Reducing the Risks of Equine Anaesthesia

Because of their large size, nature, and predisposition to adverse reactions to certain anesthetic agents, it is common knowledge in the veterinary industry that horses placed under general anaesthesia are at a higher risk compared to smaller species, like dogs and cats. They can have a 0.9% mortality rate during non-colic surgery, which increases to nearly 11.7% during colic surgery. The most common causes of mortality during anaesthesia are cardiovascular arrest, trauma (fractures and wounds), myopathy and neuropathy.

During anaesthesia, we always use multi-parameter monitoring. This is essential for complex surgeries where a balance is sought between adequate depth of anaesthesia and preserving the cardiorespiratory function. Some monitors include a gas analyser that measures the concentration of expired inhalant gas, giving an indication of the depth of anaesthesia as well as any adverse physiological reactions to anaesthetic agents. Improved monitoring allows early detection of potential complications and allows us to put interventions in place to improve patient outcomes.

Correct positioning of the patient is also crucial, as mispositioning can induce neuropathy during recovery.

Anaesthetic Monitoring Equipment - Order of Set up

<table>
<thead>
<tr>
<th>Vascular access</th>
<th>Place E.T Tube</th>
<th>Connect to anaesthesia machine</th>
<th>Turn on ventilator</th>
<th>Place infusion line</th>
<th>Place capnograph line</th>
<th>Place pulse oximeter clip</th>
<th>Place ECG sensors</th>
<th>Place IBP line</th>
<th>Place Temp probe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitored on a multiparameter monitor</td>
<td></td>
<td></td>
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**Capnography CO₂**

Capnography is the measurement of carbon dioxide in the patient’s breath and is an essential tool in providing vital information on ventilation, tissue perfusion, cellular metabolism, and anaesthetic response. Importantly, it also confirms correct placement of the endotracheal tube and helps to allow the veterinarian to maintain normocapnia for safe and adequate anaesthetic depth. Horses are susceptible to hypercapnia during anaesthesia due to ventilation/perfusion (V/Q)-mismatch, which the capnograph in correlation with arterial blood gas monitoring can easily and quickly identify. This continual evaluation of CO₂ levels can alert you to any concerns, allowing for rapid response time - an essential factor ensuring the balance between safe, but effective, anaesthetic depth.

With horses, we often take an arterial blood sample to check the values and adapt ventilation throughout surgery. Because of the V/Q (ventilation-perfusion) mismatch in horses due to their size, weight, position and pressure on the diaphragm during surgery, in combination with horses often being hypotensive during anaesthesia (due to their position causing pressure to be applied to the blood vessels, and the effect of anaesthetic drugs), this often results in significant problems during anaesthesia and, more importantly, during the recovery and post-operative period.

We feel that normocapnia is maintained between 35 and 45mmHg. If your CO₂ reading rises higher than 45mmHg, choose to mechanically ventilate or adopt adaptation ventilation until normocapnia occurs. Evaluation of the capnogram also allows you to check that there are no leaks present in the system, and that there is no breathing against the respirator.

Sidestream capnography is used at Clinique Equine Acy-Romance because it is found to provide the most reliable readings and is easy to use.

**TIP:** When placing the sidestream capnograph line next to the endotracheal tube, ensure it is facing upward to prevent condensate going into the line and obstructing it.

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**Pulse Oximetry – SpO₂**

Horses are known to be highly susceptible to hypoxemia, especially when a recumbent horse is placed in the dorsal position for surgery. Anaesthetic drugs can induce hypoventilation or apnea, which will lead to ventilation-perfusion mismatch (V/Q defects) in the lungs.

The gold standard for measuring PaO₂ is through an analysis of an arterial sample, by checking for oxygen in the arterial blood. However, another (non-invasive) way to measure oxygen concentrations is to place a small SpO₂ probe clip on the tip of the tongue (SpO₂), where the tissue is soft and non-pigmented. Due to the pressure of the clip on the tongue, in some cases blood doesn’t pass well, which can disturb readings. To prevent this from happening, ensure you regularly reposition the clip on the tongue. However, this generally only happens with small foals and isn’t a common issue for adult horses.

**TIP:** It is important to check that the tongue is moisturised throughout surgery, and if it does become dry, wet it with a moistening gel and reattach the clip.
Pulse Oximetry – SpO₂ (continued)

When recording SpO₂, a reading between 95-98% haemoglobin saturation is normal (see graph shown right). If this falls below 90% (hypoxemia), apply positive end-expiratory pressure (PEEP) during mechanical ventilation to ensure the patient is respirating at a proper level to get enough oxygen circulating through the blood. Hypoxemia can also be treated with medication and the recruitment manoeuvre.

Invasive Blood Pressure – IBP

We feel that the measurement of blood pressure during equine anaesthesia is the most important parameter to monitor. The inhalant anaesthetics used during surgery often cause vasodilation, which commonly results in arterial hypotension for horses. This can cause serious problems during the recovery and post-operative phases where the heavy horse tries to stand up almost immediately after coming out of anaesthesia. We therefore pay very close attention to the monitoring of blood pressure and put immediate interventions into place when problems occur to prevent further issues arising later.

