



Body fluids, electrolytes and acid-base balance

Acid-Base Balance:

The pH symbol is used to indicate the hydrogen ion concentration of body fluids; 7.35 to 7.45 is the normal pH range of arterial blood. As the number of hydrogen ions increases, the fluid becomes acidic. As the number of hydrogen ions decreases, the fluid becomes alkaline. When the number of free hydrogen ions in a solution increases to the point that the pH value becomes less than 7.35, the body is in a state of **acidosis**. The opposite occurs with **alkalosis**, in which a pH value higher than 7.45 results from a low hydrogen ion concentration.

6.8	7.35	7.45	7.8	
Death	Acidosis	Normal	Alkalosis	Death

Regulators of Acid-Base Balance:

A. **Buffer Systems:** Buffers prevent excessive changes in pH by binding with or releasing hydrogen ions. If body fluids become too acidic, meaning excess hydrogen ions are present in body fluids, buffers bind with the hydrogen ions. If body fluids become too alkaline, meaning not enough hydrogen ions are present in body fluids, buffers can release hydrogen ions. The action of a buffer is immediate, but limited in its capacity to maintain or restore normal acid-base balance. The major buffer in ECF is:

- Bicarbonate (HCO_3^-) system.
- Carbonic acid (H_2CO_3) system.
- Plasma proteins, hemoglobin, and phosphates.

B. **Respiratory regulation of acid-base balance:** The response of the respiratory system to changes in pH is rapid, occurring within minutes. The lungs help to regulate acid-base balance by eliminating or retaining CO_2 . When blood levels of carbonic acid and carbon dioxide rise, the rate and depth of respiration increase, this causes an increased amount of CO_2 to be exhaled, and carbonic acid levels fall. By contrast, when blood levels of carbonic acid and carbon dioxide fall, the rate and depth of respiration decrease, this causes an increased level of carbon dioxide to be retained, and carbonic acid levels rise. CO_2 levels in the blood are measured as PCO_2 , the partial pressure of the dissolved CO_2 in venous blood, and PaCO_2 , the partial pressure of the dissolved CO_2 in arterial blood. Normal PaCO_2 is 35 to 45 mmHg.

C. **Renal control of hydrogen ion concentration:** The kidneys are slower to respond to changes, requiring hours to days to correct imbalances, but their



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response is more permanent. The kidneys maintains acid-base balance by excreting or conserving bicarbonate and hydrogen ions from body fluids. In case of acidosis, the kidneys reabsorbed and regenerate bicarbonate and excrete hydrogen ions. When alkalosis occur , excess bicarbonate is excreted and hydrogen ions are retained. Normal HCO_3^- is 22–26 mEq/L.

Factors affecting fluid, electrolytes, and acid-base balance:

1. Age: Body water distribution is relative to body size. The smaller the body, the larger the fluid content:

- ❖ Adult, 60% water.
- ❖ Child, 60% to 77% water.
- ❖ Infant, 77% water.
- ❖ Embryo, 97% water.

In the elderly, body water diminishes because of tissue loss; the percentage of total body weight that is fluid may be reduced to 45% to 50% in persons over age 65. Caution must be used when administering diuretics, especially thiazide diuretics, to the elderly to prevent diuretic-induced electrolyte disturbances.

Infants are at high risk for fluid and electrolyte imbalance because of:

- ❖ Their immature kidneys cannot concentrate urine.
- ❖ Higher metabolic rate.
- ❖ They have a rapid respiratory rate and larger body surface area than adults, leading to greater insensible losses through the skin and respirations.
- ❖ They cannot express thirst, nor actively seek fluids.

Older adults are at high risk for fluid and electrolyte imbalance because of:

- ❖ Decreases in thirst sensation.
- ❖ Decreases in ability of the kidneys to concentrate urine.
- ❖ Decreases in intracellular fluid and in total body water.
- ❖ Use of diuretics for hypertension and heart disease.
- ❖ Decreased intake of food and water, especially in older adults with dementia or who are dependent on others to feed them.
- ❖ Preparations for diagnostic tests that include being NPO for long periods of time, laxatives, or contrast dyes.
- ❖ Impaired renal function, for example in older adults with diabetes.

2. Sex and body size: Fat cells contain little or no water, but muscle tissue has a high water content therefore people with high percentage of body fat has less body water than people with higher percentage of muscle. Women generally have proportionately more body fat, and therefore less body water than men.

3. Environmental temperature: such as hot environments cause the body to lose water and sodium through sweating.



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4. Lifestyle:

- a. **Diet:** People with anorexia or bulimia are at risk for severe fluid and electrolytes imbalance because of inadequate intake. When calorie intake is not adequate to meet the body's needs, fat stores are broken down and fatty acids are released, increasing the risk of acidosis.
 - b. **Exercise:** cause the body to lose water and sodium.
 - c. **Stress:** leads to increase cellular metabolism, and increase production of ADH and stimulate the renin –angiotension –aldosterone system , both of which decrease urine production. The overall response of the body to stress is to increase blood volume.
 - d. **Heavy alcohol consumption:** increase the risk of low calcium, magnesium, and phosphate levels. And increase the risk for acidosis associated with breakdown of fat tissue.
- 5. Illness** (such as DM, COPD), **Trauma** (such as Burns), **Surgery**, and **Medication** (such as Diuretics, and Corticosteroid) affects the body's ability to maintain fluid, electrolytes, and acid-base balance