



# ACID-BASE DISORDERS - A QUICK, SOLID REVIEW

*Don Steinert MA, RRT, MT, CLS*

Arterial blood gases is simply too large a topic to consider at one time. In this article I simply want to discuss the common causes for most ABG abnormalities with a small discussion on how to correct them. We will take a look at the four major categories of acid base disorders; respiratory acidosis, respiratory alkalosis, metabolic acidosis and metabolic alkalosis.

Respiratory acidosis can result from any impairment in respiration or decrease in the lungs' ability to exhale CO<sub>2</sub>. When CO<sub>2</sub> accumulates, there is shift in the bloods' bicarbonate buffering system in the direction of hydrogen ions and bicarbonate. This in turn causes a drop in the pH.

There are a number of conditions that will cause respiratory acidosis. These conditions can be grouped into five major categories. Airway obstruction such as COPD, bronchospasm and aspiration. Depression of the respiratory center such as with anesthetics, sedative (morphine), cerebral trauma or tumors. Neuromuscular diseases such as poliomyelitis, Guillain-Barre' syndrome, motor neuron disease, tetanus, botulism, neurotoxins, or curare. Pulmonary disease such as pulmonary fibrosis, severe pneumonia, and respiratory distress syndrome. Extrapulmonary thoracic disease such as flail chest or severe kyphoscoliosis.

In managing respiratory acidosis the aim of treatment is to improve alveolar ventilation and lower the PCO<sub>2</sub>. This is generally done by using physiotherapy, bronchodilators and antibiotics. If the patient is placed on ventilator support it is important to monitor the patient's arterial blood gas to avoid over-correction of the respiratory acidosis. Oxygen can be given safely in high concentrations to patients with acute respiratory failure. In patient's with chronic carbon dioxide retention, however, the respiratory center becomes insensitive to carbon dioxide and hypoxemia provides the main stimulus to respiration. Blood gas monitoring in these patients becomes especially important to prevent knocking out their hypoxic drive.

Respiratory Alkalosis occurs when there is an excessive loss of carbon dioxide through hyperventilation. This increase in exhalation of CO<sub>2</sub> shifts the bicarbonate equilibrium toward the formation of carbon dioxide and water, decreasing the hydrogen ion concentration. The result is an increased blood pH.

The main causes of respiratory alkalosis can be grouped into four categories. Hypoxia such as high altitude, severe anemia, and pulmonary disease. The second category is Increased respiratory drive. There are a number of conditions in this category. Voluntary hyperventilation, respiratory stimulants such as salicylates, cerebral disturbance such as trauma, infection and tumors, liver failure, septicemia due to gram negative organisms, and primary hyper-

ventilation syndrome. Pulmonary disease such as pulmonary edema and pulmonary embolism make up the third group. The fourth group is man-made, it involves mechanical overventilation as previously mentioned above.

As with other acid-base disturbances, treatment of the underlying condition is the key to success. Fortunately, a chronic compensated respiratory alkalosis is not, in itself, dangerous.

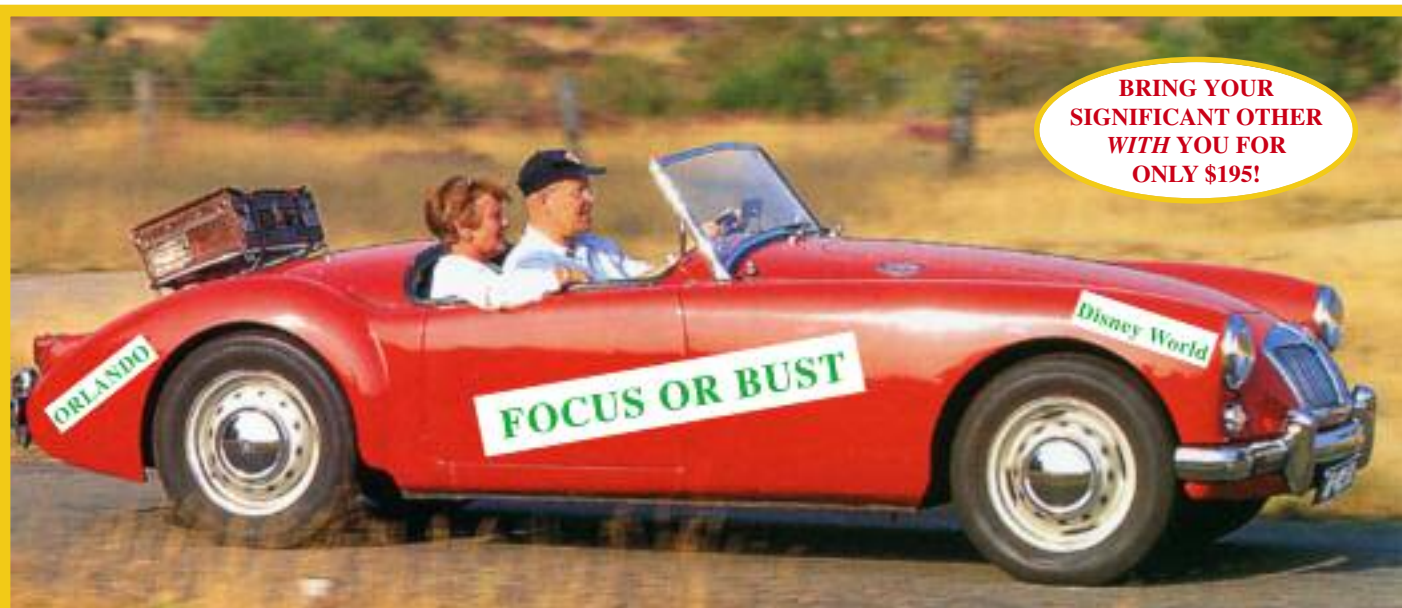
The primary abnormality in non-respiratory acidosis is either increased production or decreased excretion of hydrogen ions. In some patients both may contribute. The loss of bicarbonate from the body can also, indirectly, cause an acidosis.

