The measurement of end tidal CO2 (ETCO2) is currently the optimal method of non-invasively and continuously monitoring the adequacy of ventilation and circulation in veterinary patients. The ETCO2 monitor measures expired carbon dioxide. This measurement can be used to evaluate adequacy of ventilation, metabolic status and circulatory status. (Moens, 2010) This is different than the pulse oximeter which is used to measure hemoglobin and saturation with oxygen.

Capnography directly reflects the elimination of CO2 by the lungs to the anesthesia device. Indirectly, it reflects the production of CO2 by tissues and the circulatory transport of CO2 to the lungs. For example, an increased metabolism will increase the production of carbon dioxide increasing the ETCO2. A decrease in cardiac output will lower the delivery of carbon dioxide to the lungs decreasing the ETCO2 measurement (Canning, 2007)

Under normal circumstances, ETCO2 reflects the partial pressure of CO2 in the alveoli of the lungs. It is important to note that ETCO2 is not the same as PaCO2, which measures the partial pressure of CO2 in the blood. However ETCO2 can give you a close approximation of PaCO2 as the difference in these numbers in a normal, healthy patient is between 2-6mmHg. (Digicare, 2009)

Normal ETCO2 values for canines and felines ranges from 35-45mmHg. An increase in ETCO2 can indicate many things including hypoventilation, increased anesthetic depth, exhausted soda lime, airway obstruction, and hyperthermia. Increased ETCO2 can also be seen during laparoscopy due to absorption of CO2 (that is used to inflate the abdomen) from the peritoneum. A decrease in ETCO2 can be indicative of hyperventilation, an inadequate plane of anesthesia, hypothermia, decreased cardiac output. Absent ETCO2 readings can indicate respiratory arrest, cardiac arrest, or technical problems such as an obstructed or dislodged endotracheal tube.

The capnograph can be extremely helpful to the veterinary technician that is not well experienced with intubation. The capnograph can be used to show proper endotracheal intubation. (Dorsch, 2008) If patients have an endotracheal tube in the esophagus, the ETCO2 reading will be at zero, sine little to no CO2 is produced in the esophagus and stomach. Patients that are properly intubated with the endotracheal tube in the correct position will display a nice plateau on the capnograph.

The capnograph can also be a valuable tool to assess the adequacy of chest compressions during CPR. The quality of CPR can be monitored using end tidal CO2 levels during compressions. Studies have shown that the greatest chance for the return of spontaneous circulation happens when CO2 levels are maintained above 20mmHg during cardiac arrest.
CO2 levels below 20 mmHg may be an indicator of inadequate chest compression depth and rate.

End tidal CO2 monitoring can provide an early warning sign of shock. A patient with a sudden drop in cardiac output will show a drop in ETCO2 numbers that may be regardless of any change in breathing. This has implications for trauma patients, cardiac patients – any patient at risk for shock.

In 2000 a study was done examining the relation of ETCO2 cardiac output. 5 pigs had hemorrhagic shock induced by bleeding, 5 pigs had septic shock induced by infusion of e-coli, and 6 pigs had cardiogenic shock induced by repeated episodes of v-fib. The pigs' cardiac output was continuously measured as well as their ETCO2. The study showed that CO and ETCO2 were highly related in diverse experimental models of circulatory shock in which cardiac output was reduced by >40 % of baseline values… measurement of ETCO2 is a noninvasive alternative for continuous assessment of cardiac output during low flow circulatory shock states of diverse causes.(Xiahua,2000)

A capnometer only gives a numerical display of ETCO2. It will not give you a waveform, therefore it is hard to assess ET tube placement, cuff seal, and associated problems you can otherwise derive from the waveform analysis.

A capnograph should have four basic parts.

1- Carbon dioxide is cleared from the anatomic dead space, also known as return to baseline
2- Expiration of dead space and alveolar carbon dioxide
3- The plateau, this is the highest point and gives you're your ETCO2 measurement
4- Return to baseline, as the patient begins to inhale fresh gas.

If your baseline does not return to zero, this can signal the anesthesia technician to problems such as excessive mechanical dead space, exhausted soda lyme, inadequate fresh gas flows.
on a non-rebreather and possibly a faulty one way valve. In the case of dead space, as dead space volume increases, effective alveolar ventilation decreases. Mechanical or equipment dead space is made up of any portion of the endotracheal tube that extends beyond the patients incisors as well as patient monitor adapters (such as ETCO2 sampling line connectors, and mainstream sampling connectors).

A capnograph can be an invaluable tool for the patient under general anesthesia. A capnograph can alert the veterinary technician to possible problems with either the anesthetic equipment or the patient themselves before it is too late.

For more information on capnography, consider visiting www.capnography.com.

References:


Xiahua, (2000) End-tidal carbon dioxide as a noninvasive indicator of cardiac index during circulatory shock, Critical Care Medicine, Vol 28, No 7