Revised: JAN '25

BIOS256 - Week 5 Case Study: Dehydration with Emesis

Homeostasis refers to the body's ability to maintain a stable internal environment, ensuring the balance of fluids, electrolytes, and pH levels. Fluids in the body can be divided into intracellular fluids (inside the cells) and extracellular fluids (outside the cells). Dehydration occurs when fluid output exceeds intake, causing intracellular fluid to leave the cells in an attempt to restore solute concentrations. Symptoms of dehydration include thirst, dry mouth, oliguria (low urine output), enophthalmos (sunken eyes), and drowsiness. Conversely, overhydration occurs when fluid intake exceeds output, causing extracellular fluid to enter the cells to balance solute concentrations. Overhydration can lead to symptoms such as nausea, malaise (discomfort), altered mental status, seizures, and even coma.

Electrolyte balance is equally critical in maintaining homeostasis, as electrolytes are charged solutes that help regulate fluid dynamics and various physiological functions. Sodium is the most abundant cation in extracellular fluid and is vital for nerve impulse transmission, muscle contraction, and fluid balance. Chloride, the most prevalent anion in extracellular fluid, plays a role in fluid and pH balance, and is also key to hydrochloric acid production in the stomach. Potassium is the primary cation in intracellular fluid and helps regulate nerve impulses, muscle contractions, and fluid balance. Calcium, stored in bones, is involved in muscle contraction, blood clotting, and nerve function. Bicarbonate works with chloride to maintain pH balance within the body.

Maintaining pH balance is also crucial for bodily functions. The blood plasma has a normal pH range of 7.35–7.45, slightly alkaline. The body uses buffer systems such as the carbonic acid-bicarbonate system, protein buffers, and phosphate buffers to regulate pH. Acidosis occurs when the blood pH drops below 7.35, while alkalosis occurs when the pH rises above 7.45. The respiratory and metabolic systems play key roles in regulating pH. Compensation occurs when one of these systems attempts to counteract the effects of the other system

Imbalance	Cause	Effect on Blood pH	Compensation Mechanism
Metabolic Acidosis	Accumulation of organic acids (e.g., lactic acid) or loss of bicarbonate (e.g., diarrhea)	pH < 7.35	Increased breathing rate (hyperventilation) to expel CO_2 and raise pH
Metabolic Alkalosis	Loss of acids (e.g., vomiting) or increase in bicarbonate (e.g., excessive antacids)	pH > 7.45	Decreased breathing rate (hypoventilation) to retain CO_2 and lower pH
Respiratory Acidosis	Hypoventilation (slow breathing), CO_2 buildup in blood	pH < 7.35	Kidney retention of bicarbonate to neutralize excess acid and raise pH
Respiratory Alkalosis	Hyperventilation (rapid breathing), excessive CO_2 loss	pH > 7.45	Kidney excretion of bicarbonate to decrease pH

Background:

Dee Dawood, a 4-week-old infant, presents to the clinic with several days of worsening vomiting. After chestfeeding, she vomits forcefully, even hitting the walls behind her caregiver. Dee remains extremely hungry, drinks vigorously, but immediately vomits again.