiogram (ECG)
ECG Leads

• Alligator clips
  • May cause trauma
  • File or clamp teeth smooth
  • May attach to skin staples
• Use fine gauge wire needles
• Use stick-on patches
• Esophageal stethoscope
Tape on patches
Three-lead system used during anesthesia

- **Lead I**
  - Left forelimb
  - Or
  - Left thorax

- **Lead II**
  - Left hindlimb
  - Or
  - Left flank

- **Lead III**
  - Right forelimb
  - Or
  - Right thorax
Monitoring Pulse Pressure

- Palpation
- Auditory
  - doppler
  - esophageal stethoscope
  - pulse oximeter
Pulse Pressure

- Movement of blood through the arterial system
- Pulse pressure is not a reliable indicator of mean arterial pressure
- Pulse pressure is the difference between systolic and diastolic pressure
- Calculated:
  - 120/80   \[120 \text{ mmHg} - 80 \text{ mmHg} = 40 \text{ mmHg}\]
  - 80/40   \[80 \text{ mmHg} - 40 \text{ mmHg} = 40 \text{ mmHg}\]
Pulse Palpation

- Most common sites in dogs and cats:
  - Femoral artery
  - Carpal & Tarpal arteries
  - Lingual artery
Monitoring Pulse

- Auditory Pulse Monitoring
  - Esophageal Stethoscope
  - Doppler (ultrasonic flow detector)
Doppler

piezoelectric crystal

ultra sound energy

receiver

amplifier

blood flow
Arterial Blood Pressure

- Mean Arterial Pressure (MAP) = Cardiac Output (CO) \times \text{Systemic Vascular Resistance (SVR)}
- Cardiac Output = Heart Rate (HR) \times \text{Stroke Volume (SV)}
- Stroke Volume = \text{Load} \times \text{Contractility}
Arterial Blood Pressure

• Mean Arterial Pressure (MAP) is what drives blood (perfusion), maintain > 60 mmHg during anesthesia.
• MAP is the lateral force per unit area exerted on a vessel wall
• Calculated:
  • Systolic P+ Diastolic P+ Diastolic P / 3 = MAP
  • 120/80  [120 mmHg + 80 mmHg + 80 mmHg] / 3 = 90 mmHg
  • 80/40   [80 mmHg + 40 mmHg + 40 mmHg] / 3 = 53.3 mmHg
Indirect Arterial Blood Pressure Methods

- Indirect = non-invasive
- Two indirect methods
  - Manual = Doppler method
  - Automated = Oscillometric method
Doppler Method Arterial Blood Pressure (non-invasive)
Dinamap Arterial Blood Pressure (non-invasive)

- Detects pressure pulsations produced within a cuff bladder
- Microprocessor controlled device inflates to suprasystolic pressure then deflates cuff
- Determines systolic, mean, and diastolic pressures
Cuff size and placement

- Cuff width = 40% of limb circumference
- Cuff too narrow - artificially elevates values
- Cuff too wide - artificially lowers values
- Cat - above elbow if possible on medial side
- Dog - distal forelimb or rearlimb
- Equine - tail
- Ruminant - tail or distal limb
Direct Arterial Blood Pressure Methods

Direct = invasive

Requires an arterial catheter

Two direct methods

Connect arterial catheter to:

1. Mechanical movement is converted to electrical energy via a transducer and read with an oscilloscope

2. Pulsations can be read with an aneroid manometer
Central Venous Pressure (CVP)

- Measure of the luminal pressure of the intrathoracic vena cava or right atrium
  - Reflects ability of heart to pump blood returning to it
  - Reflects adequacy of the circulating blood volume

Connect to either: Water Manometer or Transducer
Measurement of Central Venous Pressure
Monitoring Ventilation

- Observation
  - thoracic wall movement
  - breathing bag movement

- Auditory
  - “Honker”
  - esophageal stethoscope

- Carbon Dioxide
  - blood gas
  - capnography
Ventilation

- Rate, rhythm, nature, effort
- Rate: varies widely, look for sudden changes

TACHYPNEA
- too light or too deep
- drug induced
- obese & geriatric
- hypoxia
- hyperthermic

BRADYPNEA or APNEA
- CNS depression (too deep?)
- opioids
- propofol
- after neuro procedures
Auditory Monitoring of Ventilation

“Honker” = thermistor measures changes in air temperature

Esophageal Stethoscope
Monitoring Ventilation via Carbon Dioxide

- Two Methods
  - Arterial blood gas analysis (invasive)
  - End-expired analysis = Capnography (non-invasive)
Capnograph

An instrument that measures end-tidal carbon dioxide (ETCO₂) providing an estimate of arterial carbon dioxide partial pressure (PaCO₂).

