

Capnography and Pulse Oximetry: Becoming BFFs

Stephen Cital RVT, SRA, RLAT, VTS- LAM (Res. Anesthesia)
<http://www.stephencital.com>

Technology as we all know is ever changing and advancing. Currently there are actually iPhone® cases that read ECG's (AliveCor®) as well as phone applications designed to help diagnose arrhythmias. The launch of a SpO2 sensor attachment (iSpO2®, Masimo Corp.) that can be used as a personal SpO2 monitor for fitness, endurance and aviation training increases the number of portable point of care devices.

*Not all devices are marketed, nor have FDA approval, for diagnostic use in the medical/veterinary setting.

I hope to enlighten readers on advances now available in veterinary medicine. Only one device is featured in this article, the Radical-7® Pulse CO-Oximeter by Masimo Corp., because it is the only FDA approved non-invasive CO-Oximeter now being marketed for veterinary use. The technology does not necessarily have heaps of data for animal efficacy yet, but it is an important advancement we as veterinary medical professionals should know is available. The utilization of the machine is gaining popularity in human medicine and now is the time for its utilization in veterinary medicine. Multiple human studies have found the individual components of the Masimo Radical-7® to be accurate within a reasonable margin of error for a point of care device.^{1,2} Our facility, the California National Primate Research Center at UC Davis, recently received the Radical-7® non-invasive Co-Oximeter to test and decide if this piece of monitoring equipment can provide accurate enough information to be used regularly in our anesthetized and critical patients.

The use of standard pulse oximetry in veterinary medicine is widespread and a highly accepted form of non-invasive monitoring of oxygen saturation and pulse rate in critical, non-critical and anesthetized patients; the gold standard still being arterial blood gas sampling and EKG's. Superior oxygen saturation and perfusion is essential in the ICU and OR for the best patient outcome and reduced healing times as well as organ function.^{1,3} Standard pulse oximeters use two wavelengths of light to calculate oxyhemoglobin, which is a combination of total hemoglobin, methemoglobin, carboxyhemoglobin, as well as other forms of dyshemoglobins. Then a combined total as a percent is calculated and displayed as the SpO2%. The accepted reference interval for most species is 98-100%. With using the standard 2-wavelength pulse oximetry it is easy to misinterpret SpO2% readings as "within normal limits" when a dyshemoglobin may be present.⁴

Can you remember the last time you ordered a dyshemoglobin profile or have ever had to treat one? Not only are dyshemoglobins under diagnosed in human medicine, but more so in veterinary medicine. Dyshemoglobins are caused by a metabolic disorder, toxin ingestion, toxin exposure or acquired from medications.^{1,2,4}

Now you might be asking how dyshemoglobins are assessed? Invasive Co-oximeters have been around for a while in human medicine, but with little use in veterinary medicine. Invasive Co-Oximetry entails an actual blood sample being run through a Co-Oximetry machine.

The Masimo Radical-7 non-invasive Co-Oximetry only entails clipping or taping a regular looking SpO2 sensor to the patient. One might be asking how a SpO2 sensor will differentiate the different types of hemoglobin's? The answer being, the new, advanced non-invasive Co-Oximeter uses >7 wavelengths of infrared light to calculate a combined oxyhemoglobin reading as a total SpO2% and due to the increased sensitivity from the extra wavelengths of infrared light it also calculates and shows readings for two

dyshemoglobins, methemoglobin and carboxyhemoglobin. The percentages of the two dyshemoglobins are then displayed as percentages on the screen. In our use of the machine we discovered detectable levels of methemoglobin on the Radical-7, confirming with invasive Co-Oximetry. This was startling and an important discovery as it allowed us to change our anesthesia protocols to minimize acquired MetHb buildup for better patient care.

The standard hemoglobin reading the machine also provides can be very useful for animals undergoing blood transfusions or hemodilution. The machine in addition gives a total arterial oxygen content reading for further non-invasive monitoring. This parameter is excellent for ventilator cases or respiratory compromised patients.

Cardiovascular perfusion and balanced fluid therapy is yet another fundamental part of traditional patient monitoring. However, advanced techniques to monitor such parameters can involve placing a central line for central venous pressure measurement or even placing and maintaining an arterial catheter. As we all know this may be difficult, not practical for the duration of a case or feasible in a certain species. Not to mention financially burdensome to the client or out of the scope of your practices needs and abilities. This in turn can lead to less effective treatment and response in our patients. The Masimo Radical-7 includes the features of Perfusion Index (PI) and Pleth-Variability Index (PVI). These are two new monitoring parameters and can be very telling when obtained correctly. The perfusion index is the ratio of the pulsatile blood flow to the non-pulsatile or static blood in peripheral tissues. What this means is now we can monitor peripheral tissue perfusion in our patients non-invasively giving better insight into our fluid therapy management, cardiac/renal output and efficacy of medications. A defined reference variable is not yet established in the canine or feline patient or any other specie for that matter, other than humans, which tends to be quite broad. However, the PI parameter as well as all of the other non-conventional parameters, is great for trending and monitoring. When monitoring the PI for anesthetic or pain management purposes the perfusion status is usually the converse of supporting a good PI in non-anesthetized critical patients by the drugs causing vasodilation. When proper onset of anesthetic or analgesics has taken effect we see a spike in the PI showing efficacy. This technology is particularly exciting for patients undergoing kidney transplant, open-heart surgery, thrombin disorders and trauma patients.

The Pleth Variability Index (PVI) is a new technology even in human medicine. It is a measurement in the change of perfusion index with a complete respiratory cycle. With this in mind, PVI is most reliable with patients undergoing mechanical ventilation. In a scientific abstract presented at the American College of Veterinary Anesthesiologists conference, one research group found that the PVI had good correlation in detecting hypovolemia and a return to normovolemia in dogs, but could not be used in definitively stating hypervolemia.

The last parameter is the acoustic respiratory monitor. What this acoustic respiratory monitor (aRR) has to offer is continuous respiration monitoring without endotracheal tube placement. It is perfect for the ICU setting, especially with quiet or recumbent patients. It is also idea for field knockdowns or large or exotic animals. The readings of the aRR on the Radical-7 have been nearly identical to our intubated patients with use of a traditional respirometer.

In all the Masimo Radical-7 offers an all-inclusive and advanced monitoring device. It has brought attention to parameters never monitored before as well as reminded us of the importance of drug selection. Formal validating studies are underway with the Masimo Radical-7 for the veterinary community and we anticipate positive results.

Capnography: Although capnographs are becoming more and more standard on multiparameter monitors correct or accurately interpreting of the waveforms is still fairly low in veterinary medicine. Typically, the waveforms are looked upon as just breaths. However, each wave is indicative of a breath or lack thereof.

There is so much more that can be gathered from the wave stature and anatomy. Understanding the waveforms better will allow anesthetists to gauge the quality of the breath, possible occlusions or leaks and perfusion quality of the animal.

References upon request.