

Pulse oximetry for anaesthesia in veterinary practices biology essay



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Pulse oximetry is one of the most commonly used pieces of monitoring equipment for anaesthesia in veterinary clinics today. Using a pulse oximeter allows us to monitor the percentage of haemoglobin (Hb) which is saturated with oxygen in a non-invasive way, allowing us to detect hypoxia before the patient is visibly cyanotic. The pulse oximeter consists of a probe attached to the patient (usually tongue, ear, or prepuce/vulva) which is linked to a computerised unit. The unit displays the percentage of Hb saturated with oxygen and a calculated heart rate, often with an audible signal for each pulse beat. Some units also have a graphical display of the blood flow past the probe called a plethysmograph.

The pulse oximeter is able to determine the percentage of haemoglobin saturated with oxygen, commonly referred to as SpO₂, by emitting red and infrared light from the light-emitting diodes (LEDs) on one side of the probe, which travels through the tissue (or reflects off depending on the probe type) to the photodiode on the other side of the probe. The machine analyses the light that reaches the photodiode and is able to detect subtle differences in the absorption of light by oxyhaemoglobin and deoxyhaemoglobin. As these differ in absorption levels, the amount of red and infrared light absorbed by blood is related to haemoglobin oxygen saturation.

The pulse oximeter can calculate the heart rate as it detects the pulsations as the volume of arterial blood in the tissue changes during the pulsative cycle, affecting light absorption.

Adequate oxygenation is essential at all times for the body to perform its metabolic processes. The heart and brain are the body's biggest consumers

of oxygen, and if oxygenation levels decrease to critical levels, tissue damage occurs extremely quickly. Oxygen travels in the blood in two forms – as unbound oxygen dissolved in plasma and as oxygen that is bound to the haemoglobin. In healthy patients breathing room air (which contains approximately 21% oxygen), oxygen dissolved in plasma equates to a very small percentage of the total oxygen in the blood (most texts list this as less than 1.5%), and the majority of blood oxygen is bound to haemoglobin (the remaining 98.5%). Measuring and monitoring oxygenation via pulse oximetry is very useful as it is monitoring the oxygen that is bound to haemoglobin, which is what is utilised by the body for normal cell function.

Monitoring SpO₂ however does not give you a good indication of how well the patient is ventilating (or breathing) for itself, especially during anaesthesia. A common mistake veterinary nurses make is to presume that if a patient has a SpO₂ of 95% or higher under anaesthesia, then it is breathing adequately. We can get lulled into a false sense of security by having a good saturation figure when the patient's respiration is completely inadequate.

There are two main functions of respiration, one is getting oxygen out of the air and into the body, and the other is getting carbon dioxide out of the body and into the air. It is possible for the patient to be getting enough oxygen into their body but not being able to get rid of enough carbon dioxide, so the SpO₂ will show a good reading, but the patient may be hypercapnic (elevated levels of carbon dioxide). A capnograph should be used to measure end tidal carbon dioxide (ETCO₂) levels and assess patient respiration.

Partial pressure of oxygen in arterial blood (PaO₂) is a measurement of the levels of unbound oxygen in the plasma, and as discussed above, makes up a small percentage of the total oxygen in the blood. However PaO₂ is important as it influences the saturation of haemoglobin because there must be an adequate level of dissolved oxygen in the blood to be available to bind to the haemoglobin.

It is also important to understand that oxygen saturation and PaO₂ are linked (when one goes up the other goes up and vice versa), however it does not have a direct linear correlation. As PaO₂ decreases, the saturation level decreases slowly at first, but then decreases rapidly (see table **).

In a patient which is breathing room air, the PaO₂ is about 100mmHg, whereas for a patient breathing 100% oxygen (as for anaesthesia), their PaO₂ is around 500mmHg and SpO₂ is 100%. If this patient has a PaO₂ drop to 100mmHg (a drop of 400mmHg) their SpO₂ will drop to around 98%. If a further drop to 80mmHg occurs, their SpO₂ will drop to around 95%. After this point, the SpO₂ will start a more dramatic drop; if PaO₂ drops to 60mmHg (another 20mmHg drop) will mean their SpO₂ will be about 90%. A further drop of 20mmHg to a PaO₂ of 40mmHg, the saturation will go from 90% to 75%.

