

WHAT DOES A PULSE OXIMETER TELL YOU?

Dawn Crandell DVM, Diplomate ACVECC

Veterinarians take solace in seeing a number in the high 90's on the pulse-oximeter in their anesthetized patients. I would argue that the pulse oximeter actually has more utility in the non-anesthetized, ill patient, and here's why:

The number on the pulse oximeter (SpO_2) indicates the percentage of hemoglobin in the arterial circulation that is saturated with oxygen. Typically, in a healthy individual breathing room air this is around 98-99%. Oxygen-poor blood returning from the body tissues passes through the right heart into the lungs. As it squeezes through the lung capillaries, oxygen in the alveolar air diffuses across the alveolar and capillary wall into the blood, driven by the gas pressure gradient between the oxygen-rich alveoli to the oxygen-poor blood. The oxygen gas pressure (PaO_2) in the arterial blood leaving the lungs increases, and in a healthy animal, the PaO_2 of blood leaving the lungs is about 97 mm Hg. At this arterial oxygen pressure, almost all of the hemoglobin becomes saturated with oxygen, so the pulse-oximeter will read a reassuringly high number. In fact, even if the PaO_2 drops a bit, the hemoglobin can still be well saturated with oxygen. When the PaO_2 starts to drop to less than 80 mm Hg, the hemoglobin saturation starts to decrease, and this will be reflected with a lower number on the pulse oximeter.



It is crucial to recognize that the inspired concentration of oxygen has a dramatic effect on the PaO_2 . Room air is 21% oxygen. The gas that flows through the anesthetic circuit in most veterinary anesthesia set-ups is close to 100% oxygen. Ventilation with 100% oxygen will increase the PaO_2 in the arterial blood 5-fold, to values in the 400-500 mm Hg range. Hemoglobin exposed to such a high-oxygen pressure environment will be thoroughly saturated with oxygen, and the pulse-oximeter readings will be in the high 90's accordingly. Only when the PaO_2 drops to less than 80 mm Hg will the Hb saturation drop. Realize that it will take a severe, long-standing anesthetic problem for the PaO_2 to drop from 400 to 80 mm Hg, and thus be recognized with your pulse-oximeter. So, dropping SpO_2 in a healthy anesthetized patient indicates a problem, but only when it is severe (e.g. complete apnea, the oxygen wasn't turned on, accidental esophageal intubation, etc.) and has been there for some time (i.e. several minutes after your patient became apneic). In short, a low SpO_2 reading in a patient ventilated with 100% oxygenation reflects a missed problem that is now a crisis. A capnograph, which measures the expired CO_2 concentration, will alert you to a ventilation problem far earlier, when chances of successfully managing it are greater.

The awake, non-intubated patient, on the other hand, is breathing 21% oxygen room air, and normal PaO_2 at this oxygen concentration (at our elevation) is about 97 mm Hg. When the PaO_2 drops to less than 80 mm Hg, arterial hemoglobin starts to desaturate, and the SpO_2 will start to drop. Our eyes are not very sensitive in appreciating cyanosis: the blue-tinge of the mucous membranes is not readily apparent to us until the SpO_2 is around 80% or less, and in anemic patients, may be difficult to appreciate at all because they don't have a lot of hemoglobin to discolour. An SpO_2 of 80% reflects a PaO_2 of approximately of approximately 50 mm Hg (about half normal levels!). As the PaO_2 drops further, the SpO_2 starts to drop dramatically. The pulse oximeter, used in the awake patient, is a sensitive indicator of respiratory problems and will alert you to hypoxia before you can appreciate cyanosis. At the VEC, a pulse-oximeter reading is part of a vital sign assessment in the emergency patient. In the ICU, the pulse oximeter is used to tailor the amount of oxygen administered to a patient; once Hb saturation is about 95-97%, little can be achieved with higher oxygen flow rates. Normalizing SpO_2 values reflect clinical improvement.

Consider taking your pulse oximeter beyond your surgical suite, and start using it to monitor your ill patients with respiratory disease of any cause. You might be surprised how it helps your evaluation.

Please feel free to call Dr. Judy Brown or myself to answer any questions you may have regarding pulse-oximeters or other topics pertaining to critical care.

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