Dec 2012 Newsletter

Academy of Surgical Research

Surgical Savvy

Tech Tips: A process for quick interpretation of arterial blood gas analysis in determining acid-base disturbances

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Announcements

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Arterial blood gas (ABG) analysis is a vital part of anesthesia monitoring. One of the biggest side effects of general anesthesia is respiratory depression due to a decrease in sensitivity to CO2 levels. (Lumb and Jones, 1997), and blood gas analysis provides a very precise way to measure oxygen and carbon dioxide levels. ABG also provides a real-time view of the animal's acid base balance and allow us to determine whether the animal is experiencing an acid base disturbance.

This article only seeks to touch the surface of this subject by outlining a quick and simple way of determining if and which simple acid base disturbance is present. Diagnosis and correction of acid base disturbances should always be done in cooperation with a veterinarian.

(Cont.)

In order to do our acid base balance analysis we will only be looking at three values (pH, CO_2, and HCO_3^-.).

The first thing that we will examine is the blood pH.
Normal blood pH ranges from 7.35- 7.45(Tighe and Brown, 2003)
*If you have a value of >7.35 the animal is in a state of acidosis.
*If you have a value of <7.45 the animal is in a state of alkalosis
Maintaining a normal pH range is very important, as the body has only a narrow window it must stay in to avoid serious health implications which can ultimately lead to death.

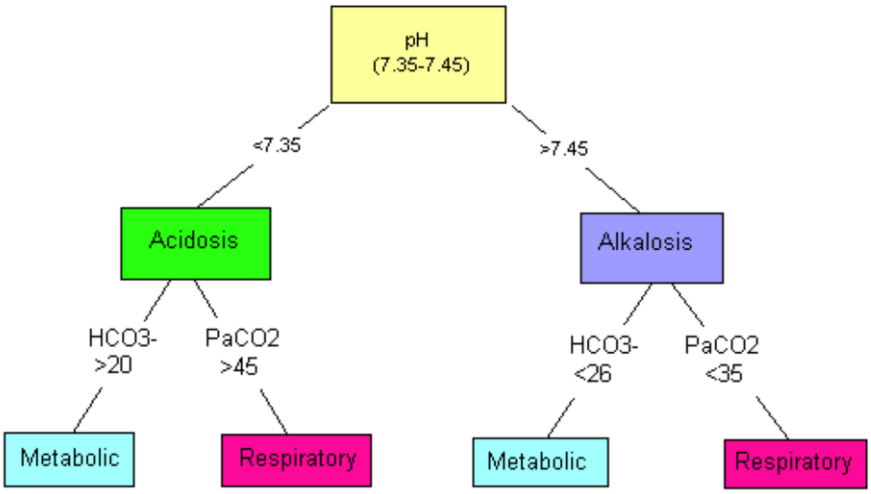
The body has renal and respiratory systems have enormous buffering capacity that help maintain a normal pH. It regulates carbonic acid by way of carbon dioxide (CO_2) and bicarbonate (HCO_3^-). This buffering system can be seen in the equation below:
$H^+ + HCO_3^- <=> H_2CO_3 <=> H_2O + CO_2$
(Tighe and Brown, 2003)
The left side of the equation can be adjusted up or down by the renal system excreting H^+ or retaining HCO_3^-. The right side of the equation is adjusted up or down through the respiratory system by exhaling more or less CO_2. Respiratory compensation is a very quick response, whereas the renal response is much slower. (Lumb and Jones, 1997)

Once we know whether or not an alkalotic or acidotic condition is present, the next step is to check and see if it is respiratory in nature by evaluating $PaCO_2$. $PaCO_2$ should normally range between 35-45 mmHg (Tighe and Brown, 2003).

*If an elevated pH (alkalosis) is accompanied by a decreased $PaCO_2$, respiratory alkalosis is present.
*If a decreased pH (acidosis) is accompanied by an increased $PaCO_2$, respiratory acidosis is present.

Finally, let's take a look at HCO_3^- to see if the disturbance is metabolic in nature. Normal HCO_3^- falls between 20-24 mEq/L (Tighe and Brown, 2003).

*If an elevated pH (alkalosis) is accompanied by an increased HCO_3^- , metabolic alkalosis is present.
*If a decreased pH (acidosis) is accompanied by a decreased HCO_3^- , metabolic acidosis is present.



(Lumb and Jones, 1997)

It is not uncommon to see slight respiratory acidosis in spontaneously breathing animals under general anesthesia due to respiratory depression due to a decrease in sensitivity to CO2 levels. (Lumb and Jones, 1997) This would be seen on a blood gas analysis as a slightly decreased pH, an increased $PaCO_2$, and normal bicarbonate. It is for this reason, among others, that it is a good idea to periodically ventilate the animal to help blow off CO_2.

On mechanically ventilated animals, you can easily adjust minute volume and/or respiratory rate to compensate for a respiratory acidosis or alkalosis which may be seen on a blood gas reading. These acid base disturbances may be commonly seen when an animal is under general anesthesia and on mechanical ventilation for extended periods of time.

Metabolic disturbances should always be corrected and treated in conjunction with a veterinarian. Any animal model with renal disease, diabetes, undergoing steroid therapy, or diuretic therapy should be closely monitored for metabolic disturbances typically associated with those diseases.

