chapter 58

Fluids and Electrolytes

Key Terms

electrolyte
extravasation
fluid overload
half-normal saline
hypocalcemia
hypokalemia
hyponatremia
infiltration
normal saline
protein substrates
substrate

Chapter Objectives

On completion of this chapter, the student will:

- List the types and uses of solutions used in the management of body fluids.
- Discuss the adverse reactions associated with the administration of a solution or electrolyte used in the management of body fluids.
- List the types and uses of electrolytes used in the management of electrolyte imbalances.
- Discuss the more common signs and symptoms of electrolyte imbalance.
- Discuss preadministration and ongoing assessment activities the nurse should perform on the patient taking an electrolyte or a solution to manage body fluids.
- List some nursing diagnoses particular to a patient receiving an electrolyte or a solution to manage body fluids.
- Discuss ways to promote an optimal response to therapy and important points to keep in mind when educating patients about the use of an electrolyte or a solution to manage body fluids.
- Discuss the use of total parenteral nutrition (TPN).

The composition of body fluids remains relatively constant despite the many demands placed on the body each day. On occasion, these demands cannot be met, and electrolytes and fluids must be given in an attempt to restore equilibrium. The solutions used in the management of body fluids discussed in this chapter include blood plasma, plasma protein fractions, protein substrates, energy substrates, plasma proteins, electrolytes, and miscellaneous replacement fluids. **Electrolytes** are electrically charged particles (ions) that are essential for normal cell function and are involved in various metabolic activities. This chapter discusses the use of electrolytes to replace one or more electrolytes that may be lost by the body. The last section of this chapter gives a brief overview of total parenteral nutrition (TPN).

SOLUTIONS USED IN THE MANAGEMENT OF BODY FLUIDS

Parenteral nutrients are used to correct nutritional or fluid deficiencies, as well as to treat certain diseases and conditions.

ACTION AND USES

Blood Plasma

Blood plasma is the liquid part of blood, containing water, sugar, electrolytes, fats, gases, proteins, bile pigment, and clotting factors. Human plasma, also called

human pooled plasma, is obtained from donated blood. Although whole blood must be typed and crossmatched because it contains red blood cells carrying blood type and Rh factors, human plasma does not require this procedure. Because of this, plasma can be given in acute emergencies. Plasma administered intravenously (IV) is used to increase blood volume when severe hemorrhage has occurred and it is necessary to partially restore blood volume while waiting for whole blood to be typed and crossmatched. Another use of plasma is in treating conditions when plasma alone has been lost, as may be seen in severe burns.

Plasma Protein Fractions

Plasma protein fractions include human plasma protein fraction 5% and normal serum albumin 5% (Albuminar-5, Buminate 5%) and 25% (Albuminar-25, Buminate 25%). Plasma protein fraction 5% is an IV solution containing 5% human plasma proteins. Serum albumin is obtained from donated whole blood and is a protein found in plasma. The albumin fraction of human blood acts to maintain plasma colloid osmotic pressure and as a carrier of intermediate metabolites in the transport and exchange of tissue products. It is critical in regulating the volume of circulating blood. When blood is lost from shock, such as in hemorrhage, there is a reduced plasma volume. When blood volume is reduced, albumin quickly restores the volume in most situations.

Plasma protein fractions are used to treat hypovolemic (low blood volume) shock that occurs as the result of burns, trauma, surgery, and infections, or in conditions where shock is not currently present but likely to occur. Plasma protein fractions are also used to treat hypoproteinemia (a deficiency of protein in the blood), as might be seen in patients with nephrotic syndrome and hepatic cirrhosis, as well as other diseases or disorders. As with human pooled plasma, blood type and crossmatch is not needed when plasma protein fractions are given.

Protein Substrates

A **substrate** is a substance that is the basic component of an organism. Protein substrates are amino acids, which are essential to life. **Protein substrates** are amino acid preparations that act to promote the production of proteins (anabolism). Amino acids are necessary to promote synthesis of structural components, reduce the rate of protein breakdown (catabolism), promote wound healing, and act as buffers in the extracellular and intracellular fluids. Crystalline amino acid preparations are hypertonic solutions of balanced essential and nonessential amino acid concentrations that provide substrates for protein synthesis or act to conserve existing body protein.

Amino acids promote the production of proteins, enhance tissue repair and wound healing, and reduce the rate of protein breakdown. Amino acids are used in certain disease states, such as severe kidney and liver disease, as well as in TPN solutions. (See the last section of this chapter for a more detailed discussion of TPN.) TPN may be used in patients with conditions such as impairment of gastrointestinal absorption of protein, in patients with an increased requirement for protein, as seen in those with extensive burns or infections, and in patients with no available oral route for nutritional intake.

Energy Substrates

Energy substrates include dextrose solutions and fat emulsion. Solutions used to supply energy and fluid include dextrose (glucose) in water or sodium chloride, alcohol in dextrose, and IV fat emulsion. Dextrose is a carbohydrate used to provide a source of calories and fluid. Alcohol (as alcohol in dextrose) also provides calories. Dextrose is available in various strengths (or percent of the carbohydrate) in a fluid, which may be water or sodium chloride (saline). Dextrose and dextrose in alcohol are available in various strengths (or percent of the carbohydrate and percent of the alcohol) in water. Dextrose solutions also are available with electrolytes, for example, Plasma-Lyte 56 and 5% Dextrose. Calories provided by dextrose and dextrose and alcohol solutions are listed in Table 58-1.

An IV fat emulsion contains soybean or safflower oil and a mixture of natural triglycerides, predominately unsaturated fatty acids. It is used in the prevention and treatment of essential fatty acid deficiency. It also provides nonprotein calories for those receiving TPN when calorie requirements cannot be met by glucose. Examples of intravenous fat emulsion include Intralipid 10% and 20%, Liposyn II 10% and 20%, and Liposyn III 10% and 20%. Fat emulsion is used as a source of calories and essential fatty acids for

Table 58-1 Calories Provided in Intravenous Carbohydrate Solutions

CARBOHYDRATE	PERCENTAGE	CALORIES/1,000 ML
Dextrose	2.5%	85
Dextrose	5%	170
Dextrose	10%	340
Dextrose	20%	680
Dextrose	50%	1,700
Dextrose	70%	2,380
Alcohol in dextrose	5% alcohol and 5% dextrose	450
	10% alcohol and 5% dextrose	720

patients requiring parenteral nutrition for extended periods (usually more than 5 days). No more than 60% of the patient's total caloric intake should come from fat emulsion, with carbohydrates and amino acids comprising the remaining 40% or more of caloric intake.

Plasma Expanders

The IV solutions of plasma expanders include hetastarch (Hespan), low–molecular-weight dextran (Dextran 40), and high–molecular-weight dextran (Dextran 70, Dextran 75). Plasma expanders are used to expand plasma volume when shock is caused by burns, hemorrhage, surgery, and other trauma and for prophylaxis of venous thrombosis and thromboembolism. When used in the treatment of shock, plasma expanders are not a substitute for whole blood or plasma, but they are of value as emergency measures until the latter substances can be used.

