34 Diagnostic Testing

LEARNING OUTCOMES

After completing this chapter, you will be able to:

1. Describe the nurse's role for each of the phases involved in diagnostic testing.
2. List common blood tests.
3. Discuss the nursing responsibilities for specimen collection.
4. Explain the rationale for the collection of each type of specimen.
5. Describe how to collect and test stool specimens.
6. Compare and contrast the different types of urine specimens.
7. Describe how to collect sputum and throat specimens.
8. Describe visualization procedures that may be used for the client with gastrointestinal, urinary, and cardiopulmonary alterations.
9. Compare and contrast CT, MRI, and nuclear imaging studies.
10. Describe the nurse's role in caring for clients undergoing aspiration/biopsy procedures.
11. Verbalize the steps used in:
    a. Obtaining a capillary blood specimen to measure blood glucose.
    b. Collecting a urine specimen for culture and sensitivity by clean catch.
12. Recognize when it is appropriate to delegate diagnostic testing skills to unlicensed assistive personnel.
13. Demonstrate appropriate documentation and reporting of diagnostic testing information.

KEY TERMS

abdominal paracentesis, *741*
angiography, *738*
anoscopy, *737*
arterial blood gases, *722*
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INTRODUCTION

Diagnostic and laboratory tests (commonly called laboratory tests) are tools that provide information about clients. Tests may be used for basic screening as part of a wellness check. Frequently tests are used to help confirm a diagnosis, monitor an illness, and provide valuable information about the client's response to treatment. Nurses require knowledge of the most common laboratory and diagnostic tests because one primary role of the nurse is to teach the client and family or significant other how to prepare for the test and the care that may be required following the test. Nurses must also know the implications of the test results in order to provide the most appropriate nursing care for the client.

DIAGNOSTIC TESTING PHASES

Diagnostic testing occurs in many environments. The traditional sites include hospitals, clinics, and the primary care provider's office. Many test sites, however, are moving to the community. Examples include the home, workplace, shopping malls, and mobile units. The more complex diagnostic tests are performed at diagnostic centers specifically built to provide those tests.

Diagnostic testing involves three phases: pretest, intratest, and post-test.

Pretest

The major focus of the pretest phase is client preparation. A thorough assessment and data collection (e.g., biologic, psychological, sociologic, cultural, and spiritual) assist the nurse in determining communication and teaching strategies. Prior to radiologic studies it is important to ask female clients if pregnancy is possible. If pregnancy is suspected, special precautions may be necessary or the test may need to be postponed.

The nurse also needs to know what equipment and supplies are needed for the specific test. Common questions include the

following: What type of sample will be needed and how will it be collected? Does the client need to stop oral intake for a certain number of hours prior to the test? Does the test include administration of dye (contrast media) and, if so, is it injected or swallowed? Are fluids restricted or forced? Are medications given or withheld? How long is the test? Is a consent form required? Answers to these types of questions can help avoid costly mistakes and reduce inconvenience to all involved. Most facilities have information about the tests available to the health care team. The laboratory at the facility can also act as a resource for information.

Intratest

This phase focuses on specimen collection and performing or assisting with certain diagnostic testing. The nurse uses standard precautions and sterile technique as appropriate. During the procedure the nurse provides emotional and physical support while monitoring the client as needed (e.g., vital signs, pulse oximetry, ECG). The nurse ensures correct labeling, storage, and transportation of the specimen to avoid invalid test results.

Post-Test

The focus of this phase is on nursing care of the client and follow-up activities and observations. As appropriate, the nurse compares the previous and current test results and modifies nursing interventions as needed. The nurse also reports the results to appropriate health team members. The National Patient Safety Goals identify the importance of reporting critical results of tests and diagnostic procedures.

Culturally Responsive Care PATIENT-CENTERED CARE

Drawing Blood Samples

An Asian client practicing traditional medicine views blood as a source of life and believes that the body cannot replace lost blood (Spector, 2013). As a result, Asian clients may be upset by venipuncture or the drawing of blood for testing, especially if there are numerous tests. They may view this as upsetting the body's normal balance and weakening the body. Also, blood represents a person's essence and they may fear that their essence is being given away. Therefore, Asian clients may need to be informed that their blood will not be given to anyone else.

CLIENT TEACHING

Preparing for Diagnostic Testing

- Instruct the client and family about the procedure for the diagnostic test ordered (e.g., whether food is allowed prior to or after testing, and the length of time of the test).
- Explain the purpose of the test.
- Instruct the client and family about activity restrictions related to testing (e.g., remain supine for 1 hour after testing is completed).
- Instruct the client and family on the reaction the diagnostic test may produce (e.g., flushing if a dye is injected).
- Provide the client with detailed information about the diagnostic testing equipment.
- Inform the client and family of the time frame for when the results will be available.
- Instruct the client and family to ask any questions so that the health care provider can clarify information and allay any fears.

Source: From *Pearson Handbook of Laboratory and Diagnostic Tests with Nursing Implications*, 7th ed. (p. 3), by J. Kee, 2013, Upper Saddle River, NJ: Pearson; and *Brunner & Suddarth's Handbook of Laboratory and Diagnostic Tests* (pp. 2–3), by M. August-Brady, 2010, Philadelphia, PA: Lippincott Williams & Wilkins.

SAFETY ALERT! SAFETY

2014 THE JOINT COMMISSION NATIONAL PATIENT SAFETY GOALS (2013)

Goal 2: Improve the Effectiveness of Communication Among Caregivers.

- Report critical results of tests and diagnostic procedures on a timely basis. **Rationale:** *Critical results of tests and diagnostic procedures fall significantly outside the normal range and may indicate a life-threatening situation.* The objective is to provide the responsible licensed caregiver these results within an established time frame so that the client can be promptly treated.

Nursing Diagnoses

Nursing diagnoses are based on client data and need. Examples of nursing diagnoses include (Herdman & Kamitsuru, 2014):

- *Anxiety* or *Fear* related to possible diagnosis of acute or chronic illness pending conclusion of diagnostic testing
- *Impaired Physical Mobility* related to prescribed bed rest and restricted movement of involved extremity after testing
- *Deficient Knowledge* (state diagnostic test) related to misperceptions received from others regarding process for test.

BLOOD TESTS

Blood tests are commonly used diagnostic tests that can provide valuable information about the hematologic system and many other body systems. A **venipuncture** (puncture of a vein for collection of a blood specimen) can be performed by various members of the health care team. A **phlebotomist**, a person from a laboratory who performs venipuncture, usually collects the blood specimen for the tests ordered by the primary care provider. In some institutions, nurses may draw blood samples. The nurse needs to know the guidelines for drawing blood samples for the facility and also the state's nurse practice act.

Complete Blood Count

Specimens of venous blood are taken for a **complete blood count (CBC)**, which includes hemoglobin and hematocrit measurements, erythrocyte (red blood cells) count, red blood cell indices, leukocyte (white blood cell) count, and a differential white cell count. The CBC is a basic screening test and one of the most frequently ordered blood tests (Table 34–1).

Hemoglobin (Hgb) is the main intracellular protein of erythrocytes. It is the iron-containing protein in the red blood cells that transports oxygen through the body (Osborn, Wraa, & Watson, 2010). The hemoglobin test is a measure of the total amount of hemoglobin in the blood. The **hematocrit (Hct)** measures the percentage of RBCs in the total blood volume. Normal values for both hemoglobin and hematocrit vary, with males having higher levels than females. Hemoglobin and hematocrit are often ordered together and commonly referred to as "H&H" when ordering laboratory tests.

TABLE 34–1 Complete Blood Count with Clinical Implications

Component	Normal Findings (Adult)	Possible Causes of Abnormal Findings	
		Increased	Decreased
RED BLOOD CELL (RBC) COUNT The number of RBCs per cubic millimeter (mm^3).	*Men:* 4.6–6.0 million/mm^3 *Women:* 4.0–5.0 million/mm^3	Dehydration Polycythemia vera High altitude Cardiovascular disease	Blood loss Anemias Overhydration Leukemias Chronic renal failure Pregnancy
HEMOGLOBIN (HGB) Composed of a pigment (heme), which contains iron, and a protein (globin).	*Men:* 13.5–18 g/dL *Women:* 12–15 g/dL	Polycythemia Dehydration Chronic obstructive pulmonary disease Heart failure	Blood loss Anemias Kidney diseases Cancers
HEMATOCRIT (HCT) The hematocrit or packed cell volume (Hct, PCV, or crit) is a fast way to determine the percentage of RBCs in the plasma. The Hct is reported as a percentage because it is the concentration of RBCs in the blood.	*Men:* 40–54% *Women:* 36–46%	Dehydration Burns Hypovolemia	Acute blood loss Pregnancy Dietary deficiencies Anemias
RBC INDICES			
Mean corpuscular volume (MCV) The mean or average size of the individual RBC.	*Men:* 80–98 μm^3 *Women:* 78–102 μm^3	Chronic liver disease Pernicious anemia	Microcytic iron deficiency anemia Lead poisoning
Mean corpuscular hemoglobin (MCH) Amount of Hgb present in one cell.	25–35 pg	Macrocytic anemias	Radiation
Mean corpuscular hemoglobin concentration (MCHC) The proportion of each cell occupied by Hgb.	31–37%	Rarely seen	Microcytic, hypochromic anemia
WHITE BLOOD CELL (WBC) COUNT Count of the total number of WBCs in a cubic millimeter of blood.	4,500–11,000/mm^3	Acute infections Tissue necrosis (e.g., myocardial infarction) Collagen diseases	Viral infections Hematopoietic diseases Rheumatoid arthritis
DIFFERENTIAL COUNT The proportion of each of the five types of WBCs in a sample of 100 WBCs.			
Neutrophils	50–70%	Acute infections	Viral diseases Leukemias Aplastic and iron deficiency anemia
Lymphocytes	25–35%	Viral infection Chronic infections Lymphocytic leukemia	Cancers Leukemia Multiple sclerosis Renal failure
Monocytes	4–6%	Viral diseases Parasitic diseases Collagen diseases Cancer	Lymphocytic leukemia Aplastic anemia

