CHAPTER 8

Fluids and Electrolytes

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Priority Concepts

Cellular Regulation; Fluid and Electrolytes

I. Concepts of Fluid and Electrolyte Balance

A. Electrolytes

1. Description: An electrolyte is a substance that, on dissolving in solution, ionizes; that is, some of its molecules split or dissociate into electrically charged atoms or ions (Box 8-1).
2. Measurement
    a. The metric system is used to measure volumes of fluids—liters (L) or milliliters (mL).
    b. The unit of measure that expresses the combining activity of an electrolyte is the milliequivalent (mEq).
    c. One milliequivalent (1 mEq) of any cation always reacts chemically with 1 mEq of an anion.
    d. Milliequivalents provide information about the number of anions or cations available to combine with other anions or cations.

B. Body fluid compartments (Fig. 8-1)

1. Description
    a. Fluid in each of the body compartments contains electrolytes.
    b. Each compartment has a particular composition of electrolytes, which differs from that of other compartments.
    c. To function normally, body cells must have fluids and electrolytes in the right compartments and in the right amounts.

d. Whenever an electrolyte moves out of a cell, another electrolyte moves in to take its place.
e. The numbers of cations and anions must be the same for **homeostasis** to exist.
f. Compartments are separated by semipermeable membranes.

2. Intravascular compartment: Refers to fluid inside a **blood** vessel
3. Intracellular compartment
    a. The intracellular compartment refers to all fluid inside the cells.
    b. Most bodily fluids are inside the cells.
4. Extracellular compartment
    a. Refers to fluid outside the cells.
    b. The extracellular compartment includes the interstitial fluid, which is fluid between cells (sometimes called the *third space*), blood, lymph, bone, connective tissue, water, and transcellular fluid.

C. Third-spacing

1. Third-spacing is the accumulation and sequestration of trapped extracellular fluid in an actual or potential body space as a result of disease or injury.
2. The trapped fluid represents a volume loss and is unavailable for normal physiological processes.
3. Fluid may be trapped in body spaces such as the pericardial, pleural, peritoneal, or joint cavities; the bowel; the abdomen; or within soft tissues after trauma or burns.
4. Assessing the intravascular fluid loss caused by third-spacing is difficult. The loss may not be reflected in weight changes or intake and output records and may not become apparent until after organ malfunction occurs.

D. Edema

1. Edema is an excess accumulation of fluid in the interstitial space; it occurs as a result of alterations in oncotic pressure, hydrostatic pressure, capillary permeability, and lymphatic obstruction (see F. Body fluid transport, for descriptions).
2. Localized edema occurs as a result of traumatic injury from accidents or surgery, local inflammatory

processes, or burns.

3. Generalized edema, also called *anasarca*, is an excessive accumulation of fluid in the interstitial space throughout the body and occurs as a result of conditions such as cardiac, renal, or liver failure.

E. Body fluid

1. Description

a. Body fluids transport **nutrients** to the cells and carry waste products from the cells.

b. Total body fluid (intracellular and extracellular) amounts to about 60% of body weight in the adult, 55% in the older adult, and 80% in the infant.

c. Thus infants and older adults are at a higher risk for fluid-related problems than younger adults; children have a greater proportion of body water than adults, and the older adult has the least proportion of body water.

2. Constituents of body fluids

a. Body fluids consist of water and dissolved substances.

b. The largest single fluid constituent of the body is water.

c. Some substances, such as glucose, urea, and creatinine, do not dissociate in solution; that is, they do not separate from their complex forms into simpler substances when they are in solution.

d. Other substances do dissociate; for example, when sodium chloride is in a solution, it dissociates, or separates, into 2 parts or elements.

Infants and older adults need to be monitored closely for fluid imbalances.

F. Body fluid transport

1. Diffusion

a. Diffusion is the process whereby a solute (substance that is dissolved) may spread through a solution or solvent (solution in which the solute is dissolved).

b. Diffusion of a solute spreads the molecules from an area of higher concentration to an area of lower concentration.
c. A permeable membrane allows substances to pass through it without restriction.
d. A selectively permeable membrane allows some solutes to pass through without restriction but prevents other solutes from passing freely.
e. Diffusion occurs within fluid compartments and from one compartment to another if the barrier between the compartments is permeable to the diffusing substances.

2. Osmosis

a. Osmosis is the movement of solvent molecules across a membrane in response to a concentration gradient, usually from a solution of lower to one of higher solute concentration.
b. Osmotic pressure is the force that draws the solvent from a less concentrated solute through a selectively permeable membrane into a more concentrated solute, thus tending to equalize the concentration of the solvent.
c. If a membrane is permeable to water but not to all solutes present, the membrane is a selective or semipermeable membrane.
d. When a more concentrated solution is on one side of a selectively permeable membrane and a less concentrated solution is on the other side, a pull called *osmotic pressure* draws the water through the membrane to the more concentrated side, or the side with more solute.

3. Filtration

a. Filtration is the movement of solutes and solvents by hydrostatic pressure.
b. The movement is from an area of higher pressure to an area of lower pressure.

4. Hydrostatic pressure

a. Hydrostatic pressure is the force exerted by the weight of a solution.
b. When a difference exists in the hydrostatic pressure on two sides of a membrane, water and diffusible solutes move out of the solution that has the higher hydrostatic pressure by the process of filtration.
c. At the arterial end of the capillary, the hydrostatic pressure is higher than the osmotic pressure; therefore, fluids and diffusible solutes move out of the capillary.
d. At the venous end, the osmotic pressure, or pull, is higher than the hydrostatic pressure, and fluids and some solutes move into the capillary.
e. The excess fluid and solutes remaining in the interstitial spaces are returned to the intravascular compartment by the lymph channels.

5. Osmolality

a. Osmolality refers to the number of osmotically active particles per kilogram of water; it is the concentration of a solution.
b. In the body, osmotic pressure is measured in milliosmoles (mOsm).
c. The normal osmolality of **plasma** is 275 to 295 mOsm/kg (275 to 295 mmol/kg).

G. Movement of body fluid

1. Description

a. Cell membranes and capillary walls separate body compartments.
b. Cell membranes are selectively permeable; that is, the cell membrane and the capillary wall allow water and some solutes free passage through them.
c. Several forces affect the movement of water and solutes through the walls of cells and capillaries; for example, the greater the number of particles within the cell, the more pressure exists to force the water through the cell membrane out of the cell.
d. If the body loses more electrolytes than fluids, as can happen in diarrhea, then

the extracellular fluid contains fewer electrolytes or less solute than the intracellular fluid.

e. Fluids and electrolytes must be kept in balance for health; when they remain out of balance, death can occur.

2. Isotonic solutions

a. When the solutions on both sides of a selectively permeable membrane have established equilibrium or are equal in concentration, they are isotonic.

b. Isotonic solutions are isotonic to human cells, and thus very little osmosis occurs; isotonic solutions have the same osmolality as body fluids.

c. Refer to Chapter 69, Table 69-1, for a list of solutions, types, and uses.

3. Hypotonic solutions

a. When a solution contains a lower concentration of salt or solute than another, more concentrated solution, it is considered hypotonic.

b. A hypotonic solution has less salt or more water than an isotonic solution; these solutions have lower osmolality than body fluids.

c. Hypotonic solutions are hypotonic to the cells; therefore, osmosis would continue in an attempt to bring about balance or equality.

d. Refer to Chapter 69, Table 69-1, for a list of solutions, types, and uses.

4. Hypertonic solutions

a. A solution that has a higher concentration of solutes than another, less concentrated solution is hypertonic; these solutions have a higher osmolality than body fluids.

b. Refer to Chapter 69, Table 69-1, for a list of solutions, types, and uses.

5. Osmotic pressure

a. The amount of osmotic pressure is determined by the concentration of solutes in solution.

b. When the solutions on each side of a selectively permeable membrane are equal in concentration, they are isotonic.

c. A hypotonic solution has less solute than an isotonic solution, whereas a hypertonic solution contains more solute.

6. Active transport
   a. If an ion is to move through a membrane from an area of lower concentration to an area of higher concentration, an active transport system is necessary.
   b. An active transport system moves molecules or ions against concentration and osmotic pressure.
   c. Metabolic processes in the cell supply the energy for active transport.
   d. Substances that are transported actively through the cell membrane include ions of **sodium, potassium, calcium**, iron, and hydrogen; some of the sugars; and the amino acids.

