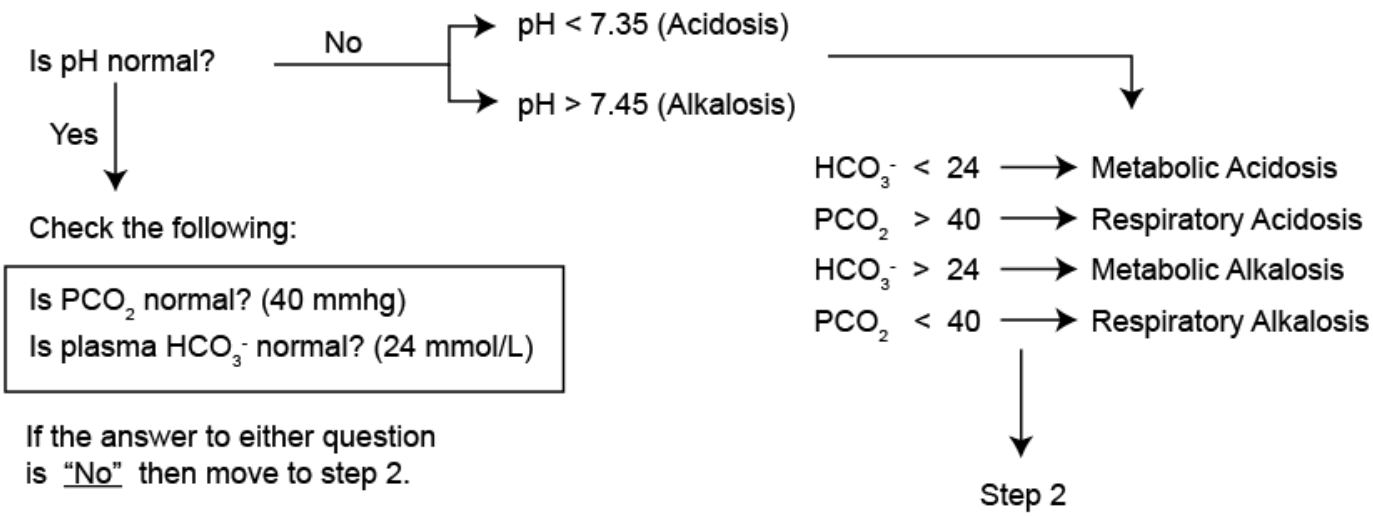
Bio 461 - Acid Base Lab

Guide for Interpretation of Acid Base Disorders

Step 1: Check pH for Acidosis or Alkalosis



Step 2: Check to see if the Compensation is Appropriate

Metabolic Acidosis: PCO2 decreases by ~ 1.25 mmhg for each 1 mmol/L decrease in HCO3-below 24.

Respiratory Acidosis:

- **Acute**: HCO3- increases by ~ 1 mmol/L per 10 mmhg increase in PCO2 above 40 mmhg.
- **Chronic**: HCO3- increases by ~ 3.5 mmol/L per 10 mmhg increase in PCO2 above 40 mmhg.

Metabolic Alkalosis: PCO2 increases by ~ 0.6 mmhg per 1 mmol/L increase in HCO3- above 24.

