

*Quality Anaesthetic monitoring
and Ventilation equipment*



Pulse-Oximetry – Principles and Pitfalls

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Pulse-Oximetry

- **Definition:**

“The determination of arterial oxygen saturation by analysis of bi-spectral pulsatile waveforms”

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Pulse-Oximetry

- The preceding definition means that Pulse-Oximeters make one big assumption when monitoring blood oxygen saturation:

Arterial circulation is pulsatile, venous circulation is not.

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Pulse-Oximetry

Features

- Easy to use. Non-invasive
- Very slow/late response in animals receiving 100% oxygen
- Clamp-type probes prone to false errors, poor reliability.
- Reflectance types better but take practice
- Much more useful in air-breathing animals

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Pulse-Oximetry

- So if the Pulse-Ox says 100% is everything OK?

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Oxygen Saturation – Pulse-Ox

- Measures the % saturation of haemoglobin *only*
- ***Indicates Hypoxaemia NOT Hypoxia***
- *What's the difference?*

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Pulse-Oximetry - Hypoxaemia

- Hypoxia is a failure of normal tissue oxygenation whereas hypoxaemia is a failure of normal blood oxygenation
- Hypoxia refers to cells starved of oxygen
- Hypoxaemia refers to blood low in oxygen saturation

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Pulse-Oximetry - Hypoxaemia

- So a patient can be hypoxic and not hypoxaemic – e.g. poor circulation. Blood is well oxygenated but the circulation is insufficient to distribute the oxygenated blood
- This will result in a circulatory hypoxia, although the pulse-ox will show near 100%

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Pulse-Oximetry and anaemia

- In a severely anaemic animal, perhaps even an animal gasping for breath the pulse-oximeter reading can be 100%
- Why is this?

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Pulse-Oximetry – dysfunctional haemoglobins

- Carboxyhaemoglobin will mimic well-oxygenated Haemoglobin
- So a pulse-ox may report an elevated reading in the presence of carboxyhaemoglobin

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Pulse-Oximetry

- We have seen 3 situations where a good SpO₂ reading does not reflect a well oxygenated animal
- Therefore an SpO₂ reading of 100% does not necessarily mean all is well

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Summary of misleading readings

- 1. Poor circulation can mean tissue hypoxia with normal Hb saturation levels
- 2. Anaemic animals can be 100% saturated but not have enough blood volume
- 3. Animals with CO poisoning will show falsely high saturation levels

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Pulse-Oximetry

- What's wrong with a low SpO₂?
- Hypoxaemia results from respiratory failure, either from illness/pathology or induced by e.g. Anaesthesia
- Hypoxaemia is a threat to organ function. With insufficient oxygen, cellular respiration and normal function can not occur.
- Hypoxaemia leads to CNS depression
- Sustained hypoxaemia is a life-threatening condition

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Pulse-Oximetry

- Do we need a Pulse-oximeter?
- Poorly oxygenated vascular beds look blue
- Cannot determine cyanosis with any degree of certainty until % saturation falls to about 80%

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Pulse-Oximetry

- Probe types & their merits
- Transmission type
 - Clamp construction – emitter on one side, sensor on the other. Light passes through the tissue and the differential absorption is measured

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Transmission Probe

- Any transmission probe will, after a period of time, tend to exsanguinate the underlying tissue. This effect is heightened by peripheral cooling and peripheral vasoconstriction



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Pulse-Oximetry: Transmission Probe



**Nonin-compatible transmission
probe on Spectacled Bear**



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Pulse-Oximetry: Transmission Probe



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Pulse-Oximetry

- **The tongue is a poor site for placement in animals (especially in small animals):**
 - Often it is in the way
 - The evaporative effect of a wet tongue leads to rapid cooling and reduced pulse amplitude
 - The thin tongue of small dogs and cats means that compression and local exsanguination occurs rapidly

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Pulse-Oximetry

- **Alternative sites:**

- Use the prepuceal fold in male dogs
- Use the vulval lips in female dogs
- Use claws/digits if not deeply pigmented

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Pulse-Oximetry

- **Alternative probes – reflectance probe**
 - Light emitter and sensor are on the same side
 - Often smaller so can be placed in locations where a transmission probe is not feasible
 - **Work well in the following locations:**
 - Medial wall of ear canal
 - Buccal surface of gums between teeth and cheek
 - Ventral tail in hairless region near perineum
 - Against nasal septum in large dogs and horses

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Reflectance Probe

- Once fixed in place there is no deterioration of signal as there is no squeezing effect



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Pulse-Oximetry: reflectance probe



**Reflectance probe placed in
Vertical ear canal against
medial wall**

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Pulse-Oximetry: reflectance probe



Reflectance probe against nasal septum

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Pulse-Oximetry

- Demonstration of two types of probes..