In practical application, when monitoring SpO₂ in a normal healthy dog or cat, it should be 95-100%. Levels between 90-95% must be investigated, and critical values for oxygen saturation are below 90%. Simply, this means that the total oxygen available to the body decreases very little when partial pressures are above 80mmHg (SpO₂ of 95%), however they decrease rapidly

below this level, such as patients with lung disease, lack of oxygen, inadequate ventilation etc. Practically put, if your patient has a SpO₂ of 90-95% this can indicate hypoxaemia and must be investigated as your patient's haemoglobin is not fully saturated. If your patient has a SpO₂ of less than 90%, then immediate therapy must be initiated - oxygen if not receiving already, ventilation assistance etc. SpO₂ of 85% or below for more than 30 seconds is considered an emergency.

Placing the SpO₂ Probe

There are two main types of probes available on the market - transmission or reflective. Transmission probes are the most common, and are usually mounted in a clip. These are generally used on the tongue, pinna, toe webbing, vulva or prepuce, or any other area that is thin and relatively hairless.

Reflective probes have the light source and sensor side by side and are often taped to the base of the tail after it has been clipped, or covered and inserted into the oesophagus or rectum. When placing rectally, it is important to ensure that there are no faeces between the sensor and the rectum wall.

Tongue, Cheeks, Prepuce, Vulva

With tongues, start at the tip and work your way toward the base. Always direct the light downward, toward the floor; regardless of the animal's position to reduce the effects of ambient light (ambient light will affect accuracy). For patient comfort, keep the tongue moist during longer procedures by applying a dampened gauze swab between the tongue and

the probe. Do not have the gauze too thick as it can alter the reading by impeding the light transmission.

To get a better reading on smaller tongues, bring the sides of the tongue up and pass the light through both layers. Do not fold the tip of the tongue, as you will restrict blood flow to the tongue.

The same principals apply to placing the probe on the cheek, prepuce or vulva.

Hock

Moisten the hock area with isopropyl alcohol and/or water, and clip hair if needed.

Pinna (Ear)

The probe can be placed on the ear using the same technique as the tongue. Long haired animals may need a patch shaved first for the sensor to work correctly.

Toes

Probes can be placed on the metatarsals or metacarpals or in the webbing between them.

Tail

Place the reflective probe on the ventral base of the tail. The LEDs should be positioned dorsally. You may need to clip a small patch of hair, only large enough for the LEDs to lay on the skin. Be sure the skin is clean. Hold the sensor snugly against the tail and wrap with non-adhesive wrap.

Poor SpO₂ Readings

When you detect a poor or low saturation reading, it is vital that you check the patient before you check the machine. Make sure your patient is stable by assessing all vital signs. Pulse oximeters need a strong regular pulse where the probe is located. If there is only a weak pulse, the pulse oximeter may display a reading but it might not be accurate. Most pulse oximeters have a pulse strength indicator as a bar graph and this should be used to ascertain whether you have correct placement.

If the clip of the probe is too strong, this can also affect your reading by constricting the blood flow in front of the sensor. If this is the case, swapping the clip for a more gentler one is the best option, otherwise reposition the sensor to somewhere that can take the pressure (this will usually be thicker).

An irregular signal caused by an irregular heartbeat or by the patient moving, shivering or fitting can cause problems for a pulse oximeter. If a patient moves too much, try relocating the probe to another location.

Ambient light may be too bright for the sensor to operate correctly. Theatre lights can especially cause issues. Any sensor that is located in bright light should have a drape placed over it to reduce light contamination for more accurate readings.

Do not place the sensor is on the same limb as a blood pressure cuff, the blood flow restriction from the cuff during measurement will interfere with the pulse oximeter sensor operating correctly.

Other factors that can affect SpO₂ readings include pigmented skin – either normal pigment or jaundiced patients; peripheral vasoconstriction – eg hypothermia, shock, drug-induced; or excess hair – can cause interference and should be clipped away to allow the probe to sit directly against the skin. Wetting down with alcohol can also help with excess hair when you are not allowed to clip.

Pulse Oximeter Maintenance

Read your manufacturer's instructions regarding the care of your pulse oximeter and probe. For infection control, you should always wipe the probe sensor and clip between patients. Most sensors can be surface-cleaned by wiping with 70% isopropyl alcohol. Do not immerse the sensor in liquid unless the manufacturer instructions state immersion is possible.

After each cleaning and prior to each use, inspect the sensor and cable for fraying, cracking, breakage, or other damage. Inspect the clip for cracking or breakage, or loss of spring tension that would allow slippage or movement of the sensor from its proper position. If defects are noted, do not use the sensor or clip as it may provide an inaccurate reading.

When used properly, pulse oximeters are an easy to use and readily available piece of monitoring equipment especially for anaesthesia, however it is important to note that they do not replace hands-on monitoring, and are not a valid method of assessing whether a patients respiration is adequate, as they provide a late indication of respiratory issues.