Intravenous Replacement Solutions

Intravenous replacement solutions are a source of electrolytes and water for hydration (Normosol M Ringer's Injection, Lactated Ringer's, Plasma-Lyte R), and used to facilitate amino acid utilization and maintain electrolyte balance (Lypholyte, Multilyte, TPN Electrolytes). Dextrose and electrolyte solutions such as Plasma-Lyte R and 5% dextrose are used as a parenteral source of electrolytes, calories, or water for hydration. Invert sugar-electrolyte solutions, such as Multiple Electrolytes and Travert 5% and 10%, contain equal parts of dextrose and fructose and are used as a source of calories and hydration.

ADVERSE REACTIONS, CONTRAINDICATIONS, PRECAUTIONS, AND INTERACTIONS

Blood Plasma

Solutions used in the management of body fluids are contraindicated in patients with hypersensitivity to any component of the solution. All solutions used to manage body fluids discussed in this chapter are Pregnancy Category C drugs and are used cautiously during pregnancy and lactation. No interactions have been reported.

Plasma Protein Fractions

Adverse reactions are rare when plasma protein fractions are administered, but nausea, chills, fever, urticaria, and hypotensive episodes may occasionally be seen.

Plasma proteins are contraindicated in those with a history of allergic reactions to albumin, severe anemia, or cardiac failure; in the presence of normal or increased intravascular volume; and in patients on cardiopulmonary bypass. Plasma protein fractions are used cautiously in patients who are in shock or dehydrated and in those with congestive cardiac failure or hepatic or renal failure. These solutions are Pregnancy Category C drugs and are used cautiously during pregnancy and lactation.

Most IV solutions should not be combined with any other solutions or drugs but should be administered alone. The nurse should consult the drug insert or other appropriate sources before combining any drug with any plasma protein fraction.

Protein Substrates

Administration of protein substrates (amino acids) may result in nausea, fever, flushing of the skin, metabolic acidosis or alkalosis, and decreased phosphorus and calcium blood levels.

Solutions used in the management of body fluids are contraindicated in patients with hypersensitivity to any component of the solution. Plasma expanders are used cautiously in patients with renal disease, congestive heart failure, pulmonary edema, and severe bleeding disorders. These solutions are Pregnancy Category C drugs and are used cautiously during pregnancy and lactation. Protein substrates should not be combined with any other solutions or drugs without consulting the drug insert or other appropriate sources.

Energy Substrates

Low– or high–molecular-weight dextran administration may result in allergic reactions, which are evidenced by urticaria, hypotension, nausea, vomiting, headache, dyspnea, fever, tightness of the chest, and wheezing. Hyperglycemia and phlebitis may be seen with administration of glucose.

The energy substrates are contraindicated in patients with hypersensitivity to any component of the solution. Dextrose solutions are contraindicated in patients with diabetic coma with excessively high blood sugar. Concentrated dextrose solutions are contraindicated in patients with increased intracranial pressure, delirium tremens (if patient is dehydrated), hepatic coma, or glucose–galactose malabsorption syndrome. Alcohol dextrose solutions are contraindicated in patients with epilepsy, urinary tract infections, alcoholism, and diabetic coma.

Alcohol dextrose solutions are used cautiously in patients with hepatic and renal impairment, vitamin deficiency (may cause or potentate vitamin deficiency),

diabetes, or shock; during postpartum hemorrhage; and after cranial surgery. The nurse should consult the drug insert or other appropriate sources before combining any drug with an IV solution. Dextrose solutions are used cautiously in patients receiving a corticosteroid or corticotropin. Dextrose and alcohol dextrose solutions are incompatible with blood (may cause hemolysis).

The most common adverse reaction associated with the administration of fat emulsion is sepsis caused by administration equipment and thrombophlebitis caused by vein irritations from concurrently administering hypertonic solutions. Less frequently occurring adverse reactions include dyspnea, cyanosis, hyperlipidemia, hypercoagulability, nausea, vomiting, headache, flushing, increase in temperature, sweating, sleepiness, chest and back pain, slight pressure over the eyes, and dizziness.

IV fat emulsions are contraindicated in conditions that interfere with normal fat metabolism (eg, acute pancreatitis) and in patients allergic to eggs. IV fat emulsions are used with caution in those with severe liver impairment, pulmonary disease, anemia, and blood coagulation disorders. These solutions are Pregnancy Category C drugs and are used cautiously during pregnancy and lactation. In general, fat emulsions should not be combined with any other solutions or drugs, except when combined in TPN. The nurse should consult appropriate sources before combining any drug with a fat emulsion.

Plasma Expanders

Administration of hetastarch, a plasma expander, may be accompanied by vomiting, a mild temperature elevation, itching, and allergic reactions. Allergic reactions are evidenced by wheezing, edema around the eyes (periorbital edema), and urticaria. Other plasma expanders may result in mild cutaneous eruptions, generalized urticaria, hypotension, nausea, vomiting, headache, dyspnea, fever, tightness of the chest, bronchospasm, wheezing, and rarely, anaphylactic shock.

Plasma expanders are contraindicated in patients with hypersensitivity to any component of the solution and those with severe bleeding disorders, severe cardiac failure, renal failure with oliguria, or anuria. Plasma expanders are used cautiously in patients with renal disease, congestive heart failure, pulmonary edema, and severe bleeding disorders. Plasma expanders are Pregnancy Category C drugs and are used cautiously during pregnancy and lactation. The nurse should consult the drug insert or other appropriate sources before combining a plasma expander with another drug for IV administration.

Fluid Overload

One adverse reaction common to all solutions administered by the parenteral route is fluid overload, that is, the administration of more fluid than the body is able to handle. The term **fluid overload** (circulatory overload) is not a specific amount of fluid that is given. It describes a condition when the body's fluid requirements are met and the administration of fluid occurs at a rate that is greater than the rate at which the body can use or eliminate the fluid. Thus, the amount of fluid and the rate of administration of fluid that will cause fluid overload depend on several factors, such as the patient's cardiac status and adequacy of renal function. The signs and symptoms of fluid overload are listed in Display 58-1.

DISPLAY 58-1 ● Signs and Symptoms of Fluid Overload

- Headache
- Weakness
- Blurred vision
- Behavioral changes (confusion, disorientation, delirium, drowsiness)
- Weight gain
- Isolated muscle twitching
- Hyponatremia
- Rapid breathing
- Wheezing
- Coughing
- Rise in blood pressure
- Distended neck veins
- Elevated central venous pressure
- Convulsions

NURSING PROCESS

● The Patient Receiving a Solution for Management of Body Fluids

ASSESSMENT

Preadministration Assessment

Solutions used to manage body fluids are often administered IV. Before administering an IV solution, the nurse assesses the patient's general status, reviews recent laboratory test results (when appropriate), weighs the patient (when appropriate), and takes the vital signs. Blood pressure, pulse, and respiratory rate provide a baseline, which is especially important when the patient is receiving blood plasma, plasma expanders, or plasma protein fractions for shock or other serious disorders.