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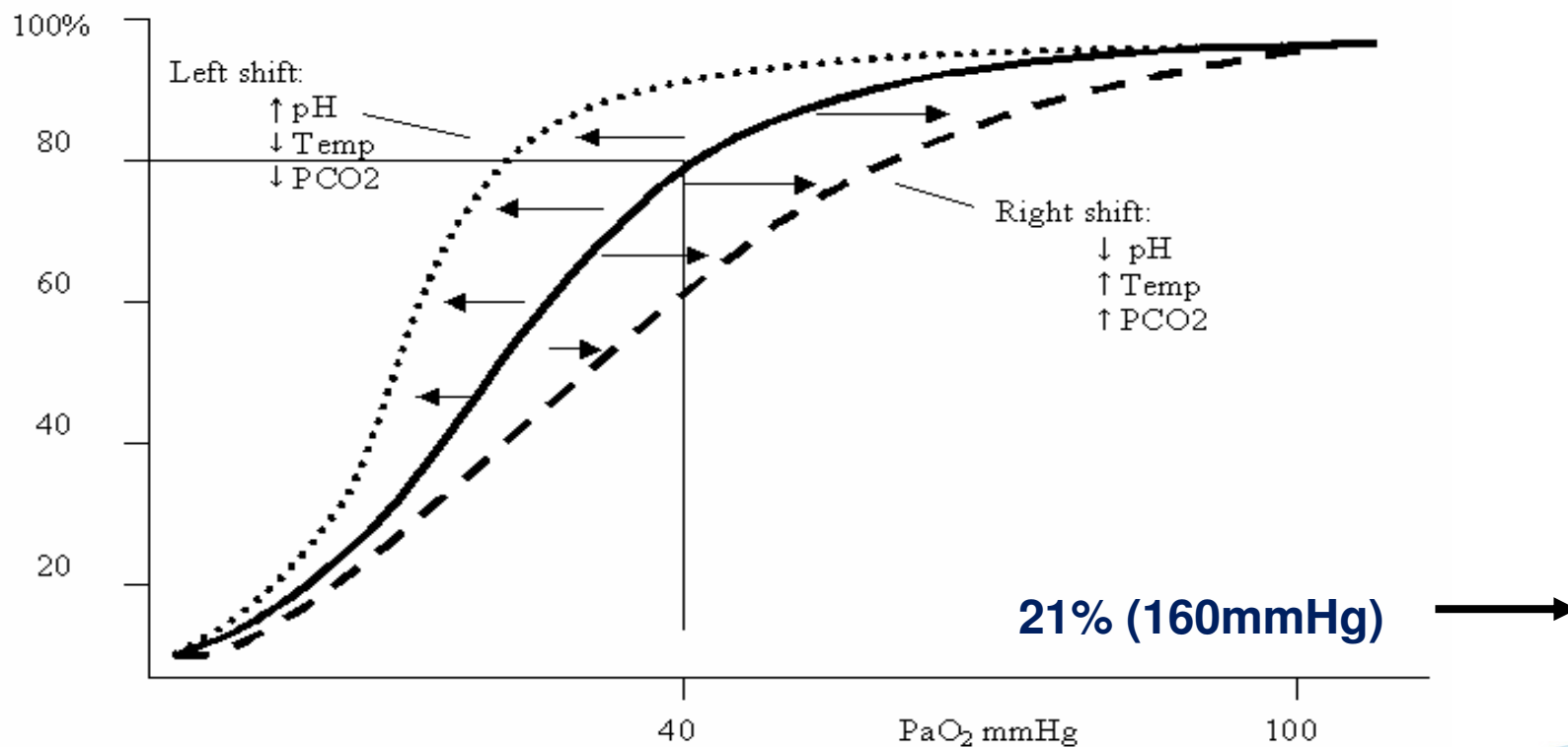
Pulse-Oximetry – limitations in veterinary practice

- Most patients are run on 100% oxygen
- This means that in small animals it will take something catastrophic to reduce the PaO₂ to less than 100mmHg
- In horses the situation is different where V/Q mismatches can readily reduce the PaO₂ to around or even less than 100mmHg. Lung pathology in small animals can result in equally severe V/Q mismatches
- It is the shape of the oxygen dissociation curve that dictates this response..

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Why Pulse-ox has a slow response