TABLE 34–1 Complete Blood Count with Clinical Implications—*continued*

Component	Normal Findings (Adult)	Possible Causes of Abnormal Findings	
		Increased	**Decreased**
Eosinophils	1–3%	Allergic reactions Phlebitis Thrombophlebitis Parasitic infestations	Stress (burns, shock) Adrenocortical hyperfunction
Basophils	0.4–1.0%	Leukemia Inflammatory process	Hypersensitivity reaction Stress Pregnancy
PLATELET COUNT Platelets are basic elements in the blood that promote coagulation.	150,000–400,000/mm^3	Infections Polycythemia vera Acute blood loss Splenectomy	Idiopathic (unknown cause) thrombocytopenic purpura Cancer Systemic lupus erythematosus (SLE) Some types of anemias

From *Pearson Handbook of Laboratory and Diagnostic Tests with Nursing Implications*, 7th ed. (pp. 208; 210; 312–313; 337–338; 392–393; 395–396), by J. Kee, 2013. Reprinted and electronically reproduced by permission of Pearson Education, Inc., Upper Saddle River, NJ.

Hemoglobin and hematocrit increase with dehydration as the blood becomes more concentrated, and decrease with hypervolemia and resulting hemodilution. Both the hemoglobin and hematocrit are related to the **red blood cell (RBC) count**, which is the number of RBCs per cubic millimeter of whole blood. Low RBC counts are indicative of anemia. Clients with chronic hypoxia may develop higher than normal counts, a condition known as **polycythemia**. **Red blood cell (RBC) indices** may be performed as part of the CBC to evaluate the size, weight, and hemoglobin concentration of RBCs.

The **leukocyte** or **white blood cell (WBC) count** determines the number of circulating WBCs per cubic millimeter of whole blood. High WBC counts are often seen in the presence of a bacterial infection; by contrast, WBC counts may be low if a viral infection is present. In the WBC differential, leukocytes are identified by type, and the percentage of each type is determined. This information is useful in diagnosing certain disorders that have characteristic patterns of distribution (Figure 34–1 ■).

Serum Electrolytes

Serum electrolytes are often routinely ordered for any client admitted to a hospital as a screening test for electrolyte and acid–base imbalances. Serum electrolytes also are routinely assessed for clients at risk in the community, for example, clients who are being treated with a diuretic for hypertension or heart failure. The most commonly ordered serum tests are for sodium, potassium, chloride, and bicarbonate ions. Serum electrolytes may be ordered as a Chem 7 or BMP (basic metabolic panel). The laboratory terminology varies depending on the laboratory. Normal values of commonly measured electrolytes are shown in Box 34–1.

Blood levels of two metabolically produced substances, urea and creatinine, are routinely used to evaluate renal function. The kidneys, through filtration and tubular secretion, normally eliminate both. Urea, the end product of protein metabolism, is measured as **blood urea nitrogen (BUN)**. **Creatinine** is produced in relatively constant quantities by the muscles and is excreted by the kidneys. Thus the amount of creatinine in the blood relates to renal excretory function.

Culturally Responsive Care — PATIENT-CENTERED CARE

Biocultural Considerations

Studies have documented differences in clinical laboratory reference ranges between African and Western populations. For example, one study found that participants from western Kenya had lower hemoglobin, hematocrit, and RBC levels than North American and European populations. Thus some researchers recommend the development of region-specific hematologic reference values (Zeh et al., 2011).

Serum Osmolality

Serum osmolality is a measure of the solute concentration of the blood. The particles included are sodium ions, glucose, and urea (BUN). Serum osmolality can be estimated by doubling the serum sodium, because sodium and its associated chloride ions are the major determinants of serum osmolality. Serum osmolality values are used primarily to evaluate fluid balance. Normal values are 280 to 300 mOsm/kg. An increase in serum osmolality indicates a fluid volume deficit; a decrease reflects a fluid volume excess.

Drug Monitoring

Therapeutic drug monitoring is often conducted when a client is taking a medication with a narrow therapeutic range (e.g., digoxin, theophylline, aminoglycosides). This monitoring includes drawing

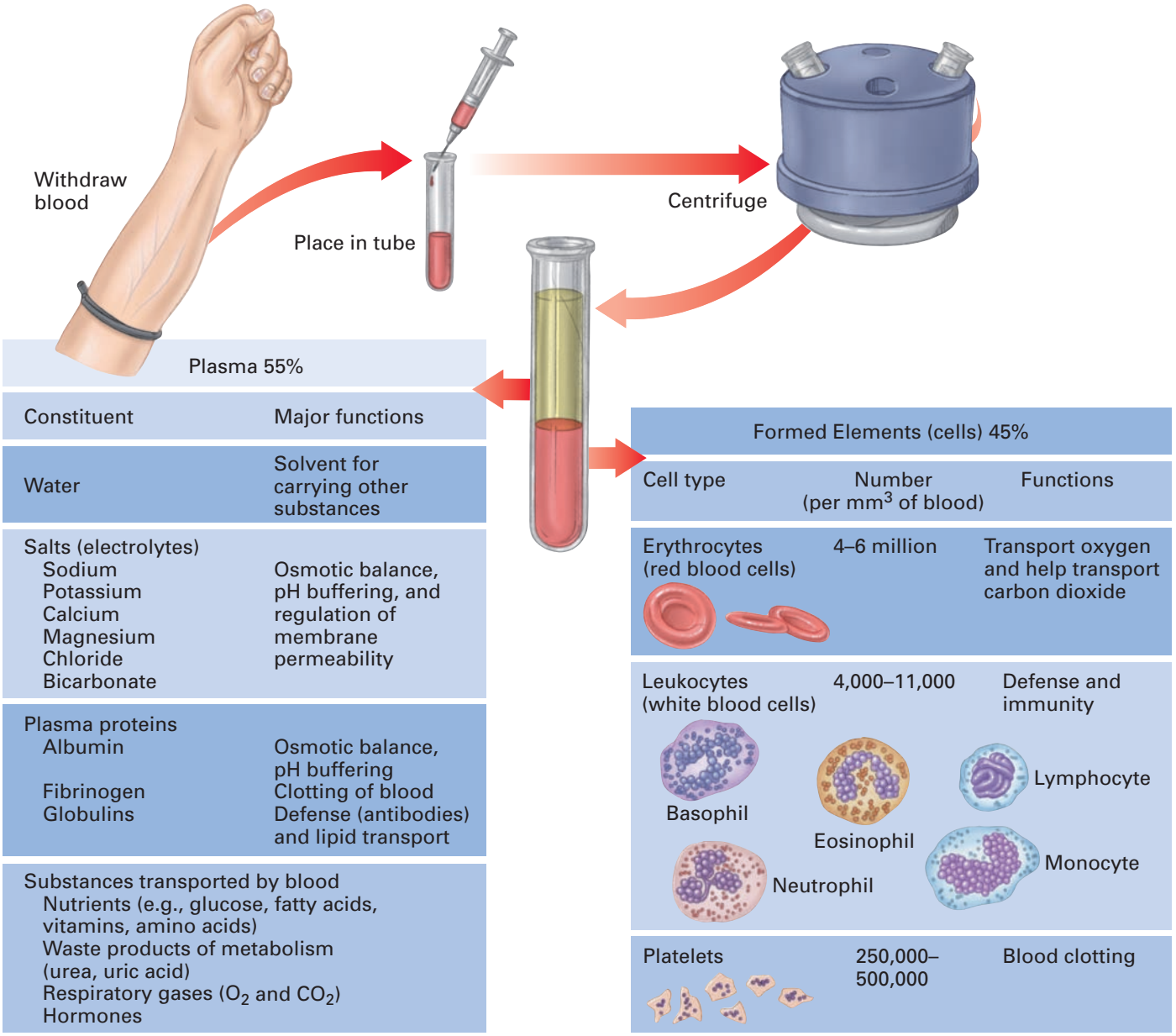


Figure 34–1 ■ Composition of blood.

