Homeostasis

Homeostasis, for the purposes of this chapter, is defined as the mechanism for maintaining a steady state in the body.

**FLUID AND ELECTROLYTES**

**Physiology**

A. Basic concepts of body fluid.

1. Water is a primary body fluid. It is used to transport nutrients as well as to remove waste products.
   a. Infant: 70% to 80% of body weight is water.
   b. Adult: 50% to 60% of body weight is water.
   c. Older adult: 45% to 55% of body weight is water.

2. Intracellular fluid: provides the cell with internal fluid necessary for cellular function.
   a. Approximately 40% to 50% of body weight.
   b. Electrolytes: potassium (primary), magnesium, phosphate.

3. Extracellular (intravascular and interstitial) fluids: transport system for cellular waste, oxygen, electrolytes, and nutrients; help regulate body temperature; lubricate and cushion joints.
   a. Approximately 20% to 30% of body weight.
   b. An infant maintains a larger percentage of extracellular fluids than does an older child or adult.
   d. Interstitial: fluid surrounding tissue cells.
   e. Electrolytes: sodium (primary), chloride, bicarbonate.

B. Dynamic transport of fluid and electrolytes.

1. Osmosis: movement of water between two compartments separated by a semipermeable membrane; from an area of low-solute concentration to an area of high-solute concentration.
   a. Oncotic pressure: the osmotic pressure created by plasma proteins; proteins pull fluid from the tissue space to the vascular space.
   b. Osmotic pressure is the amount of pressure required to stop the flow of water. It is determined by the concentration of solutes in solution.

2. Hydrostatic pressure: the pressure created by the fluid volume in the vascular bed.

C. Fluid movement in capillaries.

1. Filtration occurs in the arterial end of the capillaries because the hydrostatic pressure is higher than the oncotic pressure. Fluid then moves out of the vascular bed into the tissue.

2. Capillary hydrostatic pressure and interstitial oncotic pressure move water out of the capillaries. At the venous end of the capillaries, the oncotic pressure is greater and the fluid moves back into the vascular volume.

3. Osmolality refers to the concentration of the dissolved particles in a solution; osmolality controls the movement of fluid in each of the compartments.
   a. Hyperosmolar (hypertonic): fluids in which the concentration of solutes is higher than in the cells.
   b. Hypo-osmolar (hypotonic): fluids in which the concentration of solutes is less than in the cells.
   c. Iso-osmolar (isotonic): fluids with the same osmolality as the cell normal distribution of solutes and water in body fluid.

D. Fluid shifts.

1. Plasma to interstitial fluid shift (edema).
      (1) Venous hydrostatic pressure increases (client with fluid overload in heart failure).
      (2) Decrease in oncotic pressure, as in a client with excessive protein loss (renal disease).
      (3) Increased interstitial oncotic pressure, as in trauma and burns where the capillary wall has been damaged and plasma protein moves to the interstitial space.
   
   b. Hypovolemia may occur as a result of excessive fluid shift into the interstitial spaces, resulting in circulatory collapse (client with burns).

2. Interstitial to plasma fluid shift: movement of fluid back into the circulatory volume, as in client with mobilization of burn edema; or in the case of excessive administration of hypertonic solution, causing the interstitial water to be returned to the plasma; client may demonstrate symptoms of circulatory overload.

3. Fluid spacing.
   a. First spacing: normal distribution of fluids.
   c. Third spacing: fluid that is trapped and cannot easily move back into ECF—for example, edema associated with burns and ascites.
E. Homeostatic mechanisms.
1. Endocrine system.
   a. Hypothalamus secretes antidiuretic hormone, which regulates the water reabsorption by the kidneys.
   b. Adrenal cortex secretes aldosterone, which promotes sodium retention and potassium excretion, thereby causing an increase in plasma volume.
2. Lymphatic system: assists in the return of excessive protein and fluid, which escapes into the tissue, to the plasma volume.
3. Cardiovascular system maintains blood pressure to ensure adequate renal perfusion.
4. Kidneys maintain fluid volume and concentration of urine via the glomerular filtration rate.

**ALERT** Understand general principles of pathophysiology.

**Fluid Imbalances**

A. Fluid deficit: extracellular fluid volume deficit hypovolemia results from vascular fluid volume loss.
1. Sensible fluid loss: fluid loss of which an individual is aware, as in urine.
2. Insensible fluid loss: fluid loss of which an individual is not aware (approximately 600-900 mL of fluid is lost every 24 hours through the skin and lungs in a healthy adult).
3. Causes of fluid deficit (all result from loss of both water and sodium).
   a. Decreased fluid intake.
   b. Loss of fluid through the gastrointestinal tract, as in vomiting, nasogastric suctioning, diarrhea.
   c. Excessive excretion due to renal disease; inappropriate antidiuretic hormone secretion.
   d. iatrogenic loss due to overuse of diuretics or inadequate replacement of fluid loss.
   e. Increased insensible fluid loss through skin and lungs due to febrile state.
   f. Impaired integrity of the skin as in burns, wounds, and hemorrhage.

**NURSING PRIORITY** Sodium is the major electrolyte that affects fluid balance. “Where goes the sodium, so goes the water.”

   a. Restlessness, lethargy, confusion.
   b. Dry skin and thirst (dry mucous membranes).
   c. Decreased skin turgor.
      (1) Assess skin turgor on the abdomen or the inner thigh in children (unless abdominal distention is present).
      (2) Assess skin turgor on the forehead or sternum in older adult clients.
      (3) Assess skin turgor on the sternum, abdomen, and anterior forearm in adults.
   d. Weight loss.
   e. Oliguria, concentrated urine.
   f. Postural hypotension.
   g. Increased respiratory and cardiac rate.
   h. Decreased central venous pressure (CVP).
   i. Infants and children: poor perfusion, poor capillary refill resulting in mottled skin color changes.
   j. Weakness, confusion, speech difficulty in the older adult client.

5. Laboratory findings.
   a. Increased urine specific gravity.
   b. Increased blood urea nitrogen (greater than 25 mg/dL) without increase in creatinine.
   c. Increased hematocrit (the normal ratio of hematocrit to hemoglobin is 3:1)—for example, 12 grams hemoglobin to 36% hematocrit.

**ALERT** Identify signs and symptoms for client with fluid and/or electrolyte balance.

B. Extracellular fluid volume excess (circulatory overload): the retention of sodium and water in the intravascular and interstitial spaces.
   a. Excessive oral fluid intake.
   b. Failure to excrete fluids, as in renal disease and cardiac failure.
   c. Iatrogenic: fluid increase due to excessive infusion of hypotonic or isotonic fluids.
   d. Excess hypotonic and/or hypotonic IV fluids.
2. Clinical manifestations.
   a. Pitting edema, sacral edema.
   b. Dyspnea, crackles, possible pulmonary edema.
   c. Bounding pulse, weight gain.
   d. Lethargy, dizziness, headache, confusion.
   e. Variable urine volume.
   f. Increased CVP, jugular vein distention.
   g. Increased blood pressure.
3. Laboratory findings: based on the area of the body in which the shift occurs.
   a. Decreased specific gravity of urine (less than 1.010).
   b. Decreased hematocrit.
   c. Decreased serum sodium secondary to dilution.
   d. Vascular to interstitial space shift due to tissue damage such as blisters, sprains.
   e. Large fluid shifts occur in severe injuries, burns, intestinal perforations and obstruction, and lymphatic obstruction.

   a. Decreased circulating volume, resulting in symptoms of hypovolemia.
   b. Localized symptoms when the fluid is obstructing an organ, as in the intestinal tract.

**ALERT** Implement interventions to restore client fluid and/or electrolyte balance.
C. Nursing management of client with fluid imbalances.
   1. Assessment.
      a. Evaluate client’s history and predisposing factors contributing to the problem.
      b. Assess for direction of fluid problem: fluid excess or deficit.
      c. Evaluate appropriate lab data.
      d. Evaluate client’s ability to tolerate and correct the problem.
      e. Older adult clients are more likely to develop extracellular fluid volume excess due to chronic diseases (renal, cardiac).
   2. Nursing intervention.
      a. Maintain accurate intake and output records.
      b. Obtain accurate daily weight.
      c. Evaluate for presence of edema.
      d. Maintain intravenous (IV) replacement fluids at prescribed flow rate.
      e. Monitor cardiovascular changes.
         (1) Central venous pressure, status of jugular vein.
         (2) Changes in blood pressure (blood pressure is not a reliable indicator of early problems of fluid balance in infants and children).
      f. Monitor for changes in respiratory status.
      g. Maintain good skin care: practice good oral hygiene, elevate edematous extremities, avoid soap, use measures to prevent skin breakdown.
      h. Assess lab data for changes in the problem.
      i. Carefully monitor older adult and pediatric clients and clients with cardiac disease for tolerance of fluid replacement.

### Isotonic Solutions

- **A.** Used to expand extracellular fluid volume and for intravascular dehydration.
- **B.** Solutions.
   1. D$_5$W: 5% dextrose in water (physiologically hypotonic).
   2. 0.9% NaCl (normal saline solution).
   3. Lactated Ringer’s solution.
- **C.** May be used to dilute medications or to keep the vein open.

### Hypotonic Solutions

- **A.** Solutions containing more water and less basic electrolytes.
- **B.** 0.45% or half-strength NaCl (normal saline solution).
- **C.** May be used to replenish cellular fluid.
- **D.** Monitor closely for intravascular fluid loss, hypotension, changes in level of consciousness, and edema.

### Hypertonic Solutions

- **A.** Administered slowly; can cause intravascular volume overload; carefully monitor serum sodium, lung sounds, and blood pressure.
- **B.** Solutions.
   1. Dextrose 5% in 0.45% or half-strength NaCl (normal saline).
   2. Dextrose 5% in 0.9% NaCl (normal saline).
- **C.** Used to treat situations of hyponatremia and hypovolemia.

### Nursing Implications in Administration of Intravenous Fluid

- **ALERT** Apply knowledge of nursing procedures and motor skills when caring for a client receiving intravenous and parenteral therapy.

### Selection of Site and Equipment

- **A.** Vein selection (Figure 6-1).
   1. Distal veins of the upper extremities should be used first. Subsequent venipuncture should be proximal to or higher than the previous site.
   2. Veins above or below an area of flexion.
   3. Try to select a site on the client’s nondominant extremity.
   4. Select a vein large enough to accommodate the catheter.
- **B.** Infants: scalp veins are frequently used because of easy access and less movement in the area; it is also easier to stabilize the insertion site.
- **C.** Children: veins on the dorsal surface of the foot are frequently used (these should not be used as an access site in adults because of the risk for developing thrombophlebitis).

### INTRAVENOUS FLUID REPLACEMENT THERAPY
4. Veins of an extremity affected by stroke or neurologic trauma.
5. Veins in the lower extremities and sclerosed or irritated veins.
6. Avoid previous venipuncture sites, areas of inflammation or bruising.

E. Venous access devices (Figure 6-2).
1. Butterfly needle: has wings for stabilization of needle; used for short-term infusions and for saline/heparin locks.
2. Plastic cannula/catheter: tubing threaded over a needle; used for infusions over several days and often with IV antibiotics.
4. Select the smallest-gauge needle or cannula for the type of fluid infused. The larger the gauge of the needle or cannula, the smaller the needle or cannula.
   a. 22-gauge needle or catheter most common for IV fluids.
   b. 18- or 20-gauge needle or catheter for blood or rapid administration of fluids.
   c. May convert a cannula into a saline/heparin lock if continuous fluids are not infusing.
5. Central line (see Appendix 6-10).
6. Implantable or tunneled ports (see Appendix 6-10).

