Anaesthesia

- Rebreathing:
 - Too low fresh gas flow (FGF)
 - Exhausted soda lime
 - Sticking expiratory valve.

Decreased end-tidal carbon dioxide

- Leak at endotracheal-tube cuff
- Small patient with too high FGF or dead space – dilution
- Overventilation:
 - Pain/nociception
 - Too light
 - Excessive intermittent positive-pressure ventilation
- Reduced cardiac output:
 - Hypotension
 - Bradycardia
 - Hypovolaemia
 - Hypothermia
 - Reduced venous return
 - Haemorrhage
 - Imminent cardiac arrest.

Increased inspired carbon dioxide

- Exhausted soda lime
- Insufficient FGF with non-rebreathing system
- Excessive dead space
- Stuck expiratory valve.

KEY LEARNING OBJECTIVES

- Understand normal end-tidal carbon dioxide (EtCO₂) values
- Understand the normal capnograph waveform
- Troubleshoot abnormalities

MULTIPLE CHOICE QUESTIONS

1. What does capnography NOT assess?
 - (A) Adequacy of ventilation
 - (B) Correct endotracheal tube placement
 - (C) Too low fresh gas flow when using a T-piece
 - (D) Peripheral oxygenation
2. The baseline of the capnograph is elevated and the monitor says FiCO₂ is 12 mmHg. What could be the cause?
 - (A) Exhausted soda lime
 - (B) Reduced cardiac output
 - (C) Oesophageal intubation
 - (D) Hole in sampling line
3. Hypocapnia, low ETCO₂, can be caused by which of the following?
 - (A) A deep plane of anaesthesia
 - (B) A stuck expiratory valve
 - (C) A leak at the endotracheal tube cuff
 - (D) Hypoventilation

Pulse oximetry: when to be worried under anaesthesia

Frances Downing

Successful and efficient delivery of oxygen is essential in ensuring normal organ function in all animals, whether they are conscious, sedated or anaesthetized. The delivery of oxygen to tissues is dependent on cardiac output and the oxygen content of arterial blood (C_aO₂). Oxygen is carried in the blood in two forms: approximately 97% is bound to haemoglobin (Hb) in red blood cells, whilst the remaining 3% is dissolved directly in plasma.

Clinically, pulse oximetry can be used to assess blood oxygen levels in our patients. Pulse oximeters determine the percentage saturation of haemoglobin (SpO₂) in blood by using the absorption of two different wavelengths of light to assess and compare the quantity of saturated (oxygenated) and desaturated (deoxygenated) Hb. We can use pulse oximetry to identify patients suffering from hypoxaemia and, if needed, instigate appropriate interventions, such as oxygen supplementation and positive-pressure ventilation. The timely use of appropriate interventions may contribute to a reduction in perioperative morbidity and mortality.

Pulse oximetry does have clinical limitations, however. It does not provide rapid or reliable information about the adequacy of ventilation in our patients, only oxygenation; a patient can have a normal SpO₂ despite significant hypoventilation and even respiratory arrest. Additionally, there are several factors that may adversely affect the accuracy and reliability of pulse oximetry in assessing oxygen content of blood. These include peripheral vasoconstriction, anaemia and abnormal forms of haemoglobin, for example, methaemoglobin and carboxyhaemoglobin.

KEY LEARNING OBJECTIVES

- Understand the information a pulse oximeter can provide during the perioperative period
- Understand the limitation of pulse oximetry during anaesthesia
- Develop confidence in managing hypoxaemia in patients under anaesthesia

MULTIPLE CHOICE QUESTIONS

1. Which of the following does NOT affect the accuracy of a pulse oximeter?
 - (A) Movement artefact, including shivering
 - (B) Peripheral vasoconstriction
 - (C) Jaundice
 - (D) Dark, pigmented skin

2. Severe hypoxaemia is commonly defined as $P_aO_2 < 60$ mmHg. This correlates to a SpO_2 reading of what?
- (A) 87%
 - (B) 90%
 - (C) 93%
 - (D) 97%

3. Which of the following is NOT a potential cause of hypoxaemia (low blood oxygen)?
- (A) Ventilation-perfusion (V/Q) mismatching
 - (B) Low inspired oxygen levels (FiO_2)
 - (C) Hypoventilation
 - (D) Hypocapnia

CPCR in the anaesthetized patient

Joanne Michou

Survival rates following cardiopulmonary arrest (CPA) to discharge are relatively low in veterinary medicine, estimated at 3–6% in dogs and cats, compared to 20% in humans that experience in-hospital CPA. However, with appropriate monitoring, understanding potential complications for each patient condition, procedure or anaesthetic plan, being fully prepared and using safety checklists, it is feasible to reduce this number significantly by reducing error and detecting abnormalities earlier. Resuscitation attempts that are organized, cohesive and led by well functioning knowledgeable teams adhering to evidence-based cardiopulmonary resuscitation (CPR) guidelines, RECOVER 2012 (The Reassessment Campaign On Veterinary Resuscitation) should improve survival from CPA.

RECOGNITION OF CARDIOPULMONARY ARREST

In anaesthetized patients, CPA may be avoided if monitoring is effective, allowing cardiorespiratory alterations to be picked up earlier, such as sudden change in heart rate, change in electrocardiogram (ECG) complexes or decrease in end-tidal carbon dioxide ($EtCO_2$). There is high-level evidence that anaesthesia-related CPAs are associated with increased survival compared to CPAs from other causes.

WHEN TO START CPR

Assessment for CPA should be rapid and last no more than 15 seconds. The deleterious delay in starting BLS is significant. With serious adverse effects occurring in less than 2% of human patients not in CPA that receive chest compressions, and the potential benefits of early chest compressions in patients in CPA, chest compressions should be provided to dogs and cats as soon as possible if CPA cannot be definitively ruled out.

BASIC LIFE SUPPORT

BLS consists of CAB: Circulation, Airway, Breathing. The guidelines stress the importance of early delivery of

high-quality chest compressions with minimal interruption. In addition, it is likely that early intubation and ventilation in veterinary CPR is highly valuable. All anaesthetized patients should have an endotracheal tube in place with a breathing system attached, providing the ability to ventilate the patient immediately.

Depending on the surgical site, open-chest CPR may be appropriate.

ADVANCED LIFE SUPPORT

Monitoring and vascular access should be in place for any anaesthetized patient, but available monitoring is widely variable between veterinary practices.

- $EtCO_2$ is highly valuable to identify return of spontaneous circulation (ROSC) and maintaining $EtCO_2 > 15$ mmHg indicates effective compressions
- ECG to identify rhythm and decide on drug therapy (adrenaline/epinephrine) or defibrillation
- Pulse oximeter or a Doppler probe on the cornea can detect pulsatile blood flow.

Administer reversals, target treatment:

- Turn off anaesthetic, empty breathing system
- Reverse/treat cause if known
- For animals with increase vagal tone the use of atropine is reasonable
- Assess for other causes and treat: 4Hs (hypoxia, hypovolaemia/hypotension, hyperkalaemia, hypothermia) and 4Ts (thrombosis, tension pneumothorax, tamponade-cardiac, toxins).

OPTIONS AND AIM OF ELECTROCARDIOGRAM

During each 2 minutes of BLS inter-cycles, assess if the rhythm is shockable (ventricular tachycardia, ventricular fibrillation), non-shockable (asystole, pulseless electrical activity) or you have ROSC:

- What is the arrest rhythm?
- Is there a pulse?

POST-ARREST CARE

Post-cardiac arrest monitoring should be sufficient to detect impending recurrence of CPA. Do not remove monitoring! Goal-directed therapy must be individually tailored to each patient.