The main causes of non-respiratory acidosis can also be grouped into four categories. Increased hydrogen ion formation can occur as an inherited organic acidosis, but more commonly practitioners see diabetes or alcohol as a cause for ketoacidosis. Metabolic acidosis can also occur by poisoning from ethanol, methanol, ethylene glycol or salicylates. Decreased hydrogen ion excretion is seen in renal tubular acidosis and generalized renal failure. Carbonate dehydratase inhibitors may also be a cause. Acid ingestion such as excessive parenteral administration of amino acids like arginine, lysine and histidine are also occasionally seen as causes of non-respiratory acidosis.

Management of non-respiratory acidosis, like other acid base problems, is directed at correcting the underlying cause. Such things as rehydration and insulin for diabetic ketoacidosis and removal of salicylate in salicylate overdose are common examples. If reversal of the underlying cause is not immediately possible, bicarbonate can be given to buffer hydrogen ions. Large amounts of bicarbonate, however, can be dangerous, and close patient monitoring is vital.

Non-respiratory (Metabolic) alkalosis is characterized by a primary increase in the extracellular fluid bicarbonate concentration, with a consequent reduction in hydrogen ions. In normal people, increase in plasma bicarbonate concentrations leads to incomplete renal tubular bicarbonate reabsorption and excretion of bicarbonate in the urine. Massive quantities of bicarbonate must be ingested to produce a sustained alkalosis.

There are two main categories of causes for non-respiratory alkalosis. The first, and somewhat common, is gastrointestinal; extensive vomiting, gastric aspiration, and congenital chloride-losing diarrhea. Common renal causes are potassium depletion, rapid correction of chronically raised PCO<sub>2</sub>, and diuretic therapy (not potassium sparing). Renal syndromes such as Cushing's and Conn's can also result in metabolic alkalosis.



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*Where do the Candidates Stand?... Continued from previous page*

opposed the concept of vouchers feeling that vouchers took needed resources from public schools. Now it seems that he's softened his opinion a bit and unlike his fellow Democrats, he is no longer vehemently opposed to a voucher-based school system.

Barack Obama is supportive of the concept of charter schools, wherein independent groups receive state funding to establish new schools. Here's what he had to say. "We know that some of the best ideas in education don't come from Washington, but from local schools all over America. That's why charter schools are a great way for students to learn."

As for John McCain, when asked how the quality of public schools in this country could be improved, he answered: "Choice and competition is the key to success in education..That means charter schools and it means the use of vouchers to fund them."

### **Prayer in Public Schools**

Agreement here. Both candidates generally support voluntary prayer in schools. Neither sees it as a violation of the First Amendment.

### **Higher Education**

According to the Obama 08 statement on higher education: Obama will make college affordable for all Americans by creating a new American Opportunity Tax Credit. This credit will ensure that the first \$4000 of a college education will be covered for most Americans and will cover two-thirds the cost of tuition at the average public college or university. Community college tuition would be completely free for most students. And here's one great idea from Obama: Eliminate the current federal financial aid application (the FAFSA) and enable families to apply, simply by checking

a box on their federal income tax return. (A stroke of genius, I'd say. Why didn't someone think of this before?) Not surprisingly, Barack Obama advocates affirmative action programs in higher education, believing it's a means of overcoming historic and potential discrimination. But he also feels that affirmative action should be less race based and more class based - largely because he recognizes the strong and ongoing intersection between race and class in our society.

John McCain favors the use of tax-free savings accounts or other tax credits for educational expenses including tuition and computers. John McCain cautiously backs affirmative action as a means of leveling the educational playing field - but only if the affirmative action programs do not include quotas.

Fast forward to 2012. It'll be interesting to see if the educational policies that have unfolded bear any resemblance to those touted in the political rhetoric of pre-election 2008. Time will tell.

*Sandra McCleaster, MA, RRT is a veteran therapist, author, lecturer, educator and adjunct faculty member at Bergen Community College in Paramus, NJ.*

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The second category is administration of alkali such as inappropriate treatment of acidotic states, and chronic alkali ingestion.

So there we have it. Although most readers know all of this stone cold, let this article serve as a good review or even a concise reference guide to the basic disorders of acid-base balance for all - students, thereapists early in their careers and veterans alike.

*Don Steinert is an Associate Professor in the Department of Nursing and a faculty member in the Respiratory Therapy Program at the University of the District of Columbia.*