ALERT Access implanted venous access devices.

7. Heparin or saline lock: may be an IV cannula or a butterfly needle.
   a. Used for intermittent access.
   b. May be flushed with a heparin solution, 100 units per 1 mL (depending on institution policy), or saline flush solution at regular intervals to maintain patency and prevent clot formation of line.
8. Site may be converted to fluid infusion if necessary.

ALERT Monitor and maintain infusion site(s) and rate(s).

Starting an Intravenous Infusion

1. **NURSING PRIORITY** Always check the IV fluid for expiration date, color, and clarity.

   A. Cleanse site thoroughly; re-cleanse the site if area was palpated before insertion.
   B. Wear gloves during insertion of the needle and as long as there is possibility of skin contact with the client’s blood.
   C. Apply the tourniquet 4 to 6 inches above the site and insert the needle with the bevel up at a 15-degree to 30-degree angle.
D. After the needle has advanced into the vein and there is good blood return, release the tourniquet.
E. If the stylet has been removed (IV catheter or cannula), do not attempt to reinsert the stylet into the catheter shaft.
F. Always obtain a new catheter or needle if the insertion attempt was unsuccessful.
G. Cover the insertion site (transparent dressing or sterile gauze); do not place tape directly over the insertion site.
H. Label the site with time, date, catheter/needle size, and initials of nurse.
I. Label the infusion container with:
   1. Time container was hung; rate of infusion.
   2. Any medications that were added.
J. Do not encircle the arm with tape; this can restrict circulation to the extremity.

**ALERT** Insert/remove peripheral intravenous line.

**Maintenance of Intravenous Infusions**

A. Factors influencing rate of fluid administration.
   1. Type of fluid, age of client, and client’s response to fluids.
   2. Cardiac and renal status.
   3. Size of the vein and gauge of catheter or needle.

**ALERT** Monitor and maintain infusion site(s) and rate(s).

B. Maintain accurate intake and output records.
C. Average maintenance fluid rate is 3000 mL over 24 hours.
D. Peripheral IV infusion sites are changed every 72 to 96 hours (3-4 days, depending on institution policy) unless complications (inflammation, irritation, or fluid extravasation) occur at the site.
E. Carefully monitor the infusion rate; control with either a roller clamp or an infusion pump.

**NURSING PRIORITY** Always monitor the rate of infusion by evaluating the amount of fluid that has actually been infused and by checking the pump or IV control settings.

F. Pediatric considerations.
   1. Children are very susceptible to rapid fluid shifts; cerebral edema may occur with infusion of D5W. Most common IV solutions are a combination of normal saline (0.22%-0.3%) and 5% dextrose to decrease the possibility of an untoward fluid shift.
   2. Volume chambers holding no more than a 3- to 4-hour supply of fluid or controlled infusion devices (pumps) should be used for children to prevent the inadvertent rapid infusion of too much fluid.
   3. Always make sure infants and young children are voiding before beginning IV infusion of fluids containing added potassium.

**Indications for Use of Infusion Control Devices**

A. To deliver a medication that requires a precise rate of administration (vasopressor agents, PCA).
B. To deliver fluids that would precipitate adverse effects if administered too rapidly (hyperalimentation).
C. To deliver fluids in controlled amounts to clients very sensitive to volume administered (infants, children under 10 years old, older adult clients, clients with pulmonary edema, and clients with decreased renal function).

**ALERT** Operate and monitor the use of an infusion pump.

**Complications of Peripheral Intravenous Therapy** (Figure 6-3)

**Infiltration**

A. Common causes: dislodging of the needle by client movement or obstruction of fluid flow.
B. Signs and symptoms: edema, blanching of skin, discomfort at site, fluid that is flowing slowly or has stopped, cooler skin temperature.
C. Preventive nursing management: use the smallest gauge of catheter possible; use an arm board to stabilize catheter, especially for restless, confused clients or those with catheters placed in the antecubital fossa area; check frequently for coolness of skin around site; avoid looping tubing below bed level; check IV flow rate at least every 2 hours.

**FIGURE 6-3** Complications of peripheral IV therapy. (From Zerwekh J, Claborn J, Gaglione T: Mosby’s fluids and electrolytes memory notecards: visual, mnemonic, and memory aids for nurses, ed 2, St. Louis, 2010, Mosby.)
D. Nursing interventions.
   1. Discontinue IV solution and remove catheter.
   2. Apply warm, moist heat for 20 minutes to increase fluid absorption (if not contraindicated); may reapply warm, moist heat 3-4 times throughout the day; raise affected extremity to increase venous return and reduce swelling.
   3. If infiltrated solution contains an irritating medication (chemotherapy, vasoconstrictive fluids), call the physician for orders to counteract effects of medication in the subcutaneous tissue.

**Phlebitis**

A. Common causes: overuse of a vein; irritating infusion solutions or medications; catheter left in vein for too long; use of large-gauge catheters.

B. Signs and symptoms: tenderness, pain along the course of the vein, edema, redness at insertion site, red streak along course of vein, extremity with IV feels warmer than other extremity.

C. Preventive nursing management.
   1. Change IV site every 72-96 hours.
   2. Use large veins to administer irritating solutions.
   4. Dilute medications adequately and infuse at prescribed rates.
   5. Choose the smallest-gauge catheter possible to administer solutions.

D. Nursing interventions: apply warm, moist compresses to stimulate circulation and promote absorption.

**Box 6-1 GUIDELINES TO DECREASE INFECTION RELATED TO IV THERAPY**

- Practice good hand hygiene (even when gloves are worn): before and after insertion, palpating, removing, or dressing any IV site.
- Replace and rotate peripheral catheters no more often than every 72-96 hours or when complications (infiltration, phlebitis, infection) occur.
- Pediatrics: do not replace peripheral catheters unless clinically indicated.
- Replace dressing on peripheral lines, PICC lines, or CVP lines if the dressing is damp, loosened or soiled.
- For peripheral catheters with large bulky dressings that prevent visualization or prevent palpation of the area, remove the dressing and visually inspect the site at least daily and apply new dressing.
- CVP, PICC lines: replace gauze dressings every 2 days and transparent dressing every 7 days, or when inspection of site is necessary.
- Transparent dressings are recommended because they permit continuous visual inspection of the catheter site, permit patients to bathe and shower without saturating the dressing, and require less frequent changes than do standard gauze and tape dressings.
- Peripheral IV, CVP, and PICC lines: replace intravenous tubing and add-on devices no more frequently than 72-hour intervals.
- Serious catheter-related infections are more frequently associated with central venous catheters (CVCs).
- There are no specific recommendations regarding the use of antibiotic ointments and/or iodine ointment.
- Avoid the use of steel needles (butterfly or needles) for the administration of fluids and medication that might cause tissue necrosis if extravasation occurs.
- A PICC catheter is recommended if the IV therapy is likely to exceed 6 days.

E. Prevention of infections related to IV therapy (Box 6-1).

**ACID-BASE BALANCE**

**Basic Concepts of Acid-Base Balance**

A. Terms used to describe acid-base balance.
   1. pH: the chemical abbreviation for negative logarithm of hydrogen ion concentration.
   2. CO₂: carbon dioxide.
   3. Pao₂: pressure of dissolved CO₂ gas in the blood.
   4. O₂: oxygen.
   5. PaO₂: pressure of dissolved O₂ gas in the blood.
   6. HCO₃⁻: bicarbonate.
   7. mm Hg: millimeters of mercury.
   8. H⁺: hydrogen ion concentration.

B. Normal blood gas values.
   1. pH: 7.4 (7.35-7.45).
   2. PaO₂: 80 to 100 mm Hg.
   3. Paco₂: 35 to 45 mm Hg.
   4. HCO₃⁻: 22 to 26 mEq/L.

C. The hydrogen ion (H⁺) concentration determines the acidity or alkalinity of a solution (pH); the higher the H⁺ concentration, the more acidic the solution. An inverse relationship exists between pH and H⁺ concentration: increased pH has fewer H⁺ ions and is more alkaline; decreased pH has more H⁺ ions and is more acid (Figure 6-4).

D. Acid-base ratio is determined by sampling arterial blood. This provides a reliable index of overall body function.

E. The body maintains a normal or neutral state of acid-base balance. The stable concentration of H⁺ balance is reflected in arterial blood with a relatively constant pH of 7.35 to 7.45.

F. It is necessary for the pH to remain relatively constant for the various enzyme systems of all body organs to function correctly.

G. O₂ saturation levels reflected in blood gas readings do not have a direct effect on the acid-base balance but are used to identify status of oxygenation.

H. A state of acid-base decompensation exists when the acid-base levels are either below 7.35 or above 7.45.

**From Centers for Disease Control and Prevention (CDC) and Morbidity and Mortality Weekly Report (MMWR): Recommendations and Reports Guidelines for the Prevention of Intravascular Catheter-Related Infections August 9, 2002 / 51(RR10), 1-26. Available at: www.cdc.gov/mmwr/preview/mmwrhtml/rr5110a1.htm**
I. Compensation: the system not primarily affected is responsible for returning the pH to a more normal level.

J. Full compensation: the problem in the system primarily affected is corrected, thereby returning the pH to a more normal level.

K. \( \text{PaCO}_2 \) imbalance: the origin or primary system is respiratory, or it is compensating for a metabolic problem.

L. \( \text{HCO}_3^- \) imbalance: the origin or primary system is metabolic, or it is compensating for a respiratory problem.

M. The major clinical manifestations of an acid-base imbalance are indicative of central nervous system (CNS) involvement. The severity of the symptoms will depend on the length of time the imbalance exists, as well as the severity of the deviation.

1. Acidosis (metabolic or respiratory): symptoms are indicative of depression of the CNS; this is common.

2. Alkalosis (metabolic or respiratory): symptoms are indicative of increased stimulation of the CNS; death is a rare occurrence.

N. The normal ratio of \( \text{HCO}_3^- \) to \( \text{PaCO}_2 \) is 20:1; when this ratio is maintained, the pH is normal.

**Regulation of Acid-Base Balance**

A. Buffer system: the most rapid-acting of the regulatory systems. The buffer system is activated when there is an excess acid or base present.

1. A buffer is a chemical that helps maintain a normal pH.

2. The buffer system chemicals are paired. The primary buffer chemicals are sodium \( \text{HCO}_3^- \) and carbonic acid. The buffers are capable of absorbing or releasing \( \text{H}^+ \) ions as indicated.

3. The body buffers an acid more effectively than it neutralizes a base.

4. An effective buffer system depends on normal-functioning respiratory and renal systems.

B. Respiratory system: the second most rapid response in the regulation of acid-base balance. Carbonic acid is transported to the lungs, where it is converted to \( \text{CO}_2 \) and water, then excreted.

1. The amount of \( \text{CO}_2 \) in the blood is directly related to the carbonic acid concentrations.

2. Increased respirations will decrease \( \text{CO}_2 \) levels, thus decreasing the carbonic acid concentration and resulting in decreased \( \text{H}^+ \) concentration and an increase in the pH.

3. Decreased respirations will cause retention of \( \text{CO}_2 \), increasing the carbonic acid concentrations and resulting in increased \( \text{H}^+ \) concentration and a decrease in the pH.

4. With excessive acid formation, the respiratory center in the medulla is stimulated, which results in an increase in the depth and rate of respirations. This causes a decrease in the \( \text{CO}_2 \) levels and returns the pH to a more normal point.