H. Body fluid intake and output (Fig. 8-2)

1. Body fluid intake
   a. Water enters the body through 3 sources—orally ingested liquids, water in foods, and water formed by oxidation of foods.
   b. About 10 mL of water is released by the **metabolism** of each 100 calories of fat, carbohydrates, or proteins.
2. Body fluid output
   a. Water lost through the skin is called *insensible loss* (the individual is unaware of losing that water).
   b. The amount of water lost by perspiration varies according to the temperature of the environment and of the body.
   c. Water lost from the lungs is called *insensible loss* and is lost through expired air that is saturated with water vapor.
   d. The amount of water lost from the lungs varies with the rate and the depth of respiration.
   e. Large quantities of water are secreted into the gastrointestinal tract, but almost all of this fluid is reabsorbed.

f. A large volume of electrolyte-containing liquids moves into the gastrointestinal tract and then returns again to the extracellular fluid.
g. Severe diarrhea results in the loss of large quantities of fluids and electrolytes.
h. The kidneys play a major role in regulating fluid and electrolyte balance and excrete the largest quantity of fluid.
i. Normal kidneys can adjust the amount of water and electrolytes leaving the body.
j. The quantity of fluid excreted by the kidneys is determined by the amount of water ingested and the amount of waste and solutes excreted.
k. As long as all organs are functioning normally, the body is able to maintain balance in its fluid content.

The client with diarrhea is at high risk for a fluid and electrolyte imbalance.

II. Maintaining Fluid and Electrolyte Balance

A. Description

1. Homeostasis is a term that indicates the relative stability of the internal environment.
2. Concentration and composition of body fluids must be nearly constant.
3. When one of the substances in a client is deficient—either fluids or electrolytes—the substance must be replaced normally by the intake of food and water or by therapy such as intravenous (IV) solutions and medications.
4. When the client has an excess of fluid or electrolytes, therapy is directed toward assisting the body to eliminate the excess.

B. The kidneys play a major role in controlling balance in fluid and electrolytes.

C. The adrenal glands, through the secretion of aldosterone, also aid in controlling extracellular fluid volume by regulating the amount of sodium reabsorbed by the kidneys.

D. Antidiuretic hormone from the pituitary gland regulates the osmotic pressure of extracellular fluid by regulating the amount of water reabsorbed by the kidneys.

If the client has a fluid or an electrolyte imbalance, the nurse must closely monitor the client's cardiovascular, respiratory, neurological, musculoskeletal, renal, integumentary, and gastrointestinal status.

III. Fluid Volume Deficit

A. Description

1. Dehydration occurs when the fluid intake of the body is not sufficient to meet the fluid needs of the body.

2. The goal of treatment is to restore fluid volume, replace electrolytes as needed, and eliminate the cause of the fluid volume deficit.

B. Types of fluid volume deficits

1. Isotonic dehydration
    a. Water and dissolved electrolytes are lost in equal proportions.
    b. Known as *hypovolemia*, isotonic dehydration is the most common type of dehydration.
    c. Isotonic dehydration results in decreased circulating blood volume and inadequate tissue perfusion.
2. Hypertonic dehydration
    a. Water loss exceeds electrolyte loss.
    b. The clinical problems that occur result from alterations in the concentrations of specific plasma electrolytes.
    c. Fluid moves from the intracellular compartment into the plasma and interstitial fluid spaces, causing cellular dehydration and shrinkage.
3. Hypotonic dehydration
    a. Electrolyte loss exceeds water loss.
    b. The clinical problems that occur result from fluid shifts between compartments, causing a decrease in plasma volume.
    c. Fluid moves from the plasma and interstitial fluid spaces into the cells, causing a plasma volume deficit and causing the cells to swell.

C. Causes of fluid volume deficits

1. Isotonic dehydration

    a. Inadequate intake of fluids and solutes
    b. Fluid shifts between compartments

c. Excessive losses of isotonic body fluids

2. Hypertonic dehydration—conditions that increase fluid loss, such as excessive perspiration, hyperventilation, ketoacidosis, prolonged fevers, diarrhea, early-stage kidney disease, and diabetes insipidus

3. Hypotonic dehydration

a. Chronic illness
b. Excessive fluid replacement (hypotonic)
c. Kidney disease
d. Chronic **malnutrition**

D. Assessment (Table 8-1)

E. Interventions

1. Prevent further fluid losses and increase fluid compartment volumes to normal ranges.
2. Provide oral rehydration therapy if possible and IV fluid replacement if the dehydration is severe; monitor intake and output.

3. In general, isotonic dehydration is treated with isotonic fluid solutions, hypertonic dehydration with hypotonic fluid solutions, and hypotonic dehydration with hypertonic fluid solutions.
4. Administer medications, such as antidiarrheal, antimicrobial, antiemetic, and antipyretic medications, as prescribed to correct the cause and treat any symptoms.
5. Monitor electrolyte values and prepare to administer medication to treat an imbalance, if present.

IV. Fluid Volume Excess

A. Description

1. Fluid intake or fluid retention exceeds the fluid needs of the body.
2. Fluid volume excess is also called *overhydration* or *fluid overload.*

3. The goal of treatment is to restore fluid balance, correct electrolyte imbalances if present, and eliminate or control the underlying cause of the overload.

B. Types

1. Isotonic overhydration

a. Known as *hypervolemia*, isotonic

overhydration results from excessive fluid in the extracellular fluid compartment.

b. Only the extracellular fluid compartment is expanded, and fluid does not shift between the extracellular and intracellular compartments.

c. Isotonic overhydration causes **circulatory overload** and interstitial edema; when severe or when it occurs in a client with poor cardiac function, heart failure and pulmonary edema can result.

2. Hypertonic overhydration
   a. The occurrence of hypertonic overhydration is rare and is caused by an excessive sodium intake.
   b. Fluid is drawn from the intracellular fluid compartment; the extracellular fluid volume expands, and the intracellular fluid volume contracts.
3. Hypotonic overhydration
   a. Hypotonic overhydration is known as *water intoxication*.
   b. The excessive fluid moves into the intracellular space, and all body fluid compartments expand.

c. Electrolyte imbalances occur as a result of dilution.

C. Causes

1. Isotonic overhydration
   a. Inadequately controlled IV therapy
   b. Kidney disease
   c. Long-term corticosteroid therapy
2. Hypertonic overhydration
   a. Excessive sodium ingestion
   b. Rapid infusion of hypertonic saline
   c. Excessive sodium bicarbonate therapy
3. Hypotonic overhydration
   a. Early kidney disease
   b. Heart failure
   c. Syndrome of inappropriate antidiuretic hormone secretion
   d. Inadequately controlled IV therapy

e. Replacement of isotonic fluid loss with hypotonic fluids
f. Irrigation of wounds and body cavities with hypotonic fluids

D. Assessment (see Table 8-1)

A client with acute kidney injury, chronic kidney disease, and heart failure is at high risk for fluid volume excess.

E. Interventions

1. Prevent further fluid overload and restore normal fluid balance.
2. Administer diuretics; osmotic diuretics may be prescribed initially to prevent severe electrolyte imbalances.
3. Restrict fluid and sodium intake as prescribed.
4. Monitor intake and output; monitor weight.
5. Monitor electrolyte values and prepare to administer medication to treat an imbalance if present.

V. Hypokalemia

The normal potassium level is 3.5 to 5.0 mEq/L (3.5 to 5.0 mmol/L).

A. Description

1. Hypokalemia is a **serum potassium** level lower than 3.5 mEq/L (3.5 mmol/L)
2. Potassium deficit is potentially life-threatening because every body system is affected

B. Causes

1. Actual total body potassium loss
   a. Excessive use of medications such as diuretics or corticosteroids
   b. Increased secretion of aldosterone, such as in Cushing's syndrome
   c. Vomiting, diarrhea
   d. Wound drainage, particularly gastrointestinal
   e. Prolonged nasogastric suction
   f. Excessive diaphoresis

g. Kidney disease impairing reabsorption of potassium

2. Inadequate potassium intake: Fasting; nothing by mouth status
3. Movement of potassium from the extracellular fluid to the intracellular fluid
    a. Alkalosis
    b. Hyperinsulinism
4. Dilution of serum potassium
    a. Water intoxication
    b. IV therapy with potassium-deficient solutions

C. Assessment (Tables 8-2 and 8-3)

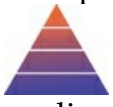
D. Interventions

1. Monitor electrolyte values.
2. Administer potassium supplements orally or intravenously, as prescribed.

3. Oral potassium supplements
    a. Oral potassium supplements may cause nausea and vomiting and should not be taken on an empty stomach; if the client complains of abdominal pain, distention, nausea, vomiting, diarrhea, or gastrointestinal bleeding, the supplement may need to be discontinued.
    b. Liquid potassium chloride has an unpleasant taste and should be taken with juice or another liquid.

4. Intravenously administered potassium (Box 8-2)

5. Institute safety measures for the client experiencing muscle weakness.



6. If the client is taking a potassium-losing diuretic, it may be discontinued; a potassium-sparing (retaining) diuretic may be prescribed.
7. Instruct the client about foods that are high in potassium content (see Box 11-2).

Potassium is never administered by IV push, intramuscular, or

subcutaneous routes. IV potassium is always diluted and administered using an infusion device!

VI. Hyperkalemia

A. Description

1. Hyperkalemia is a serum potassium level that exceeds 5.0 mEq/L (5.0 mmol/L)
2. Pseudohyperkalemia: a condition that can occur due to methods of blood specimen collection and cell lysis; if an increased serum value is obtained in the absence of clinical symptoms, the specimen should be redrawn and evaluated.