Ongoing Assessment

During the ongoing assessment, the nurse checks the needle site every 15 to 30 minutes or more frequently if the patient is restless or confused. When one of these preparations is given with a regular IV infusion set, the nurse checks the infusion rate every 15 minutes. The needle site is inspected for signs of **extravasation** (escape of fluid from a blood vessel into surrounding tissues) or **infiltration** (the collection of fluid into tissues).

If signs of extravasation or infiltration are apparent, the nurse restarts the infusion in another vein.

When these solutions are given, a central venous pressure line may be inserted to monitor the patient's response to therapy. Central venous pressure readings are taken as ordered. During administration, the nurse takes the blood pressure, pulse, and respiratory rate as ordered or at intervals determined by the patient's clinical condition. For example, a patient in shock and receiving a plasma expander may require monitoring of the blood pressure and pulse rate every 5 to 15 minutes, whereas the patient receiving dextrose 3 days after surgery may require monitoring every 30 to 60 minutes.

The nurse observes patients receiving IV solutions at frequent intervals for signs of fluid overload. If signs of fluid overload (see Display 58-1) are observed, the nurse slows the IV infusion rate and immediately notifies the primary health care provider.

Gerontologic Alert

Older adults are at increased risk for fluid overload because of the increased incidence of cardiac disease and decreased renal function that may accompany old age. Careful monitoring for signs and symptoms of fluid overload (see Table 58-2) is extremely important when administering fluids to older adults.

FAT EMULSIONS. When a fat emulsion is administered, the nurse must monitor the patient's ability to eliminate the infused fat from the circulation. The lipidemia must clear between daily infusions. The nurse monitors for lipidemia through assessing the result of the following laboratory exams: hemogram, blood coagulation, liver function tests, plasma lipid profile, and platelet count. The nurse reports an increase in any of these laboratory examinations as abnormal.

NURSING DIAGNOSES

Drug-specific nursing diagnoses are highlighted in the Nursing Diagnoses Checklist. Other nursing diagnoses applicable to these drugs are discussed in depth in Chapter 4.

Nursing Diagnoses Checklist

- ✓ **Excess Fluid Volume** related to adverse effects resulting from too rapid intravenous infusion
- ✓ **Deficient Fluid Volume** related to inability to take oral fluids, abnormal fluid loss, other factors (specify cause of deficient fluid volume)
- ✓ **Imbalanced Nutrition: Less than Body Requirements** related to inability to eat, recent surgery, other factors (specify cause of altered nutrition)

PLANNING

The expected outcomes of the patient may include an optimal response to therapy, prevention of fluid overload, correction of the fluid volume deficit (where appropriate), improved oral nutrition (where appropriate), and an understanding of the administration procedure.

IMPLEMENTATION

Promoting an Optimal Response to Therapy

Patients receiving an IV fluid should be made as comfortable as possible, although under some circumstances this may be difficult. The extremity used for administration should be made comfortable and supported as needed by a small pillow or other device. An IV infusion pump may be ordered for the administration of these solutions. The nurse sets the alarm of the infusion pump and checks the functioning of the unit at frequent intervals.

Nursing Alert

The nurse must administer all IV solutions with great care. At no time should any IV solution be infused at a rapid rate, unless there is a specific written order to do so.

Unless otherwise directed, the IV solution should be administered at room temperature. If the solution is refrigerated, the nurse allows the solution to warm by exposing it to room temperature 30 to 45 minutes before use. The average length of time for infusion of 1000 mL of an IV solution is 4 to 8 hours. The only exception is when there is a written or verbal order by the primary health care provider to give the solution at a rapid rate because of an emergency. In this instance, the order must specifically state the rate of administration as drops per minute, milliliters per minute, or the period of time over which a specific amount of fluid is to be infused (eg, 125 mL/h or 1000 mL in 8 hours). Calculation of IV flow rates is discussed in Chapter 3.

LIPID SOLUTIONS. Fat solutions (emulsions) should be handled with care to decrease the risk of separation or "breaking out of the oil." Separation can be identified by yellowish streaking or the accumulation of yellowish droplets in the emulsion. Fat solutions are administered to adults at a rate no greater than 1 to 2 mL/min.

Nursing Alert

During the first 30 minutes of infusion of a fat solution, the nurse carefully observes the patient for difficulty in breathing, headache, flushing, nausea, vomiting, or signs of a hypersensitivity reaction. If any of these reactions occur, the nurse discontinues the infusion and immediately notifies the primary health care provider.

AMINO ACIDS. A microscopic filter is attached to the IV line when amino acid solutions are administered. The filter prevents microscopic aggregates (particles that may form in the IV bag) from entering the bloodstream where they could cause massive emboli.

Managing Fluid Volume Deficit and Nutritional Imbalances

Many times the solutions used in the management of body fluids are given to correct a fluid volume deficit and to supply carbohydrates (nutrition). The nurse reviews the patient's chart for a full understanding of the rationale for administration of the specific solution.

When appropriate, nursing measures that may be instituted to correct a fluid volume and carbohydrate deficit may be included in a plan of care. Examples of these measures include offering oral fluids at frequent intervals and encouraging the patient to take small amounts of nourishment between meals and to eat as much as possible at mealtime.

Educating the Patient and Family

The nurse gives the patient or family a brief explanation of the reason for and the method of administration of an IV solution. Sometimes, patients and families tamper with or adjust the rate of flow of IV administration sets. The nurse emphasizes the importance of not touching the IV administration set or the equipment used to administer IV fluids.

EVALUATION

- The therapeutic effect of the drug is achieved.
- The fluid volume deficit is corrected.
- The nutrition deficit is corrected.
- The patient and family demonstrate an understanding of the procedure.

ELECTROLYTES

Along with a disturbance in fluid volume (eg, loss of plasma, blood, or water) or a need for providing parenteral nutrition with the previously discussed solutions, an electrolyte imbalance may exist. An electrolyte is an electrically charged substance essential to the normal functioning of all cells. Electrolytes circulate in the blood at specific levels where they are available for use when needed by the cells. An electrolyte imbalance occurs when the concentration of an electrolyte in the blood is either too high or too low. In some instances, an electrolyte imbalance may be present without an appreciable disturbance in fluid balance. For example, a patient taking a diuretic is able to maintain fluid balance by an adequate oral intake of water, which replaces the water lost through diuresis. However, the patient is likely to be unable to replace the potassium that is also lost during diuresis. When the potassium concentration in the blood is too low, as may occur with the administration of a diuretic, an imbalance may occur that requires the addition of potassium. Commonly used electrolytes are listed in the Summary Drug Table: Electrolytes.