5. With excessive base formation, the respiratory rate slows to promote retention of \( \text{CO}_2 \) and decrease the alkalotic state. \( \text{CO}_2 \) is considered an acid substance because it combines with water to form carbonic acid. The \( \text{PaCO}_2 \) levels are influenced only by respiratory causes.

6. If the respiratory system is the source of the pH alteration, then it loses the ability to correct the problem.

C. Renal system: the slowest, but very effective, mechanism of acid-base regulation.

1. The kidneys reabsorb sodium (Na) and produce and conserve sodium bicarbonate (NaHCO\(_3\)).

2. In acidosis the \( \text{H}^+ \) concentration is increased; therefore the \( \text{H}^+ \) ions are excreted before the potassium (K\(^+\)) ions, thereby precipitating hyperkalemia. When the acidosis is corrected, the potassium moves back into the cell.

3. In alkalosis the \( \text{H}^+ \) concentration is decreased; there is an augmented renal excretion of K\(^+\) ions, thereby precipitating hypokalemia.

4. If the renal system is the source of the pH alteration, it loses the ability to correct the problem.

**Alterations in Acid-Base Balance**

**ALERT** Know laboratory values for ABGs, evaluate results of diagnostic testing, and intervene as needed.

A. **Respiratory acidosis**: characterized by excessive retention of \( \text{CO}_2 \) due to hypoventilation; therefore an increased carbonic acid concentration produces an increase in \( \text{H}^+ \) ions and a decrease in the pH (decreases below 7.35).
1. Causes.
   a. Depression of the respiratory center.
      (1) Head injuries.
      (2) Oversedation with sedatives and/or narcotics.
   b. Conditions affecting pulmonary function.
      (1) Obstructive pulmonary diseases.
      (2) Pneumonia.
      (3) Atelectasis.
   c. Conditions that interfere with chest wall excursion.
      (1) Thoracic trauma: flail chest.
      (2) Diseases affecting innervation of thoracic muscle (Guillain-Barré syndrome, myasthenia gravis, polio).
      (3) Mechanical hypoventilation.

2. Clinical manifestations.
   b. Disorientation, decreased level of consciousness.
   c. Decreased blood pressure.
   d. Ventricular irritability related to hyperkalemia.
   e. Hypoxemia secondary to respiratory depression.

   a. pH decreases below 7.35.
   b. Paco₂ increases above 45 mm Hg.
   c. HCO₃⁻ remains normal, unless compensated.

4. Compensation/correction.
   a. Compensation: renal system will compensate by retaining HCO₃⁻ and excreting increased amounts of H⁺ ions.
   b. Correction: vigorous pulmonary hygiene to improve ventilation and decrease Paco₂ levels; may require mechanical ventilation.

5. Nursing management.
   a. Preventive management.
      (1) Have client turn, cough, and deep-breathe every 2 hours after surgery.
      (2) Use narcotics judiciously in the immediate postoperative period.
      (3) Maintain adequate hydration.
   b. Use semi-Fowler’s position to facilitate deep breathing.
   c. Thoroughly assess client’s pulmonary function.
   d. Perform postural drainage and percussion, followed by suction, to remove excessive pulmonary secretions.
   e. Anticipate the need for mechanical ventilation if client does not respond to pulmonary hygiene.
   f. Anticipate use of bronchodilator.
   g. Administer O₂ with caution, because it may precipitate CO₂ narcosis.
   h. Evaluate for hyperkalemia.
   i. Support renal system to promote adequate compensation.

B. Respiratory alkalosis: characterized by a low Paco₂ due to hyperventilation. An excessive amount of CO₂ is exhaled, resulting in a decrease in H⁺ concentration and an increase in pH (above 7.45).

   a. Primary stimulation of CNS: hyperventilation.
      (1) Emotional origin (anxiety, fear, apprehension).
      (2) CNS infection (encephalitis).
      (3) Salicylate poisoning.
   b. Reflex stimulation of CNS.
      (1) Hypoxia stimulates hyperventilation (heart failure, pneumonia, pulmonary emboli).
      (2) Fever.
      c. Mechanical hyperventilation, resulting in “over breathing.”

2. Clinical manifestations.
   a. Deep, rapid breathing (hyperventilation).
   b. CNS stimulation, resulting in confusion, lethargy, seizures.
   c. Hypokalemia.
   d. Hyperreflexia, muscle weakness, tingling of extremities.

   a. pH increases above 7.45.
   b. Paco₂ decreases below 35 mm Hg.
   c. HCO₃⁻ remains normal.

4. Compensation/correction.
   a. Compensation: renal system will compensate by increasing HCO₃⁻ excretion and retaining H⁺ ions, thus returning pH to a more normal level.
   b. Correction: prevent loss of CO₂ from respiratory systems.

5. Nursing management.
   a. Identify and eliminate (if possible) causative factor.
   b. Evaluate need for sedation.
   c. Use rebreathing mask or techniques to increase CO₂ levels.
   d. Remain with client to decrease anxiety levels.

C. Metabolic alkalosis: characterized by an increase in the HCO₃⁻ levels in the serum, leading to a decrease in the H⁺ concentration and an increase in the pH (increase above 7.45).

1. Causes (either an increase in serum HCO₃⁻ or a decrease in serum H⁺ concentration).
   a. Diuretic therapy: loss of H⁺, chloride (Cl⁻), K⁺ precipitates an increase in the HCO₃⁻ level in the serum.
   b. Excessive loss of H⁺ ions.
      (1) Prolonged nasogastric suctioning without adequate electrolyte replacement.
      (2) Excessive vomiting, resulting in loss of hydrochloric acid and K⁺.
   c. Prolonged steroid therapy: loss of H⁺, Cl⁻, and K⁺ ions, leading to an increased retention of HCO₃⁻ by the kidneys.
   d. Excessive intake of bicarbonate (baking soda).
   e. Hypokalemia.
2. Clinical manifestations.
   a. Nausea, vomiting.
   b. Increased irritability, disorientation, restlessness.
   c. Muscle cramping, tremors, seizures.
   d. Shallow, slow respirations (hypoventilation).
   e. Dysrythmias (tachycardia) related to hyperkalemia.
   a. pH increases above 7.45.
   b. PaCO₂ remains normal.
   c. HCO₃⁻ increases above 26 mEq/L.
4. Compensation/correction.
   a. Compensation: respiratory system will compensate by retaining CO₂ (hypoventilation) to compensate for the alkalosis.
   b. Correction: replacement of electrolytes and fluids lost due to excessive renal excretion or due to excessive gastric loss of acid.
5. Nursing management.
   a. Preventive.
      (1) Provide foods high in potassium and chloride for client receiving diuretics.
      (2) Administer potassium supplement to client receiving long-term diuretic therapy.
      (3) Administer IV solution with replacement electrolytes.
   b. Maintain accurate intake and output records.
   c. Evaluate the lab values for a decrease in serum potassium levels.
D. Metabolic acidosis: characterized by a decrease in HCO₃⁻ level in the serum, leading to an increase in H⁺ concentration and a decrease in pH (below 7.35).
1. Causes (deficit of a base or an increase in acid).
   a. Incomplete oxidation of fatty acids.
      (1) Diabetic ketoacidosis.
      (2) Starvation.
      (3) Shock, resulting in lactic acidosis.
   b. Abnormal loss of alkaline substances.
      (1) Deep, prolonged vomiting may cause excessive loss of base products.
      (2) Severe diarrhea and loss of pancreatic secretions.
   c. Renal insufficiency and failure: kidneys lose ability to compensate for acid overload; thus H⁺ ions are not excreted, nor is HCO₃⁻ retained in normal amounts.
   d. Salicylate poisoning due to accumulation of ketone bodies produced as a result of the increased metabolic rate.
2. Clinical manifestations.
   a. Drowsiness, confusion, headache, disorientation.
   b. Deep, rapid respirations (Kussmaul) compensatory action by the lungs.
   c. GI problems: nausea, vomiting, diarrhea.
   d. Dysrythmias related to hyperkalemia.
   e. Decreased blood pressure.
   a. pH decreases below 7.35.
   b. PCO₂ remains normal.
   c. HCO₃⁻ decreases below 22 mEq/L.
4. Compensation/correction.
   a. Compensation: respiratory system compensates by increasing rate and depth of respirations to blow off CO₂ and increase the pH.
   b. Correction: identification of the underlying problem and promotion of optimal function.
5. Nursing management.
   b. In severe acidosis, HCO₃⁻ may be given intravenously to neutralize acid and return pH to normal.
   c. In clients with diabetes, evaluate for ketoacidosis and administer insulin accordingly.
   d. Assess renal function and hydration status.
   e. Maintain accurate intake and output records.
   f. Evaluate lab values for hyperkalemia.
   g. Support respiratory system to promote compensation.

**INFLAMMATION**

Inflammation is the tissue response to localized injury or trauma. It is an expected response to tissue injury.

**Basic Concepts of Inflammation**

A. Acute.
   1. Occurs rapidly.
   2. Neutrophils (white blood cells) are usually the predominant cell.
   3. Essential for normal tissue repair.
B. Chronic.
   1. Characterized by pain, redness, and swelling.
   2. Persists longer than 2 weeks; has a damaging course that lasts for weeks, months, or even years.
   3. Examples: rheumatoid arthritis, tuberculosis, chronic glomerulonephritis.
C. Inflammatory response.
   1. Vascular response.
      a. Initial local vasoconstriction caused by tissue injury.
      b. Vasodilatation in area of injury.
      c. Hyperemia and increased capillary permeability lead to changes in osmotic pressure and a leakage of fluid (exudate).
   2. Systemic response.
      a. Fever.
      b. Leukocytosis (increased numbers of neutrophils in circulation).
      c. Weight loss and nausea.
      d. Increased pulse and respiration.
      e. Increased sedimentation rate.
D. Cardinal signs of inflammation (Table 6-1).
E. Healing process (see Wound Care in Chapter 3).


**Table 6-1 CARDINAL SIGNS OF INFLAMMATION**

<table>
<thead>
<tr>
<th>Clinical Symptom</th>
<th>Pathophysiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Redness</td>
<td>Hyperemia from vasodilation</td>
</tr>
<tr>
<td>Heat</td>
<td>Increased metabolism at site and local vasodilation</td>
</tr>
<tr>
<td>Pain</td>
<td>Pressure from fluid exudate on adjacent nerve endings, which leads to nerve stimulation; change in local pH</td>
</tr>
<tr>
<td>Edema</td>
<td>Fluid shift and accumulation in interstitial spaces</td>
</tr>
<tr>
<td>Loss of function</td>
<td>Decreased movement due to swelling and pain</td>
</tr>
</tbody>
</table>

**INFECTION**

Infection is the process by which an organism (pathogen, pathogenic agent) invades the host and establishes a parasitic relationship. Infection may be localized or systemic.

A. Healthcare associated infections (HAIs, nosocomial infections): infections acquired from exposure to pathogens in a hospital setting or health care setting.

B. Iatrogenic infections are HAIs that result from a diagnostic or therapeutic procedure (urinary tract infection from urinary catheterization).

C. Emerging infection is an infectious disease that has increased over past 20 years.

D. Development of multiple drug-resistant organisms (MDRO) has further complicated treatment of infections (they are resistant to antibiotics).