B. Causes

1. Excessive potassium intake
    a. Overingestion of potassium-containing foods or medications, such as potassium chloride or salt substitutes
    b. Rapid infusion of potassium-containing IV solutions
2. Decreased potassium excretion
    a. Potassium-sparing (retaining) diuretics
    b. Kidney disease
    c. Adrenal insufficiency, such as in Addison's disease
3. Movement of potassium from the intracellular fluid to the extracellular fluid
    a. Tissue damage
    b. Acidosis
    c. Hyperuricemia
    d. Hypercatabolism

C. Assessment (see Tables 8-2 and 8-3)

Monitor the client closely for signs of a potassium imbalance. A potassium imbalance can cause cardiac dysrhythmias that can be life-threatening, leading to cardiac arrest!

D. Interventions

1. Discontinue IV potassium (keep the IV catheter patent) and withhold oral potassium supplements.
2. Initiate a potassium-restricted diet.
3. Prepare to administer potassium-excreting diuretics if renal function is not impaired.
4. If renal function is impaired, prepare to administer sodium polystyrene sulfonate (oral or rectal route), a cation-exchange resin that promotes gastrointestinal

sodium absorption and potassium excretion.

5. Prepare the client for dialysis if potassium levels are critically high.
6. Prepare for the administration of IV calcium if hyperkalemia is severe, to avert myocardial excitability.
7. Prepare for the IV administration of hypertonic glucose with regular insulin to move excess potassium into the cells.
8. When blood transfusions are prescribed for a client with a potassium imbalance, the client should receive fresh blood, if possible; transfusions of stored blood may elevate the potassium level because the breakdown of older blood cells releases potassium.
9. Teach the client to avoid foods high in potassium (see Box 11-2).
10. Instruct the client to avoid the use of salt substitutes or other potassium-containing substances.
11. Monitor the serum potassium level closely when a client is receiving a potassium-sparing (retaining) diuretic.

VII. Hyponatremia

The normal sodium level is 135 to 145 mEq/L (135 to 145 mmol/L)

A. Description

1. Hyponatremia is a **serum sodium** level lower than 135 mEq/L (135 mmol/L).
2. Sodium imbalances usually are associated with fluid volume imbalances.

B. Causes

1. Increased sodium excretion
    a. Excessive diaphoresis
    b. Diuretics
    c. Vomiting
    d. Diarrhea
    e. Wound drainage, especially gastrointestinal
    f. Kidney disease
    g. Decreased secretion of aldosterone
2. Inadequate sodium intake
    a. Fasting; nothing by mouth status
    b. Low-salt diet
3. Dilution of serum sodium
    a. Excessive ingestion of hypotonic fluids or irrigation with hypotonic fluids

b. Kidney disease
c. Freshwater drowning
d. Syndrome of inappropriate antidiuretic hormone secretion
e. Hyperglycemia
f. Heart failure


C. Assessment (Table 8-4)

D. Interventions

1. If hyponatremia is accompanied by a fluid volume deficit (hypovolemia), IV sodium chloride infusions are administered to restore sodium content and fluid volume.
2. If hyponatremia is accompanied by fluid volume excess (hypervolemia), osmotic diuretics may be prescribed to promote the excretion of water rather than sodium.
3. If hyponatremia is caused by inappropriate or excessive secretion of antidiuretic hormone, medications that antagonize antidiuretic hormone may be administered.
4. Instruct the client to increase oral sodium intake as prescribed and inform the client about the foods to include in the diet (see Box 11-2).


5. If the client is taking lithium, monitor the lithium level, because hyponatremia can cause diminished lithium excretion, resulting in toxicity.


Hyponatremia precipitates lithium toxicity in a client taking this medication.

VIII. Hypernatremia

A. Description: Hypernatremia is a serum sodium level that exceeds 145 mEq/L (145 mmol/L).


B. Causes

1. Decreased sodium excretion
    a. Corticosteroids
    b. Cushing's syndrome
    c. Kidney disease
    d. Hyperaldosteronism
2. Increased sodium intake: Excessive oral sodium ingestion or excessive administration of sodium-containing IV fluids
3. Decreased water intake: Fasting; nothing-by-mouth

status

4. Increased water loss: Increased rate of metabolism, fever, hyperventilation, infection, excessive diaphoresis, watery diarrhea, diabetes insipidus

C. Assessment (see Table 8-4)

D. Interventions

1. If the cause is fluid loss, prepare to administer IV infusions.

2. If the cause is inadequate renal excretion of sodium, prepare to administer diuretics that promote sodium loss.

3. Restrict sodium and fluid intake as prescribed.

IX. Hypocalcemia

The normal calcium level is 9 to 10.5 mg/dL (2.25 to 2.75 mmol/L)

A. Description: Hypocalcemia is a **serum calcium** level lower than 9.0 mg/dL (2.25 mmol/L).

B. Causes

1. Inhibition of calcium absorption from the gastrointestinal tract
    a. Inadequate oral intake of calcium
    b. Lactose intolerance
    c. Malabsorption syndromes such as celiac sprue or Crohn's disease
    d. Inadequate intake of vitamin D
    e. End-stage kidney disease
2. Increased calcium excretion
    a. Kidney disease, polyuric phase
    b. Diarrhea
    c. Steatorrhea
    d. Wound drainage, especially gastrointestinal
3. Conditions that decrease the ionized fraction of calcium
    a. Hyperproteinemia
    b. Alkalosis
    c. Medications such as calcium chelators or binders
    d. Acute pancreatitis
    e. Hyperphosphatemia
    f. Immobility
    g. Removal or destruction of the

parathyroid glands


C. Assessment (Table 8-5 and Fig. 8-3; also see Table 8-3)

D. Interventions

1. Administer calcium supplements orally or calcium intravenously.


2. When administering calcium intravenously, warm the injection solution to body temperature before administration and administer slowly; monitor for electrocardiographic changes, observe for **infiltration**, and monitor for hypercalcemia.

3. Administer medications that increase calcium absorption.
    a. Aluminum hydroxide reduces **phosphorus** levels, causing the countereffect of increasing calcium levels.
    b. Vitamin D aids in the absorption of calcium from the intestinal tract.

4. Provide a quiet environment to reduce environmental stimuli.


5. Initiate seizure precautions.


6. Move the client carefully, and monitor for signs of a pathological fracture.


7. Keep 10% calcium gluconate available for treatment of acute calcium deficit.

8. Instruct the client to consume foods high in calcium (see Box 11-2).

X. Hypercalcemia

A. Description: Hypercalcemia is a serum calcium level that exceeds 10.5 mg/dL (2.75 mmol/L).


B. Causes

1. Increased calcium absorption
    a. Excessive oral intake of calcium
    b. Excessive oral intake of vitamin D
2. Decreased calcium excretion
    a. Kidney disease
    b. Use of thiazide diuretics
3. Increased bone resorption of calcium
    a. Hyperparathyroidism
    b. Hyperthyroidism

c. Malignancy (bone destruction from metastatic tumors)
d. Immobility
e. Use of glucocorticoids

4. Hemoconcentration
a. Dehydration
b. Use of lithium
c. Adrenal insufficiency

C. Assessment (see Tables 8-3 and 8-5)

D. Interventions

A client with a calcium imbalance is at risk for a pathological fracture. Move the client carefully and slowly; assist the client with ambulation.

1. Discontinue IV infusions of solutions containing calcium and oral medications containing calcium or vitamin D.
2. Thiazide diuretics may be discontinued and replaced with diuretics that enhance the excretion of calcium.
3. Administer medications as prescribed that inhibit calcium resorption from the bone, such as phosphorus, calcitonin, bisphosphonates, and prostaglandin synthesis inhibitors (acetylsalicylic acid, nonsteroidal antiinflammatory medications).
4. Prepare the client with severe hypercalcemia for dialysis if medications fail to reduce the serum calcium level.

5. Move the client carefully and monitor for signs of a pathological fracture.

6. Monitor for flank or abdominal pain, and strain the urine to check for the presence of urinary stones.
7. Instruct the client to avoid foods high in calcium (see Box 11-2).

XI. Hypomagnesemia

The normal magnesium level is 1.8 to 2.6 mEq/L (0.74 to 1.07 mmol/L).

A. Description: Hypomagnesemia is a **serum magnesium** level lower than 1.8 mEq/L (0.74 mmol/L).

B. Causes

1. Insufficient magnesium intake
    a. Malnutrition and starvation
    b. Vomiting or diarrhea
    c. Malabsorption syndrome
    d. Celiac disease
    e. Crohn's disease
2. Increased magnesium excretion
    a. Medications such as diuretics
    b. Chronic alcoholism
3. Intracellular movement of magnesium
    a. Hyperglycemia
    b. Insulin administration
    c. Sepsis

C. Assessment (Table 8-6; also see Table 8-3)

D. Interventions

1. Because hypocalcemia frequently accompanies hypomagnesemia, interventions also aim to restore normal serum calcium levels.

