



Acid Base Balance

September 2012

Up2Date

The human body has intrinsic buffering systems to maintain a neutral pH within the body. Looking at the acid base imbalance systematically can help determine treatment; i.e. when should we give bicarb?

To determine a plan of care, get labs including a blood gas (venous or arterial), albumin, lactate, chemistry and a PMHx.

- The iStat chem8 provides: Cr, Bun, Glu, Cl⁻, Na, K⁺, iCa, Hct, Hgb, TCo₂, and Anion gap.
- The iStat G4+ provides: pH, pCO₂, Po₂, TCo₂, HCO₃⁻, base excess, and lactate.

1. Determine pH;

- If >7.45 arterial, then patient's primary problem is **alkalosis**, (venous >7.40)
- If <7.35 arterial, then patient's primary problem is **acidosis** (venous <7.30)

2. Look at CO₂ and HCO₃⁻:

- Determine the acid base disorder:

Acid base disorder	Expected mechanism of compensation	Timing
Metabolic acidosis (pH<7.35 and HCO ₃ <24)	↑ Minute ventilation causing ↓ pCO ₂	minutes
Metabolic alkalosis (pH>7.45 and HCO ₃ >24)	↓ Minute ventilation causing ↑ pCO ₂	minutes
Respiratory acidosis (pH<7.35 and pCO ₂ >40)	↑ Reabsorption of HCO ₃ & ↑ excretion of H ⁺ in kidneys	hours - days
Respiratory alkalosis (pH>7.45 and pCO ₂ <40)	↓ Reabsorption of HCO ₃ & ↓ excretion of H ⁺ in kidneys	hours - days

- The acid base disorder can be a mixed metabolic and respiratory disorder. If compensation for the abnormal pH is not what is expected, there is likely a mixed acid base disorder. Please refer to the following link for a detailed review of how to determine a mixed acid base disorder.
- <http://www.youtube.com/watch?v=HNIQEonfiuM> (2012, Strong).

3. Evaluate your labs for causes of acid base imbalance;

- **Na+** (normal 135-145); high Na+ consider dehydration and fluid resuscitation.
- **Cl-** (normal 92-109); acidosis associated with high Cl- indicates HCO₃⁻ loss, Cl- being retained to maintain pH= hyperchloremic metabolic acidosis. (Consider renal failure, diarrhea).
- **K+** (3.5-5.1); K+ is a dependent variable in acidosis, shifting out of the cell (causing hyperkalemia) during acidosis and into the cell (causing hypokalemia) during alkalosis. Rapid correction of acidosis can cause critical K+ shifts.
- **Lactate** (>2=elevated); >4 considered severe and requires treatment. (Consider infection, shock, toxic sources ie. salicylate OD, etc.)
- **Albumin** (4-6); albumin is a weak acid, low albumin can contribute to alkalosis (Consider hepatic failure, dilution from IV fluids); high albumin can contribute to acidosis (Consider hypovolemia).
- **Anion gap** (normal 8-12); Anion gap is the difference between plasma cations (+) and plasma anions (-) and is used to differentiate the type of metabolic acidosis. $AG=(Na+K)-(HCO_3+CL)$

Increased acid (elevated anion gap); MUDPILECATS	Bicarb loss (normal anion gap)
• Methanol ; Formic Acid	• Diarrhea
• Uremia : increased Bun/Cr	• Renal failure
• DKA	• Proximal renal tubule acidosis
• Paraldehyde	
• Iron and INH	
• Lactic acidosis ; most common cause	
• Ethylene glycol ; Oxalic acid	
• Carbon Monoxide, Cyanide	
• Alcoholic ketoacidosis ; serum acetone, vomiting	
• Toluene	
• Salicylic acid	

- **Glucose**; Consider possible ketoacidosis and correct glucose disorder.
- **Base excess** (normal -2 to +2); base excess=reflection of deviation of HCO₃ level from normal. Predictor of mortality and used to guide resuscitation. NCME protocol when BE -6 then start with 20-40ml/kg NS and /or blood. Consider Bicarb after fluid resuscitation if history and labs indicate it.

Consider all possible causes for acidosis and correct the problem if possible before considering Bicarb. Research shows that sodium bicarb has no measurable, beneficial effect in acidotic patients (Forythe, 2000).

NCME protocol for Sodium Bicarb administration is:

- **Moderate to severe acidosis**; Adults- administer 50meq for every -6 of base deficit with a max of 150meq, Peds-administer 1meq/kg for every -6 of base deficit. Max of 2meq/kg and reeval ABG/VBG.
- **Severe metabolic acidosis** (pH <7.2 or DKA <6.99), administer 0.5-2.0 meq/kg depending on the degree of acidosis.
- **TCA OD with widened QRS**, 1meq/kg IV, repeat until QRS narrows with max 150meq.
- **Cardiac arrest**, administer 1meq/kg 8.4% IV. Repeat based on ABG.

References:

1. McCance, K., Heuther, S. (2006). Pathophysiology, The biologic basis for disease in adults and children, (5), pg. 111-119.
2. Weingart, S. (2011, April 11). Acid base in the critically ill. Podcast retrieved from <http://emcrit.org/podcasts/acid-base-i/>.
3. Forsythe, S., Schmidt, G.(2000). Sodium bicarbonate for the treatment of lactic acidosis. *Chest*, 117, 260-267.
4. Strong, E. (2012, Jan 31). Understanding ABGs Lecture 4; Compensation and mixed disorders. U tube video retrieved from <http://www.youtube.com/watch?v=HNIQEonfiuM> .