**Chain of Transmission**

A. Pathogens.

   1. Incubation period: the period of time from exposure to the pathogen until symptoms of infection occur in the host.

   2. A person can be asymptomatic and still transmit a pathogen that will produce an infection in someone else.

   3. Toxigenicity refers to the destructive potential of the toxin that is released by the pathogen.

B. Reservoir.

   1. Environment within which the organism can live and multiply; provided by some organic substance, human or animal.

   2. A carrier provides an environment in which the pathogen can grow and multiply but shows no symptoms of the infection.

C. Portal of exit.

   1. How the infection leaves the host.

   2. Common ports of exit include skin, mucous membranes, respiratory tract, feces, and body fluids.

   3. Understanding port of exit is necessary to prevent transmission of pathogens.

D. Route of transmission.

   1. Method by which the pathogen moves to another host.

   2. Direct transmission occurs by immediate transfer from one host to another, as in sexually transmitted diseases, or by inhalation of contaminated droplets from respiratory tract infections.

   3. Indirect transmission occurs via an intermediate carrier (e.g., health care workers, mosquitoes, contaminated water, contaminated food).

E. Port of entry into susceptible host.

   1. May enter the host by inhalation or ingestion, through the mucous membranes, or percutaneously.

   2. Biologic and personal characteristics of the new host will determine the lines of defense that the host will have against the invading pathogen.

F. Control of transmission.

   1. Transmission of a contagious disease can be broken by interfering with any link of the transmission chain.

   2. Treatment is aimed at breaking the transmission chain at the most vulnerable and cost-effective point.

      a. Barrier precautions: gloves, gowns, condoms.

      b. Proper handling of food and water supplies.

      c. Avoidance of high-risk behavior: unsafe sex, IV drug use.

      d. Good hand hygiene technique and good personal hygiene (Box 6-2).

      e. Identification of carriers: skin test for tuberculosis, cultures for *Staphylococcus*.

3. Host susceptibility can be greatly reduced through immunizations (see Chapter 2).

**Prevention of Transmission of Infection in the Health Care Setting**

A. Maintain standard precautions (see Appendix 6-8), especially good hand hygiene.

B. Consider all blood and body fluids from all clients to be contaminated.

---

**Box 6-2 HAND HYGIENE**

**Hand Hygiene With Soap and Water**

- Handwashing should be done under flow of water.
- Wet hands and wrists under running water: keep hands and forearms lower than elbows.
- Using antibacterial soap, lather and wash hands using friction for at least 15 seconds.
- Rinse hands thoroughly under running water, keeping hands lower than elbows.
- Do not allow washed hands to touch inside of sink.
- Use soap and water any time the hands are visibly soiled.

**Hand Hygiene With Antiseptic Cleanser**

- Rub hands together covering all surfaces of the hands and fingers with cleanser.
- Rub hands together until cleanser is dry.
- Use if hands are not visibly soiled.

**NURSING PRIORITY** Hand hygiene is the most important and most basic action to prevent transmission of infections. Hand hygiene must be performed before and after the use of gloves.
C. Avoid contaminating outside of container when collecting specimens.
D. Do not recap needles and syringes.
E. Cleanse work surface areas with appropriate germicide (household bleach in concentrations of 1:100 to 1:10 is effective).
F. Clean up spills of blood and body fluid immediately. Remove as much of the body fluid as possible, then wash the area with a germicide solution.
G. Follow Centers for Disease Control and Prevention (CDC) recommendations for immunization of health care workers (see Table 2-2).

**ALERT** Apply principles of infection control; understand incubation periods for infectious diseases; evaluate client response to treatment.

**Nursing Interventions**

**Goal:** To prevent infection.
A. Handwashing is the single most effective mechanism for preventing spread of infection (see Box 6-2).
B. Monitor vital signs: increase in pulse, respiration, and temperature occurring 4 to 5 days after surgery may indicate infectious process.
C. Monitor for *Staphylococcus* and *Pseudomonas* pathogens (produce purulent, draining wounds).
D. Maintain aseptic technique in dressing changes and wound irrigations.
E. Maintain standard precautions (see Appendix 6-8).
F. Administer antibiotic medications (see Appendix 6-9).
G. Identify clients at increased risk for infections.
   1. Older adults (Box 6-3).
   2. Immunocompromised clients.
   3. Clients compromised by chronic health care problems.
   4. Poorly nourished clients.
   5. Clients with high-risk lifestyle (IV drug use, unprotected sex).

**Goal:** To promote healing.
A. Encourage high fluid intake when client has a fever: 2000–3000 mL daily for adults.
B. Encourage a diet high in protein, carbohydrates, and vitamins—specifically vitamins A, C, and B complex.
C. Immobilize an injured extremity with a cast, splint, or bandage.

**Box 6-3 OLDER ADULT CARE FOCUS**

**Infections**
- May be manifested by changes in behavior: confusion, disorientation.
- May not exhibit fever or pain.
- Closely monitor client response to antibiotics, especially with regard to renal function.
- Maintain adequate hydration.
- Monitor gastrointestinal function; diarrhea is common with antibiotics.

**Box 6-4 SIGNS OF INFECTION**

**Generalized**
- Fever, localized inflammation, joint pain, fatigue, and increased white blood cells

**Gastrointestinal Tract**
- Diarrhea, nausea, and vomiting

**Respiratory Tract**
- Purulent sputum, sore throat, chest pain, and congestion

**Urinary Tract**
- Urgency and frequency, hematuria, purulent discharge, dysuria, and flank pain

D. Administer antipyretic medications (see Appendix 3-3).
E. Identify early signs of infection to facilitate treatment (Box 6-4).

**Goal:** To decrease pain.
A. Cold packs applied after initial trauma may help decrease swelling and pain.
B. Heat may be used later to promote healing and to localize the inflammatory agents.
C. Elevate the injured area to decrease edema and promote venous return.

**ALERT** Use correct hand hygiene techniques—soap and water or an antimicrobial cleanser.

**Goal:** To prevent complications.
A. Increase surveillance for clients with leukopenia or impaired circulation, clients receiving steroids or drugs that depress bone marrow, and clients exposed to a communicable disease.
B. Protect healing wounds from injury that could be caused by pulling or stretching.
C. Identify clients with compromised immune response; they are at high risk for opportunistic infection.

**ALERT** Protect immunocompromised clients.

**Systemic Inflammatory Response Syndrome (SIRS) and Multiple Organ Dysfunction Syndrome (MODS)**

SIRS is a systemic inflammatory response secondary to a major body insult or trauma. MODS is the failure of two or major organ systems and occurs as a result of SIRS.
A. Characteristics.
   1. Risk factors.
      a. Systemic inflammatory response syndrome (SIRS) occurs as a result of tissue injury.
         (1) Tissue trauma: burns, crush injuries, surgery.
         (2) Ischemic or necrotic tissue: infarctions (myocardial, intestinal), pancreatitis, vascular disease.
         (3) Invasion of pathogens (bacterial, viral, fungal infection).
         (4) Infection from gram-negative bacteria.
b. SIRS characterized by overwhelming inflammation of organs involved.
c. Transition from SIRS to MODS is not clearly understood.
d. Organ perfusion is compromised secondary to hypertension, decreased perfusion, microemboli, and shunting of blood flow.

B. Clinical manifestations.
1. Precipitating event.
2. Respiratory: increased vascular permeability leads to alveoli collapse and development of adult respiratory distress syndrome (ARDS).
3. Cardiac compromise, decreased systemic vascular resistance (SVR) and vasodilation lead to severe hypotension and decreased cardiac output.
4. Neurologic problems of confusion, agitation, and lethargy.
5. Acute renal failure secondary to decreased renal perfusion.
6. GI tract problems are abdominal distention and paralytic ileus.
7. Hypermetabolic response with hyperglycemia and insulin resistance.
8. Failure of the coagulation system leads to development of disseminated intravascular coagulopathy (DIC).

Treatment
A. Prevention.
1. Prevent development of infections.
2. Surgical removal or debridement of necrotic or damaged tissue.
3. Maintain positive nitrogen balance for wound healing.
B. Aggressive treatment of existing infection.
C. Support of involved organs.

Nursing Interventions

Goal: Prevention and/or early detection of infection.
A. Identify clients at increased risk for development of SIRS and MODS.
B. Strict asepsis for clients with urinary catheter, IV sites, endotracheal tube, arterial line, and wound care.
C. Aggressive pulmonary hygiene.
D. Strict adherence to standard precautions (Appendix 6–8).

Goal: Maintain tissue oxygenation (Chapter 15).
A. Monitor for respiratory failure and hypoxia.
B. Decrease oxygen demand and increase oxygen delivery: supplemental oxygen, adequate hemoglobin level, sedation, mechanical ventilation.

Goal: Support nutritional needs.
A. Provide protein and calories to support hypermetabolic state.
B. Provide enteral feedings to maintain positive nitrogen balance (see Appendix 18–9).
C. Monitor glucose levels, preferably maintain levels below 150 mg/dL.
D. Close monitoring of fluid balance.

Sepsis
Sepsis is a systemic inflammatory response to infection.
A. Gram-negative bacteria are most common.
B. Increased risk in clients with urinary catheters, respiratory infections, invasive procedures (arterial lines, CVP, any indwelling line).
C. At-risk clients: older adults, clients with chronic health problems, clients on immunosuppressive therapy and the clients who are malnourished.
D. Exaggerated body response to an antigen, resulting in release of endotoxins that affect platelets and cause vasodilatation, increased capillary permeability, and development of MODS.

E. Clinical manifestations.
1. Compromised respiratory function.
   a. Initially, hyperventilation occurs as a compensating mechanism.
   b. Hypoventilation and respiratory acidosis occur when compensation fails.
   c. Respiratory failure and development of ARDS (Chapter 15).
2. Compromised cardiac function.
   a. Initially increased cardiac output with decreased systemic vascular resistance (SVR) secondary to hypermetabolic state.
   b. Cardiac decompensation with development of severe hypotension and MODS.
3. Development of severe hypotension progressing to septic shock despite adequate fluid resuscitation.
4. Development of (SIRS) progressing to MODS.

Treatment
A. Prevention of infection.
B. Aggressive treatment of infections.
C. Aggressive pulmonary support.
D. Fluid resuscitation.

Nursing Interventions
See care of a client in shock (Chapter 16).

Antibiotic-Resistant Infections
A. Strains of bacteria that have developed a resistance to common antibiotics (multiple drug-resistant organisms (MDROs).
1. Methicillin-resistant Staphylococcus aureus: wound, skin and soft tissue, pneumonia.
B. Transmission.
1. Most common mode of transmission is from person to person, including from health care workers to hospitalized clients.
C. Clients at increased risk.
   1. Treatment with multiple antibiotics.
   2. Multiple hospitalizations.
   3. Older adults with chronic conditions.
   4. Clients with compromised immune function.

Treatment
Cultures, followed by administration of antibiotics sensitive to bacteria.

Nursing Interventions
Goal: To decrease spread of infection.
A. Routine cultures of healthcare workers.
B. Identification of clients at increased risk.