As an anesthetist, it is paramount to identify abnormalities in the patient before it becomes an emergency. Maintaining the patient's acid base balance is a crucial part to maintaining balanced anesthesia during longer procedures, and it a useful tool in ensuring that the respiratory status of your patient is acceptable, especially when using mechanical ventilation.

1. *Veterinary Anesthesia*; Lumb, W.V.; Jones, E.W.; Lea & Febiger, Philadelphia, 1997, ISBN 0683082388
2. *Mosby's Comprehensive Review for Veterinary Techhnicians*; Tighe, Monica M, and Brown, Marg, St. Louis, Missouri, 2003, ISBN-13:9780323019347

Tech Tips: Difficulties in Anesthesia Induction in Guinea Pigs

By: Jillian Horvath, SRA

Anesthetic induction of guinea pigs has been, to say the least, very technically challenging. You would think that the fact it is a rodent, it could be treated similar to a rat or a mouse, but that is certainly not the case. Through the course of trial and error, it was found that in order to minimize problems associated with anesthesia in guinea pigs, they needed to be fasted. Guinea pigs, once sedated, do have the ability to regurgitate. They also tend to keep food trapped in pockets within their cheeks[1]. Guinea pigs tend to produce large amounts of secretions when exposed to inhalants anesthetics such as isoflurane[2]. If possible, the animal's head should be elevated to reduce the risk of aspiration and/or suffocation from regurgitated food.

Guinea pigs should be fasted for a minimum of one hour, but no more than 4 hours due to the need to maintain peristalsis and normal blood glucose levels. Removing food for too long can slow gut motility drastically resulting in ileus. Sometimes there is a need for force feeding. Offering supplemental nutrition such as Nutrical® or a slurry of their pellets, is helpful in maintaining glucose levels and promote gut motility.

There are 2 common ways in which guinea pigs can be anesthetized. The use of an inhalant anesthetic such as isoflurane (1.5 -2%) and oxygen (2 L/min), or the use injectable anesthetics such as ketamine (30-44 mg/kg) /xylazine(0.1-5.0mg/kg)[3] . With the Isoflurane and oxygen chamber, the animal's head needs to be elevated as soon as possible by placing a small towel or a stack of paper towels under the animal. If this is not done, there may be the issue of regurgitation. One possible option is a ketamine/xylazine injection, anesthesia induction appears to be faster and easier on the animal, plus there appear to be fewer issues with regurgitation as compared with an inhalant anesthetic. Once the animals are anesthetized with ketamine/xylazine, they were placed on a face mask 2.0 L/min of oxygen and surgery was conducted. There is no problem with regurgitation and no need to have the animals head elevated.

There are many positive aspects of using ketamine/xylazine. One is the animals remain anesthetized for longer periods of time, and require little to no additional doses of the cocktail if the initial dose is adequate for the surgical procedure. Ketamine/xylazine cocktail reduces the risks of breath holding, resulting in hypoxia or even death. Ketamine is a potent anesthetic and it crosses the blood brain barrier resulting is sufficient analgesia, unconsciousness and amnesia, and the onset is rapid, usually within 1 minute[4]. The cocktail of ketamine/xylazine can be reversed using yohimbine and anesthetic recovery is quicker than if left to wait for the cocktail to disperse through the animals system. A negative aspect of ketamine/xylazine is that left without the use of yohimbine, anesthetic recovery can take hours, resulting in the animal outside of the window for fasting and you are at risk for the decrease in gut motility that was described above.

There are also positive aspects to using isoflurane/oxygen; the recovery time is much faster using isoflurane/oxygen. Once the animal is removed from isoflurane/oxygen, recovery time is usually within minutes.

You are reducing the probability of gut motility depression with a rapid recovery. Isoflurane/oxygen emits noxious fumes and guinea pigs tend to hold their breath because of the smell resulting in a greater risk of causing hypoxia and even death if left untreated. With isoflurane/oxygen, there is also a greater risk of regurgitation causing blockage of the airway and possible death.

In conclusion, regurgitation is a possibility in anesthetized guinea pigs. However, but with the proper anesthetic regime, problems during surgery and post-operatively can be minimized or prevented. Using ketamine/xylazine in guinea pigs, there is little to no risk of regurgitation, but a slower recovery. With isoflurane/oxygen, there is possibility of regurgitation but a more rapid recovery than injectable anesthetics.

1. Katherine E. Quesenberry & James W. Carpenter, *Ferrets, Rabbit, and Rodents*, St. Louis, Missouri, Saunders, 2004, p.364.
2. John C. Thurmon, William J. Tranquilli, and G. John Benson, *Lumb and Jones Veterinary Anesthesia*¸Baltimore, Maryland, Williams and Wilkins, 1996, p. 715.
3. John C. Thurmon, William J. Tranquilli, and G. John Benson, *Lumb and Jones Veterinary Anesthesia*¸Baltimore, Maryland, Williams and Wilkins, 1996, p. 718.
4. John C. Thurmon, William J. Tranquilli, and G. John Benson, *Lumb and Jones Veterinary Anesthesia*¸Baltimore, Maryland, Williams and Wilkins, 1996, p. 242

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