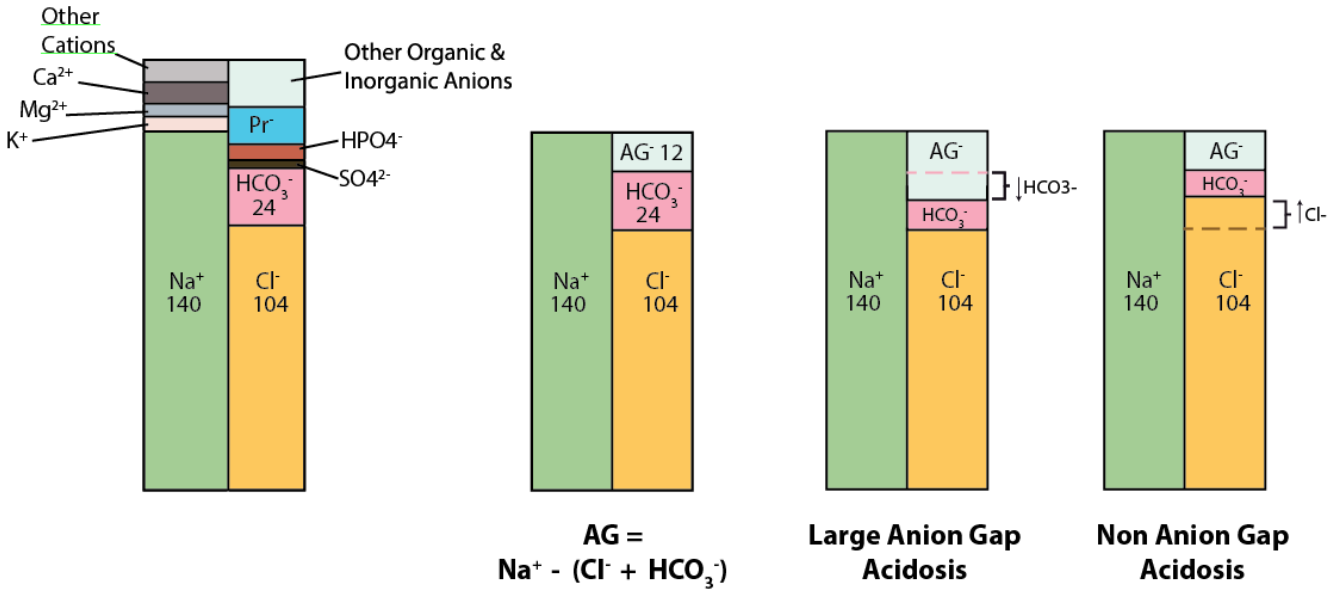
Respiratory Alkalosis:

- **Acute**: HCO3- decreases by ~ 2 mmol/L per 10 mmhg decrease in PCO2 below 40 mmhg.
- **Chronic**: HCO3- decreases by ~ 5 mmol/L per 10 mmhg decrease in PCO2 below 40 mmhg.

* If the compensation is inappropriate, suspect a mixed acid / base disorder.

Step 3: Check the Anion Gap

$Na^+ - (Cl^- + HCO_3^-)$ Normal Values ~ 12 mmol/L



AG = $Na^+ - (Cl^- + HCO_3^-)$ | **Large Anion Gap Acidosis** | **Non Anion Gap Acidosis**

*Albumin is the major unmeasured anion and contributes the most to the value of the anion gap. Every one gram decrease in albumin will decrease the anion gap about 2.7 mmol. This can help explain small anion gaps. This also means that a normally high anion gap acidosis in a patient with hypoalbuminemia may appear as a normal anion gap acidosis. Keep this in mind as **this is an important piece of information that will be necessary in one of the case studies later on**.

If the Anion Gap is 20 mmol/L or larger, then there is most likely to be a large anion gap acidosis. This large gap acidosis is caused by the addition of organic acids. More specifically, organic acids contribute to the anion gap when they deprotonate and generate a negatively charged conjugate base (ie., lactate). The body will try and buffer these additional protons with the bicarbonate buffer system which occurs at a 1:1 molar ratio. For example, 1 mmol of acid tirates 1 mmol of HCO3-. Therefore, we can deduce that if we measure a large anion gap of say 21, that means we essentially have 9 more mmol/L of negatively charged anions added to the gap (Large gap of 21 – normal gap of 12 = 9). Keeping with the 1:1 ratio, this would require 9 mmol/L of HCO3- to buffer the 9 mmol/L of protons donated by excess organic acids. We can further deduce that this decrease in 9 mmol/L of HCO3- would give us a predicted HCO3- value of 15 mmol/L when measured in the lab (the normal 24 mmol/L – 9 mmol/L = 15mmol/L).