Appendix 6-1 ELECTROLYTE IMBALANCES: POTASSIUM

<table>
<thead>
<tr>
<th>CAUSES</th>
<th>SYMPTOMS</th>
<th>NURSING IMPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Serum Potassium (K⁺) Levels: 3.5-5.0 mEq/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypokalemia: Serum K⁺ below 3.5 mEq/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreased intake of K⁺</td>
<td>Fatigue, muscle weakness, hyporeflexia</td>
<td>1. Identify source of depletion.</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>Confusion, drowsiness, fatigue</td>
<td>3. Encourage foods high in K⁺.</td>
</tr>
<tr>
<td>Fistulas</td>
<td>Bradycardia, weak irregular pulse</td>
<td>4. Replace K⁺ (oral potassium supplements and IV).</td>
</tr>
<tr>
<td>Nasogastric suction without replacement</td>
<td>ECG changes: flat T wave, S-T depression, U waves, PVCs</td>
<td>5. Maintain accurate I&amp;O records.</td>
</tr>
<tr>
<td>Skin loss: diaphoresis</td>
<td>GI: Decreased bowel sounds, development of ileus, nausea, vomiting</td>
<td>6. Evaluate for digitalis toxicity (low serum K⁺ potentiates digitalis).</td>
</tr>
<tr>
<td>Excessive renal excretion: Diuretics</td>
<td></td>
<td>7. Evaluate for alkalosis.</td>
</tr>
<tr>
<td>Increasing aldosterone</td>
<td></td>
<td>8. Provide client education regarding diuretics.</td>
</tr>
<tr>
<td>Alkalosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steroid therapy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetics: Insulin and glucose moves K⁺ into cell</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hyperkalemia: Serum K⁺ above 5.0 mEq/L

<table>
<thead>
<tr>
<th>CAUSES</th>
<th>SYMPTOMS</th>
<th>NURSING IMPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased urinary excretion:</td>
<td>Drowsiness</td>
<td>1. Identify origin of increase.</td>
</tr>
<tr>
<td>Renal failure</td>
<td>Muscle weakness and twitching paresthesia of hands and feet and around the mouth</td>
<td>2. Monitor K⁺ levels.</td>
</tr>
<tr>
<td>Decreased aldosterone</td>
<td>GI-Diarrhea with hyperactive bowel sounds</td>
<td>3. Administer diuretics and fluids, if renal function is adequate.</td>
</tr>
<tr>
<td>Decreased secretion</td>
<td>ECG changes:</td>
<td>4. Administer hypertonic glucose and insulin to initiate K⁺ transfer into cell.</td>
</tr>
<tr>
<td>Potassium sparing diuretics</td>
<td>Peaks T waves</td>
<td>5. Utilize exchange resins; Kayexalate.</td>
</tr>
<tr>
<td>Trauma</td>
<td>Widened QRS complex</td>
<td>7. Maintain accurate I&amp;O records.</td>
</tr>
<tr>
<td>Fever; sepsis</td>
<td>Dysrhythmias:</td>
<td></td>
</tr>
<tr>
<td>Excessive administration of IV K⁺</td>
<td>Bradycardia with ventricular ectopic beats (irregular pulse)</td>
<td></td>
</tr>
<tr>
<td>Salt substitutes containing potassium</td>
<td>Ventricular fibrillation</td>
<td></td>
</tr>
<tr>
<td>Acidosis</td>
<td>Cardiac arrest (Figure 6-5)</td>
<td></td>
</tr>
</tbody>
</table>

ECG, Electrocardiogram; GI, gastrointestinal; I&O, intake and output; IV, intravenous; PVCs, premature ventricular contractions.
### Appendix 6-2 MEDICATIONS TO CORRECT POTASSIUM IMBALANCE

<table>
<thead>
<tr>
<th>MEDICATIONS</th>
<th>NURSING IMPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Potassium Supplements</strong></td>
<td></td>
</tr>
<tr>
<td>Oral: Potassium chloride (KCl)</td>
<td>1. Sustained-release preparations are better tolerated and more convenient.</td>
</tr>
<tr>
<td>Sustained release: K-Dur, Micro-K, Slow-K</td>
<td>2. Oral preparations generally have unpleasant taste and are irritating to GI system; they should be administered with a full glass of water or juice.</td>
</tr>
<tr>
<td>Potassium gluconate (Kaon)</td>
<td>3. Pediatric implications: make sure child/infant is urinating adequately before beginning supplementation.</td>
</tr>
<tr>
<td>IV: Potassium acetate</td>
<td>4. Potassium acetate is the only IV preparation.</td>
</tr>
<tr>
<td>▲ High-Alert Medication (Box 5-1, p. 86)</td>
<td>5. IV K⁺ must be diluted and administered by IV drip. Do not give K⁺ IM or by IV push; may cause cardiac arrest. Administer no more than 10 mEq of K⁺ intravenously per 1 hour.</td>
</tr>
<tr>
<td></td>
<td>6. IV K⁺ solutions are irritating to the vein. If pain occurs, either slow the infusion rate or dilute solution in larger volume of fluid.</td>
</tr>
<tr>
<td></td>
<td>7. Administer with caution to clients with heart disease and those taking digitalis preparations.</td>
</tr>
</tbody>
</table>

| **Exchange Resin** | |
| Sodium polystyrene sulfonate (Kayexalate): PO or rectal retention enema (Medication is not absorbed systemically.) | 1. Laxatives are given to facilitate excretion of the resin. |
| | 2. Cleansing enema precedes the Kayexalate retention enema to enhance effectiveness. |
| | 3. Carefully evaluate the client with CHF and/or hypertension. |
| | 5. Use with caution in clients requiring sodium restriction. |

*CHF,* Congestive heart failure; *GI,* gastrointestinal; *IM,* intramuscularly; *IV,* intravenous; *PO,* by mouth (orally).
### Chapter 6: Homeostasis

**Appendix 6-3  ELECTROLYTE IMBALANCES: SODIUM**

<table>
<thead>
<tr>
<th>CAUSES</th>
<th>SYMPTOMS</th>
<th>NURSING IMPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Serum Sodium (Na(^+)) Levels: 135-145 mEq/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyponatremia: Serum Na(^+) below 135 mEq/L (loss of sodium or water excess)</td>
<td>Solution deficit (Na(^+) loss):</td>
<td>1. Identify source of depletion.</td>
</tr>
<tr>
<td></td>
<td>CNS problems: changes in level of consciousness, confusion seizures</td>
<td>2. Maintain accurate I&amp;O records, and determine weight daily (best measurement of fluid status).</td>
</tr>
<tr>
<td></td>
<td>Weakness, restlessness</td>
<td>3. Irrigate nasogastric tubes with normal saline solution.</td>
</tr>
<tr>
<td></td>
<td>Oliguria</td>
<td>4. 0.9% NaCl (normal saline) IV or half-strength 0.45% NaCl if client has sodium deficit.</td>
</tr>
<tr>
<td></td>
<td>Abdominal cramps</td>
<td>5. If seizures are present, may administer IV hypertonic solution containing 3% NaCl.</td>
</tr>
<tr>
<td></td>
<td>Postural hypotension</td>
<td>6. Monitor blood pressure.</td>
</tr>
<tr>
<td></td>
<td>Cold and clammy skin</td>
<td>7. Restrict fluid intake if client has fluid excess.</td>
</tr>
<tr>
<td></td>
<td>Dilutional hyponatremia (water excess):</td>
<td>8. Occurs in clients who are NPO, taking diuretics, perspiring, vomiting, having diarrhea; clients with burns or excessive administration of D(_5)W.</td>
</tr>
<tr>
<td></td>
<td>Hypertension</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Muscle twitching, cramping</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Increased urine</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weight gain</td>
<td></td>
</tr>
</tbody>
</table>

**NURSING PRIORITY:** Older adult clients and infants are at higher risk because of variations in total body water; carefully monitor clients receiving fluid replacement with D\(_5\)W.

### Hypernatremia: Serum Na\(^+\) above 145 mEq/L (sodium retention or water loss)

<table>
<thead>
<tr>
<th>SYMPTOMS</th>
<th>NURSING IMPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid excess (Na(^+) retention):</td>
<td>1. Identify origin of increase.</td>
</tr>
<tr>
<td>Pitting edema</td>
<td>2. Maintain accurate I&amp;O records, and determine weight daily.</td>
</tr>
<tr>
<td>Weight gain</td>
<td>3. Administer D(_5)W IV if fluid is normal or there is a fluid deficit.</td>
</tr>
<tr>
<td>Flushed skin</td>
<td>4. Administer diuretics to remove excess Na(^+).</td>
</tr>
<tr>
<td>Lethargic</td>
<td>5. Restrict fluid intake if client has fluid excess.</td>
</tr>
<tr>
<td>Hypertension</td>
<td>6. Assess for cerebral edema—lethargy, headache, nausea, vomiting, increased BP.</td>
</tr>
<tr>
<td>Decreased hematocrit</td>
<td></td>
</tr>
<tr>
<td>Fluid deficit (hemoconcentration of Na(^+), water loss):</td>
<td></td>
</tr>
<tr>
<td>Concentrated urine</td>
<td></td>
</tr>
<tr>
<td>Dry mucous membranes</td>
<td></td>
</tr>
<tr>
<td>Flushed skin, tachycardia increased temperature weight loss, decreased CVP</td>
<td></td>
</tr>
</tbody>
</table>

ADH, Antidiuretic hormone; BP, blood pressure; CNS, central nervous system; CVP, central venous pressure; D\(_5\)W, 5% dextrose in water; I&O, intake and output; IV, intravenously; NPO, nothing by mouth.

### Appendix 6-4  MEDICATIONS TO CORRECT SODIUM IMBALANCE

<table>
<thead>
<tr>
<th>MEDICATION</th>
<th>NURSING IMPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium supplements</td>
<td></td>
</tr>
<tr>
<td>Sodium chloride (NaCl, table salt)</td>
<td>1. Administer with caution in clients with CHF, renal problems, edema, or hypertension.</td>
</tr>
<tr>
<td>Saline solutions: 0.9% and 0.45% saline solution for infusion</td>
<td>2. Determine weight daily; maintain accurate I&amp;O records to evaluate fluid retention.</td>
</tr>
<tr>
<td>High-Alert Medication</td>
<td>3. Evaluate serum Na(^+) levels.</td>
</tr>
<tr>
<td></td>
<td>4. Do not store containers of sodium chloride above a concentration of 0.9% (normal saline) on the nursing unit.</td>
</tr>
</tbody>
</table>

CHF, Congestive heart failure; I&O, intake and output.
### Appendix 6-5 ELECTROLYTE IMBALANCES: CALCIUM

<table>
<thead>
<tr>
<th><strong>CAUSES</strong></th>
<th><strong>SYMPTOMS</strong></th>
<th><strong>NURSING IMPLICATIONS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hypocalcemia:</strong> Serum Ca(^{++}) below 8.6 mg/dl or below 4 mEq/L, or below 3.5 mEq/L in infants</td>
<td>Tetany: + Chvostek's sign; + Trousseau's sign (Chapter 13) Neuromuscular irritability Numbness and tingling in extremities or around mouth Laryngeal stridor Seizures Abdominal cramping and distention Hyperreflexia Dysrhythmias</td>
<td>1. Identify origin of deficiency. 2. Keep Ca(^{++}) replacement medications easily accessible for clients who have had thyroid or parathyroid surgically removed. 3. Assess for tetany. 4. Reduce environmental stimuli for both adults and infants. 5. Institute seizure precautions. 6. Provide client education regarding Ca(^{++}) intake.</td>
</tr>
</tbody>
</table>

**Infants:**

- **Early onset**—decreased activity of parathyroid; infants of diabetic mothers; premature infants; exchange transfusion
- **Late onset**—decreased dietary intake, infants who are fed evaporated milk formulas containing phosphorus, intestinal malabsorption

Early onset in infant: restlessness, edema, apnea, intermittent cyanosis, vomiting, abdominal distention, high-pitched cry Late onset in infant: increasing CNS excitability

1. Teach parents to use infant formulas and or oral supplements until the child is 1 year old. 2. Do not give a child whole cow's milk until 1 year old.

