ABG problems for students

Keith Conover, M.D., FACEP
5/5/2007
(Normal lab values and formulas on last page)

Questions 1-2 refer to the following scenario.

George is big. (Fat, that is.) George is ***really*** *big. George is so big he can barely get through the clinic doors. He is seeing you because he gets headaches all the time, and falls asleep all the time. You suspect he has sleep apnea, and get an ABG:*

pH 7.34
pCO_2 60

1) George has an:
   a) acidemia
   b) alkalemia

2) Which of the following is George's ***primary*** acid-base disorder?
   a) chronic respiratory acidosis
   b) chronic respiratory alkalosis
   c) acute respiratory acidosis
   d) acute respiratory alkalosis

Questions 3-4 refer to the following scenario:

Jill is a 25-year old with severe asthma, who has been on and off steroids in the past, who has been hospitalized about ten times for asthma, and once her asthma was so bad that she was intubated. She comes into the Emergency Department acutely short of breath, breathing at a rate of 40, and can only speak a few words without stopping to catch her breath. Her lips are slightly blue, and you can see retractions above the clavicle with each breath. Her lab tests show:

pH: 7.24
pCO_2 60

3) Jill's primary acid-base disorder is:
   a) metabolic acidosis
   b) metabolic alkalosis
   c) respiratory acidosis
   d) respiratory alkalosis

4) Has Jill had this acid-base disorder long enough to develop compensation?
   a) yes
   b) no

Questions 5-9 refer to the following scenario.

For the past few days, Jack has had "the flu" with URI symptoms and decreased appetite. He's a type I diabetic on a dose of 45 units of 70/30 (NPH/Regular mix) insulin each morning and 40 units each evening. He's generally good at controlling his blood sugar, and usually checks it *regularly. He's been cutting his insulin down the past few days because he hasn't been eating much. His brother visited him today, and found him in bed, feverish, "breathing hard" and confused. When you see him in the Emergency Department, you find the following lab values:*

pH	*7.30*
pCO_2	*30*
$[HCO_3]$	*15*
Na^+	*140*
Cl^-	*100*

5) Jack has an:
    a) acidemia.
    b) alkalemia.

6) Which of the following is Jack's ***primary*** acid-base disorder?
    a) metabolic acidosis
    b) metabolic alkalosis
    c) respiratory acidosis
    d) respiratory alkalosis

7) Does Jack show appropriate compensation for this disorder?
    a) yes
    b) no

8) Jack's anion gap is:
    a) 40
    b) 25
    c) 12
    d) 0

9) Jack's primary acid-base disorder is most likely due to:
    a) vomiting and loss of gastric acid.
    b) diabetic ketoacidosis.
    c) hyperventilation to compensate from the hypoxia of a pneumonia.
    d) poor ventilation due to a pneumonia.

10) Jim is brought into the Emergency Department after a car wreck on a January night. He has no obvious injury except for some minor scrapes, but it took the paramedics about half an hour to extricate him, and he's hypothermic: core temperature 89 degrees F. He's on O_2: a nonrebreather face mask. As part of routine trauma labs, you get what looks like a normal ABG to you: 7.40/pO_2 220/pCO_2 40. The lab calls you because they heard the patient is hypothermic, and would like to give you a corrected ABG report. You:
    a) Thank them for the corrected report, discard the previous report, and treat the patient according to the newly-discovered acid-base disorder.
    b) Thank them for the corrected report, note it in the chart, and even though the numbers look abnormal, relax because the patient's acid-base status is normal.

Normal pH	*7.4*
Normal pCO_2	*40*
Normal $[HCO3^-]$	*27*
Normal anion gap (Δ)	*12*

Check the pH on the blood gas to tell whether the patient has an Acidemia (↓pH) or Alkalemia (↑pH) or EupHemia (normal pH).

Check the bicarb on the SMA-6 and the pCO2 on the gas. ↓pH with ↓[HCO3-], or ↑pH with ↑[HCO3-], indicates a primary metabolic acidosis or alkalosis; ↓pH with ↑pCO2, or ↑pH with ↓pCO2, indicates a primary respiratory acidosis or alkalosis.

Check for the expected degree of compensation. (Empiric Equations Below)

For metabolic acidosis, check to see if it is an anion gap acidosis, a non-anion gap acidosis, or a mixed disorder. If all of the acidosis is due to anion-gap acids, then the increase in the anion gap should be the same as the decrease in the [HCO3-]. E.g., if the A.G. is 20 (normal 12), and the [HCO3-] is 19 (normal 27), then all of the acidosis (all of the ↓[HCO3-]) is due to the ↑A.G. from excess organic acids that form the anion gap. AG = [Na+] - ([Cl-] + [HCO3-])

For metabolic acidosis, Winters' equation:
pH = 1.5 ([HCO3-] + 8) ± 2
for good compensation except:
lactic acidosis may have overcompensation due to CNS effects.

For metabolic alkalosis or acidosis, with respiratory compensation:
pCO2 = last 2 digits of the pH = [HCO3-] + 15
(for [HCO3-] from 8 to 35)

For respiratory acidosis, every increase in pCO2 has an expected decrease in pH:
↑pCO2 10 = ↓pH .08 (acute)
↑pCO2 10 = ↓pH .03 (later, with metabolic compensation)

For respiratory alkalosis, each decrease in pCO2 has an expected increase in bicarbonate:
↓pCO2 10 = ↓[HCO3-] 2 (acute)
↓pCO2 10 = ↓[HCO3-] 5 (chronic/compensated)