BOX 34–1 Normal Electrolyte Values for Adults*

Venous Blood	
Sodium	135–145 mEq/L
Potassium	3.5–5.3 mEq/L
Chloride	95–105 mEq/L
Calcium (total) (ionized)	4.5–5.5 mEq/L or 8.5–10.5 mg/dL 56% of total calcium (2.5 mEq/L or 4.0–5.0 mg/dL)
Magnesium	1.5–2.5 mEq/L or 1.6–2.5 mg/dL
Phosphate	1.8–2.6 mEq/L (phosphorus)
Serum osmolality	280–300 mOsm/kg water

*Normal laboratory values vary from agency to agency.

blood samples for peak and trough levels to determine if the blood serum levels of a specific drug are at a therapeutic level and not a subtherapeutic or toxic level. The **peak level** indicates the highest concentration of the drug in the blood serum, and the **trough level** represents the lowest concentration. Ideally, a client's peak and trough levels fall within the therapeutic range.

Arterial Blood Gases

Measurement of **arterial blood gases** is another important diagnostic procedure (see Chapter 50 ∞). Specialty nurses, medical technicians, and respiratory therapists normally take specimens of arterial blood from the radial, brachial, or femoral arteries. Because of the relatively great pressure of the blood in

these arteries, it is important to prevent hemorrhaging by applying pressure to the puncture side for about 5 to 10 minutes after removing the needle.

Blood Chemistry

A number of other tests may be performed on blood serum (the liquid portion of the blood). These are often referred to as a **blood chemistry**. In addition to serum electrolytes, common chemistry examinations include determining certain enzymes that may be present (including lactic dehydrogenase [LDH], creatine kinase [CK], aspartate aminotransferase [AST], and alanine aminotransferase [ALT]), serum glucose, hormones such as thyroid hormone, and other substances such as cholesterol and triglycerides. These tests provide valuable diagnostic cues. For example, cardiac markers (e.g., CPK-MB, myoglobin, troponin T, and troponin I) are released into the blood during a myocardial infarction (MI, or heart attack). Elevated levels of these markers in the venous blood can help differentiate between an MI and chest pain that is caused by angina or pleuritic pain.

A common laboratory test is the glycosylated hemoglobin or **hemoglobin A_{1C} (HbA_{1C})** test, which is a measurement of blood glucose that is bound to hemoglobin. Hemoglobin A_{1C} is a reflection of how well blood glucose levels have been controlled during the prior 3 to 4 months. The normal range is 4.0% to 5.5%. An elevated HbA_{1C} reflects hyperglycemia in people with diabetes.

The first specific blood test used to detect and guide treatment for heart failure is the brain natriuretic peptide or B-type natriuretic peptide (BNP) test. B-type natriuretic peptide is secreted primarily by the left ventricle in response to increased ventricular volume and pressure. BNP levels increase as heart failure becomes more severe.

See Table 34–2 for normal values of common blood chemistry tests.

Metabolic Screening

Newborns are routinely screened for congenital metabolic conditions. Tests for phenylketonuria (PKU) and congenital hypothyroidism are required in all states in the United States. Other conditions that are frequently screened for include sickle cell disease and galactosemia. Screening involves collecting peripheral venous blood (via a heel-stick) on prepared blotting paper and sending the specimen to the state laboratory for analysis. Discovered abnormalities allow the provider and parents to plan early care (e.g., special diets for children with PKU) that can prevent long-term complications.

Capillary Blood Glucose

A capillary blood specimen is taken to measure the current blood glucose level when frequent tests are required or when a venipuncture cannot be performed. This technique is less painful than a venipuncture and easily performed. Hence, clients can perform this technique on themselves.

The development of home glucose test kits and reagent strips has simplified the testing of blood glucose and greatly facilitated the management of home care by clients with diabetes. A number of manufacturers have developed blood glucose meters or monitors (Figure 34–2 ■).

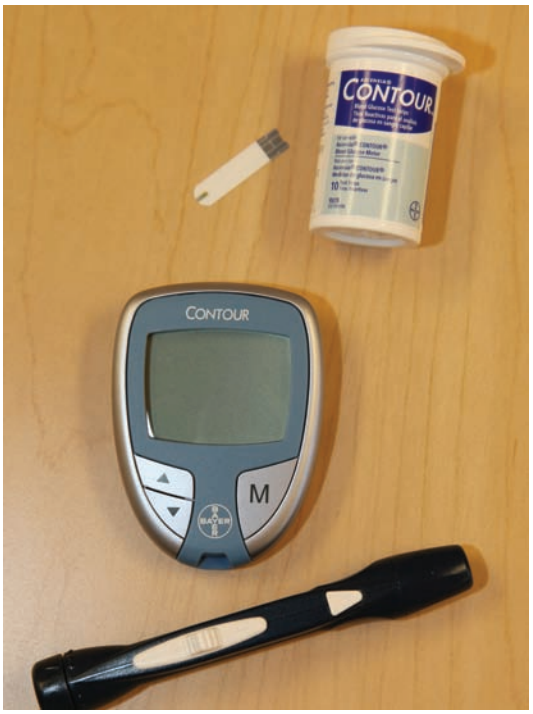


Figure 34–2 ■ Blood glucose monitor, test strips, and lancet injector.

Advances in technology have resulted in clients having greater choices for a glucose meter that meets their needs. For example, a person with a visual impairment could choose a voice-activated glucose meter or a meter with a large visual display (Wahowiak, 2013). Some meters may be used for alternative site testing (AST). This is when the client obtains a blood sample from an area of the body other than the finger such as the palm of the hand, forearm, or thigh. It is important to instruct a client who is using one of these devices that AST may not be as accurate as fingertip testing. It is recommended that AST only be used by people with fairly stable diabetes and for testing before meals (Whitmore, 2012, p. 585). For high-tech clients, mini-meters are available in different colors and meters that automatically analyze their trends in glucose control, medications, food, and exercise. This allows clients to see patterns and trends that can help them be successful in controlling their diabetes.

Glucose meters can vary in the following ways: amount of blood needed, code vs. noncode requirement, testing speed, size, ability to store results, cost of the meter, and test strips. It is important that clients who require glucose monitoring be comfortable and confident in the use of the meter. Once the client chooses a blood glucose meter, it is imperative for the nurse or client to review the manufacturer's operating guidelines. Being familiar with the proper use of the equipment helps ensure accurate readings. This will assist clients in controlling their diabetes. Clients who are comfortable taking their blood glucose readings and knowledgeable about interpreting the results will feel empowered to make changes, as needed, for optimal self-management skills.

TABLE 34–2 Common Blood Chemistry Tests with Clinical Implications

Test	Normal Findings (Adult)	Significance	Possible Causes of Increased Level	Possible Causes of Decreased Level
LIVER FUNCTION TESTS				
ALT (alanine aminotransferase), formerly known as serum pyretic transaminase (SGPT)	*Men:* 10–55 unit/L *Women:* 7–30 unit/L	Marker of hepatic injury; more specific of liver damage than AST	Hepatitis, infectious mononucleosis, acute pancreatitis, acute myocardial infarction, heart failure	Not clinically significant
AST (aspartate aminotransferase), formerly known as serum glutamic-oxaloacetic transaminase (SGOT)	*Men:* 10–40 unit/L *Women:* 9–25 unit/L	Found in heart, liver, and skeletal muscle. Can also be used to indicate liver injury	Liver diseases (e.g., hepatitis, alcoholism, drug toxicity), acute myocardial infarction, anemias, skeletal muscle diseases	Chronic renal dialysis, vitamin B_6 deficiency
Albumin	*Adults:* 3.5–4.8 g/dL or 35–48 g/L *Panic value:* <1.5 g/dL	Is a protein produced by the liver	No pathology causes the liver to produce more albumin. An increased level reflects dehydration	Chronic liver dysfunction, AIDS, severe burns, malnutrition, renal disease, acute and chronic infections
Alkaline phosphatase	*Adults:* 25–100 unit/L	Found in the tissues of the liver, bone, intestine, kidney, and placenta. Used as an index of liver and bone disease when correlated with other clinical findings	Liver disease, bone disease, hyperparathyroidism, myocardial infarction, chronic renal failure, heart failure	Malnutrition, pernicious anemia and severe anemias, hypothyroidism, magnesium and zinc deficiency (nutritional)
Ammonia	*Adults:* 15–45 mcg/dL	The liver converts ammonia, a by-product of protein metabolism, into urea, which is excreted by the kidneys	Liver disease, cirrhosis, Reye's syndrome, GI hemorrhage	Renal failure
Bilirubin	*Adults:* *Total:* 0.3–1.0 mg/dL *Direct:* 0.0–0.2 mg/dL *Indirect:* 0.1–1.0 mg/dL *Panic value:* >10 mg/dL	Results from the breakdown of hemoglobin in the red blood cells; removed from the body by the liver, which excretes it into the bile	*Total:* hepatitis, obstruction of the common bile or hepatic ducts, pernicious anemia, sickle cell disease *Direct:* cancer of the head of the pancreas, choledocholithiasis *Indirect:* hemolytic anemias, drug toxicity, transfusion reaction	Not clinically significant
GGT (gamma-glutamyl transferase)	*Men:* 1–94 unit/L *Women:* 1–70 unit/L	Found primarily in the liver, kidney, prostate, and spleen. Is more specific for the hepatobiliary system	Liver disease, alcohol abuse	Not clinically significant
Prothrombin	*Adults:* 11–13 seconds *Critical value:* >20 seconds for non-anticoagulated individuals	A protein produced by the liver for clotting of blood	Liver disease or damage, vitamin K deficiency, obstruction of common bile duct, deficiency of factors II, V, VII, or X	Thrombophlebitis, malignant tumor
CARDIAC MARKERS				
CK (creatine kinase)	*Total:* *Men:* 38–174 unit/L *Women:* 26–140 unit/L *Isoenzymes:* MM (CK_3): 96–100% MB (CK_2): 0–6% BB (CK_1): 0%	An enzyme found in the heart and skeletal muscles. Has three isoenzymes: MM or CK_3, MB or CK_2, and BB or CK_1	*Total:* acute MI, myocarditis, after open heart surgery, acute cerebrovascular disease, muscular dystrophy, chronic alcoholism *CK isoenzymes:*MB (CK_2): myocardial infarct, myocardial ischemia, angina pectoris	Not clinically significant