ACTIONS AND USES

Bicarbonate (HCO_3^-)

This electrolyte plays a vital role in the acid-base balance of the body. Bicarbonate may be given IV as sodium bicarbonate ($NaHCO_3$) in the treatment of metabolic acidosis, a state of imbalance that may be seen in diseases or situations such as severe shock, diabetic acidosis, severe diarrhea, extracorporeal circulation of blood, severe renal disease, and cardiac arrest. Oral sodium bicarbonate is used as a gastric and urinary alkalinizer. It may be used as a single drug or may be found as one of the ingredients in some antacid preparations. It is also useful in treating severe diarrhea accompanied by bicarbonate loss.

Bicarbonate is no longer used as the first line treatment during cardiopulmonary resuscitation following cardiac arrest. Recent evidence suggests little benefit, and the drug may actually be detrimental to resuscitation. According to the American Heart Association, bicarbonate is used when all other treatment options have failed.

Calcium (Ca^{++})

Calcium is necessary for the functioning of nerves and muscles, the clotting of blood (see Chap. 44), the building of bones and teeth, and other physiologic processes. Examples of calcium salts are calcium gluconate and calcium carbonate. Calcium may be given for the treatment of **hypocalcemia** (low blood calcium), which may be seen in those with parathyroid disease or after accidental removal of the parathyroid glands during surgery of the thyroid gland. Calcium may also be given during cardiopulmonary resuscitation, particularly after open heart surgery, when epinephrine fails to improve weak or ineffective myocardial contractions. Calcium may be used as adjunct therapy of insect bites or stings to reduce muscle cramping, such as occurs with black widow spider bites. Calcium may also be recommended for those eating a diet low in calcium or as a dietary supplement when there is an increased need for calcium, such as during pregnancy.

SUMMARY DRUG TABLE ELECTROLYTES

GENERIC NAME	TRADE NAME*	USES	ADVERSE REACTIONS	DOSAGE RANGES
calcium acetate	PhosLo	Control of hyperphosphatemia in end-stage renal disease	See Display 58-2	3–4 tablets PO with each meal
calcium carbonate	Calcium-600, Caltrate, Oyster Shell Calcium Tums, Tums E-X, Tums Ultra, *generic*	Dietary supplement for prevention or treatment of calcium deficiency, osteoporosis, osteomalcia, rickets, latent tetany	Rare; see Display 58-2 for signs of hypercalcemia	500–2000 mg/d PO
calcium citrate	Citracal, Citracal Liquitab, *generic*	Same as calcium carbonate; premenstrual syndrome	Same as calcium carbonate	500–2000 mg/d PO
calcium gluconate	*Generic*	Same as calcium carbonate; premenstrual syndrome	Same as calcium carbonate	500–2000 mg/d PO
calcium lactate	*Generic*	Same as calcium carbonate	Same as calcium carbonate	500–2000 mg/d PO
oral electrolyte mixtures	Infalyte Oral Solution, Naturalyte, Pedialyte, Pedialyte Electrolyte, Pedialyte Freezer Pops, Rehydralyte, Resol	Maintenance of water and electrolytes after corrective parenteral therapy of severe diarrhea; maintenance to replace mild to moderate fluid losses when food and liquid intake are discontinued, to restore fluid and minerals lost in diarrhea and vomiting in infants and children	Rare	Individualize dosage following the guidelines on the product labeling
magnesium	Almora, Magonate, Mag-Ox 400, Magtrate, Mag-200, Slow-Mag, Uro-Mag, *generic*	Dietary supplement, hypomagnesemia	Rare; see Display 58-2 for signs of hypermagnesemia	54–483 mg/d PO
potassium replacements	Effer K, K+10, Kaon Cl, K-Dur, Klor-Con, K-Lyte, K-Tab, Micro-K, Slow-K, *generic*	Hypokalemia	See Display 58-2; most common: nausea, vomiting, diarrhea, flatulence, abdominal discomfort, skin rash	40–150 mEq/d PO
sodium chloride	*generic*	Prevention or treatment of extracellular volume depletion, dehydration, sodium depletion, aid in the prevention of heat prostration	Nausea, vomiting, diarrhea, abdominal cramps, edema, irritability, restlessness, weakness, hypertension, tachycardia, fluid accumulation, pulmonary edema, respiratory arrest (see Display 58-2)	Individualize dosage

*The term *generic* indicates the drug is available in generic form.

Magnesium (Mg^{++})

Magnesium plays an important role in the transmission of nerve impulses. It is also important in the activity of many enzyme reactions, for example, carbohydrate metabolism. Magnesium sulfate is used as replacement therapy in hypomagnesemia. Magnesium sulfate ($MgSO_4$) is used in the prevention and control of seizures in obstetric patients with pregnancy-induced hypertension (PIH, also referred to as eclampsia and preeclampsia). It may also be added to TPN mixtures.

Potassium (K^+)

Potassium is necessary for the transmission of impulses; the contraction of smooth, cardiac, and skeletal muscles; and other important physiologic processes. Potassium as a drug is available as potassium chloride (KCl) and potassium gluconate, and is measured in milliequivalents (mEq), for example, 40 mEq in 20 mL or 8 mEq controlled-release tablet. Potassium may be given for **hypokalemia** (low blood potassium). Examples of causes of hypokalemia are a marked loss of gastrointestinal fluids (severe vomiting, diarrhea, nasogastric suction, draining intestinal fistulas), diabetic acidosis, marked diuresis, and severe malnutrition.

Sodium (Na^+)

Sodium is essential for the maintenance of normal heart action and in the regulation of osmotic pressure in body cells. Sodium, as sodium chloride (NaCl), may be given IV. A solution containing 0.9% NaCl is called **normal saline,** and a solution containing 0.45% NaCl is called **half-normal saline.** Sodium also is available combined with dextrose, for example, dextrose 5% and sodium chloride 0.9%.

Sodium is administered for **hyponatremia** (low blood sodium). Examples of causes of hyponatremia are excessive diaphoresis, severe vomiting or diarrhea, excessive diuresis, and draining intestinal fistulas.

Combined Electrolyte Solutions

Combined electrolyte solutions are available for oral and IV administration. The IV solutions contain various electrolytes and dextrose. The amount of electrolytes, given as milliequivalents per liter (mEq/L), also varies. The IV solutions are used to replace fluid and electrolytes that have been lost and to provide calories by means of their carbohydrate content. Examples of IV electrolyte solutions are dextrose 5% with 0.9% NaCl, lactated Ringer's injection, Plasma-Lyte, and 10% Travert (invert sugar—a combination of equal parts of fructose and dextrose) and Electrolyte No. 2. The primary health care provider selects the type of combined electrolyte solution that will meet the patient's needs.

Oral electrolyte solutions contain a carbohydrate and various electrolytes. Examples of combined oral electrolyte solutions are Pedialyte and Rehydralyte. Oral electrolyte solutions are most often used to replace lost electrolytes, carbohydrates, and fluid in conditions such as severe vomiting or diarrhea.