**Hypercalcemia:** Serum Ca\(^{++}\) above 10.5 mg/dl or above 5 mEq/L

- Metastatic malignancy
- Hyperparathyroidism
- Thiazide diuretics
- Prolonged immobilization
- Vitamin D overdose

Anorexia, nausea, constipation CNS depression Decreasing muscle tone, coordination Pathological fractures Dysrhythmias—increases sensitivity to digitalis preparations.

1. Identify origin of increase. 2. Administer loop diuretics to facilitate removal of serum Ca\(^{++}\), normal saline fluid replacement. 3. Increase client's fluid intake 3000 to 4000 mL/24 hours. 4. Decrease Ca\(^{++}\) intake. 5. Encourage client mobility. 6. Provide client education regarding supplemental vitamins. 7. Increase fiber intake. 8. Assess client taking digitalis for symptoms of toxicity.

CNS, Central nervous system; IV, intravenous.

### Appendix 6-6 MEDICATIONS TO CORRECT CALCIUM IMBALANCE

#### Calcium Salts

<table>
<thead>
<tr>
<th><strong>MEDICATION</strong></th>
<th><strong>ACTION</strong></th>
<th><strong>NURSING IMPLICATIONS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium citrate (Citracal); PO Calcium gluconate; IV, PO Calcium carbonate (TUMS, Rolaids); PO</td>
<td>Activator for coagulation enzyme factors Necessary for cardiac muscle function IV infusion for treatment of hypocalcemic tetany Adjunctive therapy to prevent hypocalcemia during exchange transfusion</td>
<td>1. May be given in conjunction with vitamin D to enhance absorption. 2. PO supplements are more effective if taken ½–1 hr after meals. 3. Prevent IV infiltration; Ca(^{++}) solutions cause tissue hypoxia and sloughing. 4. Do not add Ca(^{++}) preparations to solutions containing carbonates or phosphates. 5. Use with caution for client receiving digitalis. 6. Monitor infusion rate carefully; sudden increase in serum Ca(^{++}) level may precipitate severe cardiac dysrhythmias. 7. Corticosteroids decrease Ca(^{++}) absorption. Administer several hours apart.</td>
</tr>
</tbody>
</table>

IV, Intravenous; PO, by mouth.
General Nursing Implications
— Give oral medications with or after meals to decrease GI irritation and side effects.
— Following therapy, withdrawal from steroids must be done gradually.
— For clients on long-term therapy, increased amounts of corticosteroids will be required during periods of stress such as surgery.
— Decreases client’s ability to respond to and fight infection.
— Closely evaluate the client on digitalis preparations and thiazide diuretics for the development of hypokalemia.
— Use with NSAIDs increases risk for intestinal irritation and perforation (Appendix 3-3).
— Uses: Inflammatory conditions—respiratory, gastrointestinal, joint inflammation, and skin conditions.
  Adrenocortical hormone replacement if adrenal glands are insufficient or have been removed. Suppress rejection of transplanted organs.

MEDICATIONS

**Adrenocortical Hormones (Corticosteroids, Glucocorticoids):**

*Antiinflammatory action:* Inhibit synthesis of chemical mediators (histamine, prostaglandins), thereby suppressing inflammatory response. Suppress infiltration of area by phagocytes and suppress production of lymphocytes, further reducing the immune response and inflammation. During stress, an increase release of corticosteroids occurs to maintain blood pressure and plasma levels of glucose. Used as immunosuppressant for delaying organ rejection. Long-term use will suppress the function of the adrenal glands.

<table>
<thead>
<tr>
<th>Medication</th>
<th>Side Effects</th>
<th>Nursing Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrocortisone base (Cortef): PO</td>
<td>Increased susceptibility to infections (bodywide)</td>
<td>1. Administer medication before 9:00 a.m. to decrease adrenal cortical suppression.</td>
</tr>
<tr>
<td>Hydrocortisone sodium succinate (Solu-Cortef): IV, IM</td>
<td>GI upset, gastric irritation</td>
<td>2. Monitor for psychologic changes.</td>
</tr>
<tr>
<td>Dexamethasone (Decadron): PO, IV, IM, topical</td>
<td>Osteoporosis</td>
<td>3. Decrease salt intake in diet; encourage high-protein and high-potassium diet.</td>
</tr>
<tr>
<td>Prednisone (Deltasone, Meticorten): PO</td>
<td>Psychologic disturbances (depression, euphoria)</td>
<td>4. Determine weight daily; evaluate weight gain and blood pressure.</td>
</tr>
<tr>
<td>Methylprednisolone (Medrol): PO, IM, IV</td>
<td>Hypokalemia</td>
<td>5. Topical steroids usually do not provoke physical evidence of absorption.</td>
</tr>
<tr>
<td>Methylprednisolone sodium succinate (Solu-Medrol): IV</td>
<td>Hyperglycemia</td>
<td><strong>Teaching:</strong> Take medication in the morning with food. Diet should include adequate K+ intake and decreased Na+ intake. Do not stop taking the medication or change the dosing without a doctor’s order. Report to health care provider: any early signs of infection; or a weight gain of 5 lb or more in a week. Do not take a live virus vaccine (MMR, varicella). Do not take with aspirin products.</td>
</tr>
</tbody>
</table>

1. **NURSING PRIORITY:** It is critical that clients on corticosteroids do not stop taking the medications abruptly. This can result in a significant drop in blood pressure and hypoglycemia. Clients should advise all their health care providers if they are on steroids.

GI, Gastrointestinal; IM, intramuscular; IV, intravenous; PO, by mouth (orally).
Appendix 6-8 INFECTION CONTROL PROCEDURES

General Information
— Many clients with disease-specific isolation precautions require only standard precautions.
— The specific substances covered by standard precautions include blood and all other body fluids, body secretions, and body excretions, even if blood is not visible. Moisture from perspiration (sweat) is an exception.
— Transmission-based precautions are followed, in addition to standard precautions, whenever a client is known or suspected to be infected with contagious pathogens.

Standard Precautions
1. Wash hands before and after client care and after removing gloves. Wash hands immediately with soap and water if visibly contaminated with blood or body fluids.
2. Wear gloves if there is a possibility you might come in contact with any body fluid or contaminated surfaces or objects.
3. Change gloves between tasks and procedures on the same client if moving from a contaminated body area (perineal area) to a clean body area. Do not wash gloves for reuse.
4. Wear gloves, gown, eye protection (goggles, glasses) or face shield and a mask during procedures likely to generate droplets of blood or body fluids.
5. Wear a gown when there is risk clothing will come in contact with body fluids. Perform hand hygiene after removing the gown. Do not reuse gowns, even if they are not soiled.
6. Have used client care equipment properly cleaned; discard any single-use items after use.
7. Ensure that hospital procedures for routine care, cleaning, and disinfection of environmental surfaces, beds, bedrails, and bedside equipment are followed.
8. Place contaminated linens in a leak-proof bag; handle contaminated linens in a manner that prevents contamination and transfer of microorganisms.
9. Discard all sharps in puncture resistant container. Do not bend, break, reinsert them into their original sheaths, or handle them unnecessarily. Discard them intact immediately after use.
10. Place clients who pose a risk for transmission to others in a private room. This includes clients who cannot contain secretions/excretions or wound drainage, infants with respiratory or intestinal infections.
11. Practice good hand hygiene.

Respiratory Hygiene and Cough Etiquette
• Educate health care personnel regarding measures to contain their own respiratory secretions.
• Post signs in strategic places regarding covering the mouth and nose when coughing or sneezing; provide non-touch receptacles for disposal of tissue.

Safe Injection Practices
• Use single-dose vials for parenteral administration when possible.
• If multidose vials must be used, the needle or cannula and the syringe used to access the vial must be sterile.
• Do not use the same syringe to administer medications to multiple clients, even if the needle is changed.
• Do not keep multidose vials in the immediate client treatment area.

Infection Control for Lumbar Punctures
• Wear a surgical mask when placing a catheter or injecting material into the spinal column or subdural space (myelogram, lumbar puncture, spinal or epidural anesthesia).

Airborne Precautions (droplet smaller than 5 mcg)
1. Place client in airborne isolation infection room (AIIR) as soon as possible.
2. Personal protection equipment (PPE):
   • Wear respiratory protection (N95 respirator mask approved by the National Institute for Occupational Safety and Health [NIOSH]) when entering the room.
   • Wear gloves, and gown when entering the room, remove prior to leaving room.
3. Limit client transport and client movement out of the room. Health care personnel who are not immune are restricted from entering the client’s room.
4. Conditions requiring use of airborne precautions – pulmonary or laryngeal tuberculosis, varicella, rubella and smallpox.

Droplet Precautions (droplets larger than 5 mcg)
1. Applicable to clients known to be, or suspected of being, infected with pathogens that are transmitted via respiratory droplets (sneezing, coughing, talking).
2. Place the client in a private room whenever possible; may place two clients in the same room if they are infected with the same pathogen.
3. PPE:
   • Wear a mask when entering the client room or examination area.
   • No recommendation regarding routine use of eye protection.
4. Place a mask on the client if transporting in the health care setting.
5. Instruct client and family regarding respiratory hygiene/cough etiquette.
6. Limit movement of the client from the room; if the client must leave the room, have him or her wear a surgical mask.

Contact Precautions
1. Applicable to clients with diseases easily transmitted by direct contact such as gastrointestinal, respiratory tract, skin, or wound infections and clients colonized with multidrug-resistant bacteria.
2. Place the client in a private room if condition may facilitate transmission—uncontrolled drainage, incontinence. May place two clients infected with same pathogen in the same room.
3. PPE:
   • Wear a gown when entering the client’s room; remove gown prior to leaving the room.
   • Wear gloves when entering the client’s room. Always change gloves after contact with infected material. Remove gloves before leaving the client’s room and perform hand hygiene; do not touch anything in the room as you are leaving.
   • Wear gloves when touching the client’s intact skin and surfaces and articles in close proximity to the client.
4. Dedicate use of noncritical client care equipment to the single client; if common equipment use is unavoidable, the equipment must be disinfected before use on another client.
Appendix 6-9  ANTIBIOTIC MEDICATIONS

General Nursing Implications

— Always assess for antibiotic allergies, especially penicillin allergy, before administration.
— If cultures are ordered, they should be obtained before the administration of the first dose.
— Teach the client to finish the entire prescribed course of medication even though he or she may feel well.
— Schedule IM and IV administration at evenly spaced intervals around the clock.
— Give most oral antibiotic drugs on an empty stomach (1 hour before or 2 hours after meals).
— Take medications with a full glass of water.
— Observe for hypersensitivity:
  • Anaphylaxis—hypotension, respiratory distress, urticaria, angioedema, vomiting, diarrhea
  • Serum sickness—fever, vasculitis, generalized lymphadenopathy, edema of joints, bronchospasm
— Observe for superinfection:
  • Stomatitis—sore mouth, white patches on oral mucosa, black furry tongue, diarrhea
  • Monilial vaginitis—rash in perineal area, itching, vaginal discharge
  • New localized signs and symptoms—redness, heat, edema, pain, drainage, cough
  • Recurrence of systemic signs and symptoms—fever, malaise

MEDICATIONS SIDE EFFECTS NURSING IMPLICATIONS

Penicillin: Bactericidal: Interferes with the formation of the bacterial cell wall

