



Body fluids, electrolytes and acid-base balance

Acid-Base Disturbances:

Acid-base imbalance are usually classified as respiratory or metabolic by underlying cause of the disorders. Carbonic acid level are normally regulated by the lungs and problems lead respiratory acidosis and alkalosis. Bicarbonate and hydrogen ion levels are regulated by the kidneys and problems lead metabolic acidosis and alkalosis.

1. Respiratory Acidosis (Carbonic Acid Excess): is characterized by an increased hydrogen ion concentration (a blood pH below 7.35), an increased arterial carbon dioxide pressure (PaCO₂ greater than 45 mm Hg), and an excess of carbonic acid. Respiratory acidosis is caused by hypoventilation or impaired lung function as a result of:

- A. Chronic lung disease such as asthma, chronic obstructive pulmonary disease (COPD) & respiratory failure.
- B. Acute lung conditions that impair alveolar gas exchange (e.g., pneumonia, acute pulmonary edema, aspiration of foreign body)
- C. CNS depression due to anesthesia or a narcotic or sedatives overdose can slow the respiratory rate enough to cause carbon dioxide retention. Also brain injury that affects the respiratory center.

When respiratory acidosis occurs the kidneys retain bicarbonate and excrete hydrogen ions to restore the normal carbonic acid to bicarbonate ratio, but this response may require hours to days to restore normal PH.

2. Respiratory Alkalosis (Carbonic Acid Deficit): Respiratory alkalosis is characterized by a decreased hydrogen ion concentration (a blood pH above 7.45) and a decreased arterial carbon dioxide pressure (PaCO₂ less than 35 mm Hg) and a decreases in carbonic acid. Respiratory alkalosis is caused by hyperventilation (excessive exhalation of carbon dioxide) resulting in hypocapnia (decreased arterial carbon dioxide concentration). When respiratory alkalosis occurs the kidneys will excrete bicarbonate and hydrogen ions are retained to return normal PH.

3. Metabolic Acidosis (Bicarbonate Deficit): a decrease in bicarbonate concentration (HCO₃⁻ less than 22 mEq/L) in relation to the amount of carbonic acid in the body, its characterized by an increase in hydrogen ion concentration (blood pH below 7.35). This may occurs because of:

- a. Diabetic ketoacidosis (DKA): The cells are deprived of glucose (decrease or absence of insulin) for metabolism; the liver, in response to the needs



Fundamentals of Nursing II

of the cells, increases the metabolism of fatty acids, which causes an increase in ketone bodies, making the extracellular fluid more acidic.

- b. Renal failure:** The normal mechanism of the kidneys to conserve sodium and water and excrete hydrogen is compromised.
- c. Anaerobic metabolism:** Cellular catabolism and acid accumulation occur with starvation, severe malnutrition, infection, fever, trauma, shock, and excessive exercise.
- d. Drug overdose:** Acid accumulation results from excessive ingestion of medication such as salicylate.

In response to metabolic acidosis, the respiratory center is stimulated, causing an increase in the rate and depth of respirations (Kussmaul breathing), to lower the acid concentration in extracellular fluid by increasing the exhalation of carbon dioxide. The respiratory compensatory mechanism is usually ineffective in decreasing acids, especially if the client has chronic obstructive pulmonary disease or in ketoacidosis. The renal compensatory mechanism tries to increase the pH by exchanging sodium ions with hydrogen ions to increase the excretion of hydrogen.

4. Metabolic Alkalosis (Bicarbonate Excess): characterized by an increased loss of acid from the body or increased levels of bicarbonate (HCO_3^- more than 26 mEq/L). The blood pH is above 7.45. The following clinical conditions can place clients at risk for metabolic alkalosis:

- a. Excessive ingestion of antacids or parenteral administration of sodium bicarbonate or other alkaline salts (e.g., sodium or potassium acetate, lactate, or citrate) increases the amount of base in extracellular fluids.**
- b. Vomiting and nasogastric suctioning or lavage cause a loss in hydrochloric acid and chloride; with the loss of the hydrogen and chloride ions, bicarbonate ions are absorbed, unneutralized, into the bloodstream and the pH of the extracellular fluid rises (alkalosis).**
- c. Diarrhea, and steroid or diuretic therapy can cause the excessive loss of K^+ , chloride, and other electrolytes; the potassium deficit causes the kidneys to exchange hydrogen ions (instead of potassium ions) for sodium ions, which promotes the loss of hydrogen, thereby increasing bicarbonate level.**

The respiratory and renal compensatory mechanisms respond to an increased bicarbonate–carbonic acid ratio. The rate and depth of respirations are decreased in an effort to retain carbon dioxide.