ADVERSE REACTIONS, CONTRAINDICATIONS, PRECAUTIONS, AND INTERACTIONS

Bicarbonate (HCO_3^-)

In some instances, excessive oral use may produce nausea and vomiting. Some individuals may use sodium bicarbonate (baking soda) for the relief of gastric disturbances, such as pain, discomfort, symptoms of indigestion, and gas. Prolonged use of oral sodium bicarbonate or excessive doses of IV sodium bicarbonate may result in systemic alkalosis.

Bicarbonate is contraindicated in patients losing chloride by continuous gastrointestinal suction or through vomiting, in patients with metabolic or respiratory alkalosis, hypocalcemia, renal failure, or severe abdominal pain of unknown cause, and in those on sodium-restricted diets. Bicarbonate is used cautiously in patients with congestive heart failure or renal impairment and with glucocorticoid therapy. Bicarbonate is a Pregnancy Category C drug and is used cautiously during pregnancy.

Oral administration of bicarbonate may decrease the absorption of ketoconazole. Increased blood levels of quinidine, flecainide, or sympathomimetics may occur when these agents are administered with bicarbonate. There is an increased risk of crystalluria when bicarbonate is administered with the fluoroquinolones. Possible decreased effects of lithium, methotrexate, chlorpropamide, salicylates, and tetracyclines may occur when these drugs are administered with sodium bicarbonate. Sodium bicarbonate is not administered within 2 hours of enteric-coated drugs; the protective enteric coating may disintegrate before the drug reaches the intestine.

Calcium (Ca^{++})

Irritation of the vein used for administration, tingling, a metallic or chalky taste, and "heat waves" may occur when calcium is given IV. Rapid IV administration (calcium gluconate) may result in bradycardia, vasodilation, decreased blood pressure, cardiac arrhythmias, and

cardiac arrest. Oral administration may result in gastrointestinal disturbances. Administration of calcium chloride may cause peripheral vasodilation, temporary fall in blood pressure, and a local burning. Display 58-2 gives adverse reactions associated with hyper- and hypocalcemia.

DISPLAY 58-2 ● Signs and Symptoms of Electrolyte Imbalances

CALCIUM
Normal laboratory values: 4.5–5.3 mEq/L or 9–11 mg/dL*

Hypocalcemia
Hyperactive reflexes, carpopedal spasm, perioral paresthesias, positive Trousseau's sign, positive Chvostek's sign, muscle twitching, muscle cramps, tetany (numbness, tingling, and muscular twitching usually of the extremities), laryngospasm, cardiac arrhythmias, nausea, vomiting, anxiety, confusion, emotional lability, convulsions

Hypercalcemia
Anorexia, nausea, vomiting, lethargy, bone tenderness or pain, polyuria, polydipsia, constipation, dehydration, muscle weakness and atrophy, stupor, coma, cardiac arrest

MAGNESIUM
Normal laboratory values: 1.5–2.5 mEq/L or 1.8–3 mg/dL*

Hypomagnesemia
Leg and foot cramps, hypertension, tachycardia, neuromuscular irritability, tremor, hyperactive deep tendon reflexes, confusion, disorientation, visual or auditory hallucinations, painful paresthesias, positive Trousseau's sign, positive Chvostek's sign, convulsions

Hypermagnesemia
Lethargy, drowsiness, impaired respiration, flushing, sweating, hypotension, weak to absent deep tendon reflexes

POTASSIUM
Normal laboratory values: 3.5–5 mEq/L*

Hypokalemia
Anorexia, nausea, vomiting, mental depression, confusion, delayed or impaired thought processes, drowsiness, abdominal distention, decreased bowel sounds, paralytic ileus, muscle weakness or fatigue, flaccid paralysis, absent or diminished deep tendon reflexes, weak irregular pulse, paresthesias, leg cramps, ECG changes

Hyperkalemia
Irritability, anxiety, listlessness, mental confusion, nausea, diarrhea, abdominal distress, gastrointestinal hyperactivity, paresthesias, weakness and heaviness of the legs, flaccid paralysis, hypotension, cardiac arrhythmias, ECG changes

SODIUM
Normal laboratory values: 132–145 mEq/L*

Hyponatremia
Cold clammy skin, decreased skin turgor, apprehension, confusion, irritability, anxiety, hypotension, postural hypotension, tachycardia, headache, tremors, convulsions, abdominal cramps, nausea, vomiting, diarrhea

Hypernatremia
Fever, hot dry skin, dry sticky mucous membranes, rough dry tongue, edema, weight gain, intense thirst, excitement, restlessness, agitation, oliguria or anuria

*These laboratory values may not concur with the normal range of values in all hospitals and laboratories. The hospital policy manual or laboratory values sheet should be consulted for the normal ranges of all laboratory tests.
ECG, electrocardiographic.

Calcium is contraindicated in patients with hypercalcemia or ventricular fibrillation and in patients taking digitalis. Calcium is used cautiously in patients with cardiac disease. Hypercalcemia may occur when calcium is administered with the thiazide diuretics. When calcium is administered with atenolol there is a decrease in the effect of atenolol, possibly resulting in decreased beta blockade. There is an increased risk of digitalis toxicity when digitalis preparations are administered with calcium. The clinical effect of verapamil may be decreased when the drug is administered with calcium. Concurrent ingestion of spinach or cereal may decrease the absorption of calcium supplements.

Magnesium (Mg^{++})

Adverse reactions seen with magnesium administration are rare. If they do occur, they are most likely related to overdose and may include flushing, sweating, hypotension, depressed reflexes, muscle weakness, and circulatory collapse (see Display 58-2).

Magnesium sulfate is contraindicated in patients with heart block or myocardial damage and in women with PIH during the 2 hours before delivery. Magnesium is a Pregnancy Category A drug, and studies indicate no increased risk of fetal abnormalities if the agent is used during pregnancy. Nevertheless, caution is used when administering magnesium during pregnancy. In addition, magnesium chloride is contraindicated in patients with renal impairment or marked myocardial disease and those in a coma. Magnesium (sulfate) is used with caution in patients with renal function impairment. Prolonged respiratory depression and apnea may occur when magnesium is administered with the neuromuscular blocking agents.

Potassium (K^{+})

Nausea, vomiting, diarrhea, abdominal pain, and phlebitis have been seen with oral and IV administration of potassium. Adverse reactions related to hypo- or hyperkalemia are listed in Display 58-2.

If extravasation of the IV solution should occur, local tissue necrosis (death of tissue) may be seen. If extravasation occurs, the primary health care provider is contacted immediately and the infusion slowed to a rate that keeps the vein open.