TABLE 34–2 Common Blood Chemistry Tests with Clinical Implications—*continued*

Test	Normal Findings (Adult)	Significance	Possible Causes of Increased Level	Possible Causes of Decreased Level
Myoglobin	5–70 ng/mL	After an MI, serum levels of myoglobin rise in 2–4 h, making it an early marker for muscle damage in MI	MI, angina, other muscle injury (e.g., trauma), renal failure, rhabdomyolysis	Rheumatoid arthritis, myasthenia gravis
Troponin I Troponin T	*Troponin I:* <0.35 ng/mL *Critical value:* >1.5 ng/mL *Troponin T:* <0.2 ng/mL	Cardiac troponin is highly concentrated in the heart muscle. This test is used in the early diagnosis of MI. After an MI, troponin I begins to increase in 4–6 h and remains elevated for 5–7 days Troponin T begins to increase in 3–4 h and remains elevated for 10–14 days	*Troponin I:* small infarct, myocardial injury *Troponin T:* acute MI, unstable angina, myocarditis	Not clinically significant
BNP (BRAIN NATRIURETIC PEPTIDE, OR B-TYPE NATRIURETIC PEPTIDE)	<100 pg/mL or <100 ng/L	A hormone produced by the ventricles of the heart; is a marker of ventricular systolic and diastolic dysfunction. This test is useful in diagnosing and guiding treatment of heart failure	Heart failure, symptomatic cardiac volume overload, paroxysmal atrial tachycardia	Not clinically significant
LIPOPROTEIN PROFILE				
Cholesterol	*Adults (desirable):* <200 mg/dL	This test is an important screening test for heart disease	Type II familial hypercholesterolemia, biliary cirrhosis, chronic renal failure, poorly controlled diabetes mellitus, alcoholism, diet high in cholesterol and fats	Severe hepatocellular disease, hyperthyroidism, malnutrition, chronic anemias, severe burns
HDL-C (high-density lipoprotein cholesterol)	*Men:* 35–65 mg/dL *Women:* 35–80 mg/dL	A class of lipoproteins produced by the liver and intestines; the "good" cholesterol	HDL excess, chronic liver disease, long-term aerobic or vigorous exercise	Familial hypolipoproteinemia, familial hypertriglyceridemia, poorly controlled diabetes mellitus, chronic renal failure
LDL (low-density lipoprotein)	*Adults (desirable):* <130 mg/dL	Up to 70% of the total serum cholesterol is present in LDL; the "bad" cholesterol	Type II familial hyperlipidemia. Secondary causes can include diet high in cholesterol and saturated fat, nephritic syndrome, multiple myeloma, diabetes mellitus, chronic renal failure	Hypolipoproteinemia, hyperthyroidism, chronic anemias, severe hepatocellular disease
Triglycerides	*Desirable:* <150 mg/dL	This test evaluates suspected atherosclerosis and measures the body's ability to metabolize fat	Hyperlipoproteinemia, liver disease, renal disease, hypothyroidism, pancreatitis, myocardial infarction	Malnutrition, hyperthyroidism, brain infarction, chronic obstructive lung disease

Capillary blood specimens are commonly obtained from the lateral aspect or side of the finger in adults. This site avoids the nerve endings and calloused areas at the fingertip. The earlobe may be used if the client is in shock or the fingers are edematous. Some newer monitors allow for obtaining specimens from less sensitive areas on the arms, legs, or abdomen (i.e., AST).

Skill 34-1 describes how to obtain a capillary blood specimen and measure blood glucose using a portable meter.

SKILL34-1

Obtaining a Capillary Blood Specimen to Measure Blood Glucose

PURPOSES

- To determine or monitor blood glucose levels of clients at risk for hyperglycemia or hypoglycemia
- To promote blood glucose regulation by the client
- To evaluate the effectiveness of insulin administration

ASSESSMENT

Before obtaining a capillary blood specimen, determine:

- The policies and procedures for the facility
- The frequency and type of testing
- The client's understanding of the procedure
- The client's response to previous testing.
- Assess the client's skin at the puncture site to determine if it is intact and the circulation is not compromised. Check color, warmth, and capillary refill.
- Review the client's record for medications that may prolong bleeding such as anticoagulants, or medical problems that may increase the bleeding response.
- Assess the client's self-care abilities that may affect accuracy of test results, such as visual impairment and finger dexterity.

PLANNING

DELEGATION

Check the applicable nurse practice act and the facility policy and procedure manual to determine who can perform this skill. It is usually considered an invasive technique and one that requires problem solving and application of knowledge. It is the responsibility of the nurse to know the results of the test, and supervise unlicensed assistive personnel (UAP) responsible for assisting the nurse.

Equipment

- Blood glucose meter (glucometer)
- Blood glucose reagent strip compatible with the meter
- 2 × 2 gauze
- Warm cloth or other warming device (optional)
- Antiseptic swab
- Clean gloves
- Sterile lancet (a sharp device to puncture the skin)
- Lancet injector (a spring-loaded mechanism that holds the lancet)

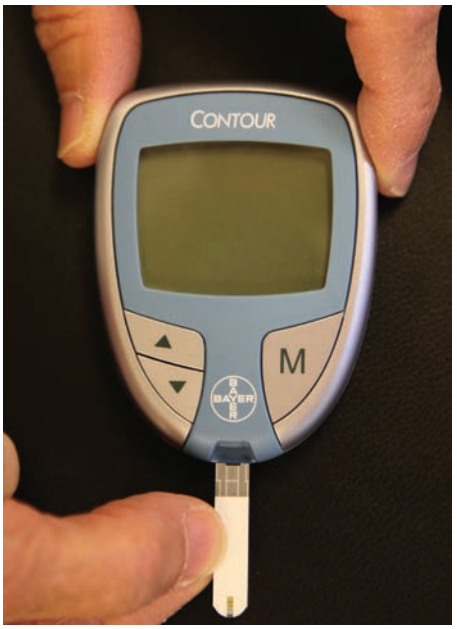
IMPLEMENTATION

Preparation

Review the type of meter and the manufacturer's instructions. Assemble the equipment at the bedside.

Performance

1. Prior to performing the procedure, introduce self and verify the client's identity using agency protocol. Explain to the client what you are going to do, why it is necessary, and how he or she can participate. Discuss how the results will be used in planning further care or treatments.
2. Perform hand hygiene and observe other appropriate infection prevention procedures.
3. Provide for client privacy.
4. Prepare the equipment.
   - Some meters turn on when a test strip is inserted into the meter. ❶
   - Calibrate the meter and run a control sample according to the manufacturer's instructions and/or confirm the code number. The newer no-code models do not require calibration. The technology is integrated into the test strips.
5. Select and prepare the vascular puncture site.
   - Choose a vascular puncture site (e.g., the side of an adult's finger). Avoid sites beside bone. Wrap the finger first in a warm cloth *or* hold a finger in a dependent (below heart level) position. If the earlobe is used, rub it gently with a small piece of gauze. **Rationale:** *These actions increase the blood flow to the area, ensure an adequate specimen, and reduce the need for a repeat puncture.*
   - Clean the site with the antiseptic swab or soap and water and allow it to dry completely. **Rationale:** *Alcohol can affect accuracy, and the site stings when punctured if wet with alcohol.*



❶ Insert the test strip into the meter.