There are two methods for obtaining blood pressure: Non-invasive (NIBP) and Invasive (IBP). Both are important, as they indicate the status of the horse under anaesthesia, but early placement is important to ensure access when blood pressure drops - IBP allows for an accurate measurement to be given during those critical moments.

As well as measuring blood pressure, placing an IBP line can also provide reliable samples of oxygen, CO₂, pH, electrolytes and haematocrit - making an arterial catheter one of the most vital tools available to the anaesthesiologist. Since hypotension and other complications to anaesthesia can cause difficulty obtaining an accurate SpO₂ reading, blood gas analysis provides a crucial indication of what may not be able to be obtained by oximetry.

To measure invasive blood pressure in adult horses, we place an invasive blood pressure line into the arterial lumen of the patient. This is either done in the facial (most often), metatarsal, or tail artery depending on the location of the surgery being performed. This is simple to do in horses as their arteries are usually very easy to access. During foal surgeries, a non-invasive cuff can be placed on the leg or tail, as well as using the invasive method.

TIP 1: When placing the invasive blood pressure line, start as low as possible on the artery and place the catheter in the direction of the heart. We tend to use a needle or small catheter, and in the case of long surgeries, a little bit of glue helps to hold the catheter in place!

TIP 2: Don’t forget to zero the IBP function on the monitor to record a correct reading. The sensor needs to be placed at the level of the right atrium and be opened to the air before zeroing on the monitor.

TIP 3: The height of the pressure transducer should always be at the height of the heart. When the surgery table moves up or down, the height of the pressure transducer should be adapted accordingly for correct IBP measurement.
Invasive Blood Pressure – IBP (continued)

This is an example of a normal blood pressure wave with consistent waves followed by a small peak after each one (wave shown in red).

**TIP 4**: If this pattern changes, flush the catheter and check the wave again, and ensure proper I.V. fluid therapy is being given.

Normal readings

- **Systolic**: 90 to 120 mmHg
- **Diastolic**: 40 to 70 mmHg
- **MAP**: 60 to 85 mmHg

Hypotension

- **MAP**: <60 mmHg

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Electrocardiogram – ECG

An ECG detects heart problems such as arrhythmias (AV block and atrium fibrillation), heart defects, heart inflammation, cardiac arrest, and inadequate blood supply.

When carrying out a 3-lead ECG, apply gel to the area where placing the three ECG electrodes to gain better contact with the skin. The electrodes are usually placed on the left jugular vein, on the sternum, and above the left elbow.

**TIP 1**: An easy trick to remember these electrode positions are:

- **Red** = Blood running through veins. Place red electrode on the left jugular vein.
- **Black** = Shadow under the head which sees little sunlight. Place black electrode on the sternum.
- **White** = Light which shines on the front legs. Place white electrode above the left elbow.

The most commonly encountered heart problem in horses are arrhythmias, especially AV blocks, due to their large heart size.

For example, in case of hyperpotassaemia (hyperkalemia), changes in the P and T wave can be noted before a cardiac arrest takes place, and successful interventions can be quickly initiated. And in the case of electrolyte imbalance with hyperkalemia (for example a foal with a bladder rupture), it is important to closely monitor and note changes in the ECG waveform, to allow for immediate intervention when these potentially dangerous abnormalities arise.

**TIP 2**: To get a more detailed view of the ECG, some multiparameter monitors can drop to a 2-lead display, which makes the detection of irregularities and changes in the P-QRS-T complexes easier to identify, hence increasing the efficacy of interventions.

- Red electrode placed on jugular vein
- Black electrode placed on sternum
- White electrode placed above left elbow
The Importance of Monitoring your Patient

It is important to monitor and accurately interpret as many parameters as possible to gain a good, overall picture of your patients' well being during anaesthesia.

**TIP:** With so many things to monitor on screen during surgery, as well as the constant physical examining of your patient, a helpful feature of the monitor we use is to adjust the wave colors and the order the waves are displayed on the screen for easy viewing and recognition at a glance.

<table>
<thead>
<tr>
<th>Wave</th>
<th>Parameter</th>
<th>Wave Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ECG [2 waves]</td>
<td>Green</td>
</tr>
<tr>
<td>2</td>
<td>Blood pressure</td>
<td>Red</td>
</tr>
<tr>
<td>3</td>
<td>Heart rate</td>
<td>Red</td>
</tr>
<tr>
<td>4</td>
<td>(\text{SpO}_2)</td>
<td>Purple</td>
</tr>
<tr>
<td>5</td>
<td>ETCO(_2)</td>
<td>Cyan</td>
</tr>
</tbody>
</table>

Even though this article covers the essential use of multi-parameter monitoring during surgery, it is important to note that the most dangerous parts of equine anaesthesia are the induction and recovery phases. Monitoring of the patient during these phases is not possible due to their size and temperament, which is why continuous education and development is required for anaesthetists to reduce anaesthetic mortality. This will also advance understanding of what multi-parameters are displaying, and how to interpret the wealth of information they can provide.

In summary, Robert Smith, MDa stated that "There are no safe anesthetic drugs, there are no safe anesthetic techniques, there are only safe anesthetists"\(^3\), which is why continuous anaesthetist development is vital for the overall safety of horses during anaesthesia.

References


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