2. Oral preparations of magnesium may cause diarrhea and increase magnesium loss.
3. Magnesium sulfate by the IV route may be prescribed in ill clients when the magnesium level is low (intramuscular injections cause pain and tissue damage); initiate seizure precautions, monitor serum magnesium levels frequently, and monitor for diminished deep tendon reflexes, suggesting hypermagnesemia, during the administration of magnesium.
4. Instruct the client to increase the intake of foods that contain magnesium (see Box 11-2).

XII. Hypermagnesemia

A. Description: Hypermagnesemia is a **serum magnesium** level that exceeds 2.6 mEq/L (1.07 mmol/L).

B. Causes

1. Increased magnesium intake
    a. Magnesium-containing antacids and laxatives
    b. Excessive administration of magnesium intravenously
2. Decreased renal excretion of magnesium as a result of renal insufficiency

C. Assessment (see Tables 8-3 and 8-6)

D. Interventions

Calcium gluconate is the antidote for magnesium overdose.

1. Diuretics are prescribed to increase renal excretion of magnesium.

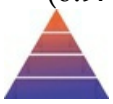
2. Intravenously administered calcium chloride or calcium gluconate may be prescribed to reverse the effects of magnesium on cardiac muscle.
3. Instruct the client to restrict dietary intake of magnesium-containing foods (see Box 11-2).

4. Instruct the client to avoid the use of laxatives and antacids containing magnesium.

XIII. Hypophosphatemia

A. Description

1. Hypophosphatemia is a **serum phosphorus** (phosphate) level lower than 3.0 mg/dL (0.97 mmol/L).



2. A decrease in the serum phosphorus level is accompanied by an increase in the serum calcium level.

B. Causes

1. Insufficient phosphorus intake: Malnutrition and starvation
2. Increased phosphorus excretion
    a. Hyperparathyroidism
    b. Malignancy
    c. Use of **magnesium**-based or aluminum hydroxide–based antacids
3. Intracellular shift
    a. Hyperglycemia
    b. **Respiratory alkalosis**

C. Assessment

1. Cardiovascular
    a. Decreased contractility and cardiac output
    b. Slowed peripheral pulses
2. Respiratory: Shallow respirations
3. Neuromuscular
    a. Weakness
    b. Decreased deep tendon reflexes
    c. Decreased bone density that can cause fractures and alterations in bone shape

d. Rhabdomyolysis

4. Central nervous system
    a. Irritability
    b. Confusion
    c. Seizures
5. Hematological
    a. Decreased platelet aggregation and increased bleeding
    b. Immunosuppression

D. Interventions

1. Discontinue medications that contribute to hypophosphatemia.
2. Administer phosphorus orally along with a vitamin D supplement.
3. Prepare to administer phosphorus intravenously when serum phosphorus levels fall below 1 mg/dL and when the client experiences critical clinical manifestations; administer IV phosphorus slowly because of the risks associated with hyperphosphatemia.
4. Assess the renal system before administering phosphorus.
5. Move the client carefully, and monitor for signs of a pathological fracture.
6. Instruct the client to increase the intake of the phosphorus-containing foods while decreasing the intake of any calcium-containing foods (see Box 11-2).

A decrease in the serum phosphorus level is accompanied by an increase in the serum calcium level, and an increase in the serum phosphorus level is accompanied by a decrease in the serum calcium level. This is called a reciprocal relationship.

XIV. Hyperphosphatemia

A. Description

1. Hyperphosphatemia is a serum phosphorus level that exceeds 4.5 mg/dL (1.45 mmol/L).
2. Most body systems tolerate elevated serum phosphorus levels well.
3. An increase in the serum phosphorus level is accompanied by a decrease in the serum calcium level.
4. The problems that occur in hyperphosphatemia center

on the hypocalcemia that results when serum phosphorus levels increase.

B. Causes

1. Decreased renal excretion resulting from renal insufficiency
2. Tumor lysis syndrome
3. Increased intake of phosphorus, including dietary intake or overuse of phosphate-containing laxatives or enemas
4. Hypoparathyroidism

C. Assessment: Refer to assessment of hypocalcemia.

D. Interventions

1. Interventions entail the management of hypocalcemia.

2. Administer phosphate-binding medications that increase fecal excretion of phosphorus by binding phosphorus from food in the gastrointestinal tract.

3. Instruct the client to avoid phosphate-containing medications, including laxatives and enemas.
4. Instruct the client to decrease the intake of food that is high in phosphorus (see Box 11-2).
5. Instruct the client in medication administration: Take phosphate-binding medications, emphasizing that they should be taken with meals or immediately after meals.

Box 8-1

Properties of Electrolytes and Their Components

Atom

An atom is the smallest part of an element that still has the properties of the element.
The atom is composed of particles known as the *proton* (positive charge), *neutron* (neutral), and *electron* (negative charge).
Protons and neutrons are in the nucleus of the atom; therefore, the nucleus is positively charged.
Electrons carry a negative charge and revolve around the nucleus.
As long as the number of electrons is the same as the number of protons, the atom has no net charge; that is, it is neither positive nor negative.
Atoms that gain, lose, or share electrons are no longer neutral.

Molecule

A molecule is 2 or more atoms that combine to form a substance.

Ion

An ion is an atom that carries an electrical charge because it has gained or lost electrons.
Some ions carry a negative electrical charge and some carry a positive charge.

Cation

A cation is an ion that has given away or lost electrons and therefore carries a positive charge.
The result is fewer electrons than protons, and the result is a positive charge.

Anion

An anion is an ion that has gained electrons and therefore carries a negative charge.
When an ion has gained or taken on electrons, it assumes a negative charge and the result is a negatively charged ion.

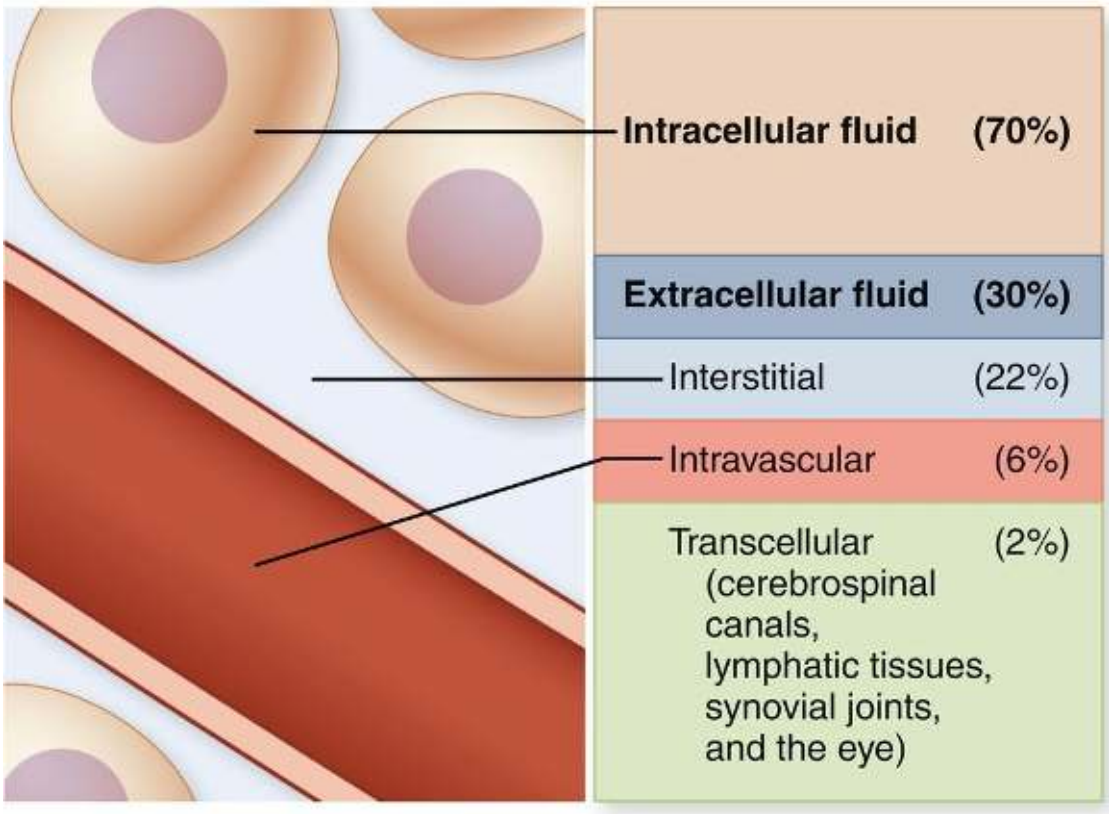


FIG. 8-1 Distribution of fluid by compartments in the average adult.