Potassium is contraindicated in patients who are at risk for experiencing hyperkalemia, such as those with renal failure, oliguria, or azotemia (the presence of nitrogen-containing compounds in the blood), anuria, severe hemolytic reactions, untreated Addison's disease (see Chap. 50), acute dehydration, heat cramps, and any form of hyperkalemia. Potassium is used cautiously in patients with renal impairment or adrenal insufficiency, heart disease, metabolic acidosis, or prolonged or severe diarrhea. Concurrent use of potassium with

angiotensin-converting enzyme (ACE) inhibitors may result in elevated serum potassium. Potassium-sparing diuretics and salt substitutes used with potassium can produce severe hyperkalemia. The use of digitalis with potassium increases the risk of digoxin toxicity.

Sodium (Na^+)

Sodium as the salt (eg, NaCl) has no adverse reactions except those related to overdose (see Display 58-2). In some instances, excessive oral use may produce nausea and vomiting.

Sodium is contraindicated in patients with hypernatremia, fluid retention, and when the administration of sodium or chloride could be detrimental. Sodium is used cautiously in surgical patients and those with circulatory insufficiency, hypoproteinemia, urinary tract obstruction, congestive heart failure, edema, and renal impairment. Sodium is a Pregnancy Category C drug and is used cautiously during pregnancy.

NURSING PROCESS

The Patient Receiving an Electrolyte

ASSESSMENT

Preadministration Assessment

Before administering any electrolyte, electrolyte salt, or a combined electrolyte solution, the nurse assesses the patient for signs of an electrolyte imbalance (see Display 58-2). All recent laboratory and diagnostic tests appropriate to the imbalance are reviewed. The nurse obtains vital signs to provide a database.

Ongoing Assessment

During therapy, the nurse periodically obtains (daily or more frequently) serum electrolyte or bicarbonate studies to monitor therapy.

BICARBONATE. When given in the treatment of metabolic acidosis, the drug may be added to the IV fluid or given as a prepared IV sodium bicarbonate solution. Frequent laboratory monitoring of the blood pH and blood gases is usually ordered because dosage and length of therapy depend on test results. The nurse frequently observes the patient for signs of clinical improvement and monitors the blood pressure, pulse, and respiratory rate every 15 to 30 minutes or as ordered by the primary health care provider. Extravasation of the drug requires selection of another needle site because the drug is irritating to the tissues.

CALCIUM. Before, during, and after the administration of IV calcium, the nurse monitors the blood pressure, pulse, and respiratory rate every 30 minutes until the patient's condition has stabilized. After administration of calcium, the nurse observes the patient for signs of hypercalcemia (see Display 58-2).

Nursing Alert

Systemic overloading of calcium ions in the systemic circulation results in acute hypercalcemic syndrome. Symptoms of hypercalcemic syndrome include elevated plasma calcium, weakness, lethargy, severe nausea and vomiting, coma, and, if left untreated, death. The nurse reports any signs of hypercalcemic syndrome immediately to the primary health care provider.

To combat this syndrome the physician may prescribe IV sodium chloride and a potent diuretic, such as furosemide. When used together these two drugs markedly increase calcium renal clearance and reduce hypercalcemia.

POTASSIUM. Patients receiving oral potassium should have their blood pressure and pulse monitored every 4 hours, especially during early therapy. The nurse also observes the patient for signs of hyperkalemia (see Display 58-2), which would indicate that the dose of potassium is too high. Signs of hypokalemia may also occur during therapy and may indicate that the dose of potassium is too low and must be increased. If signs of hypokalemia or hyperkalemia are apparent or suspected, the nurse notifies the primary health care provider. In some instances, frequent laboratory monitoring of the serum potassium may be ordered.

The nurse inspects the IV needle site every 30 minutes for signs of extravasation. Potassium is irritating to the tissues. If extravasation occurs, the nurse discontinues the IV immediately and notifies the primary health care provider. The acutely ill patient and the patient with severe hypokalemia will require monitoring of the blood pressure and pulse rate every 15 to 30 minutes during the time of the IV infusion. The nurse measures the intake and output every 8 hours. The infusion rate is slowed to keep the vein open, and the primary health care provider is notified if an irregular pulse is noted.

MAGNESIUM. When magnesium sulfate is ordered to treat convulsions or severe hypomagnesemia, the patient requires constant observation. The nurse obtains the patient's blood pressure, pulse, and respiratory rate immediately before the drug is administered, as well as every 5 to 10 minutes during the time of IV infusion or after the drug is given direct IV. The nurse continues monitoring these vital signs at frequent intervals until the patient's condition has stabilized. Because magnesium is eliminated by the kidneys, it is used with caution

in patients with renal impairment. The nurse monitors the urine output for at least 100 mL every 4 hours. Voiding less than 100 mL of urine every 4 hours is reported to the primary health care provider.

The nurse observes the patient for early signs of hypermagnesemia (see Display 58-2) and contacts the primary health care provider immediately if this imbalance is suspected. Frequent plasma magnesium levels are usually ordered. The nurse notifies the primary health care provider if the magnesium level is higher or lower than the normal range.

Nursing Alert

As plasma magnesium levels rise above 4 mEq/L, the deep tendon reflexes are first decreased and then absent as the plasma levels reach 10 mEq/L. The knee jerk reflex is tested before each dose of magnesium sulfate. If the reflex is absent or a slow response is obtained, the nurse withholds the dosage and notifies the primary health care provider.

SODIUM. When NaCl is administered by IV infusion, the nurse observes the patient during and after administration for signs of hypernatremia (see Display 58-2). The nurse checks the rate of IV infusion as ordered by the primary health care provider, usually every 15 to 30 minutes. More frequent monitoring of the infusion rate may be necessary when the patient is restless or confused. To minimize venous irritation during administration of sodium or any electrolyte solution, the nurse uses a small bore needle placed well within the lumen of a large vein.

Patients receiving a 3% or 5% NaCl solution by IV infusion are observed closely for signs of pulmonary edema (dyspnea, cough, restlessness, bradycardia). If any one or more of these symptoms should occur, the IV infusion is slowed to keep the vein open, and the primary health care provider is contacted immediately. Patients receiving NaCl by the IV route have their intake and output measured every 8 hours. The nurse observes the patient for signs of hypernatremia every 3 to 4 hours and contacts the primary health care provider if this condition is suspected.

NURSING DIAGNOSES

Drug-specific nursing diagnoses are highlighted in the Nursing Diagnoses Checklist. Other nursing diagnoses applicable to these drugs are discussed in depth in Chapter 4.

PLANNING

The expected outcomes of the patient depend on the specific drug, dose, route of administration, and reason for administration of an electrolyte but may include an optimal response to therapy, compliance with the prescribed therapeutic regimen, and an understanding of the drug regimen and adverse drug effects.

