Essentials of Anaesthetic Monitoring in Veterinary Practice

A refresher and update lecture

By Prof Yves Moens, Dipl ECVAA

Presented by Dr Alessandra Bergadano, Dipl ECVAA
Technical Monitoring human

From 1864 to 2010
Technical monitoring for vets

eighties

Bulky, fixed
paper recordings

today

Compact, portable
Usb-stick
A fine combination

• 1. Capnometry/Graphy
• 2. Pulsoximetry
• 3. Electrocardiography
• 4. Blood pressure
• 5. Temperature
Capnometry/Graphy
Capnometry/graphy

• Continuous measurement of CO$_2$ in respiratory gas
• Displayed numbers
  – ETCO$_2$: content of „end tidal“ part
  – FICO$_2$: content in inspiratory gas
• Principle = infrared spectroscopy
• Curves :“capnogram“
Capnometry/graphy

• Continuous measurement of CO$_2$ in respiratory gas, why?

• Idea: ETCO$_2$ = ± PaCO$_2$

• = continuous, non invasive measurement of PaCO$_2$
Capnometry/graphy

Principle

Capnogram
Capnometry/graphy

1969

1999

2009
Capnometry/graphy

Various combinations with and without Wave forms
Capnometry/graphy

$\text{ETCO}_2$ depends of:

- Ventilation
- Circulation
- Metabolism

*Essential for correct interpretation!!*
Capnometry/graphy

Classical side stream
Main stream

Side stream
Capnometry/graphy

• Info on the efficacy of ventilation: PaCO$_2$ is determined by ventilation (min vol)
  - info: hyper- or hypoventilation
  - info: respiratory rate
  - no info on respiratory volumes !!

• Apnoe monitor
Capnometry/graphy

- Definitive confirmation of correct endotracheal tube placement!

*Oesophageal intubation is a very common mistake!*
Capnometry/graphy

• Control of pulmonary perfusion: ETCO$_2$ is low when:
  – Low cardiac output
  – Mismatch of Ventilation/Perfusion
    – Pulmonary embolus

• Best detector of acute circulatory deficiency (cardiac arrest, imminent cardiac arrest)
Low CO and cardiac arrest – anaesthetic overdose

Air embolism from infusion line
Capnometry/graphy

- Control of the efficacy of external or internal cardiac massage

- $\text{ETCO}_2$ during cardiac massage is a good help for prognosis of reanimation efforts
Capnometry/graphy

- Control of correct removal of expired CO$_2$ from anaesthetic circuits through control of FICO$_2$
  - Semi-open systems like Bain, T-piece
    - Necessary minimal flow guided by FICO$_2$ instead of fixed values/kg
  - Circle systems
    - FICO$_2$ as a guide for replacement of carbon dioxide absorber when exhausted
Capnometry/graphy

- Control of the correct function of the inspiratory and expiratory valves of a circle system
- Detection of disconnections tube-circuit
- Detection of big leaks like eg from non insufflated cuffs
Capnometry/graphy

- Extremely important monitor
- For interpretation the acknowledgment of 3 contributors to the value is important: Ve-Ci-Me
- Needs correct technical sampling of gas (side stream)
Capnometry/graphy

- Intubation in principle necessary

- Capnograms are necessary for detailed interpretation

- Main stream is advantageous for small tidal volumes and high respiratory rates

**no Information on oxygenation !!!**
Pulsoximetry
Pulsoximetry

• Continuous non invasive measurement of the saturation of arterial hemoglobin $\text{SpO}_2$ and heart rate

• Dual wavelength infrared Spectroscopy

• Correct interpretation supposes familiarity with the oxyhemoglobin dissociation curve
Pulsoximetry

![Graph showing extinction of light at different wavelengths for HbO2 and Hb]

![Diagram of pulsoximetry device with light passing through artery and intervening tissue]

![Image of a digital pulse oximeter displaying SpO2 and pulse values]
Oxyhemoglobin dissociation Curve

80 mmHg = 90%
90 mmHg = 95%
Pulsoximetry
Pulsoximetry

- During anaesthesia (immobility)
- Intensive Care-Recovery: more difficult (movement)
Pulsoximetry

$\text{SpO}_2 \ 80\%$

"HR" X
## Measurement artefacts for $\text{SpO}_2$

<table>
<thead>
<tr>
<th>Factor</th>
<th>effects on $\text{SpO}_2$ Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carboxy Methemoglobin</td>
<td>to high</td>
</tr>
<tr>
<td>Pigmentation</td>
<td>variable (to low)</td>
</tr>
<tr>
<td>Hypoperfusion</td>
<td>variable (to low)</td>
</tr>
<tr>
<td>Vasoconstriction</td>
<td>variable (to low)</td>
</tr>
<tr>
<td>Arrythmies</td>
<td>variable (to low)</td>
</tr>
<tr>
<td>Hypothermie</td>
<td>variable (to low)</td>
</tr>
<tr>
<td>Movement</td>
<td>variable (to low)</td>
</tr>
</tbody>
</table>
Pulsoximetry

Difficult measurement during vasoconstriction

Displayed number (low) real??