![Diagram showing the flow of CO₂ through different compartments: Interstitial fluid, Arterial, Venous, Alveolar, End Tidal CO₂.](image)

- Arterial pCO₂ 40 mmHg
- Venous pCO₂ 45 mmHg
- Alveolar pCO₂ 40 mmHg
- End Tidal CO₂ 35 mmHg
Capnography

- Normal arterial CO$_2$ = 40-45 mmHg
- End-expired (end-tidal) CO$_2$ approximates arterial values

INCREASED CO$_2$
- hypoventilation
- overproduction
- rebreathing

DECREASED CO$_2$
- hyperventilation
- cardiac arrest
Normal
Clinical Uses of Capnography

rebreathing of carbon dioxide:

![Graph](image1)

-cardiac arrest:

![Graph](image2)
Cardiogenic Oscillation

undulations in capnogram that are synchronous with cardiac contractions
Clinical Uses of Capnography

- Monitoring respiration and ventilation
  - apnea alarm
- Verify tracheal intubation
- Monitoring for rebreathing of carbon dioxide:
  - added dead space
  - faulty inspiratory/expiratory valves in circle
  - used up carbon dioxide absorber (soda-sorb)
- Prediction of survival from cardiac arrest
Types of Capnographs

Mainstream

Sidestream
IR Absorbing Gases
Types of Capnographs (Side Stream shown)
Monitoring Oxygenation

- Three Methods
  - Mucous membrane color (non-invasive)
  - Arterial blood gas analysis (invasive)
  - Pulse Oximetry (non-invasive)
Adequate Oxygenation Depends Upon

- adequate blood oxygen
  - dissolved (partial pressure measured in mmHg)
  - bound to hemoglobin (saturation measured in %)
- adequate hemoglobin content
- adequate peripheral perfusion

Arterial blood transportation of oxygen

\[ \text{O}_2 \text{ Sat} = 98-99\% \]

\[ \text{PaO}_2 = 1-2\% \]
What is the Oxyhemoglobin Dissociation Curve?

A curve depicting the relationship between hemoglobin oxygen saturation and the partial pressure of oxygen in the blood.

Hypoxia = $PO_2$ of 60 mmHg

90% Sat = $PO_2$ of 60 mmHg
Mucus Membrane Color

“Cyanosis”

- Occurs when unsaturated HgB exceeds 5g/100 mls
- Blood turns from a red to a blue color
- Unreliable
  - anemia
  - bad lighting
  - skin pigment
Arterial blood gas analysis provides information about:

- Acid-Base
- Oxygenation
  - hemoglobin saturation
  - oxygen partial pressure
- Ventilation
  - carbon dioxide partial pressure
Pulse Oximeter
An instrument that provides a continuous estimate of the percent of hemoglobin saturated with oxygen.

Also provides information about:
- pulse rate
- pulse rhythm - audible changes
- cardiac output
Pulse Oximetry

HgB and OxyHgB absorb at different wavelengths

light emitting diodes

photodetector
Types of probes

OxyTip\textsuperscript{\textregistered} sensors and cables - Patient Connections
(check sensor packaging for specific instructions on weight ranges and sensor applications)

**OxyTip+ Adult/Pediatric Adhesive sensor**

- Oxy AP 30
- Oxy AP 25

**OxyTip+ AIIFit Adhesive sensor**

- Each adhesive tape included

**OxyTip+ Sensitive Skin Multi-site sensor**

- Dry SE 3

**OxyTip+ Wrap Multi-site sensor**

- Dry WHL, Dry WHL, Dry W DB

**OxyTip+ Ear Reusable sensor**

- Dry E-GN, Dry E-UH, Dry E-DB

**OxyTip+ Finger Reusable sensor**

- Dry F-FL, Dry F-HL, Dry F-H, Dry F-N, Dry F-DB

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Interference with the pulse oximeter

- Motion
- Low perfusion
- Optical interference
  - external light interference
  - anemia (hemoglobin < 5 gm/dl)
  - carbon monoxide
  - methemoglobin
  - intravascular dyes (methelyne blue)
Additional Things to Monitor

- Adequacy of anesthesia
- Temperature
- Blood loss
Depth of Anesthesia

- CNS activity (EEG)
- Muscle relaxation (jaw tone)
- Response to stimuli
- Sympathetic responses, HR, BP, RR
- Eye position/activity
Response to Stimuli

Pedal Reflex

Tail Pinch

Towel Clamps
Muscle relaxation

Relaxed Jaw Tone
Eye Position & Activity

- Eye rotated ventral-medial indicate surgical plane of anesthesia
- Dull palpebral reflex
- Horses: nystagmus and tearing indicates light plane of anesthesia

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Blood Loss

- Subjective: inaccurate, can’t see it all. One 4x4 swab can contain 10 mls of blood
- Objective: weigh swabs, measure volume in suction containers etc...
Changes in Temperature

Core
  - esophageal
  - middle ear

• Periphery
  - rectal
  - nasal
Hypothermia

- Increased cardiac irritability
  - bradycardia
  - spontaneous fibrillation
- Hypoventilation
- Increased blood viscosity

- Decreased anesthetic requirements
- Decreased metabolism
  - delayed recovery
- Shivering in recovery
  - increased oxygen requirements
Warming Blanket
Homemade Warming Blanket
Hot Dog & Water Blanket