Nursing Diagnoses Checklist

- ☑ **Imbalanced Nutrition: Less than Body Requirements** related to adverse drug reaction (nausea, vomiting)
- ☑ **Risk for Injury** related to adverse drug effects (muscular weakness)
- ☑ **Disturbed Thought Processes** related to adverse drug effects
- ☑ **Risk for Decreased Cardiac Output** related to adverse drug effects (cardiac arrhythmias)

IMPLEMENTATION

Promoting an Optimal Response to Therapy

In some situations, electrolytes are administered when an electrolyte imbalance may potentially occur. For example, the patient with nasogastric suction is prescribed one or more electrolytes added to an IV solution, such as 5% dextrose or a combined electrolyte solution, to be given IV to make up for the electrolytes that are lost through nasogastric suction. In other instances, electrolytes are given to replace those already lost, such as the patient admitted to the hospital with severe vomiting and diarrhea of several days' duration.

When electrolytes are administered parenterally, the dosage is expressed in milliequivalents (mEq), for example, calcium gluconate 7 mEq IV. When administered orally, sodium bicarbonate, calcium, and magnesium dosages are expressed in milligrams (mg). Potassium liquids and effervescent tablet dosages are expressed in milliequivalents; capsule or tablet dosages may be expressed as milliequivalents or milligrams.

Electrolyte disturbances can cause varying degrees of confusion, muscular weakness, nausea, vomiting, and cardiac irregularities (see Display 58-2 for specific symptoms). Serum electrolyte blood levels have a very narrow therapeutic range. Careful monitoring is needed to determine if blood levels fall above or below normal. Normal values may vary with the laboratory, but a general range of normal values for each electrolyte is found in Display 58-2. Adverse reactions are usually controlled by maintaining blood levels of the various electrolytes within the normal range.

ADMINISTERING BICARBONATE. The nurse gives oral sodium bicarbonate tablets with a full glass of water; the powdered form is dissolved in a full glass of water. If oral sodium bicarbonate is used to alkalinize the urine, the nurse checks the urine pH two or three times a day or as ordered by the primary health care provider. If the urine remains acidic, the nurse notifies the primary health care provider because an increase in the

dose of the drug may be necessary. IV sodium bicarbonate is given in emergency situations, such as metabolic acidosis or certain types of drug overdose when alkalinization of the urine is necessary to hasten drug elimination.

ADMINISTERING CALCIUM. When calcium is administered IV, the solution is warmed to body temperature immediately before administration, and the drug is administered slowly. In some clinical situations, the primary health care provider may order the patient to have a cardiac monitor because additional drug administration may be determined by electrocardiographic changes.

ADMINISTERING POTASSIUM. When given orally, potassium may cause gastrointestinal distress. Therefore, it is given immediately after meals or with food and a full glass of water. Oral potassium must not be crushed or chewed. If the patient has difficulty swallowing, the nurse consults the primary health care provider regarding the use of a solution or an effervescent tablet, which effervesces (fizzes) and dissolves on contact with water. Potassium in the form of effervescent tablets, powder, or liquid must be thoroughly mixed with 4 to 8 oz of cold water, juice, or other beverage. Effervescent tablets must stop fizzing before the solution is sipped slowly during a period of 5 to 15 minutes. Oral liquids and soluble powders that have been mixed and dissolved in cold water or juice are also sipped slowly during a period of 5 to 15 minutes. The nurse advises patients that liquid potassium solutions have a salty taste. Some of these products have a flavoring added, which makes the solution more palatable.

The primary health care provider orders the dose of the potassium salt (in mEq) and the amount and type of IV solution, as well as the time interval during which the solution is to be infused. After the drug is added to the IV container, the container is gently rotated to ensure mixture of the solution. A large vein is used for administration; the veins on the back of the hand should be avoided. An IV containing potassium should infuse in no less than 3 to 4 hours. This necessitates frequent monitoring of the IV infusion rate, even when an IV infusion pump is used.

Nursing Alert

Concentrated potassium solutions are for IV mixtures only and should never be used undiluted. Direct IV injection of potassium could result in sudden death. When potassium is given IV, it is always diluted in 500 to 1000 mL of an IV solution. The maximum recommended concentration of potassium is 80 mEq in 1000 mL of IV solution (although in acute emergency situations a higher concentration of potassium may be required).

ADMINISTERING MAGNESIUM. Magnesium sulfate may be ordered intramuscularly, IV, or by IV infusion diluted in a specified type and amount of IV solution. When ordered to be given intramuscularly, this drug is given undiluted as a 50% solution for adults and a 20% solution for children. Magnesium sulfate is given deep intramuscularly in a large muscle mass, such as the gluteus muscle.

Gerontologic Alert

Older adults may need a reduced dosage of magnesium because of decreased renal function. The nurse should closely monitor serum magnesium levels when magnesium is administered to older adults.

Monitoring and Managing Adverse Reactions

When electrolyte solutions are administered, adverse reactions are most often related to overdose. Correcting the imbalance by decreasing the dosage or discontinuing the solution usually works, and the adverse reactions subside within a short period of time. Frequent serum electrolyte levels are used to monitor blood levels.

If gastrointestinal disturbances occur from oral administration, taking the drug with meals may decrease the nausea. Should the patient become disoriented or confused, the nurse gently reorients the individual. Frequent observation and quickly answering the call light helps to maintain the patient's safety. If weakness or muscular cramping occurs, the nurse assists the patient when ambulating to prevent falls or other injury.

Some electrolytes may cause cardiac irregularities. The nurse checks the pulse rate at regular intervals, usually every 4 hours or more often if an irregularity in the heart rate is observed. Depending on the patient's condition, cardiac monitoring may be indicated when administering the electrolytes (particularly when administering potassium or calcium). For example, if potassium is administered to a patient with cardiac disease, a cardiac monitor is needed to continuously monitor the heart rate and rhythm during therapy.

Nursing Alert

Mild (5.5–6.5 mEq/L) to moderate (6.5–8 mEq/L) potassium blood level increases may be asymptomatic and manifested only by increased serum potassium concentrations and characteristic ECG changes, such as disappearance of P waves or spreading (widening) of the QRS complex.

Educating the Patient and Family

To ensure accurate compliance with the prescribed drug regimen, the nurse carefully explains the dose and time intervals to the patient or a family member. Because

overdose (which can be serious) may occur if the patient does not adhere to the prescribed dosage and schedule, it is most important that the patient completely understands how much and when to take the drug. The nurse stresses the importance of adhering to the prescribed dosage schedule during patient teaching.

The primary health care provider may order periodic laboratory and diagnostic tests for some patients receiving oral electrolytes. The nurse encourages the patient to keep all appointments for these tests, as well as primary health care provider or clinic visits. Persons with a history of using sodium bicarbonate (baking soda) as an antacid are warned that overuse can result in alkalosis and could disguise a more serious problem. Those with a history of using salt tablets (sodium chloride) are advised not to do so during hot weather unless it is recommended by a primary health care provider. Excessive use of salt tablets can result in a serious electrolyte imbalance.

The nurse includes the following points for specific electrolytes in a patient teaching plan.

CALCIUM

- Contact the primary health care provider if the following occur: nausea, vomiting, anorexia, constipation, abdominal pain, dry mouth, thirst, or polyuria (symptoms of hypercalcemia).
- Do not exceed the dosage recommendations.

