Question of the Week #22
Acid/base regulation

You and your anesthesiologist have just arrived in ICU to transfer your patient, who is scheduled to have an A-V shunt insertion for dialysis. He has a history of smoking a pack a day for the past 40 years and has been diagnosed with COPD. He has been vomiting most of the day. His nurse states that he is more lethargic than when he was admitted 3 days ago. When you rouse him to interview him, he complains of a headache.

While reviewing his lab values, you see an arterial blood gas drawn 2 hours ago. The values are:

- pH = 7.15
- pCO₂ = 55 mm Hg
- HCO₃⁻ = 18 mEq

Provide your analysis of the ABG values. What is the relationship of these values to your patient’s condition? What significance do they have for your plan of care?

Response:

pH and acid/base values give us a very good indication of how well the body is able to regulate its systems. The body relies on the respiratory system to control CO₂, or the acid, component, and the kidneys to control bicarbonate(HCO₃⁻), or the base component. These 2 systems help each other out by “compensating” and controlling the rate of acid and base absorption or secretion, which returns the pH, or concentration of hydrogen ions, back to a viable range. As opposed to temperature, pulse, and blood pressure, all of which have a fairly wide “normal” range, pH is much less forgiving. Values may differ slightly based on your lab, but these 3 factors must be taken into account when interpreting ABG’s.

pH measures the concentration of hydrogen ions. Normal arterial blood values are 7.35 to 7.45; a lower pH signifies an increased concentration of hydrogen ions, or acidosis; a higher pH means a decreased concentration of hydrogen ions, or alkalosis.

CO₂ is regulated by the lungs and should be considered the “acid” part of acid/base. Normal values are 35-45 mm Hg. Anyone who has had a baby or helped someone have a baby has witnessed the side effects of respiratory alkalosis, when someone is breathing too rapidly and “blows off” her CO₂. As you can imagine, normal healthy people can change their rate of respirations very quickly to either retain or lose acid and correct a deviation in pH. People with respiratory conditions (or on a ventilator) who are unable to change their breathing patterns must rely on their kidneys to compensate.

Bicarbonate is regulated by the kidneys. Normal values are 22-26 mEq/L. This is the “buck stops here” system, and final regulation of acid/base balance depends on this much-maligned set of body parts. It typically takes the kidneys 2-3 days to correct an
acid/base imbalance. Patients in renal failure are unable to regulate HCO$_3^-$ or hydrogen ion (H$^+$) concentrations and are typically in metabolic acidosis.

Our patient in this example is in both respiratory and metabolic acidosis. Severe acidosis may produce life-threatening dysrhythmias and hypotension. A pH less than 7.1 will require administration of sodium bicarb. Due to the relationship between potassium and hydrogen, these patients will also frequently have an electrolyte imbalance, so it’s a good idea to check them, especially sodium and potassium. These electrolytes play a key role in the transmission and conduction of nerve impulses, maintenance of cardiac rhythms, and skeletal and smooth muscle contraction. Check your patient’s EKG for signs of electrolyte imbalance. Other signs of acidosis and electrolyte imbalances are nausea, vomiting, weakness, and headaches.

Have a code cart handy and be prepared to assist anesthesia in drawing more ABG’s. Most facilities have a special ABG kit with a heparinized syringe. Use universal precautions when handling the specimen, label it appropriately, and place the syringe on ice per hospital policy. It should be transported to the lab immediately. The requisition slip should include, besides patient identification information, the concentration of oxygen the patient is receiving. Some trauma centers are able to process ABG’s in the procedure room with a point of care blood analyzer.

Arterial blood gas interpretation may look overwhelming initially, but this is an excellent reminder of how our bodies incorporate principles of chemistry in order to adapt and survive. Talk with your anesthesia care provider about additional opportunities to evaluate ABG’s, or spend an afternoon with an intensive care nurse. Ask for lab printouts and compare your analysis with the patient’s diagnosis. Hurray and Saver (1992) have written an excellent article which includes practice problems and case studies. Understanding acid/base balance allows us to anticipate patient needs and provide the best care possible for this high-risk population.

References and resources
