Pulse Oximetry: Is It Useful For Horses?

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The use of pulse oximeters in veterinary medicine is becoming very common for monitoring patients during anesthesia and surgery. But is it practical and useful for the equine practitioner? Let me try to answer some questions and quickly review how and why the pulse oximeter can be helpful.

1. What does the monitor measure?

The pulse oximeter measures hemoglobin saturation, which allows us to estimate arterial oxygenation. Because horses are prone to hypoxemia (which will produce a minor drop in oxygenation) and ventilation-perfusion mismatching (which will produce a major drop in oxygenation) during anesthesia and recumbency, you need to know the patient’s oxygenation level. The pulse oximeter also “sees” every pulse, so the practitioner can often hear dropped beats, which may allow detection of arrhythmias. It is also quick to respond to a cardiac arrest as peripheral pulses are often lost before the heart actually stops beating. Prompt treatment can be initiated, which is often effective in saving the patient.

2. What are normal saturation values?

A normal saturation value should be 95% or higher, although values in awake, standing horses will depend on what probe is used and where it is placed. Values in anesthetized horses should be the same: if the horse is breathing well, saturation will be greater than 95%. However, many anesthetized horses do not breathe well, so saturation will be decreased. If saturation drops below 90% (as can occur when using an injectable anesthetic), additional oxygen should be supplied or ventilation should be assisted. A saturation of 90% approximates a PaO₂ of 50 mm of Hg, below this the horse is considered hypoxic. Normal arterial PO₂ should be >90 mm of Hg.

3. What probes can be used and where should they be placed?

Probes for human use can be adapted for use on the horse. However, when I evaluated the human finger-tip probe (Nellcor N-200 with Dura-Sensor probe), placed on the tongue of horses undergoing abdominal surgery, it showed good correlation to arterial blood gas values (Pearson correlation coefficient of 0.85-0.88). This probe also showed good correlation with arterial blood gas values in neonatal foals (0.96 when placed on the lip, 0.89 when placed on the tongue and 0.88 when placed on the ear). A reflectance probe (Nellcor RS-10) also works well when taped onto the underside of foals’ tails or when positioned over the coronary band. Newer probes specifically designed for the veterinary market are even more accurate. Before making a selection, ask what testing has been done as accuracy varies with manufacturer, probe and probe placement. Nostril, lip, tongue, ear and gum are preferred sites for placement (Figures 1, 2 and 3).

4. What will interfere with getting accurate readings and how can you check the accuracy?

As with the use of a pulse oximeter in other species, motion, hair, pigment and peripheral vasoconstriction are the biggest impediments to getting a reading. Other causes of inaccuracy include ambient light (the pulse oximeter uses light to make the measurement) and excessive tightness of the sensor clip. Peripheral vasoconstriction may be pharmacologically induced, especially if xylazine, detomidine or ketamine have been used. Vasoconstriction may also be physiologic, such as from the flight or fight response or shock. You can’t be completely certain of the accuracy of the reading without the availability of a blood gas analysis. One check, however, is to compare peripheral pulse rate to that displayed by the pulse oximeter. If they match, the pulse oximeter should be receiving a good signal. Because the horse has such a forceful, relatively long palpable pulse, the pulse oximeter occasionally may double-count the equine pulse.
5. Can the pulse oximeter replace the blood pressure monitor?

No. The pulse oximeter doesn’t measure blood pressure. In some instances hypotension may lead to peripheral vasoconstriction and the signal may fail. But when I compared pulse oximeter readings to arterial blood gas values in horses undergoing colic surgery, the pulse oximeter functioned and gave readings when mean blood pressure readings were as low as 24 mm of Hg. These anesthetized horses were severely hypotensive, but the monitor was functioning because they were not vasoconstricted.

6. Can the pulse oximeter be used for anesthesia away from the clinic?

Probably. This will depend on the portability and battery life of the model you purchase. A lightweight, portable, battery-operated oximeter is helpful when using an injected anesthetic. I recently used a pulse oximeter during a two-hour field surgery on a horse in Guatemala. The pulse oximeter is non-invasive, easy to attach and will provide valuable information about how well the horse is breathing. Some models have audible alarms that indicate dangerously low heart rate and saturation readings.

7. Can the pulse oximeter be used in awake horses to assess oxygenation?

Yes. However, because most applications have not been thoroughly investigated, there is room for much new data. I have used the pulse oximeter to monitor young foals with respiratory disease, especially to determine the response to and need for oxygen therapy. The pulse oximeter will not replace the need for blood gases, but can minimize the number of samples needed. Other applications might include assessing therapy of horses with chronic obstructive pulmonary disease or other lung disorders. The device may also prove useful to evaluate sequential pulse oximeter values for assessing fitness.

Although the pulse oximeter reading will not tell you the exact PaO₂ value, because of the shape of the oxyhemoglobin curve, it can give you a good idea of the minimum value. For instance, if saturation is 98%, PaO₂ may be 95 or approximately 300 mm of Hg. In either case, the horse is receiving plenty of oxygen. If the saturations drop close to 90%, you can predict PaO₂ and take action to improve ventilation and oxygenation. Reliability of the monitor is critical and has to do not only with probe design and placement, but with the internal nomogram used in the calculation. You have to trust that the manufacturer has evaluated the accuracy of the readings over a wide range of saturation values. Most models of pulse oximeters tend to be less accurate at low saturation reading. This may be due to the differing properties of equine blood.

Experience in positioning the probe and interpreting the readings comes with practice as with any equipment. Used routinely to monitor anesthetized horses, the pulse oximeter will provide valuable information in a practical and relatively inexpensive manner.

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