<table>
<thead>
<tr>
<th>Penicillin</th>
<th>Dose</th>
<th>Side Effects</th>
<th>Nursing Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penicillin V (PEN VEE K, Veetids): PO, IV</td>
<td>Parenteral injection—more hazardous than oral administration</td>
<td>1. Observe for allergic reactions and have emergency equipment available.</td>
<td></td>
</tr>
<tr>
<td>Aminopenicillins</td>
<td>Diarrhea, especially in children</td>
<td>2. Amoxicillin can be scheduled without regard to meals.</td>
<td></td>
</tr>
<tr>
<td>Amoxicillin (Amoxil): PO</td>
<td>Allergic reactions: skin rashes, joint pain, dermatitis, kidney damage</td>
<td>3. Observe client for 30 minutes after IM or IV administration for symptoms of allergic reactions.</td>
<td></td>
</tr>
<tr>
<td>Ampicillin (Principen, Totacillin): PO, IM, IV</td>
<td>Anaphylactic reaction (hypersensitivity): decreased BP, increased pulse, respiratory distress, diaphoresis</td>
<td>4. Clients with beta-hemolytic strep infections should receive penicillin for a minimum of 10 days to prevent development of rheumatic fever or glomerulonephritis.</td>
<td></td>
</tr>
<tr>
<td>Cloxacillin (Tegopen): PO</td>
<td>Ticarcillin—hypotremia</td>
<td>5. Discard liquid forms of penicillin after 7 days at room temperature and 14 days when refrigerated.</td>
<td></td>
</tr>
<tr>
<td>Nafcillin: IV</td>
<td></td>
<td>6. For IV administration, dilute reconstituted penicillin in 50 to 100 mL of 5% dextrose or 0.9% sodium chloride injection and infuse over 30 to 60 minutes.</td>
<td></td>
</tr>
</tbody>
</table>

Extended-spectrum penicillin

| Ticarcillin disodium (Ticar): IM, IV | Penicillin with beta-lactamase inhibitor |
| Amoxicillin with clavulamic acid (Augmentin): PO | |

Continued
### Aminoglycoside: Bactericidal: Interferes with protein synthesis

<table>
<thead>
<tr>
<th>Medication</th>
<th>Side Effects</th>
<th>Nursing Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gentamicin (Garamycin): IM, IV</td>
<td>Ototoxicity—hearing loss is irreversible</td>
<td>1. Monitor serum peak and trough levels to determine toxic levels.</td>
</tr>
<tr>
<td>Amikacin (Amikin): IM, IV</td>
<td>Nephrotoxicity—albuminuria, casts, oliguria</td>
<td>2. Neurotoxicity may be increased if given soon after surgery.</td>
</tr>
<tr>
<td>Tobramycin (Nebcin): IV, nebulizer</td>
<td>Skin rash, headache, hypotension, pain, and tenderness at injection site</td>
<td>3. Assess for ototoxicity (change in hearing, ringing in the ears, dizziness, or unsteady gait) and nephrotoxicity (monitor BUN and creatinine).</td>
</tr>
<tr>
<td>Neomycin sulfate (Mycitradin): PO, IM, topical, ophthalmic</td>
<td>Oral Neomycin is not absorbed systemically</td>
<td>4. Not commonly used for long-term therapy.</td>
</tr>
<tr>
<td>Gentamicin (Garamycin): IM, IV</td>
<td></td>
<td>5. Encourage PO fluids of 2000-3000 mL of fluid daily.</td>
</tr>
<tr>
<td>Neomycin PO may be used to suppress intestinal flora before surgery and to suppress ammonia formation in clients with cirrhosis.</td>
<td></td>
<td>6. For IV piggyback medications, administer over 30-60 minutes.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. Neomycin PO may be used to suppress intestinal flora before surgery and to suppress ammonia formation in clients with cirrhosis.</td>
</tr>
</tbody>
</table>

### Cephalosporins: Bactericidal: Broad-spectrum; interfere with the formation of the bacterial cell wall

<table>
<thead>
<tr>
<th>Generation</th>
<th>Medication</th>
<th>Side Effects</th>
<th>Nursing Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>First generation</td>
<td>Cefadroxil (Duricef, Ultracef): PO</td>
<td>Hypersensitivity—rash, superinfection</td>
<td>1. Give oral cephalosporins with food or milk.</td>
</tr>
<tr>
<td></td>
<td>Cephalexin (Keflex): PO</td>
<td>GI upset, neutropenia (decreased WBCs), pain at injection site, renal damage seizures</td>
<td>2. Administer IM medications deep into the muscle.</td>
</tr>
<tr>
<td></td>
<td>Cefazolin (Kefzol, Ancef): IM, IV</td>
<td></td>
<td>3. Should not be given to clients with a known allergy to penicillin.</td>
</tr>
<tr>
<td>Second generation</td>
<td>Cefuroxime (Ceftin, Zinacef): PO, IM, IV</td>
<td></td>
<td>4. Decrease phlebitis at IV site by diluting solution and administering it slowly.</td>
</tr>
<tr>
<td></td>
<td>Loracarbef (Lorabid): PO</td>
<td></td>
<td>5. Antibacterial activity increases from first generation to fourth generation: treatment usually begins with first generation to prevent development of increased resistance.</td>
</tr>
<tr>
<td>Third generation</td>
<td>Cefixime (Suprax): PO</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ceftriaxone (Rocephin): IM, IV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fourth generation</td>
<td>Cefepime (Maxipime): IM, IV</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Tetracyclines: Bacteriostatic: Broad-spectrum; interfere with protein synthesis of infectious organism and thus diminish its growth and reproduction

<table>
<thead>
<tr>
<th>Medication</th>
<th>Side Effects</th>
<th>Nursing Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tetracycline (Sumycin): PO, IV, IM</td>
<td>PO may cause GI irritation (loose stools, diarrhea), sore throat, photosensitivity</td>
<td>1. Administer on empty stomach; withhold antacids, dairy foods, and foods high in calcium at least 2 hours after PO administration; do not administer with milk.</td>
</tr>
<tr>
<td>Doxycycline (Vibramycin): PO, IV</td>
<td>Diarrhea may indicate severe suprainfection in bowel</td>
<td>2. Can give doxycycline and minocycline with food.</td>
</tr>
<tr>
<td>Demeclocycline (Declomycin): PO</td>
<td>Discoloration of teeth in children up to 8 years old</td>
<td>3. Do not give at the same time as iron preparations. Give them as far apart as possible (e.g., 2-3 hours).</td>
</tr>
<tr>
<td>Minocycline (Minocin): PO, IV</td>
<td>Can cause staining of developing teeth in the fetus if taken after fourth month of gestation</td>
<td>4. Advise client to avoid direct or artificial sunlight.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. If diarrhea occurs, important to determine cause.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Observe for development of superinfections.</td>
</tr>
</tbody>
</table>
### ANTIBIOTIC MEDICATIONS—cont’d

<table>
<thead>
<tr>
<th>MEDICATIONS</th>
<th>SIDE EFFECTS</th>
<th>NURSING IMPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sulfonamides: Bacteriostatic:</strong> Suppress bacterial growth by inhibiting synthesis of folic acid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulfamethoxazole: PO (available only in combination with trimethoprim)</td>
<td>Blood dyscrasias—hemolytic anemia</td>
<td>1. Encourage 8–10 glasses of water per day to prevent crystalluria.</td>
</tr>
<tr>
<td>Trimethoprim sulfamethoxazole (<em>TMP-SMZ, Bactrim, Septra</em>): PO, IV</td>
<td>Renal dysfunction—crystalluria (irritation and obstruction) (Stevens-Johnson syndrome)</td>
<td>3. Avoid prolonged exposure to sun.</td>
</tr>
<tr>
<td>Sulfasalzine (<em>Azulfidine</em>): PO</td>
<td>Nausea, vomiting, diarrhea</td>
<td>1. Antiinflammatory properties used to treat irritable bowel (IBS), rheumatoid arthritis.</td>
</tr>
<tr>
<td></td>
<td>Hepatitis, bone marrow suppression</td>
<td>2. Monitor CBC.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Maintain adequate hydration.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Urine may turn orange.</td>
</tr>
<tr>
<td><strong>Macrolides: Bacteriostatic:</strong> Inhibit protein synthesis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erythromycin base (<em>Erythrocin</em>): PO</td>
<td>Nausea, vomiting, abdominal distress, diarrhea</td>
<td>1. Administer with a full glass of water.</td>
</tr>
<tr>
<td>Azithromycin (<em>Zithromax</em>): PO, IV</td>
<td>Cholestatic hepatitis: abnormal liver function studies, jaundice, fever</td>
<td></td>
</tr>
<tr>
<td>Clarithromycin (<em>Biaxin</em>): PO</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fluoroquinolones: Bactericidal:</strong> Inhibit bacterial DNA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ciprofloxacin (<em>Cipro</em>): PO, IV</td>
<td>GI: Nausea, vomiting, abdominal distress, diarrhea</td>
<td>1. Absorption is reduced by milk products, antacids.</td>
</tr>
<tr>
<td>Levofoxacin (<em>Levaquin</em>): PO, IV</td>
<td>CNS: dizziness, headache, confusion</td>
<td>2. Administer IV infusions over 60 minutes.</td>
</tr>
<tr>
<td></td>
<td>Superinfections, hypersensitivity</td>
<td></td>
</tr>
<tr>
<td><strong>Other Antibiotics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metronidazole (<em>Flagyl</em>): PO, IV</td>
<td>Nausea, dry mouth, headache</td>
<td>1. Classified as an antiprotozoal antibiotic; is effective against anaerobic microorganisms.</td>
</tr>
<tr>
<td></td>
<td>Disulfiram reaction when taken with alcohol: nausea, copious vomiting, flushing, palpitations, headache; may last 30 minutes to an hour</td>
<td>2. Avoid concurrent use with alcohol or products containing alcohol. Will cause a disulfiram reaction.</td>
</tr>
<tr>
<td>Vancomycin (<em>Vancocin</em>): PO, IV</td>
<td>Otoxicity, thrombophlebitis at site</td>
<td>1. Acts by inhibiting cell wall synthesis; used only for serious infections.</td>
</tr>
<tr>
<td></td>
<td>Red man syndrome: flushing, rash, pruritus, tachycardia, and hypotension</td>
<td>2. IV infusions over at least 60 minutes to prevent adverse effects.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Serum peak and trough levels are monitored.</td>
</tr>
<tr>
<td>Linezolid (<em>Zyvox</em>): PO, IV</td>
<td>GI: diarrhea, nausea</td>
<td>1. New class of antibiotics—oxazolidinones.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Reserved for treatment of infections from MDROs.</td>
</tr>
</tbody>
</table>

### Antifungal

| Nystatin (*Mycostatin*): PO, topical | | |
| | 1. Used for treatment of candidiasis (mouth, esophagus, vagina). |
| | 2. Oral treatment encourage client to hold medication in their mouth and "swish" around to provide good contact with all affected areas. |

*BUN*, Blood urea nitrogen; *GI*, gastrointestinal; *IM*, intramuscular; *IV*, intravenous; *PO*, by mouth; *MDRO*, multiple drug resistant organisms.
**Appendix 6-10 VASCULAR ACCESS LINES**

**Central Line:** A single or multilumen catheter inserted into the venous system and progressed into the thoracic cavity with the end of the line in the superior vena cava or the right atrium.

**Nursing Implications for Central Line**

— Most common insertion is percutaneous into the subclavian or jugular vein.
  • A central line is necessary for a central venous pressure (CVP) reading and for total parenteral nutrition solutions.
  • Obtain a chest x-ray to evaluate for a possible pneumothorax after insertion of catheter into subclavian vein.
— Pulmonary artery catheters have a port at the level of the right atrium for central venous pressure measurement.
— When changing the tubing on straight central lines, position the client flat (if tolerated) and have client hold his or her breath and bear down when the line is opened. Immediately connect the new line and have the client breathe normally. Because the catheter goes into the thoracic cavity, it is subjected to changes in pressure, which increase the risk for air embolus.
— Maintain sterile technique when changing the dressing on the puncture site.