Fluid intake	
Ingested water	1200-1500 mL
Ingested food	800-1100 mL
Metabolic oxidation	300 mL
TOTAL	2300-2900 mL

Fluid output	
Kidneys	1500 mL
Insensible loss through skin	600-800 mL
Insensible loss through lungs	400-600 mL
Gastrointestinal tract	100 mL
TOTAL	2600-3000 mL

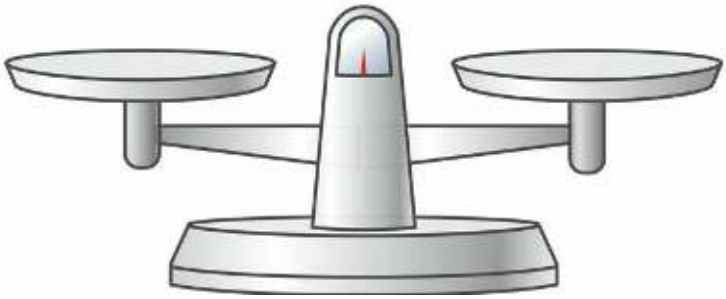


FIG. 8-2 Sources of fluid intake and fluid output (approximates).

Table 8-1

Assessment Findings: Fluid Volume Deficit and Fluid Volume Excess

Fluid Volume Deficit	Fluid Volume Excess
Cardiovascular	
■ Thready, increased pulse rate	■ Bounding, increased pulse rate
■ Decreased blood pressure and orthostatic (postural) hypotension	■ Elevated blood pressure
■ Flat neck and hand veins in dependent positions	■ Distended neck and hand veins
■ Diminished peripheral pulses	■ Elevated central venous pressure
■ Decreased central venous pressure	■ Dysrhythmias
■ Dysrhythmias	
Respiratory	
■ Increased rate and depth of respirations	■ Increased respiratory rate (shallow respirations)
■ Dyspnea	■ Dyspnea
	■ Moist crackles on auscultation
Neuromuscular	
■ Decreased central nervous system activity, from lethargy to coma	■ Altered level of consciousness
■ Fever, depending on the amount of fluid loss	■ Headache
■ Skeletal muscle weakness	■ Visual disturbances
	■ Skeletal muscle weakness
	■ Paresthesias
Renal	
■ Decreased urine output	■ Increased urine output if kidneys can compensate; decreased urine output if kidney damage is the cause
Integumentary	
■ Dry skin	■ Pitting edema in dependent areas
■ Poor turgor, tenting	■ Pale, cool skin
■ Dry mouth	
Gastrointestinal	
■ Decreased motility and diminished bowel sounds	■ Increased motility in the gastrointestinal tract
■ Constipation	■ Diarrhea
■ Thirst	■ Increased body weight
■ Decreased body weight	■ Liver enlargement
	■ Ascites
Laboratory Findings	
■ Increased serum osmolality	■ Decreased serum osmolality
■ Increased hematocrit	■ Decreased hematocrit
■ Increased blood urea nitrogen (BUN) level	■ Decreased BUN level
■ Increased serum sodium level	■ Decreased serum sodium level
■ Increased urinary specific gravity	■ Decreased urine specific gravity

Table 8-2

Assessment Findings: Hypokalemia and Hyperkalemia

Hypokalemia	Hyperkalemia
Cardiovascular	
■ Thready, weak, irregular pulse	■ Slow, weak, irregular heart rate
■ Weak peripheral pulses	■ Decreased blood pressure
■ Orthostatic hypotension	■ Dysrhythmias
■ Dysrhythmias	
Respiratory	
■ Shallow, ineffective respirations that result from profound weakness of the skeletal muscles of respiration	■ Profound weakness of the skeletal muscles leading to respiratory failure
■ Diminished breath sounds	
Neuromuscular	
■ Anxiety, lethargy, confusion, coma ■ Skeletal muscle weakness, leg cramps ■ Loss of tactile discrimination ■ Paresthesias ■ Deep tendon hyporeflexia	■ *Early:* Muscle twitches, cramps, paresthesias (tingling and burning followed by numbness in the hands and feet and around the mouth) ■ *Late:* Profound weakness, ascending flaccid paralysis in the arms and legs (trunk, head, and respiratory muscles become affected when the serum potassium level reaches a lethal level)
Gastrointestinal	
■ Decreased motility, hypoactive to absent bowel sounds	■ Increased motility, hyperactive bowel sounds
■ Nausea, vomiting, constipation, abdominal distention	■ Diarrhea
■ Paralytic ileus	
Laboratory Findings	
■ Serum potassium level lower than 3.5 mEq/L (3.5 mmol/L)	■ Serum potassium level that exceeds 5.0 mEq/L (5.0 mmol/L)
■ Electrocardiogram changes: ST depression; shallow, flat, or inverted T wave; and prominent U wave	■ Electrocardiographic changes: Tall peaked T waves, flat P waves, widened QRS complexes, and prolonged PR intervals

Table 8-3

Electrocardiographic Changes in Electrolyte Imbalances

Electrolyte Imbalance	Electrocardiographic Changes
Hypokalemia	ST depression
	Shallow, flat, or inverted T wave
	Prominent U wave
Hyperkalemia	Tall peaked T waves
	Flat P waves
	Widened QRS complexes
	Prolonged PR interval
Hypocalcemia	Prolonged ST segment
	Prolonged QT interval
Hypercalcemia	Shortened ST segment
	Widened T wave
	Heart block
Hypomagnesemia	Tall T waves
	Depressed ST segment
Hypermagnesemia	Prolonged PR interval
	Widened QRS complexes

Box 8-2

Precautions With Intravenously Administered Potassium

- Potassium is never given by intravenous (IV) push or by the intramuscular or subcutaneous route.
- A dilution of no more than 1 mEq/10 mL (1 mmol/10 mL) of solution is recommended.
- Many health care agencies supply prepared IV solutions containing potassium; before administering and frequently during infusion of the IV solution, rotate and invert the bag to ensure that the potassium is distributed evenly throughout the IV solution.
- Ensure that the IV bag containing potassium is properly labeled.
- The maximum recommended infusion rate is 5 to 10 mEq/hr (5 to 10 mmol/hr), never to exceed 20 mEq/hr (20 mmol/hr) under any circumstances.
- A client receiving more than 10 mEq/hr (10 mmol/hr) should be placed on a cardiac monitor and monitored for cardiac changes, and the infusion should be controlled by an infusion device.
- Potassium infusion can cause phlebitis; therefore, the nurse should assess the IV site frequently for signs of phlebitis or infiltration. If either occurs, the infusion should be stopped immediately.
- The nurse should assess renal function before administering potassium and monitor intake and output during administration.

Table 8-4

Assessment Findings: Hyponatremia and Hypernatremia

Hyponatremia	Hypernatremia
Cardiovascular	
■ Symptoms vary with changes in vascular volume	■ Heart rate and blood pressure respond to vascular volume status
■ *Normovolemic*: Rapid pulse rate, normal blood pressure	
■ *Hypovolemic*: Thready, weak, rapid pulse rate; hypotension; flat neck veins; normal or low central venous pressure	
■ *Hypervolemic*: Rapid, bounding pulse; blood pressure normal or elevated; normal or elevated central venous pressure	
Respiratory	
■ Shallow, ineffective respiratory movement is a late manifestation related to skeletal muscle weakness	■ Pulmonary edema if hypervolemia is present
Neuromuscular	
■ Generalized skeletal muscle weakness that is worse in the extremities	■ *Early*: Spontaneous muscle twitches; irregular muscle contractions
■ Diminished deep tendon reflexes	■ *Late*: Skeletal muscle weakness; deep tendon reflexes diminished or absent
Central Nervous System	
■ Headache	■ Altered cerebral function is the most common manifestation of hypernatremia
■ Personality changes	■ *Normovolemia or hypovolemia*: Agitation, confusion, seizures
■ Confusion	■ *Hypervolemia*: Lethargy, stupor, coma
■ Seizures	
■ Coma	
Gastrointestinal	
■ Increased motility and hyperactive bowel sounds	■ Extreme thirst
■ Nausea	
■ Abdominal cramping and diarrhea	
Renal	
■ Increased urinary output	■ Decreased urinary output
Integumentary	
■ Dry mucous membranes	■ Dry and flushed skin
	■ Dry and sticky tongue and mucous membranes
	■ Presence or absence of edema, depending on fluid volume changes
Laboratory Findings	
■ Serum sodium level less than 135 mEq/L (135 mmol/L)	■ Serum sodium level that exceeds 145 mEq/L (145 mmol/L)
■ Decreased urinary specific gravity	■ Increased urinary specific gravity

