

# ACID-BASE BALANCE

by  
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The concept of acid-base balance is an important, but often misunderstood, aspect of emergency care. The concept is really quite simple and can be explained without the use of complex chemical equations or mathematical calculations.

To understand the concept of acid-base balance, one must first understand the concept of pH. pH is a system of measuring the relative acidity or alkalinity of a solution. Actually, pH is a measure of the concentration of hydrogen ions in a given solution. The more hydrogen ions present, the more acidic the solution. The fewer hydrogen ions present, the more alkaline (or basic) the solution. pH, because of the way it is mathematically calculated, is inversely related to the hydrogen ion concentration. The more hydrogen ions present, the lower the pH. The fewer hydrogen ions present, the higher the pH. The pH scale ranges from 1 to 14. At neutral pH, the pH of water, the number of hydrogen ions is equal to the number of hydroxyl ions and the solution is neither acidic or basic. The normal pH of the body is 7.4 (7.35-7.45) which is slightly basic.

The body can only tolerate slight changes in pH. If the pH starts to change in either direction, the body will immediately respond to return the pH to normal. A decrease in pH below 7.4 results in the state referred to as acidosis. An increase in pH above 7.4 results in the state referred to as alkalosis. The body tends to tolerate acidosis much better than it does alkalosis. There are two causes of acid-base disturbances. These causes, often referred to as components, are either respiratory or metabolic, or a combination of both. There is a fundamental relationship between respiration and acid-base balance. A decrease in ventilation results in the accumulation of CO<sub>2</sub> which is an acid. When

the concentration of CO<sub>2</sub> in the blood (pCO<sub>2</sub>) increases, the pH decreases. The inverse is also true. When respirations increase, as occurs in hyperventilation, CO<sub>2</sub> is eliminated from the body. Thus, the body loses acid and the net pH increases.

↓ Ventilations = ↑ paCO<sub>2</sub> =  
↓ pH = Respiratory Acidosis

↑ Ventilations = ↓ paCO<sub>2</sub> =  
↑ pH = Respiratory Alkalosis

Acids can also come from metabolic sources. These acids are usually the end-products of chemical reactions. For example, in cardiac arrest the cells of the body become deficient in oxygen. When this occurs the cells then begin to generate energy by anaerobic metabolism (glycolysis). Unfortunately, anaerobic metabolism results in the production of lactic acid which effectively lowers the pH of the body. This condition, referred to as lactic acidosis, is a form of metabolic acidosis also occurs in such things as shock, diabetic coma, and with poor nutrition. Metabolic alkalosis is relatively rare and is most often caused, in the emergency setting, by an overdose of sodium bicarbonate. It is important to point out that it is unusual to have purely one type of acid-base disturbance. Usually, it is a combination of two. For example, in cardiac arrest you have both respiratory and metabolic acidosis. The respiratory component is due to the decrease in ventilation which accompanies cardiac arrest. The metabolic component results from anaerobic metabolism. Thus, treatment includes both increased ventilation and oxygenation as well as the administration of sodium bicarbonate.

DISORDER	pH	paCO <sub>2</sub>	COMMON CAUSE
Respiratory Acidosis	<7.4	>40	Hypoventilation
Respiratory Alkalosis	>7.4	<40	Hyperventilation
Metabolic Acidosis	<7.4	No Change	Cardiac Arrest
Metabolic Alkalosis	>7.4	No Change	Overdose of NaHCO <sub>3</sub>

  

DISORDER	TREATMENT
Respiratory Acidosis	Increase Ventilations and Oxygen Delivery
Respiratory Alkalosis	Decrease Ventilations to Increase CO <sub>2</sub>
Metabolic Acidosis	Administer Sodium Bicarbonate
Metabolic Alkalosis	Prevention is the Best Treatment