If we get the lab measurements back and see that actual measured HCO3- is significantly higher than our predicted 15 mmol/L, then we know there must be a source of HCO3- coming from some other hidden pathological process (ie., metabolic alkalosis) in addition to the large gap metabolic acidosis. Likewise, if we see that the actual measured HCO3- is significantly lower than our predicted 15 mmol/L, then we suspect that HCO3- is being lowered by some other hidden pathological process (ie., non-anion gap metabolic acidosis).

This process of seeing how close our measured base (HCO3-) is to our predicted base is sometimes called “checking the excess anion gap” to see if a hidden metabolic alkalosis or even a non-anion gap metabolic acidosis exists.

Examples of Some Pathologies that May Cause Acid Base Disorders

Increased Anion Gap Acidosis	Non Anion Gap Acidosis
Diabetic Ketoacidosis	Diarrhea
Renal Failure that involves the glomerulus	RTA (Renal Tubular Acidosis)
Starvation (Ketones)	Hypoaldosteronism
Salicylate poisoning	Hyperparathyroidism
Excess Alcohol Consumption	Carbonic Anhydrase Inhibitors
Lactic Acidosis	Hyperchloremia

**This list represents only a few of the possibilities for each type of acidosis. There are many other possible causes.*

**** Some Common Causes of Metabolic Alkalosis ****

Excess Vomiting (loss of Chloride and H+)
Certain Diuretics
Hyperaldosteronism
Heavy ingestion of antacids
Severe dehydration

Acid Base Disorder Practice Questions

For each question below please identify the following:

a. **What is the Acid/Base Disorder?**
b. **Is the disorder appropriately compensated?**
c. **What is the anion Gap?**

1. Consider a patient with a pH of 7.50, a PC02 of 29 mm Hg, an HCO3- of 22 mmol/L, a Na+ of 140 mmol/L, and a Cl- of 105 mmol/L.
2. Consider a patient with a pH of 7.25, a PC02 of 60 mm Hg, an HCO3- of 26 mmol/L, a Na+ of 142 mmol/L, and a Cl- of 100 mmol/L.
3. Consider a patient with a pH of 7.34, a PC02 of 60 mm Hg, an HCO3- of 31 mmol/L, a Na+ of 140 mmol/L, and a Cl- of 97 mmol/L.
4. Consider a patient with a pH of 7.50, a PC02 of 48 mm Hg, an HCO3- of 36 mmol/L, a Na+ of 140 mmol/L, and a Cl- of 90 mmol/L.
5. Consider a patient with a pH of 7.20, a PC02 of 21 mm Hg, an HCO3- of 8 mmol/L, a Na+ of 140 mmol/L, and a Cl- of 119 mmol/L.
6. Consider a patient with a pH of 7.50, a PC02 of 20 mm Hg, an HCO3- of 15 mmol/L, a Na+ of 140 mmol/L, and a Cl- of 103 mmol/L.
7. Consider a patient with a pH of 7.40, a PC02 of 40 mm Hg, an HCO3- of 24 mmol/L, a Na+ of 145 mmol/L, and a Cl- of 100 mmol/L.
8. Consider a patient with a pH of 7.50, a PC02 of 20 mm Hg, an HCO3- of 15 mmol/L, a Na+ of 145 mmol/L, and a Cl- of 100 mmol/L.
9. Consider a patient with a pH of 7.10, a PC02 of 50 mm Hg, an HCO3- of 15 mmol/L, a Na+ of 145 mmol/L, and a Cl- of 100 mmol/L.
10. Consider a patient with a pH of 7.15, a PC02 of 13 mm Hg, an HCO3- of 5 mmol/L, a Na+ of 140 mmol/L, and a Cl- of 110 mmol/L.