Table 8-5

Assessment Findings: Hypocalcemia and Hypercalcemia

Hypocalcemia	Hypercalcemia
Cardiovascular	
■ Decreased heart rate ■ Hypotension ■ Diminished peripheral pulses	■ Increased heart rate in the early phase; bradycardia that can lead to cardiac arrest in late phases ■ Increased blood pressure ■ Bounding, full peripheral pulses
Respiratory	
■ Not directly affected; however, respiratory failure or arrest can result from decreased respiratory movement because of muscle tetany or seizures	■ Ineffective respiratory movement as a result of profound skeletal muscle weakness
Neuromuscular	
■ Irritable skeletal muscles: Twitches, cramps, tetany, seizures	■ Profound muscle weakness
■ Painful muscle spasms in the calf or foot during periods of inactivity	■ Diminished or absent deep tendon reflexes
■ Paresthesias followed by numbness that may affect the lips, nose, and ears in addition to the limbs	■ Disorientation, lethargy, coma
■ Positive Trousseau's and Chvostek's signs	
■ Hyperactive deep tendon reflexes	
■ Anxiety, irritability	
Renal	
■ Urinary output varies depending on the cause	■ Urinary output varies depending on the cause
Gastrointestinal	
■ Increased gastric motility; hyperactive bowel sounds	■ Decreased motility and hypoactive bowel sounds
■ Cramping, diarrhea	■ Anorexia, nausea, abdominal distention, constipation
Laboratory Findings	
■ Serum calcium level less than 9.0 mg/dL (2.25 mmol/L)	■ Serum calcium level that exceeds 10.5 mg/dL (2.75 mmol/L)
■ Electrocardiographic changes: Prolonged ST interval, prolonged QT interval	■ Electrocardiographic changes: Shortened ST segment, widened T wave, heart block

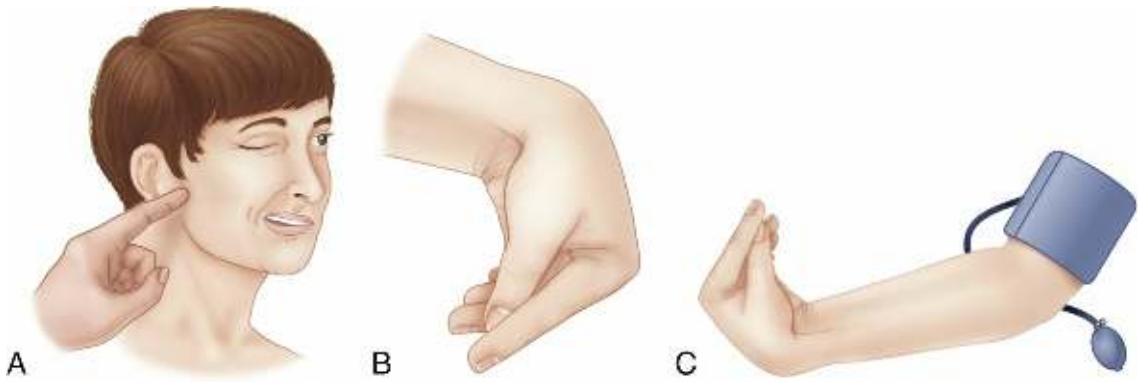


FIG. 8-3 Tests for hypocalcemia. **A**, Chvostek's sign is contraction of facial muscles in response to a light tap over the facial nerve in front of the ear. **B**, Trousseau's sign is a carpal spasm induced by inflating a blood pressure cuff **(C)** above the systolic pressure for a few minutes.

Table 8-6

Assessment Findings: Hypomagnesemia and Hypermagnesemia

Hypomagnesemia	Hypermagnesemia
Cardiovascular	
■ Tachycardia	■ Bradycardia, dysrhythmias (cardiac arrest if severe)
■ Hypertension	■ Hypotension
Respiratory	
■ Shallow respirations	■ Respiratory insufficiency when the skeletal muscles of respiration are involved
Neuromuscular	
■ Twitches, paresthesias ■ Positive Trousseau's and Chvostek's signs ■ Hyperreflexia ■ Tetany, seizures	■ Diminished or absent deep tendon reflexes ■ Skeletal muscle weakness
Central Nervous System	
■ Irritability ■ Confusion	■ Drowsiness and lethargy that progresses to coma
Laboratory Findings	
■ Serum magnesium level less than 1.8 mEq/L (0.74 mmol/L)	■ Serum magnesium level that exceeds 2.6 mEq/L (1.07 mmol/L)
■ Electrocardiographic changes: Tall T waves, depressed ST segments	■ Electrocardiographic changes: Prolonged PR interval, widened QRS complexes

Practice Questions

39. The nurse is caring for a client with heart failure. On assessment, the nurse notes that the client is dyspneic, and crackles are audible on auscultation. What additional manifestations would the nurse expect to note in this client if excess fluid volume is present?
    1. Weight loss and dry skin
    2. Flat neck and hand veins and decreased urinary output
    3. An increase in blood pressure and increased respirations
    4. Weakness and decreased central venous pressure (CVP)
40. The nurse reviews a client's record and determines that the client is at risk for developing a potassium deficit if which situation is documented?
    1. Sustained tissue damage
    2. Requires nasogastric suction
    3. Has a history of Addison's disease
    4. Uric acid level of 9.4 mg/dL (557 mcmol/L)
41. The nurse reviews a client's electrolyte laboratory report and notes that the potassium level is 2.5 mEq/L (2.5 mmol/L). Which patterns should the nurse watch for on the electrocardiogram (ECG) as a result of the laboratory value? **Select all that apply.**
    1. U waves
    2. Absent P waves
    3. Inverted T waves
    4. Depressed ST segment
    5. Widened QRS complex
42. Potassium chloride intravenously is prescribed for a client with heart failure experiencing hypokalemia. Which actions should the nurse take to plan for preparation and administration of the potassium? **Select all that apply.**
    1. Obtain an intravenous (IV) infusion pump.

2. Monitor urine output during administration.
3. Prepare the medication for bolus administration.
4. Monitor the IV site for signs of infiltration or phlebitis.
5. Ensure that the medication is diluted in the appropriate volume of fluid.
6. Ensure that the bag is labeled so that it reads the volume of potassium in the solution.

43. The nurse is assessing a client with a lactose intolerance disorder for a suspected diagnosis of hypocalcemia. Which clinical manifestation would the nurse expect to note in the client?
    1. Twitching
    2. Hypoactive bowel sounds
    3. Negative Trousseau's sign
    4. Hypoactive deep tendon reflexes
44. The nurse is caring for a client with Crohn's disease who has a calcium level of 8 mg/dL (2 mmol/L). Which patterns would the nurse watch for on the electrocardiogram? **Select all that apply.**
    1. U waves
    2. Widened T wave
    3. Prominent U wave
    4. Prolonged QT interval
    5. Prolonged ST segment
45. The nurse reviews the electrolyte results of a client with chronic kidney disease and notes that the potassium level is 5.7 mEq/L (5.7 mmol/L). Which patterns would the nurse watch for on the cardiac monitor as a result of the laboratory value? **Select all that apply.**
    1. ST depression
    2. Prominent U wave
    3. Tall peaked T waves
    4. Prolonged ST segment
    5. Widened QRS complexes
46. Which client is at risk for the development of a sodium level at 130 mEq/L (130 mmol/L)?
    1. The client who is taking diuretics
    2. The client with hyperaldosteronism
    3. The client with Cushing's syndrome
    4. The client who is taking corticosteroids
47. The nurse is caring for a client with heart failure who is receiving high doses of a diuretic. On assessment, the nurse notes that the client has flat neck veins, generalized muscle weakness, and diminished deep tendon reflexes. The nurse suspects hyponatremia. What additional signs would the nurse expect to note in a client with hyponatremia?
    1. Muscle twitches
    2. Decreased urinary output
    3. Hyperactive bowel sounds
    4. Increased specific gravity of the urine
48. The nurse reviews a client's laboratory report and notes that the client's serum phosphorus (phosphate) level is 1.8 mg/dL (0.58 mmol/L). Which

condition **most likely** caused this serum phosphorus level?

1. Malnutrition
2. Renal insufficiency
3. Hypoparathyroidism
4. Tumor lysis syndrome

49. The nurse is reading a primary health care provider's (PHCP's) progress notes in the client's record and reads that the PHCP has documented "insensible fluid loss of approximately 800 mL daily." The nurse makes a notation that insensible fluid loss occurs through which type of excretion?
    1. Urinary output
    2. Wound drainage
    3. Integumentary output
    4. The gastrointestinal tract
50. The nurse is assigned to care for a group of clients. On review of the clients' medical records, the nurse determines that which client is **most likely** at risk for a fluid volume deficit?
    1. A client with an ileostomy
    2. A client with heart failure
    3. A client on long-term corticosteroid therapy
    4. A client receiving frequent wound irrigations
51. The nurse caring for a client who has been receiving intravenous (IV) diuretics suspects that the client is experiencing a fluid volume deficit. Which assessment finding would the nurse note in a client with this condition?
    1. Weight loss and poor skin turgor
    2. Lung congestion and increased heart rate
    3. Decreased hematocrit and increased urine output
    4. Increased respirations and increased blood pressure
52. On review of the clients' medical records, the nurse determines that which client is at risk for fluid volume excess?
    1. The client taking diuretics who has tenting of the skin
    2. The client with an ileostomy from a recent abdominal surgery
    3. The client who requires intermittent gastrointestinal suctioning
    4. The client with kidney disease and a 12-year history of diabetes mellitus
53. Which client is at risk for the development of a potassium level of 5.5 mEq/L (5.5 mmol/L)?
    1. The client with colitis
    2. The client with Cushing's syndrome
    3. The client who has been overusing laxatives
    4. The client who has sustained a traumatic burn

Answers

39. ***Answer:*** 3

Rationale: A fluid volume excess is also known as *overhydration* or *fluid overload* and occurs when fluid intake or fluid retention exceeds the fluid needs of the body.