Obtaining a Capillary Blood Specimen to Measure Blood Glucose—*continued*

2 Place the injector against the site.

3 Apply the blood to the test strip.

6. Obtain the blood specimen.
- Apply gloves.
- Place the injector, if used, against the site, and release the needle, thus permitting it to pierce the skin. Make sure the lancet is perpendicular to the site. **Rationale:** *The lancet is designed to pierce the skin at a specific depth when it is in a perpendicular position relative to the skin.* 2

  or
- Prick the site with a lancet or needle, using a darting motion.
- Gently squeeze (but do not touch) the puncture site until a drop of blood forms. The size of the drop of blood can vary depending on the meter. Some meters require as little as 0.3 mL of blood to accurately test blood sugar.
- Hold the reagent strip under the puncture site until adequate blood covers the indicator square. The pad will absorb the blood and a chemical reaction will occur. Do not smear the blood. **Rationale:** *Smearing will cause an inaccurate reading.*
- Some meters wick the blood by just touching the puncture site with the strip. 3
- Ask the client to apply pressure to the skin puncture site with a 2×2 gauze. **Rationale:** *Pressure will assist hemostasis.*

7. Expose the blood to the test strip for the period and the manner specified by the manufacturer. As soon as the blood is placed on the test strip:
- Follow the manufacturer's recommendations on the glucose meter and monitor for the amount of time indicated by the manufacturer. **Rationale:** *The blood must remain in contact with the test strip for a prescribed time to obtain accurate results.*

  Some glucometers have the test strip placed in the machine before the specimen is obtained.

8. Measure the blood glucose.
- Place the strip into the meter according to the manufacturer's instructions. Refer to the specific manufacturer's recommendations for the specific procedure.
- After the designated time, most glucose meters will display the glucose reading automatically. Correct timing ensures accurate results. 4

4 Read the results.

- Turn off the meter and discard the test strip and 2×2 gauze in a biohazard container. Discard the lancet into a sharps container.
- Remove and discard gloves.
- Perform hand hygiene.

9. Document the method of testing and results on the client's record. If appropriate, record the client's understanding and ability to demonstrate the technique. The client's record may also include a flow sheet on which capillary blood glucose results and the amount, type, route, and time of insulin administration are recorded. Always check if a diabetic flow sheet is being used for the client.

10. Check for orders for sliding scale insulin based on capillary blood glucose results. Administer insulin as prescribed.

Continued on page 728

Obtaining a Capillary Blood Specimen to Measure Blood Glucose—*continued*

SKILL 34-1

EVALUATION

- Compare glucose meter reading with normal blood glucose level, status of puncture site, and motivation of the client to perform the test independently.
- Relate blood glucose reading to previous readings and the client's current health status.
- Report abnormal results to the primary care provider. Some agencies may have a standing policy to obtain a venipuncture blood glucose if the capillary blood glucose exceeds a certain value.
- Conduct appropriate follow-up such as asking the client to explain the meaning of the results and/or demonstrating the procedure at the next scheduled test.
- Prepare the client for home glucose monitoring and review frequency, record keeping, and insulin administration if appropriate.

LIFESPAN CONSIDERATIONS Capillary Blood Glucose

INFANTS

- The outer aspect of the heel is the most common site for neonates and infants. Placing a warm cloth on the infant's heel often increases the blood flow to the area.

CHILDREN

- Use the side of a fingertip for a young client older than age 2, unless contraindicated.
- Allow the child to choose the puncture site, when possible.
- Praise the young client for cooperating and assure the child that the procedure is not a punishment.

OLDER ADULTS

- Older adults may have arthritic joint changes, poor vision, or hand tremors and may need assistance using the glucose meter or obtaining a meter that accommodates their limitations.
- Older adults may have difficulty obtaining diabetic supplies due to financial concerns or homebound status.
- Older adults often have poor circulation. Warming the hands by wrapping with a warm washcloth for 3 to 5 minutes or placing the hand dependent for a few moments may help in obtaining a blood sample.

Home Care Considerations Capillary Blood Glucose

PATIENT-CENTERED CARE

- Assess the client or caregiver's ability and willingness to perform blood glucose monitoring at home.
- Teach the proper use of the lancet and glucose monitor, and provide written guidelines. Allow time for a return demonstration. The client may need several visits to completely learn the procedure.
- Ensure the client's ability to obtain supplies and purchase reagent strips. The strips are relatively expensive and may not be covered by the client's insurance.
- Stress the importance of record keeping. Instruct the client on when to do glucose monitoring, how to record the blood glucose levels, and when to notify the primary care provider.
- Children with diabetes who need to perform finger-sticks should be taught about safe practices for cleaning blood from surfaces (household bleach is best) and about safe storage of equipment to prevent other children from gaining access to it. Identify a place in the school where the child can store glucose-monitoring equipment and perform the procedure in private.

SPECIMEN COLLECTION AND TESTING

The nurse contributes to the assessment of a client's health status by collecting specimens of body fluids. All hospitalized clients have at least one laboratory specimen collected during their stay at a health care facility. Laboratory examination of specimens such as urine, blood, stool, sputum, and wound drainage provides important adjunct information for diagnosing health care problems and also provides a measure of the responses to therapy.

Nurses often assume the responsibility for specimen collection. Depending on the type of specimen and skill required, the nurse may be able to delegate this task to UAP under the supervision of the nurse.

Nursing responsibilities associated with specimen collection include the following:

- Provide client comfort, privacy, and safety. Clients may experience embarrassment or discomfort when providing a specimen. The nurse should provide the client with as much privacy as possible and handle the specimen discreetly. The nurse needs to be nonjudgmental and sensitive to possible sociocultural beliefs that may affect the client's willingness to participate in the specimen collection procedure.
- Explain the purpose of the specimen collection and the procedure for obtaining the specimen. Clients may experience anxiety about the procedure, especially if it is perceived as being intrusive or if they fear an unknown test result. A clear explanation will facilitate the client's cooperation in the collection of the specimen. With proper instruction, many clients are able to collect their own specimen, which promotes independence and reduces or avoids embarrassment.
- Use the correct procedure for obtaining a specimen or ensure that the client or staff follows the correct procedure. Aseptic technique is used in specimen collection to prevent contamination that can cause inaccurate test results. A nursing procedure or laboratory manual is often available if the nurse is unfamiliar with the procedure. If there is any question about the procedure, the nurse calls the laboratory for directions before collecting the specimen.
- Note relevant information on the laboratory requisition slip, for example, medications the client is taking that may affect the results.

- Transport the specimen to the laboratory promptly. Fresh specimens provide more accurate results.
- Report abnormal laboratory findings to the health care provider in a timely manner consistent with the severity of the abnormal results.

Stool Specimens

Analysis of stool specimens can provide information about a client's health condition. Some of the reasons for testing feces include the following:

- To determine the presence of **occult** (hidden) **blood**. Bleeding can occur as a result of gastrointestinal ulcers, inflammatory disease, or tumors. The test for occult blood, often referred to as the **guaiac test**, can be readily performed by the nurse in the clinical area or by the client at home. Guaiac paper used in the test is sensitive to fecal blood content.
- To analyze for dietary products and digestive secretions. For example, an excessive amount of fat in the stool (**steatorrhea**) can indicate faulty absorption of fat from the small intestine. A decreased amount of bile can indicate obstruction of bile flow from the liver and gallbladder into the intestine. For these kinds of tests, the nurse needs to collect and send the total quantity of stool expelled at one time instead of a small sample.
- To detect the presence of ova and parasites. When collecting specimens for parasites, it is important that the sample be transported immediately to the laboratory while it is still warm. Usually three stool specimens, over a period of days, are evaluated to confirm the presence of and to identify the organism so that appropriate treatment can be ordered.
- To detect the presence of bacteria or viruses. Only a small amount of feces is required because the specimen will be cultured. Collection containers or tubes must be sterile and aseptic technique used during collection. Stools need to be sent immediately to the laboratory. The nurse needs to note on the laboratory requisition if the client is receiving any antibiotics.

COLLECTING STOOL SPECIMENS

The nurse is responsible for collecting stool specimens ordered for laboratory analysis. Before obtaining a specimen, the nurse needs to determine the reason for collecting the stool specimen and the correct method of obtaining and handling it (i.e., how much stool to obtain, whether a preservative needs to be added to the stool, and whether it needs to be sent immediately to the laboratory). It may be necessary to confirm this information by checking with the agency laboratory. In many situations only a single specimen is required; in others, timed specimens are necessary, and every stool passed is collected within a designated time period.

UAP may obtain and collect stool specimen(s) in certain situations, so the nurse needs to consider the collection process before delegating this task. For example, a random stool specimen collected in a specimen container may be delegated, but the nurse should do a stool culture requiring a sterile swab in a test tube. An incorrect collection technique can cause inaccurate test results.

The task of obtaining and testing a stool specimen for occult blood may be performed by UAP. It is important for the nurse to instruct the UAP to inform the nurse if blood is detected and/or whether the test is positive. In addition, the stool specimen should be saved to allow the nurse to repeat the test.

Nurses need to give clients the following instructions:

- Defecate in a clean bedpan or bedside commode.
- If possible, do not contaminate the specimen with urine or menstrual discharge. Void before the specimen collection.
- Do not place toilet tissue in the bedpan after defecation. Contents of the paper can affect the laboratory analysis.
- Notify the nurse as soon as possible after defecation, particularly for specimens that need to be sent to the laboratory immediately.