1. Acute Respiratory Alkalosis. 2. Acute Respiratory Acidosis 3. Chronic Respiratory Acidosis 4. Metabolic Alkalosis. 5. Non-Anion Gap Metabolic Acidosis. 6. Respiratory Alkalosis and Large Anion Gap Metabolic Acidosis. 7. Large Anion Gap Metabolic Acidosis and Metabolic Alkalosis. 8.Respiratory Alkalosis, Large Anion Gap Metabolic Acidosis and Metabolic Alkalosis. 9. Respiratory Acidosis, Large Anion Gap Metabolic Acidosis and Metabolic Alkalosis. 10. Large Anion Gap Metabolic Acidosis Combined with a Non-anion Gap Metabolic

Case Studies

Case 1:

A 22-year-old female was injured was found with several broken ribs that caused a lot of pain. She is also bleeding profusely. She has received 6 liters of 0.9% NaCl. Labs are done and the following values are documented:

$[Na^+]$ = 135 *mmol/L* *$[K^+]$ = 2.0 *mmol/L* $[Cl^-]$ = 115 *mmol/L*	pH = 7.28 PaCO2 = 39 *mmHg* $[HCO_3^-]$ = 18 *mmol/L*

*Note, that if K+ is given, we should add it in the cation portion of the anion gap equation.

What is the main Acid Base Disorder?

Is this likely a mixed disorder? (explain):

Would you expect Albumin to be higher or lower than normal in this patient? (explain):

Case 2:

A 50-year-old male has been diagnosed with recent and sudden onset of hypertension.

Labs are done and the following values are documented:

$[Na^+]$ = 148 *mmol/L* $[K^+]$ = 2.2 *mmol/L* $[Cl^-]$ = 104 *mmol/L* Blood Osmolality = 295 *mosm/kg*	pH = 7.5 PaCO2 = 45 *mmHg* $[HCO_3^-]$ = 33 *mmol/L*

What is the main Acid Base Disorder?

Is this likely a mixed disorder? If you feel that there are one or two more underlying acid base disorders, then name them and also explain how you decided what they were:

This patient has one of the following conditions. Circle which condition you think the patient has and then give a detailed explanation of how this condition would lead to the symptoms and blood values above.

Conn Syndrome

Diabetes Insipidus

Severe Dehydration

Case 3:

A 30-year-old male has the following lab values:

$[Na^+]$ = 137 *mmol/L* $[K^+]$ = 3.0 *mmol/L* $[Cl^-]$ = 86 *mmol/L* Albumin = 2.0 *g/dl*	pH = 7.6 PaCO2 = 40 *mmHg* $[HCO_3^-]$ = 38 *mmol/L*

What is the main Acid Base Disorder?

Is this likely a mixed disorder? (explain):

Based on your interpretation of the data above, choose the most likely patient scenario below that fits. Please explain why you chose the scenario you did and also explain why you rejected the other two scenarios.

1. Chronic Liver disease (which can cause hyperventilation). There are toxic substances building up in the blood and this has resulted in severe vomiting episodes.

2. A long term smoker has Chronic Obstructive Lung Disease. This patient is also an alcoholic. After checking into rehab, the detox procedures have included several liters of .9% NaCl solution.

3. A patient who suffers from chronic GERD. This patient is also anxious and needs to be reminded to calm down as hyperventilating is a problem.

Case 4:

Barbara is a mountain climber. Recently she has been trying to climb very high peaks in the Himalayas. As she climbs above 18,000 feet, she begins to experience hypoxia secondary to the low PaO_2. She is hyperventilating. Some blood labs are done in the field (she climbs with very high tech climbing buddies who have an unbelievable first aid kit) and the following values are found. Acetazolamide is administered to help Barbara

$[Na^+]$ = 120 *mmol/L* $[K^+]$ = 3.0 *mmol/L* $[Cl^-]$ = 86 *mmol/L*	pH = 7.6 PaCO2 = 30 *mmHg* $[HCO_3^-]$ = 22 *mmol/L*

What is the main Acid Base Disorder?

Is this likely a mixed disorder? (explain):

What is the mechanism of action for Acetazolamide? How would Acetazolamide help Barbara (explain):

Mountain climbers in the past have been treated with Acetazolamide similar to Barbara. They all complain that when they finally summit the mountain and pop open their champagne or carbonated drink of preference, it tastes flat. Explain why: