PULSE OXIMETRY -PRINCIPLES AND CLINICAL APPLICATIONS IN VETERINARY PRACTICE

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General anaesthesia requires proper monitoring to avoid the potential complications producing irreversible changes leading to death of the patients. Some of the adverse effects are occurring gradually with progressive depression of respiratory and circulatory system. These problems can be prevented by continuous monitoring of the patients. Now a days, a variety of methods and devices are available to assess the functional status of patients. Some of the techniques are too invasive and require technical expertise but some others are relatively easy and non invasive. The most popular non-invasive methods include electrocardiography, pulse oximetry, capnography and sphygmom anometry. These devices provide informations regarding the electrical activity of heart, patient's blood oxygenation, respiratory activity and arterial blood pressure directly, though there are some limitations with each procedure. This article is indented to make the practitioners familiarize with the principles of pulse oximetry, its clinical applications and limitations in veterinary practice. It is a most popularly employed non invasive monitoring procedure adopted in human anaesthesia and critical care patients since 1980s.

Pulse oximeter is a compact, portable device used for monitoring oxygen saturation in the peripheral circulation. The colour of blood is a reflection of its oxygen saturation and it changes with oxygen saturation due to the optical properties of the haemoglobin molecule, more specifically, the heam. Before pulse oximeters were available, the arterial oxy haemoglobin saturation was assessed with the use of blood gas analyzers. This technique is expensive and requires invasive sampling of arterial blood and provides only intermittent monitoring. ie., pulse oximetry is an excellent alternative tool for measuring PaO_2 with a blood gas analyzer. As pulse oximetry provides a continuous estimate of the oxygen saturation of haemoglobin in arterial blood (SpO_2) with an early warning of desaturation, it enables clinicians to respond with preventive or corrective measures before severe problems occur. In pulse oximetry, oxygen status at the tissue level will be indicated before clinical signs are evident. SpO_2 reading above 95% indicates normal, 90% indicate minor desaturation and less than 85% indicate hypoxemia. The 85% saturation in pulse oximetry is equivalent to 55 mmHg in PaO_2 in blood gas analysis. The desaturation is not evident clinically as cyanosis until enough deoxygenated blood is present to produce blue discolouration. Once cyanosis is observed, such patients are already in a severe state of hypoxemia, the consequences of which may be difficult to reverse.

In anaesthesia, pulse oximetry provides warning signals of hypoxemia, anaesthetic equipment failure, disconnection of patient from oxygen source, endotracheal tube etc. In a normal healthy patient subjected to elective surgical procedures, pulse oximetry is not required obviously but it is certainly essential in emergency and critical care of compromised animal patients along with arterial blood gas analysis or alone. Pulse oximeter is also a useful tool in assessing the intestinal perfusion and vitality.

PRINCIPLES:

The principle of pulse oximetry is quite simple. As the blood deoxygenates, it becomes increasingly less permeable to red light. The tissues then loose its pinkish appearance, taking on a blue tint. Pulse oximetry is based on two physical principles (1) the absorbance spectra of oxygenated haemoglobin is different from that of deoxygenated haemoglobin and (2) the pulsatile component of arterial blood can be distinguished as volume fluctuations between the source of light and detector. By design, pulse oximeter utilizes two light emitting diodes (LEDs) with wavelength of red light at approximately 660 mm and infrared light at

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approximately 920 mm. to determine oxy haemoglobin saturation.

When a pulse oximeter probe is placed over a bed of tissues, two light emitting diodes (LEDs) on one side of the probe emit red and infrared light. The light is detected on the other side of the tissue bed by a photo detector that produce a current proportional to the intensity of light transmitted through the tissues. The values displayed digitally are based on the empirically derived tables, and a pulsating arterial supply is essential for getting the readings in pulse oximeter. A photo detector, placed opposite to these LEDs across the arterial vascular bed, measures the intensity of transmitted light across the vascular bed. The difference in the intensity of transmitted light between two LEDs is caused by the difference in the absorption of light by oxygenated and deoxygenated haemoglobin contained within the vascular bed. The determination of arterial haemoglobin oxygen saturation is computed by the pulse oximeter from the relative amount of light transmitted to the photo detector and are displayed digitally.

TECHNIQUE:

Two types of probes are available transmission (lingual) and reflectance (rectal and oesophageal).The probe of the pulse oximeter can be attached on the tongue, ear, oesophagus, rectum, vulval lips or on the nipple of the teat. The size, location, application and positioning of the probe of pulse oximeter present unique challenges in veterinary patients. The difference in tissue thickness and pigmentation can affect signal detection. The pressure on the probe site can result in vasoconstriction and inadequate signal detection, which can be rectified by relocating the probe. In anaesthetized / unconscious animal, the tongue appears to provide the most reliable signal detection site but this is rarely tolerated by an awake animal. Apart from the site mentioned earlier, the probe can apply on digits, Achilles tendon, lip, skin fold of the flank or axila, etc. In general, use a site with thinnest skin area is selected. Once the site has been selected, the hair is clipped and the area is cleaned before attaching the probe. While attaching the probe, make sure that the probe is in full contact without creating too much compression and make sure that the light emitting diodes are aligned.

Factors adversely affect the readings

1. Presence of intense light sources like O.T. light can give false information and this be prevented by placing a towel over the sensor.
2. Circumstances of low perfusion, only very small amount of arterial blood may flow into the arteriolar bed results in weak pulsatile activity. Clinically this may be recognized with hypothermic or hypotensive patients.
3. Increased motion may result in increased activity at the sensor and the photographic detector may be unable to differentiate between pulsation that are due to motion and that which are truly arterial.
4. Long hairs, thick and pigmented skin etc. can inhibit light transmission.
5. Dye injection / icterus, oedematous tissues etc gives false results.

CONCLUSION

Pulse oximetry is a minimum standard method for monitoring patients during anaesthesia and critical care situations. Pulse oximetry can provide early warning signs of dangerous desaturation events, which enables clinicians to respond with preventive or corrective measures before severe problems occur. But it is up to the clinician, the ultimate "Signal Processor" in interpreting the data.

Pulse oximetry probe of multi paramonitor attached to the tongue

REFERENCES

Allen J.L. (1992), Pulse oximetry in everyday zoological practice *Vet. Rec;*130: 354-355.

M. K. Narayanan (2008), *Ph.D Thesis* "Midazolam in combination with glycopyrrolate and xylazine as a preanaesthetic for general anaesthesia in dogs" submitted to Kerala Agricultural University.