When obtaining stool samples—that is, when handling the client's bedpan, when transferring the stool sample to a specimen container, and when disposing of the bedpan contents—the nurse follows medical aseptic technique meticulously. Wear clean gloves to prevent hand contamination and take care not to contaminate the outside of the specimen container. Use one or two clean tongue blades to transfer the specimen to the container and then wrap them in a paper towel before disposing of them in the waste container. This practice reduces the chance of contact with other articles and the spread of microorganisms. The amount of stool to be sent depends on the purpose for which the specimen is collected. Usually about 2.5 cm (1 in.) of formed stool or 15 to 30 mL of liquid stool is adequate. For some timed specimens, however, the entire stool passed may need to be sent. Visible pus, mucus, or blood should be included in sample specimens. For a stool culture, the nurse dips a sterile swab into the specimen, preferably where purulent fecal matter is present and, using sterile technique, places the swab in a sterile test tube.

Ensure that the specimen label and the laboratory requisition have the correct information on them and are securely attached to the specimen container. Inappropriate identification of the specimen risks errors of diagnosis or therapy for the client.

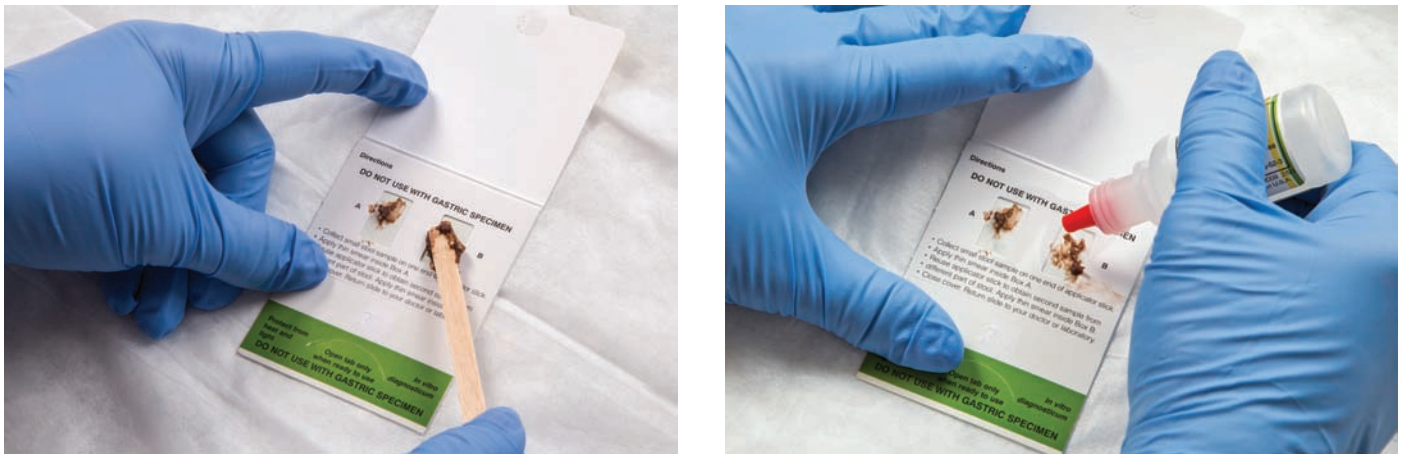
Because fresh specimens provide the most accurate results, the nurse sends the specimen to the laboratory immediately. If this is not possible, the nurse follows the directions on the specimen container. In some instances, refrigeration is indicated because bacteriologic changes take place in stool specimens left at room temperature. To prevent contamination, never place a stool specimen in a refrigerator that contains food or medication.

Document all relevant information. Record the collection of the specimen on the client's chart and on the nursing care plan. Include in the recording the date and time of the collection and all nursing assessments (e.g., color, odor, consistency, and amount of feces); presence of abnormal constituents, such as blood or mucus; results of test for occult blood if obtained; discomfort during or after defecation; status of perianal skin; and any bleeding from the anus after defecation.

FECAL OCCULT BLOOD TESTING

Fecal occult blood testing (FOBT) is the most frequently performed fecal analysis. There are two types of FOBT: the traditional guaiac smear (Hemoccult) and the fecal immunochemical test (FIT).

A commonly used test product to measure occult blood is the Hemoccult test, which uses a chemical **reagent** (substance used in a chemical reaction to detect a specific substance). This reagent detects the presence of the enzyme peroxidase in the hemoglobin molecule. To perform the test, the nurse or client uses a tongue blade to place a small amount of stool on a slide or card and then closes the card. The card is turned over and two drops of a reagent are placed onto each smear on the back of the card. The nurse then observes for a color change (Figure 34–3 ■). A blue color indicates a guaiac-positive



A B

Figure 34–3 ■ *A*, Opening the front cover of a Hemoccult slide and applying a thin smear of feces on the slide. *B*, Opening the flap on the back of the slide and applying two drops of developing fluid over each smear.

result, that is, the presence of occult blood. No color change or any color other than blue is a negative finding, indicating the absence of blood in the stool. Because the results are color based, a nurse who is color blind should not be responsible for reading the results.

Certain foods, medications, and vitamin C produce inaccurate test results. False-positive results can occur if the client has recently ingested (a) red meat (beef, lamb, liver, and processed meats); (b) raw vegetables or fruits, particularly radishes, turnips, horseradish, and melons; or (c) certain medications that irritate the gastric mucosa and cause bleeding, such as aspirin or other nonsteroidal anti-inflammatory drugs, steroids, iron preparations, and anticoagulants. False-negative results can occur if the client has taken more than 250 mg/day of vitamin C from all sources (dietary and supplemental) up to 3 days before the test—even if bleeding is present.

The newer method used for FOBT is the FIT, which has a higher sensitivity and specificity for the detection of cancer (Daly, 2012, p. 67). When comparing the two types of FOBT, the FIT has the following advantages: No dietary or medication restrictions, fewer false positives, and requires only two samples as opposed to the three required for the guaiac test. There are two different types of FITs: a liquid-based method that stores the stool sample in a liquid buffer and a dry-slide method, which stores the sample on a collection card. A new noninvasive test for colon cancer, called Cologuard, was recommended for approval to the Food and Drug Administration in March, 2014. It is a noninvasive stool DNA test for colorectal cancer screening. The DNA test measures human hemoglobin and certain cancer-specific mutations (NewsCAP, 2014).

Guidelines for instructing clients to collect their stool for occult blood are listed in Client Teaching.

CLIENT TEACHING

Collecting Stool for Occult Blood

USING THE HEMOCCULT TEST

- Avoid restricted foods, medications, and vitamin C for the period recommended by the manufacturer and during the test. Usually specified foods and vitamin C are restricted for 3 days before the test and specified medications for 7 days before the test.
- Use a ballpoint pen to label the specimens with your name, address, age, and date of specimen. Usually three specimens are collected from consecutive and different bowel movements. Each specimen must be dated accurately.
- Avoid collecting specimens during your menstrual period and for 3 days afterward, and while you have bleeding hemorrhoids or blood in your urine.
- Remove toilet bowl cleaners from the toilet bowl. Flush the toilet twice before proceeding with the test.
- Avoid contaminating the specimen with urine or toilet tissue. Empty your bladder before the test. To facilitate specimen collection, transfer the stool to a clean, dry container. Wear clean gloves.
- Use the tongue blade provided to transfer the specimen to the test folder or tape. Only a small amount of stool is required. Take the sample from the center of a formed stool to ensure a uniform sample.
- Wrap the tongue blade in a paper towel and dispose of it in the waste receptacle. Do not flush the stick.
- Follow the manufacturer's directions explicitly for the test product being used. Test products vary. For example, for the Hemoccult test, a thin layer of feces is smeared over the boxes inside the envelope, and a drop of developing solution is applied on the opposite side of the specimen paper. For the Hematest, a thin layer of feces is smeared onto guaiac filter paper, a tablet is placed in the middle of the specimen, and two or three drops of water are added to the tablet. If there is space for two specimens in the test folder, take the sample from two different areas of the stool specimen.
- Consult your health care provider if there is any problem understanding the instructions.
- Return completed specimens to your primary care provider or laboratory as instructed.

USING FITS

- The sampling procedure varies depending on the specific test. For the liquid FIT, a test strip inside the sampling tube is exposed to the stool sample and the resulting change in color indicates a positive or negative result (Daly, 2012, p. 68). For the dry-slide method, the sample is collected using a long-handled brush to stroke the surface of the stool while in the toilet bowl. The brush bristles are then dabbed on the test card. After the card is dried, the sample is sent to the laboratory for testing (Kessenich & Cronin, 2013, p. 7).

LIFESPAN CONSIDERATIONS **Stool Specimen**

INFANTS
- To collect a stool specimen for an infant, the stool is scraped from the diaper, being careful not to contaminate the stool with urine.

CHILDREN
- A child who is toilet trained should be able to provide a fecal specimen, but may prefer being assisted by a parent.
- When explaining the procedure to the child, use words appropriate for the child's age rather than medical terms. Ask the parent what words the family normally uses to describe a bowel movement.
- A specimen for pinworms is collected by the parent early in the morning, after sleep and before the child has a bowel movement. Scotch tape is attached to a tongue blade and the sticky side is laid flat against the perineum and anus to pick up any eggs or small worms. The tongue blade is then examined under a microscope.

