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| **MEDICINE** |
| **Classification of acid-base disorders with compensatory mechanisms** |
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**1.Introduction**

Acid-base disorders are disturbances in the homeostasis of hydrogen ion concentration in the plasma. Any process that increases the serum hydrogen ion concentration is an acidotic process.[[1][2][3]](https://www.ncbi.nlm.nih.gov/books/NBK482146/)

**Classification of acid-base disorders**

Acid-base disorders are classified primarily into four categories based on the primary disturbance in the acid-base balance: respiratory acidosis, respiratory alkalosis, metabolic acidosis, and metabolic alkalosis.

Here’s a breakdown of each disorder along with compensatory mechanisms:

1. **Respiratory Acidosis**

This Occurs when there is an accumulation of carbon dioxide (CO₂) due to impaired ventilation, leading to a decrease in blood pH.

**It is caused by** Chronic obstructive pulmonary disease (COPD), severe asthma, pneumonia, respiratory muscle weakness, or central nervous system depression.

**Compensatory Mechanisms**: The kidneys compensate by increasing bicarbonate (HCO₃⁻) retention and hydrogen ion (H⁺) excretion over hours to days.

**2. Respiratory Alkalosis**

Occurs when there is excessive loss of CO₂ due to hyperventilation, resulting in an increase in blood pH.

**Caused by** Anxiety, fever, hypoxia, pulmonary embolism, or certain central nervous system disorders.

**Compensatory Mechanisms:** The kidneys compensate by excreting more bicarbonate and retaining H⁺, which can take hours to days.

**3. Metabolic Acidosis**

Occurs when there is a decrease in bicarbonate or an increase in non-volatile acids in the body, leading to a decrease in blood pH.

**Caused by** Diabetic ketoacidosis, renal failure, lactic acidosis, or gastrointestinal bicarbonate loss (e.g., diarrhea).

**Compensatory Mechanisms:** The respiratory system compensates by increasing ventilation (hyperventilation) to blow off CO₂, which can occur quickly (minutes to hours).

**4. Metabolic Alkalosis**

Occurs when there is an increase in bicarbonate or a loss of hydrogen ions, resulting in an increase in blood pH.

**Caused by** Prolonged vomiting, excessive diuretic use, or mineralocorticoid excess.

**Compensatory Mechanisms:** The respiratory system compensates by decreasing ventilation (hypoventilation) to retain CO₂, which can occur quickly, but renal compensation (excreting bicarbonate) takes longer.

**Summary of Compensatory Mechanisms**

**Respiratory Compensation:**

Rapid response (minutes to hours) to metabolic disturbances. If acidosis occurs, ventilation increases; if alkalosis occurs, ventilation decreases.

**Renal Compensation:**

Slower response (hours to days) to respiratory disturbances. In acidosis, kidneys retain bicarbonate and excrete H⁺; in alkalosis, kidneys excrete bicarbonate and retain H⁺.

**Clinical Relevance**

Understanding these disorders and their compensatory mechanisms is crucial in diagnosing and managing various clinical conditions. Analyzing arterial blood gases (ABGs) helps determine the underlying acid-base disorder and guide appropriate treatment.

**Conclusion**

Acid-base disorders are commonly encountered in clinical practice and a structured approach to assessment includes taking a history, performing a physical examination and careful interpretation of routine biochemical tests and arterial blood gas analysis. Additional investigations such as lactate, glucose, ketones or toxicology testing may be needed to more fully characterize a metabolic acidosis.

**Sources and references:**

**National Institute of Health (NIH)**

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