

Acid-base lecture for SHM Website

By Elizabeth Cerceo MD, FACP, FHM

1. Acidemia/alkalemia
2. Is the primary disorder metabolic or respiratory?
3. Calculate compensation
 - a. Metabolic acidosis: Winter's formula $\text{PaCO}_2 = 1.5 (\text{HCO}_3^-) + 8 \pm 2$
 - b. Metabolic alkalosis: $\text{PaCO}_2 = 0.75 \times \Delta\text{HCO}_3^-$
 - c. Acute respiratory: ΔCO_2 of 10 = ΔpH of 0.08, ΔHCO_3^- of 2
 - d. Chronic respiratory: ΔCO_2 of 10 = ΔpH of 0.04, ΔHCO_3^- of
4. Calculate anion gap

Is there another acid base problem? If there is an anion gap metabolic acidosis, calculate a delta gap. Delta gap is the change in anion gap minus the change in bicarbonate. If this is negative, there is a coexisting nongap metabolic acidosis. If it is positive, there is a coexisting metabolic alkalosis.

Pearls:

1. For each 1 gm albumin drop, the anion gap drops by 2.5. So if albumin is 3 gm, anion gap would be ~ 9.5 (if normal is 12).
2. Last two numbers of pH is \sim same as PaCO_2 . Ex 7.22/21/65
3. Low AG in myeloma, hypoalbuminemia, high cations (Mg^{+2} , Ca^{+2} , K^+ , cationic paraproteins), overestimation of Cl^- (Br^- , I^-) or underestimation of Na^+ (hyperviscosity, hyperlipidemia)
4. D-lactic acidosis from short bowel syndrome with altered bowel flora present with recurrent encephalopathy with normal lactic acid. Treat with npo, iv dextrose, HCO_3^-
5. Osmolal gap = measured -calculated osmoles $\text{Calc Osm} = (2 \times \text{Na}^+) + (\text{glucose}/18) + (\text{BUN}/2.8) > 10$ osm gap suggests methanol, ethanol.
6. Urine anion gap = $\text{U}_{\text{Na}} + \text{U}_{\text{K}} - \text{U}_{\text{Cl}}$ (Negative value is normal. Positive value suggests RTA)

Examples:

1. A 55 year-old man admitted with weakness, weight loss, and polyuria. Vitals 101°, 122/76, HR 105/min, RR 22/min. Labs Na^+ 135, K^+ 5.4, Cl^- 101, HCO_3^- 12. 7.32/24/104
Acidemia. Metabolic. AG 22. Starting bicarb 22-12(normal AG)=10, 10+12(starting bicarb)=22 so no concomitant metabolic abnormality. Winter's 26 \pm 2 so no concomitant respiratory disorder.
2. A 72 year-old woman with 80 pack year smoking history, chronic NSAID abuse, and decreased urinary output is admitted with pneumonia. Labs Na^+ 140, K^+ 5, Cl^- 102, HCO_3^- 15. 7.10/50/51
Acidemia. Metabolic. AG 23. Starting bicarb 15-12(normal AG)=3, 3+15(starting bicarb)=18 so underlying non-anion gap metabolic acidosis. Winter's 30.5 \pm 2 so respiratory acidosis.
3. A 72 year-old man with 100 pack year smoking history has had watery diarrhea for 3 days. Labs Na^+ 136, K^+ 3.3, Cl^- 105, HCO_3^- 19. 7.09/65/48.
Acidemia. Respiratory. AG 12. Starting bicarb 12-12(normal AG)=0, 0+19(starting bicarb)=19 so non-anion gap acidosis.
4. A 91 year-old woman is admitted with one week of diarrhea. Vitals 100.4°, 92/60 sitting and 70/40 standing, HR 100/min to 125/min. Labs Na^+ 133, K^+ 2.5, Cl^- 118, HCO_3^- 5. 7.11/16/94.
Acidemia. Metabolic. AG 10. Starting bicarb (no need to calculate since normal anion gap). Winter's 15.5 \pm 2 so no concomitant respiratory disorder.
5. A 23 year-old pregnant alcoholic with diabetes mellitus type I is admitted three days after stopping insulin. She has severe nausea and vomiting. Vitals 120/80 sitting and 108/80 standing, HR 124/min to 160/min. Labs Na^+ 136, K^+ 3.6, Cl^- 70, HCO_3^- 19. 7.58/21/104.
Alkalemia. Respiratory. AG 47. Starting bicarb 47-12=35, 35+19=54 so concomitant non-anion gap metabolic acidosis.
6. A 25-year-old man with asthma has been dyspneic for four days. Labs Na^+ 132, K^+ 3.6, Cl^- 105, HCO_3^- 18. 7.44/28/69.
7. A 40-year-old woman with gallstones presents with abdominal pain, vomiting, and hyperamylasemia. Labs Na^+ 132, K^+ 2.9, Cl^- 86, HCO_3^- 38. 7.56/48/85.