Assessment findings associated with fluid volume excess include cough, dyspnea, crackles, tachypnea, tachycardia, elevated blood pressure, bounding pulse, elevated CVP, weight gain, edema, neck and hand vein distention, altered level of consciousness, and decreased hematocrit. Dry skin, flat neck and hand veins, decreased urinary output, and decreased CVP are noted in fluid volume deficit. Weakness can be present in either fluid volume excess or deficit.

Test-Taking Strategy: Focus on the **subject,** fluid volume excess. Remember that when there is more than one part to an option, all parts need to be correct in order for the option to be correct. Think about the pathophysiology associated with a fluid volume excess to assist in directing you to the correct option. Also, note that the incorrect options are **comparable or alike** in that each includes manifestations that reflect a decrease.

Level of Cognitive Ability: Synthesizing
Client Needs: Physiological Integrity
Integrated Process: Nursing Process—Assessment
Content Area: Foundations of Care: Fluids & Electrolytes
Health Problem: Adult Health: Cardiovascular: Heart Failure
Priority Concepts: Fluids and Electrolytes; Perfusion
References: Lewis et al. (2017), pp. 276-277.

40. ***Answer:*** 2

Rationale: The normal serum potassium level is 3.5 to 5.0 mEq/L (3.5 to 5.0 mmol/L). A potassium deficit is known as *hypokalemia*. Potassium-rich gastrointestinal fluids are lost through gastrointestinal suction, placing the client at risk for hypokalemia. The client with tissue damage or Addison's disease and the client with hyperuricemia are at risk for hyperkalemia. The normal uric acid level for a female is 2.7 to 7.3 mg/dL (160 to 430 mcmol/L) and for a male is 4.0 to 8.5 mg/dL (240 to 501 mcmol/L).

Test-Taking Strategy: Note the **subject,** causes of potassium deficit. First recall the normal uric acid levels and the causes of hyperkalemia to assist in eliminating option 4. For the remaining options, note that the correct option is the only one that identifies a loss of body fluid.

Level of Cognitive Ability: Analyzing
Client Needs: Physiological Integrity
Integrated Process: Nursing Process—Assessment
Content Area: Foundations of Care: Fluids & Electrolytes
Health Problem: N/A
Priority Concepts: Clinical Judgment; Fluids and Electrolytes
Reference: Ignatavicius, Workman, Rebar (2018), pp. 175, 331.

41. ***Answer:*** 1, 3, 4

Rationale: The normal serum potassium level is 3.5 to 5.0 mEq/L (3.5 to 5.0 mmol/L). A serum potassium level lower than 3.5 mEq/L (3.5 mmol/L) indicates hypokalemia. Potassium deficit is an electrolyte imbalance that can be potentially life-threatening. Electrocardiographic changes include shallow, flat, or inverted T

waves; ST segment depression; and prominent U waves. Absent P waves are not a characteristic of hypokalemia but may be noted in a client with atrial fibrillation, junctional rhythms, or ventricular rhythms. A widened QRS complex may be noted in hyperkalemia and in hypermagnesemia.

Test-Taking Strategy: Focus on the **subject,** the ECG patterns that may be noted with a client with a potassium level of 2.5 mEq/L (2.5 mmol/L). From the information in the question, you need to determine that the client is experiencing severe hypokalemia. From this point, you must know the electrocardiographic changes that are expected when severe hypokalemia exists.

Level of Cognitive Ability: Analyzing
Client Needs: Physiological Integrity
Integrated Process: Nursing Process—Assessment
Content Area: Foundations of Care: Fluids & Electrolytes
Health Problem: N/A
Priority Concepts: Clinical Judgment; Fluid and Electrolytes
References: Ignatavicius, Workman, Rebar (2018), p. 176.

42. ***Answer:*** 1, 2, 4, 5, 6

Rationale: Potassium chloride administered intravenously must always be diluted in IV fluid and infused via an infusion pump. Potassium chloride is never given by bolus (IV push). Giving potassium chloride by IV push can result in cardiac arrest. The nurse should ensure that the potassium is diluted in the appropriate amount of diluent or fluid. The IV bag containing the potassium chloride should always be labeled with the volume of potassium it contains. The IV site is monitored closely, because potassium chloride is irritating to the veins and there is risk of phlebitis. In addition, the nurse should monitor for infiltration. The nurse monitors urinary output during administration and contacts the primary health care provider if the urinary output is less than 30 mL/hr.

Test-Taking Strategy: Focus on the **subject,** the preparation and administration of potassium chloride intravenously. Think about this procedure and the effects of potassium. Note the word *bolus* in option 3 to assist in eliminating this option.

Level of Cognitive Ability: Analyzing
Client Needs: Physiological Integrity
Integrated Process: Nursing Process—Implementation
Content Area: Pharmacology: Fluid and Electrolyte Balance: Electrolytes
Health Problem: Adult Health: Cardiovascular: Heart Failure
Priority Concepts: Clinical Judgment; Safety
References: Lewis et al. (2017), p. 282.

43. ***Answer:*** 1

Rationale: A client with lactose intolerance is at risk for developing hypocalcemia, because food products that contain calcium also contain lactose. The normal serum calcium level is 9 to 10.5 mg/dL (2.25 to 2.75 mmol/L). A serum calcium level lower than 9 mg/dL (2.25 mmol/L) indicates hypocalcemia. Signs of hypocalcemia include paresthesias followed by numbness, hyperactive deep tendon reflexes, and a

positive Trousseau's or Chvostek's sign. Additional signs of hypocalcemia include increased neuromuscular excitability, muscle cramps, twitching, tetany, seizures, irritability, and anxiety. Gastrointestinal symptoms include increased gastric motility, hyperactive bowel sounds, abdominal cramping, and diarrhea.

Test-Taking Strategy: Note that the three incorrect options are **comparable or alike** in that they reflect a hypoactivity. The option that is different is the correct option.

Level of Cognitive Ability: Analyzing
Client Needs: Physiological Integrity
Integrated Process: Nursing Process—Assessment
Content Area: Foundations of Care: Fluids & Electrolytes
Health Problem: Adult Health: Gastrointestinal: Nutrition Problems
Priority Concepts: Clinical Judgment; Fluids and Electrolytes
Reference: Lewis et al. (2017), p. 284.

44. ***Answer:*** 4, 5

Rationale: A client with Crohn's disease is at risk for hypocalcemia. The normal serum calcium level is 9 to 10.5 mg/dL (2.25 to 2.75 mmol/L). A serum calcium level lower than 9 mg/dL (2.25 mmol/L) indicates hypocalcemia. Electrocardiographic changes that occur in a client with hypocalcemia include a prolonged QT interval and prolonged ST segment. A shortened ST segment and a widened T wave occur with hypercalcemia. ST depression and prominent U waves occur with hypokalemia.

Test-Taking Strategy: Focus on the **subject,** the electrocardiographic patterns that occur in a client with Crohn's disease who has a calcium level of 8 mg/dL (2 mmol/L). It is necessary to know this client is at risk for hypocalcemia and that a level of 8 mg/dL (2 mmol/L) is low. Then it is necessary to recall the electrocardiographic changes that occur in hypocalcemia. Remember that hypocalcemia causes a prolonged ST segment and prolonged QT interval.

Level of Cognitive Ability: Analyzing
Client Needs: Physiological Integrity
Integrated Process: Nursing Process—Assessment
Content Area: Foundations of Care: Fluids & Electrolytes
Health Problem: Adult Health: Gastrointestinal: Lower GI Disorders
Priority Concepts: Clinical Judgment; Fluids and Electrolytes
Reference: Lewis et al. (2017), p. 284.

45. ***Answer:*** 3, 5

Rationale: The client with chronic kidney disease is at risk for hyperkalemia. The normal potassium level is 3.5 to 5.0 mEq/L (3.5 to 5.0 mmol/L). A serum potassium level greater than 5.0 mEq/L (5.0 mmol/L) indicates hyperkalemia. Electrocardiographic changes associated with hyperkalemia include flat P waves, prolonged PR intervals, widened QRS complexes, and tall peaked T waves. ST depression and a prominent U wave occurs in hypokalemia. A prolonged ST segment occurs in hypocalcemia.

Test-Taking Strategy: Focus on the **subject,** a client with chronic kidney disease and the electrocardiographic changes that occur in a potassium imbalance. From the information in the question you need to determine that this condition is a hyperkalemic one. From this point, you must know the electrocardiographic changes that are expected when hyperkalemia exists. Remember that tall peaked T waves, flat P waves, widened QRS complexes, and prolonged PR interval are associated with hyperkalemia.

Level of Cognitive Ability: Analyzing
Client Needs: Physiological Integrity
Integrated Process: Nursing Process—Assessment
Content Area: Foundations of Care: Fluids & Electrolytes
Health Problem: Adult Health: Renal and Urinary: Chronic Kidney Disease
Priority Concepts: Clinical Judgment; Fluids and Electrolytes
Reference: Lewis et al. (2017), p. 281.