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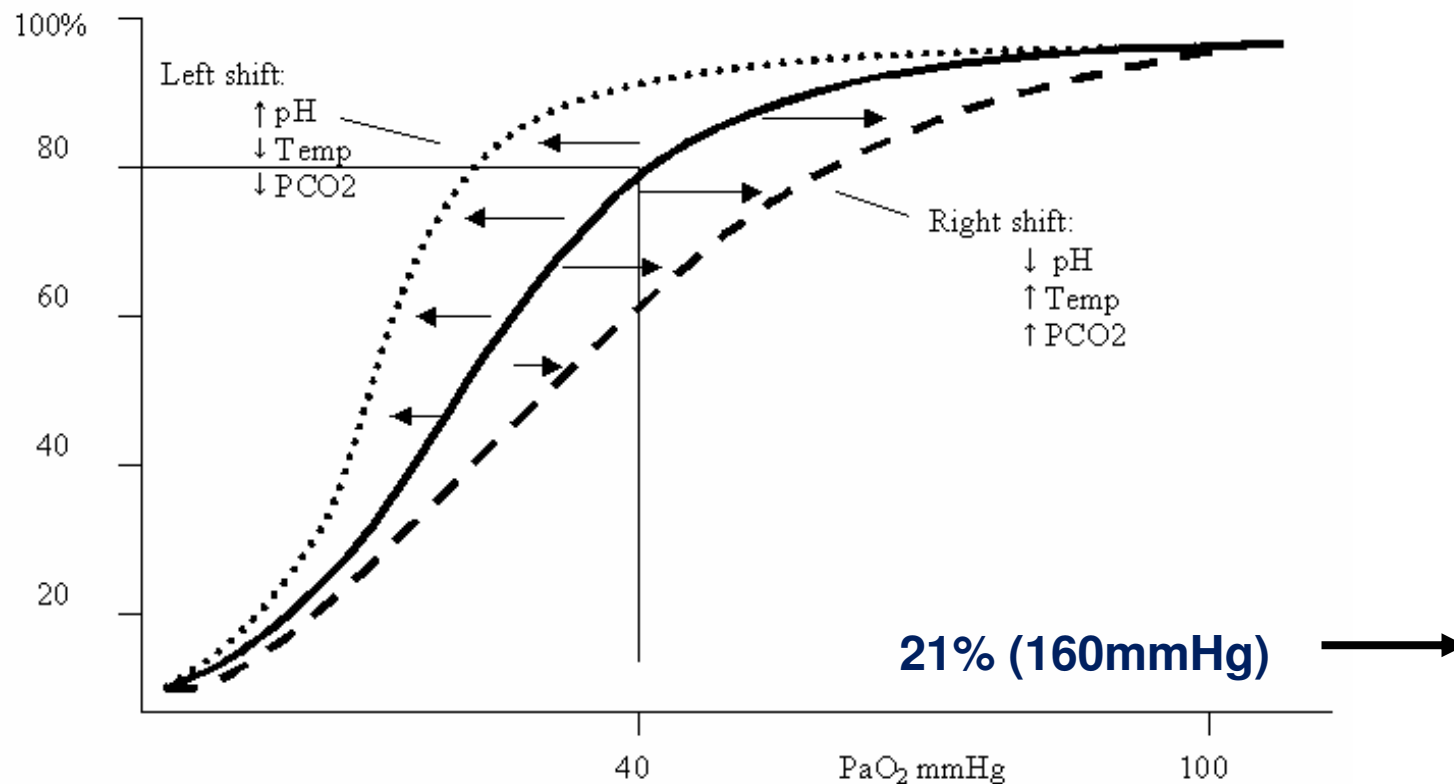
Pulse-Oximetry

- In healthy lungs, 100% oxygen saturation occurs with inspired oxygen levels as low as 18%.
- So in room air (21%) our patients should be 100% saturated

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Why pulse-ox has a slow response



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Pulse-Oximetry – extended use

- Because of the closeness of that 18% value to room air's 21% value, pulse-oximetry becomes very useful with animals breathing room air.
- This means Pulse-Oximetry is most useful in the following situations:

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Pulse-Oximetry – extended use

- **Post-op recovery.**
 - Here the animal has typically gone from breathing 100% oxygen to breathing 21% oxygen. Its respiratory drive is reduced by the anaesthesia and it is often lying on one side limiting chest expansion.
 - It is a paradox that at the time when we need to monitor oxygenation levels the most, we disconnect the animal from the pulse-oximeter and revert to observation
 - Hypoxaemia can slow CNS responses leading to apparent prolonged recovery

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Pulse-Oximetry – extended use

- **Sedated animals.**
 - Breathing 21% oxygen but with some reduction in respiratory drive, these animals are at risk of hypoxaemia
 - Monitor these with pulse-oximetry during e.g. x-ray or dressing changes
 - Hypoxaemia can slow CNS responses leading to apparent prolonged recovery

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Pulse-Oximetry – extended use

- **Animals with respiratory compromise**
 - Check these animals prior to sedation/anaesthesia
 - Rabbits: often have sub-clinical pulmonary disease. It is admittedly not easy to check the SpO₂ in a conscious rabbit, but worth trying. Try a transmission probe on an ear or a reflectance probe in the vulva. If a reduced saturation is found, ensure that these individuals receive 100% oxygen and preferably are intubated.
 - Monitor these animals carefully under anaesthesia

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Pulse-Oximetry - Hypoxaemia

- **What can you do?**
- The hypoxaemia is a result of insufficient delivery of oxygen. Therefore: (after checking pulse-ox and airway)
 - Put on 100% oxygen
 - Improve lung ventilation – give manual or mechanical IPPV – long slow breaths to recruit alveoli
 - Improve lung expansion – posture. Place in sternal recumbency, if possible on tilted table to reduce compressive effects of abdominal contents
 - Increase frequency of ventilation

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Pulse-Oximetry Summary

- Use in non intubated or non-anaesthetised animals as well as anaesthetised animals
- Use of reflectance probes can provide good sustained results
- 100% saturation does not necessarily mean all is well
- With most of our patients on 100% oxygen a true fall in O₂ saturation means something serious has happened

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THE END



Thank-you for Listening

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