**Vascular Access Devices:** Long-term vascular lines for clients receiving intravenous (IV) therapy for 3 months or longer.

- **Implanted ports (MediPort, Port-A-Cath):** MediPort vascular access line port is implanted under the skin; activities are not restricted (Figure 6-6).
- **Tunneled ports (Hickman, Broviac):** Hickman line requires surgical placement; has an external port. The distal tips of both catheters lie in the superior vena cava just above the right atrium. Not used to obtain CVP readings.
- **PICC:** A peripherally inserted central catheter (PICC) line is inserted into a large peripheral vein of the upper arm and threaded into the subclavian vein and has an external port; area requires a sterile occlusive dressing; may be used to obtain blood samples.
- **Triple- or double-lumen lines:** A venous catheter that contains two or three separate ports and lines that are encased and inserted as one line; may be part of the vascular access device (VAD). Because each line is separate, the infusing solutions do not mix.

**Nursing Implications for Vascular Access Devices**

- **Flushing:** Routine flushing may be required unless there is a continuous IV infusion. This may be done with normal saline solution, heparin, or fibrinolytics. Type of solution, frequency, and volume depend on IV therapy and whether blood was drawn from the line, as well as institution policy. Excessive force should never be used to irrigate the line. Syringes smaller than 10 mL should not be used because the smaller the syringe, the greater the pressure exerted. The push-pause technique is an important flushing method used for prevention of deposits in ports or catheter lumens.

**Alert** Assist with invasive procedures (e.g., central line placement). Obtain blood specimens peripherally or through a central line. Access implanted venous access devices.

**Nursing Priority:** Do not flush a PICC catheter if there is resistance or if catheter is occluded; increased pressure may cause catheter to rupture and or produce a catheter emboli.

- **Accessing:** Gloves are worn and appropriate skin preparation is done for implanted ports; external injection ports and connectors are cleansed before accessing.
- **Dressing changes:** Implanted sites require cleansing after exit but do not require a dressing. External sites (PICCs and ports) require dressings, either gauze or transparent. Gauze dressings are changed if they are contaminated or if observation of the site is required; dressing is routinely changed every 48 hours. Transparent dressings may not be changed for 5-7 days.
- **Changing lines:** Clamping may be necessary during a tubing change to prevent air emboli; always use a flat or padded clamp to prevent damaging the line. If the line cannot be clamped, have the client hold his or her breath and bear down (Valsalva maneuver) during the line change.

**Arterial Lines:** Used to obtain arterial blood sample for ABGs and for blood pressure monitoring.

- **Measurements:** Arterial lines are used to evaluate blood pressure measurements. Measurement should be obtained at the end of respiration to avoid effect of respiratory cycle on arterial pressure.
- **Arterial blood sample:** Blood is withdrawn to evaluate ABGs.

**Nursing Implications for Arterial Line**

- **Complications:** hemorrhage, infection, thrombus formation, neurologic damage.
- **Maintain Leur Lok connection to prevent problem with accidental disconnection and bleeding from site.**
- **Prevent thrombus formation and maintain line patency by maintaining pressure on line at 300 mm Hg to provide continuous flush at 3-6 mL per hour.**

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**FIGURE 6-6** Implantable vascular access port. (From Potter PA, Perry AG: Fundamentals of nursing, ed 7, St. Louis, 2009, Mosby.)
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• Perform Allen’s test (see Arterial Blood Gas Studies in Appendix 15-1) to determine adequate circulation to hand before placing line in radial artery.
• Assess for infection at insertion site; if present, remove catheter and change all tubing and equipment for new site.
• Prevent infection by changing pressure tubing, fluid bag, and transducer every 96 hours.
• Assess vascular status distal to arterial line by checking capillary refill, as well as color of extremity.
• Assess neurologic status distal to arterial line by checking for presence of tingling, pain, or paresthesia.

Study Questions  Homeostasis

1. The nurse would identify which set of blood gas values as consistent with a diagnosis of respiratory acidosis in a client?
   1 pH 7.0; PCO₂ 42.
   2 pH 7.46; PCO₂ 38.
   3 pH 7.35; PCO₂ 44.
   4 pH 7.32; PCO₂ 48.

2. An older adult client is experiencing difficulty with edema and fluid overload. What nursing intervention would be the most accurate in evaluating the client’s fluid balance?
   1 Measure the intake and output.
   2 Check for thirst and tissue turgor.
   3 Evaluate changes in daily weight.
   4 Evaluate vital signs every 3 hours.

3. The nurse is admitting a client from the postoperative recovery area. Postoperative orders are D₅ ½ NS with 40 mEq/L of KCl. The current liter of lactated Ringer’s solution has 450 mL left to infuse. What should the nurse do?
   1 Finish the current liter of fluid.
   2 Ask the client if he needs to void.
   3 Hang the ordered IV.
   4 Assess the IV site.

4. The nurse is reviewing the health care provider’s orders for a new client. The client has just returned from the surgical recovery area. The client is NPO, he has a nasogastric tube, and his vital signs are stable. Which order would the nurse question?
   1 20 mEq potassium IV push.
   2 1000 mL D₅ ½ NaCl to infuse at 125 mL per hour.
   3 Assist client to dangle at bedside in AM.
   4 Cefoxitin (Mefoxin) 1g IV in 50 mL D₅W over 30 minutes.

5. The nurse is assisting a client to ambulate. Upon standing at the bedside, the client becomes weak and sits back down on the bed. The nurse should assess the client for what problem?
   1 Sodium imbalance.
   2 Altered renal function.
   3 Fluid deficit.
   4 Hyperkalemia.

6. What information is most important to teach a client who is receiving steroid therapy?
   1 Record daily weights to determine weight gain.
   2 Increase dose of medication as needed.
   3 Do not discontinue medication abruptly.
   4 Increase fluid intake.

7. Which of the following clients would most likely experience a problem with maintaining a normal electrolyte balance?
   1 A client with peripheral edema and heart failure.
   2 A client with a history of alcohol intake and liver damage.
   3 A child with an acute episode of nephrotic syndrome.
   4 A client with obstructive lung disease.

8. The nurse is admitting a 5-month-old infant. The physician has ordered an IV solution of normal saline. There is also an order for potassium chloride (KCl) to be added to the solution. The infant’s temperature is 101° F rectally, and the pulse is 120 beats/min; the infant is irritable and has not voided. What would be the next best nursing action?
   1 Wait for 1 hour from admission time and then begin the infusion of normal saline with the KCl.
   2 Feed the infant before adding the KCl to the infusing solution.
   3 Consider the order a stat order and begin the infusion immediately.
   4 Start the normal saline infusion and hold the KCl until adequate urinary output has been documented.

9. A client’s condition has put him at an increased risk for development of a problem with excess fluid volume. What nursing intervention would provide the most accurate information for evaluating the clients’ fluid status?
   1 Obtaining the client’s daily weight before breakfast each day.
   2 Measuring fluid intake and output and comparing with values from the previous day.
   3 Assessing the blood pressure and comparing it with previous readings.
   4 Auscultating the lungs for the presence of adventitious breath sounds.
10. A older adult client has an order for continuous fluid replacement at 75 mL per hour. The nurse is preparing to start the IV. What site would be appropriate, and what is the equipment of choice?
1. A 22-gauge butterfly, right arm antecubital area.
2. An 18-gauge, 3-inch IV cannula (intercath), inserted in the left hand.
3. An 18-gauge, 1-inch IV cannula (intercath), in the antecubital area of left arm.
4. A 22-gauge, 1-inch intercath, top of the left hand.

11. A client has just received 250 mL of packed cells and is now receiving 1000 mL of D5W at 150 mL/hour. The client tells the nurse that he feels dizzy and has a headache. The nurse observes the distended jugular veins with the client in a semi-Fowler's position. What would be the nurse's initial response?
1. Notify the physician with the client's vital signs and complaints.
2. Check vital signs and place the client in semi-Fowler's position.
3. Reduce the D5W infusion to keep vein open rate.
4. Increase the rate of the IV because of the obvious signs of dehydration.

12. The nurse is performing a dressing change on a client who has a *Staphylococcus* infection in an abdominal incision. What infection control precautions will the nurse implement? Select all that apply:
1. Wear clean gloves to remove the old dressing.
2. Put on a gown when entering the room.
3. Wear a face shield.
4. Dispose of the gown and mask in container outside the client's door.
5. Leave all extra dressing supplies in the room.
6. Carefully cleanse the stethoscope and scissors that came in contact with the client.

13. The client is receiving an IV of 0.9% NaCl at 125 mL per hour. The client had a colon resection this morning. He has a nasogastric tube to suction and an ileostomy, and he is becoming increasingly restless. The nurse reviews the serum laboratory values. Which value would cause the nurse the most concern?
1. Blood urea nitrogen 32 mg/dL.
2. Serum glucose 190 mg/dL.
3. Hemoglobin 13.5, hematocrit 41%.
4. Sodium 155 mEq/L.

14. A client has returned to the room from the postoperative recovery area. He is lethargic but responsive. He has O2 via nasal cannula at 4 L/min and an IV infusing at 125 mL/hr. On the initial nursing assessment, the nurse notes that the O2 saturation on the pulse oximetry is 82%. What is the priority nursing action?
1. Perform a complete neurologic check.
2. Increase the O2 flow and recheck the pulse oximetry.
3. Suction the client and recheck the vital signs.
4. Stimulate the client to cough and deep-breathe.

15. The nurse is admitting a 15-year-old client with type 1 diabetes for control of his diabetes. What values on the arterial blood gases would indicate the client is developing a complication as a result of his poorly controlled diabetes?
1. Paco2 48 mm Hg, pH 7.37, Po2 98 mm Hg, HCO3− 24 mEq/L.
2. Paco2 33 mm Hg, pH 7.48, Po2 88 mm Hg, HCO3− 26 mEq/L.
3. Paco2 40 mm Hg, pH 7.45, HCO3− 32 mEq/L, O2 saturation 90%.
4. Paco2 38 mm Hg, pH 7.31, HCO3− 22 mEq/L, base excess −2.

16. A client is complaining of pain at the peripheral IV site. The nurse determines the IV is not infusing, assesses the site, and finds the area swollen, pale, and cool to touch. What is the best nursing action?
1. Discontinue the IV and apply warm, moist packs to the involved area.
2. Slow the IV infusion and see whether the swollen area decreases.
3. Notify the health care provider regarding the status of the IV.
4. Discontinue the IV and start another IV in the same vein, distal to the current site.

17. A client is being seen in the emergency department after an accident. He has no obvious physical injuries, and his blood pressure is 158/90 mm Hg. He is crying loudly, wringing his hands, and pacing the floor. His respiratory rate is 32 breaths/min, and he complains of being lightheaded. What is the best nursing response?
1. Have him lie down and begin O2 per nasal cannula at 4 L/min.
2. Put him on a stretcher and begin a head-to-toe assessment.
3. Perform a quick neurologic exam to determine his level of orientation.
4. Have him sit down and help him breathe into a paper sack.

18. The nurse is documenting information regarding an IV insertion. What information is important to include? Select all that apply:
1. Time and date of insertion.
2. Type of catheter and size.
3. Name of vein used.
5. Protective measures used.
6. Who ordered the IV and at what time.

Answers and rationales to these questions are in the section at the end of the book titled Chapter Study Questions: Answers and Rationales.