• Strenght of of the electronic signal ?
• Amplitude and morphology of the photoplethysmographic curve?
• Replace and remesure
• Coulor of the muquous membranes ?
Pulsoximetry

SpO$_2$ can be normal (>95%) during severe hypoventilation when animals are receiving O$_2$ supplementation

FIO$_2$ = 21% : S$_{PO_2}$ ↓ if P$_{aCO_2}$ ↑

FIO$_2$ > 30 % : S$_{PO_2}$ − if P$_{aCO_2}$ ↑
Pulsoximetry: clinical interpretation

- A low \( \text{SpO}_2 \) value in an \( O_2 \) supplemented breathing patient is to be investigated for:
  - Measurement artefact
  - Important Circulation problem: low cardiac output
  - Important right to left shunt (collapsed lung areas)
    - pneumothorax, lung contusion, one lung intubation, lung compression by hernia etc
Pulsoximetry

- Information less “robust” than capnography
- Values suspect during peripheral vasoconstriction
- Display of curves advised
- Detection of hypoventilation possible if FIO$_2$ 21%
- Limited sensitivity for ventilation changes during gaseous anaesthesia, (FIO$_2$ !)

no information on CO$_2$ !!!
The combination of both capnography and pulsoximetry during anaesthesia has the potential to warn and to avoid 93% of possible lethal complications

Tinker, 1998
Electrocardiography
Electrocardiography
Electrocardiography

• Heart Rate
  – Essential information indicating many different problems during anaesthesia
  – also obtainable from pulsoxymetry

• Disturbances of cardiac rhythm
  – Potentially severe problem
  – Essential for differential diagnosis of cardiac arrest
Electrocardiography

• Quality of the signal important
  – Adhesive electrodes
  – Subcutaneous needle placement
  – Crocodile clamps

• Practical alternative: Esophageal ECG
  – Simple and practical (less cables)
  – Stable good quality signal
Electrocardiography
no information on the cardiac "pump" function!!

false security!
Blood Pressure

- Why measuring?: to help to maintain mean arterial blood pressure $\geq 70$ mmHg. This should guarantee organ perfusion (not always)

- Invasive BP measurement: superior precision – technically difficult

- Non invasive measurement: simple, practical automated method for routine!!
Blood Pressure

- Non invasive: Oscillometry (sys/dias/MAP)
  - Moderate accuracy especially during:
    - Low MAP
    - Small patients
- When low values:
  - Technical control of system application
  - Clinical control of patient
  - Treat the hypotension
- Excellent technique for detecting Trends
Blood Pressure

• High Definition Oscillometry (HDO)
  – Improved accuracy
  – Available in „stand alone“

• Doppler method
  – Cheap - less practical
  – Systolic Pressure only
  – Non automated
Blood Pressure
Blood Pressure

Oscillometric method makes use of appropriate sized cuffs and the BP monitor/module
Temperature

• Most neglected parameter

• The absolute minimal: measure body temperature of each patient at the end of each anaesthesia

• Better: continuous measurement with esophageal or rectal probe
A fine combination

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Technical monitoring

- Capnography
- Pulse oxymetry
- NIBP
- Temperature
- ECG
- IBP (invasive blood pressure)
- Inhalational gas analyser
- $O_2$ measurement
- Electronic spirometry
Monitoring of lung mechanics (compliance and resistance). Spirometry with loop visualisation and compliance calculation
Monitoring of lung mechanics
Clinical Monitoring

- There are no good monitors, there are only anaesthetists you can trust

- Electronic monitoring cannot replace totally clinical monitoring !!!

- The responsible must be familiar with clinical monitoring before focusing on electronic monitoring
Clinical Monitoring

• For good anaesthetic management one must know artefacts for each measured parameter

• For good management one must be able to interpret the information (numbers) provided
Presentation 30 years ago
Questions?