OLDER ADULTS
- Older adults may need assistance if serial stool specimens are required.

Home Care Considerations **Stool Specimen** PATIENT-CENTERED CARE

- Ask the client or caregiver to call when the stool specimen is obtained. If a laboratory test is needed, the home health nurse can pick up the specimen or a family member may take it to the laboratory.
- Place the stool specimen inside a plastic biohazard bag. Carry the bag in a sealed container marked "Biohazard" and take it to the laboratory promptly. Do not expose the specimen to extreme temperatures in the car.

Evidence-Based Practice **Is There an Effective Strategy to Improve the Use of Colorectal Cancer Screening Among Medically Underserved Populations?** EVIDENCE-BASED PRACTICE

Colorectal cancer is the second leading cause of cancer death in the United States, and screening can greatly reduce its morbidity and mortality rates. Jean-Jacques et al. (2012) state that "despite improvements in the rate of colorectal cancer screening, marked disparities persist, with lower rates of colorectal cancer screening among racial and ethnic minorities, individuals with lower income or lower educational attainment, the uninsured, and individuals who were not born in the United States" (pp. 412–413). Earlier studies have shown that the direct mailing of FOBT kits to clients who are due for colorectal cancer screening has been both clinically effective and cost effective. Most of those studies, however, did not include clients with lower socioeconomic status or from racial or ethnic minority groups. Thus this group of researchers sought to examine the effects of direct mailing of FOBT kits to clients who were overdue for colorectal cancer screening and were receiving care at a community health center that served a low-income population with a high percentage of immigrants and refugees.

This randomized controlled trial consisted of 202 eligible participants; that is, they were between 50 and 80 years old, had at least two visits to the study site, and were due for colorectal cancer screening. The participants were randomly assigned to one of two groups: 98 to the usual care group and 104 to the outreach intervention. The participants in the usual care group were referred for colorectal cancer screening per the usual health center protocol. The outreach intervention participants were sent a mailing that included a letter notifying them that it was time for the colorectal cancer screening and encouraging them to use the enclosed FOBT, instructions for using the FOBT, and a colorectal cancer fact sheet. All were instructed to return the completed FOBT kit to the health center laboratory in person or to use the postage-paid envelope. The study included additional telephone outreach every 2 weeks to participants who had not responded.

The outcome measure was the percentage of participants who completed the FOBT within 4 months after the start of the outreach protocol. Thirty percent of the participants (31 of 104) of the outreach intervention and 5% of the participants (5 of 98) of the usual care group completed colorectal cancer screening. This study demonstrated that the outreach strategy improves colorectal cancer screening rates among economically disadvantaged clients from a wide range of racial, ethnic, and cultural backgrounds.

IMPLICATIONS
The results show that the outreach strategy of direct mailing of FOBT kits to clients is a positive approach to improving colorectal cancer screening for clients in underserved communities. The authors made the important point that this strategy overcomes barriers to colorectal screening because the clients did not have to miss work in order to complete the screening at a clinic, did not have to worry about obtaining transportation to a clinic, and did not need to take time away from family obligations.

Urine Specimens

The nurse is responsible for collecting urine specimens for a number of tests: **clean voided urine specimens** for routine urinalysis, **clean-catch** or **midstream urine specimens** for urine culture, and timed urine specimens for a variety of tests that depend on the client's specific health problem. Urine specimen collection may require collection via straight catheter insertion. If this is necessary, refer to Chapter 48 ∞, Skill 48–2.

CLEAN VOIDED URINE SPECIMEN

A clean voided specimen is usually adequate for routine examination. Many clients are able to collect a clean voided specimen and provide the specimen independently with minimal instructions. Male clients generally are able to void directly into the specimen container, and female clients usually sit or squat over the toilet, holding the container between their legs during voiding. Routine urine examination is usually done on the first voided specimen in the morning because

it tends to have a higher, more uniform concentration and a more acidic pH than specimens later in the day.

At least 10 mL of urine is generally sufficient for a routine urinalysis. Clients who are seriously ill, physically incapacitated, or disoriented may need to use a bedpan or urinal in bed; others may require supervision or assistance in the bathroom. Whatever the situation, clear and specific directions are required:

- The specimen must be free of fecal contamination, so urine must be kept separate from feces.
- Female clients should discard the toilet tissue in the toilet or in a waste bag rather than in the bedpan because tissue in the specimen makes laboratory analysis more difficult.
- Put the lid tightly on the container to prevent spillage of the urine and contamination of other objects.
- If the outside of the container has been contaminated by urine, clean it with a disinfectant.

The nurse must (a) make sure that the specimen label and the laboratory requisition carry the correct information and (b) attach them securely to the specimen. Inappropriate identification of the specimen can lead to errors of diagnosis or therapy for the client.

UAP may be assigned to collect a routine urine specimen. Provide the UAP with clear directions on how to instruct the client to collect his or her own urine specimen or how to correctly collect the specimen for the client who may need to use a bedpan or urinal.

CLINICAL ALERT!

Kidney function directly relates to cardiac output. Therefore, any health problem that changes cardiac output may affect urine output.

CLEAN-CATCH OR MIDSTREAM URINE SPECIMEN

Clean-catch or midstream voided specimens are collected when a urine culture is ordered to identify microorganisms causing a urinary tract infection. Although some contamination by skin bacteria may occur with a clean-catch specimen, the risk of introducing microorganisms into the urinary tract through catheterization is more significant. Care is taken to ensure that the specimen is as free as possible from contamination by microorganisms around the urinary meatus. Clean-catch specimens are collected in a sterile specimen container with a lid (Figure 34–4 ■). Disposable clean-catch kits are available. Skill 34-2 explains how to collect a clean-catch urine specimen for culture.

Figure 34–4 ■ Disposable clean-catch specimen equipment.

Collecting a Urine Specimen for Culture and Sensitivity by Clean Catch

SKILL 34-2

PURPOSE

- To determine the presence of microorganisms, the type of organism(s), and the antibiotics to which the organisms are sensitive

ASSESSMENT

- Determine the ability of the client to provide the specimen.
- Assess the color, odor, and consistency of the urine and the presence of clinical signs of urinary tract infection (e.g., frequency, urgency, dysuria, hematuria, flank pain, cloudy urine with foul odor).

PLANNING

DELEGATION

UAP may perform the collection of a clean-catch or midstream urine specimen. It is important, however, for the nurse to inform the UAP about how to instruct the client in the correct process for obtaining the specimen. Proper cleansing of the urethra should be emphasized to avoid contaminating the urine specimen.

Equipment

Equipment used varies from agency to agency. Some agencies use commercially prepared disposable clean-catch kits. Others use agency-prepared sterile trays. Both prepared trays and kits generally contain the following items:

- Clean gloves
- Antiseptic towelettes
- Sterile specimen container
- Specimen identification label.

In addition the nurse needs to obtain the following:

- Completed laboratory requisition form
- Urine receptacle, if the client is not ambulatory
- Basin of warm water, soap, washcloth, and towel for the nonambulatory client.

Collecting a Urine Specimen for Culture and Sensitivity by Clean Catch—*continued*

IMPLEMENTATION

Preparation

Gather the necessary equipment needed for the collection of the specimen. Use visual aids, if available, to assist the client to understand the midstream collection technique.

Performance

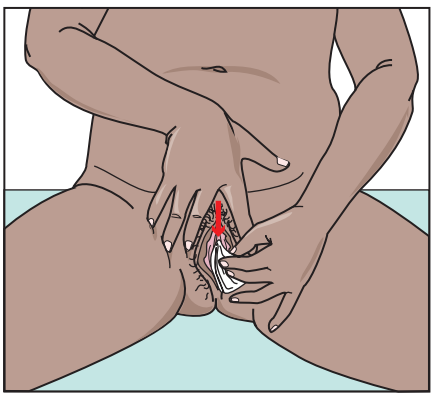
1. Prior to performing the procedure, introduce self and verify the client's identity using agency protocol. Explain to the client that a urine specimen is required, give the reason, and explain the method to be used to collect it. Discuss how the results will be used in planning further care or treatments.
2. Perform hand hygiene and observe other appropriate infection prevention procedures.
3. Provide for client privacy.
4. For an ambulatory client who is able to follow directions, instruct the client on how to collect the specimen.
   - Direct or assist the client to the bathroom.
   - Ask the client to wash and dry the genitals and perineal area with soap and water. **Rationale:** *Washing the perineal area reduces the number of skin and transient bacteria, decreasing the risk of contaminating the urine specimen.*
   - Ask the client if he or she is sensitive to any antiseptic or cleansing agent. **Rationale:** *This will avoid unnecessary irritation of the genitals or perineum.*
   - Instruct the client on how to clean the urinary meatus with antiseptic towelettes. **Rationale:** *The antiseptic further reduces bacterial contamination of the urinary meatus and the risk of contaminating the specimen.*

For Female Clients

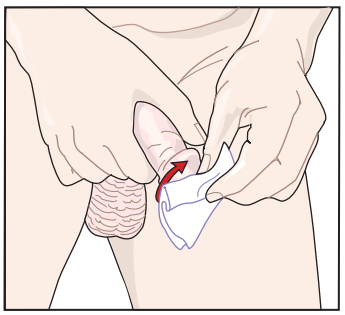
- Use each towelette only once. Clean the perineal area from front to back and discard the towelette. ❶ Use all towelettes provided (usually two or three). **Rationale:** *Cleaning from front to back cleans the area of least contamination to the area of greatest contamination.*

For Male Clients

- If uncircumcised, retract the foreskin slightly to expose the urinary meatus.
- Using a circular motion, clean the urinary meatus and the distal portion of the penis. ❷ Use each towelette only once, then discard. Clean several inches down the shaft of the penis. **Rationale:** *This cleans from the area of least contamination to the area of greatest contamination.*



❶ Cleansing the female urinary meatus. Spread the labia minora with one hand and with the other hand, cleanse the perineal area from front to back.