POTASSIUM

- Take the drug exactly as directed on the prescription container. Do not increase, decrease, or omit doses of the drug unless advised to do so by the primary health care provider. Take the drug immediately after meals or with food and a full glass of water. Avoid the use of nonprescription drugs and salt substitutes (many contain potassium) unless use of a specific drug or product has been approved by the primary health care provider.
- Contact the primary health care provider if tingling of the hands or feet, a feeling of heaviness in the legs, vomiting, nausea, abdominal pain, or black stools should occur.
- If the tablet has a coating (enteric-coated tablets), swallow it whole. Do not chew or crush the tablet.
- If effervescent tablets are prescribed, place the tablet in 4 to 8 oz of cold water or juice. Wait until the fizzing stops before drinking. Sip the liquid during a period of 5 to 10 minutes.
- If an oral liquid or a powder is prescribed, add the dose to 4 to 8 oz of cold water or juice and sip slowly during a period of 5 to 10 minutes. Measure the dose accurately.

MAGNESIUM

- Do not take oral magnesium sulfate when abdominal pain, nausea, or vomiting is present. If diarrhea and abdominal cramping occur, discontinue the drug.

EVALUATION

- The therapeutic effect of the drug is achieved.
- The patient complies with the prescribed drug regimen.
- The patient and family demonstrate an understanding of the drug regimen.
- The patient verbalizes the importance of complying with the prescribed therapeutic regimen.

TOTAL PARENTERAL NUTRITION

When normal enteral feeding in not possible or is inadequate to meet an individual's nutritional needs, intravenous (IV) nutritional therapy or total parenteral nutrition (TPN) is required. Products used to meet the IV nutritional requirements of the patient include protein substrates (amino acids), energy substrates (dextrose and fat emulsions), fluids, electrolytes, and trace minerals (see the Summary Drug Table: Electrolytes).

TPN is used to prevent nitrogen and weight loss or to treat negative nitrogen (mineral component in protein and amino acids) balance (a situation in which more nitrogen is used by the body than is taken in) in the following situations:

- When the oral, gastrostomy, or jejunostomy route cannot or should not be used
- Gastrointestinal (GI) absorption of protein is impaired by obstruction
- Inflammatory disease or antineoplastic therapy prevents normal GI functioning
- Bowel rest is needed (eg, after bowel surgery)
- Metabolic requirements for protein are significantly increased (eg, in hypermetabolic states such as serious burns, infections, or trauma)
- Morbidity and mortality may be reduced by replacing amino acids lost from tissue breakdown (eg, renal failure)
- When tube feeding alone cannot provide adequate nutrition

TPN may be administered through a peripheral vein or through a central venous catheter. Peripheral TPN is used for patients requiring parenteral nutrition for relatively short periods of time (no more than 5–14 days) and when the central venous route is not possible or necessary. Peripheral TPN is used when the patient's caloric needs are minimal and can be partially met by normal

means (through the alimentary tract). Peripheral TPN prevents protein catabolism (breakdown of cells) in patients who have adequate body fat and no clinically significant protein malnutrition. An example of a solution used in TPN is amino acids with electrolytes. These solutions may be used alone or combined with dextrose (5% or 10%) solutions.

TPN through a central vein is indicated in patients to promote protein synthesis in those who are severely hypercatabolic, severely depleted of nutrients, or require long-term nutritional parenteral nutrition. For example, amino acids combined with hypertonic dextrose and IV fat emulsions are infused through a central venous catheter to promote protein systhesis. Vitamins, trace minerals, and electrolytes may be added to the TPN mixture to meet the patient's individual needs. The daily dose depends on the patient's daily protein requirement and the patient's metabolic state and clinical responses. Various laboratory studies and assessments are required before and during administration of TPN. For example baseline studies done before beginning treatment include complete blood count, prothrombin time, body weight, electrolytes, blood urea nitrogen, glucose, creatinine, cholesterol, triglycerides (if on fat emulsion), uric acid, and various other tests. Daily assessments during stabalization of the therapy (3–5 days) include urine glucose, acetone and ketones, intake/output, electrolytes, CO_2 levels, creatinine, and blood urea nitrogen. Thereafter baseline laboratory assessments are made every 2 to 3 days or weekly as the patient's condition indicates.

Nursing Alert

Hyperglycemia is the most common metabolic complication. A too rapid infusion of amino acid–carbohydrate mixtures may result in hyperglycemia, glycosuria, mental confusion, and loss of consciousness. Blood glucose levels may be obtained every 4 to 6 hours to monitor for hyperglycemia and guide the dosage of dextrose and insulin (if required). To minimize these complications, the primary health care provider may decrease the rate of administration, reduce the dextrose concentration, or administer insulin.

To prevent a rebound hypoglycemic reaction from the sudden withdrawal of TPN containing a concentrated dose of dextrose, the rate of administration is slowly reduced or the concentration of dextrose gradually decreased. If TPN must be abruptly withdrawn, a solution of 5% or 10% dextrose is begun to gradually reduce the amount of dextrose administered.

Critical Thinking Exercises

1. *Ms. Land is receiving 20 mEq of potassium chloride (KCl) added to 1000 mL of 5% dextrose and water. Discuss preadministration and ongoing assessments you would make while her IV is infusing.*
2. *Mr. Kendall is prescribed an oral potassium chloride liquid. Discuss the instructions you should give to Mr. Kendall regarding preparing and taking the drug.*
3. *Ms. Hartsel is to receive an IV fat emulsion. Discuss special precautions the nurse should take when administering the solution.*

Review Questions

1. Which of the following is a symptom of fluid overload?
   - **A.** Tinnitus
   - **B.** Hypotension
   - **C.** Decreased body temperature
   - **D.** Behavioral changes
2. Which of the following symptoms would indicate hypocalcemia?
   - **A.** Tetany
   - **B.** Constipation
   - **C.** Muscle weakness
   - **D.** Hypertension
3. Which of the following potassium plasma concentration laboratory results would the nurse report immediately to the physician?
   - **A.** 3.5 mEq/L
   - **B.** 4.0 mEq/L
   - **C.** 4.5 mEq/L
   - **D.** 5.5 mEq/mL
4. Which of the following symptoms would most likely indicate hypernatremia?
   - **A.** Fever, increased thirst
   - **B.** Cold, clammy skin
   - **C.** Decreased skin turgor
   - **D.** Hypotension
5. Which of the following is the most common metabolic complication of TPN?
   - **A.** Hypomagnesemia
   - **B.** Hypermagnesemia
   - **C.** Hypoglycemia
   - **D.** Hyperglycemia

Medication Dosage Problems

1. Mr. Parker is to receive 1000 mL of 5% dextrose and water during a period of 10 hours. Calculate how many milliliters should infuse each hour (see Chap. 3 for additional information on calculation).
2. The patient is prescribed potassium 40 mEq orally. The drug is available from the pharmacy in a solution of 20 mEq/15 mL. The nurse administers _____.