46. ***Answer:*** 1

Rationale: The normal serum sodium level is 135 to 145 mEq/L (135 to 145 mmol/L). A serum sodium level of 130 mEq/L (130 mmol/L) indicates hyponatremia. Hyponatremia can occur in the client taking diuretics. The client taking corticosteroids and the client with hyperaldosteronism or Cushing's syndrome are at risk for hypernatremia.

Test-Taking Strategy: Focus on the **subject,** the causes of a sodium level of 130 mEq/L (130 mmol/L). First, determine that the client is experiencing hyponatremia. Next, you must know the causes of hyponatremia to direct you to the correct option. Also, recall that when a client takes a diuretic, the client loses fluid and electrolytes.

Level of Cognitive Ability: Analyzing
Client Needs: Physiological Integrity
Integrated Process: Nursing Process—Assessment
Content Area: Foundations of Care: Fluids & Electrolytes
Health Problem: N/A
Priority Concepts: Clinical Judgment; Fluids and Electrolytes
Reference: Ignatavicius, Workman, Rebar (2018), pp. 173-174.

47. ***Answer:*** 3

Rationale: The normal serum sodium level is 135 to 145 mEq/L (135 to 145 mmol/L). Hyponatremia is evidenced by a serum sodium level lower than 135 mEq/L (135 mmol/L). Hyperactive bowel sounds indicate hyponatremia. The remaining options are signs of hypernatremia. In hyponatremia, muscle weakness, increased urinary output, and decreased specific gravity of the urine would be noted.

Test-Taking Strategy: Focus on the **data in the question** and the **subject** of the question, signs of hyponatremia. It is necessary to know the signs of hyponatremia to answer correctly. Also, think about the action and effects of sodium on the body to answer correctly. Remember that increased bowel motility and hyperactive bowel

sounds indicate hyponatremia.
Level of Cognitive Ability: Analyzing
Client Needs: Physiological Integrity
Integrated Process: Nursing Process—Assessment
Content Area: Foundations of Care: Fluids & Electrolytes
Health Problem: N/A
Priority Concepts: Clinical Judgment; Fluids and Electrolytes
Reference: Lewis et al. (2017), p. 279.

48. ***Answer:*** 1

Rationale: The normal serum phosphorus (phosphate) level is 3.0 to 4.5 mg/dL (0.97 to 1.45 mmol/L). The client is experiencing hypophosphatemia. Causative factors relate to malnutrition or starvation and the use of aluminum hydroxide–based or magnesium-based antacids. Renal insufficiency, hypoparathyroidism, and tumor lysis syndrome are causative factors of hyperphosphatemia.
Test-Taking Strategy: Note the **strategic words**, *most likely.* Focus on the **subject,** a serum phosphorus level of 1.8 mg/dL (0.58 mmol/L). First, you must determine that the client is experiencing hypophosphatemia. From this point, think about the effects of phosphorus on the body and recall the causes of hypophosphatemia in order to answer correctly.
Level of Cognitive Ability: Analyzing
Client Needs: Physiological Integrity
Integrated Process: Nursing Process—Assessment
Content Area: Foundations of Care: Fluids & Electrolytes
Health Problem: N/A
Priority Concepts: Clinical Judgment; Fluids and Electrolytes
Reference: Lewis et al. (2017), pp. 285-286.

49. ***Answer:*** 3

Rationale: Insensible losses may occur without the person's awareness. Insensible losses occur daily through the skin and the lungs. Sensible losses are those of which the person is aware, such as through urination, wound drainage, and gastrointestinal tract losses.
Test-Taking Strategy: Note that the **subject** of the question is insensible fluid loss. Note that urination, wound drainage, and gastrointestinal tract losses are **comparable or alike** in that they can be measured for accurate output. Fluid loss through the skin cannot be measured accurately; it can only be approximated.
Level of Cognitive Ability: Applying
Client Needs: Physiological Integrity
Integrated Process: Communication and Documentation
Content Area: Foundations of Care: Fluids & Electrolytes
Health Problem: N/A
Priority Concepts: Clinical Judgment; Fluids and Electrolytes
References: Lewis et al. (2017), p. 274.

50. ***Answer:*** 1

Rationale: A fluid volume deficit occurs when the fluid intake is not sufficient to meet the fluid needs of the body. Causes of a fluid volume deficit include vomiting, diarrhea, conditions that cause increased respirations or increased urinary output, insufficient intravenous fluid replacement, draining fistulas, and the presence of an ileostomy or colostomy. A client with heart failure or on long-term corticosteroid therapy or a client receiving frequent wound irrigations is most at risk for fluid volume excess.

Test-Taking Strategy: Note the **strategic words,** *most likely.* Read the question carefully, noting the **subject**, the client at risk for a deficit. Read each option and think about the fluid imbalance that can occur in each. The clients with heart failure, on long-term corticosteroid therapy, and receiving frequent wound irrigations retain fluid. The only condition that can cause a deficit is the condition noted in the correct option.

Level of Cognitive Ability: Analyzing
Client Needs: Physiological Integrity
Integrated Process: Nursing Process—Assessment
Content Area: Foundations of Care: Fluids & Electrolytes
Health Problem: Adult Health: Gastrointestinal: Dehydration
Priority Concepts: Clinical Judgment; Fluids and Electrolytes
Reference: Lewis et al. (2017), p. 276.

51. ***Answer:*** 1

Rationale: A fluid volume deficit occurs when the fluid intake is not sufficient to meet the fluid needs of the body. Assessment findings in a client with a fluid volume deficit include increased respirations and heart rate, decreased central venous pressure (CVP), weight loss, poor skin turgor, dry mucous membranes, decreased urine volume, increased specific gravity of the urine, increased hematocrit, and altered level of consciousness. Lung congestion, increased urinary output, and increased blood pressure are all associated with fluid volume excess.

Test-Taking Strategy: Focus on the **subject,** assessment findings in a fluid volume deficit. Think about the pathophysiology for fluid volume deficit and fluid volume excess to answer correctly. Note that options 2, 3, and 4 are **comparable or alike** and are manifestations associated with fluid volume excess.

Level of Cognitive Ability: Analyzing
Client Needs: Physiological Integrity
Integrated Process: Nursing Process—Assessment
Content Area: Foundations of Care: Fluids & Electrolytes
Health Problem: N/A
Priority Concepts: Clinical Judgment; Fluids and Electrolytes
Reference: Lewis et al. (2017), p. 276.

52. ***Answer:*** 4

Rationale: A fluid volume excess is also known as *overhydration* or *fluid overload*

and occurs when fluid intake or fluid retention exceeds the fluid needs of the body. The causes of fluid volume excess include decreased kidney function, heart failure, use of hypotonic fluids to replace isotonic fluid losses, excessive irrigation of wounds and body cavities, and excessive ingestion of sodium. The client taking diuretics, the client with an ileostomy, and the client who requires gastrointestinal suctioning are at risk for fluid volume deficit.

Test-Taking Strategy: Focus on the **subject,** fluid volume excess. Think about the pathophysiology associated with fluid volume excess. Read each option and think about the fluid imbalance that can occur in each. Clients taking diuretics or having ileostomies or gastrointestinal suctioning all lose fluid. The only condition that can cause an excess is the condition noted in the correct option.

Level of Cognitive Ability: Analyzing
Client Needs: Physiological Integrity
Integrated Process: Nursing Process—Assessment
Content Area: Foundations of Care: Fluids & Electrolytes
Health Problem: N/A
Priority Concepts: Clinical Judgment; Fluids and Electrolytes
Reference: Ignatavicius, Workman, Rebar (2018), pp. 171-172.

53. ***Answer:*** 4

Rationale: The normal potassium level is 3.5 to 5.0 mEq/L (3.5 to 5.0 mmol/L). A serum potassium level higher than 5.0 mEq/L (5.0 mmol/L) indicates hyperkalemia. Clients who experience cellular shifting of potassium in the early stages of massive cell destruction, such as with trauma, burns, sepsis, or metabolic or respiratory acidosis, are at risk for hyperkalemia. The client with Cushing's syndrome or colitis and the client who has been overusing laxatives are at risk for hypokalemia.

Test-Taking Strategy: Eliminate the client with colitis and the client overusing laxatives first, because they are **comparable or alike,** with both reflecting a gastrointestinal loss. From the remaining options, recalling that cell destruction causes potassium shifts will assist in directing you to the correct option. Also, remember that Cushing's syndrome presents a risk for hypokalemia and that Addison's disease presents a risk for hyperkalemia.

Level of Cognitive Ability: Analyzing
Client Needs: Physiological Integrity
Integrated Process: Nursing Process—Assessment
Content Area: Foundations of Care: Fluids & Electrolytes
Health Problem: N/A
Priority Concepts: Clinical Judgment; Fluids and Electrolytes
Reference: Ignatavicius, Workman, Rebar (2018), pp. 178-179.