❷ Cleansing the male urinary meatus. Retract the foreskin if needed. Using a towelette, cleanse the urinary meatus by moving in a circular motion from the center of the urethral opening around the glans and down the distal portion of the shaft of the penis.

5. For a client who requires assistance, prepare the client and equipment.
   - Apply clean gloves.
   - Wash the perineal area with soap and water, rinse, and dry.
   - Assist the client onto a clean commode or bedpan. If using a bedpan or urinal, position the client as upright as allowed or tolerated. **Rationale:** *Assuming a normal anatomic position for voiding facilitates urination.*
   - Remove and discard gloves.
   - Perform hand hygiene.
   - Open the clean-catch kit, taking care not to contaminate the inside of the specimen container or lid. **Rationale:** *It is important to maintain sterility of the specimen container to prevent contamination of the specimen.*
   - Apply clean gloves.
   - Clean the urinary meatus and perineal area as described in step 4.
6. Collect the specimen from a nonambulatory client or instruct an ambulatory client on how to collect it.
   - Instruct the client to start voiding. **Rationale:** *Bacteria in the distal urethra and at the urinary meatus are cleared by the first few milliliters of urine expelled.*
   - Place the specimen container into the midstream of urine and collect the specimen, taking care not to touch the container to the perineum or penis. **Rationale:** *It is important to avoid contaminating the interior of the specimen container and the specimen itself.*
   - Collect urine in the container.
   - Cap the container tightly, touching only the outside of the container and the cap. **Rationale:** *This prevents contamination or spilling of the specimen.*
   - If necessary, clean the outside of the specimen container with disinfectant. **Rationale:** *This prevents transfer of microorganisms to others.*
   - Remove and discard gloves.
   - Perform hand hygiene.
7. Label the specimen and transport it to the laboratory.
   - Ensure that the specimen label is attached to the specimen cup, not the lid, and that the laboratory requisition provides the correct information. Place the specimen in a plastic bag that has a biohazard label on it. Attach the requisition securely to the bag. **Rationale:** *Inaccurate identification or information on the specimen container risks errors in diagnosis or therapy.*
   - Arrange for the specimen to be sent to the laboratory immediately. **Rationale:** *Bacterial cultures must be started immediately before any contaminating organisms can grow, multiply, and produce false results.*

Continued on page 734

Collecting a Urine Specimen for Culture and Sensitivity by Clean Catch—*continued*

SKILL 34-2

8. Document pertinent data.
- Record collection of the specimen, any pertinent observations of the urine such as color, odor, or consistency, and any difficulty in voiding that the client experienced.
- Indicate on the laboratory slip if the client is taking any current antibiotic therapy or if the client is menstruating.

SAMPLE DOCUMENTATION

6/15/15 0800 Informed of MD order for clean-catch urine for C&S. Instructed how to perform. Stated she understood. Urine specimen cloudy. States she continues to have burning on urination. Urine specimen sent to laboratory. Antibiotic started per MD orders.
——————————————————————T. Sanchez, RN

EVALUATION

- Report laboratory results to the primary care provider.
- Discuss findings of the laboratory test with primary care provider.
- Conduct appropriate follow-up nursing interventions as needed, such as administering ordered medications and client teaching.

LIFESPAN CONSIDERATIONS Urine Specimen

INFANTS

- Clean the perineal area and the urethral opening as you would with an adult client. Apply a specimen bag that has an adhesive backing that attaches to the skin. After the infant has voided the desired amount, gently remove the bag from the skin.

CHILDREN

- When collecting a routine urine specimen, explain the procedure in simple nonmedical terms appropriate to the child and ask the child to void using a clean collecting receptacle (e.g., specimen cup, potty chair, bedpan, toilet collection device).
- Give the child a clean specimen container to play with.
- Allow a parent to assist the child, if possible. The child may feel more comfortable with a parent present.
- For sterile urine specimens, straight catheterization may be necessary, in which a urinary catheter is inserted using sterile technique, the specimen is obtained, and the catheter is removed.

OLDER ADULTS

- For a clean-catch urine specimen, older adults may have difficulty controlling the stream of urine.
- Older women with arthritis may have difficulty holding the labia apart during the collection of clean-catch urine.

Home Care Considerations Urine Specimen

PATIENT-CENTERED CARE

- Assess the client's ability and willingness to collect a timed urine specimen. If poor eyesight or hand tremors are a problem, suggest using a clean funnel to pour the urine into the container.
- Always wash hands well with warm, soapy water before and after collecting urine samples.
- Always wear gloves if handling another person's urine.
- The home should have a refrigerator or other method for cooling the urine samples. Tell the client to keep the specimen container in plastic in the refrigerator, separate from other refrigerator contents. The client may also use a cooler with ice.

TIMED URINE SPECIMEN

Some urine examinations require collection of all urine produced and voided over a specific period of time, ranging from 1 to 2 hours to 24 hours. Timed specimens generally either are refrigerated or contain a preservative to prevent bacterial growth or decomposition of urine components. Each voiding of urine is collected in a small, clean container and then emptied immediately into the large refrigerated bottle or carton.

Timed urine specimens tests are performed for the following purposes:

- To assess the ability of the kidney to concentrate and dilute urine.
- To determine disorders of glucose metabolism, for example, diabetes mellitus.
- To determine levels of specific constituents, for example, albumin, amylase, creatinine, urobilinogen, or certain hormones (e.g., estriol or corticosteroids), in the urine.

To collect a timed urine specimen, follow these steps:

- Obtain a specimen container with preservative (if indicated) from the laboratory. Label the container with identifying information for the client, the test to be performed, time started, and time of completion.
- Provide a clean receptacle to collect urine (bedpan, commode, or toilet collection device).
- Post signs in the client's chart or electronic medical record, Kardex, room, and bathroom alerting personnel to save all urine during the specified time.
- At the start of the collection period, have the client void and discard this urine.
- Save all urine produced during the timed collection period in the container, refrigerating or placing the container on ice as indicated. Avoid contaminating the urine with toilet paper or feces.
- At the end of the collection period, instruct the client to completely empty the bladder and save this voiding as part of the specimen. Take the entire amount of urine collected to the laboratory with the completed requisition.
- Record collection of the specimen, time started and completed, and any pertinent observations of the urine on appropriate records.

CLINICAL ALERT!

If the client or staff forgets and discards the client's urine during a timed collection, the procedure must be restarted from the beginning.

INDWELLING CATHETER SPECIMEN

Sterile urine specimens can be obtained from closed drainage systems by inserting a sterile needle attached to a syringe through a drainage port in the tubing. Aspiration of urine from catheters can be done only with self-sealing rubber catheters—not plastic, silicone, or Silastic catheters. When self-sealing rubber catheters are used, the needle is inserted just above the location where the catheter is attached to the drainage tubing. The area from which to obtain urine may be marked by a patch on the catheter.

Closed drainage urinary systems now have needleless ports, which means that needles are not needed to obtain a sample. This protects the nurse from a needlestick injury and maintains the integrity and sterility of the catheter system by eliminating the need to puncture the tubing. The needleless port accepts a Luer-Lok syringe (Figure 34–5 ■). Position the syringe perpendicular to the center of the port and insert, twist, and lock into the port. When the specimen is obtained and the syringe removed, the port seals itself.

To collect a specimen from a Foley (retention) catheter or a drainage tube, follow these steps:

- Apply clean gloves.
- If there is no urine in the catheter, clamp the drainage tubing at least 8 cm (3 in.) below the sampling port for about 30 minutes. This allows fresh urine to collect in the catheter.
- Wipe the area where the needle or Luer-Lok syringe will be inserted with a disinfectant swab. The site should be distal to the tube leading to the balloon to avoid puncturing this tube. Disinfecting the needle insertion site removes any microorganisms on the surface of the catheter, thereby avoiding contamination of the needle and the entrance of microorganisms into the catheter.
- Insert the needle at a 30- to 45-degree angle. This angle of entrance facilitates self-sealing of the rubber. Insert the Luer-Lok syringe at a 90-degree angle for the needleless port.
- Unclamp the catheter.
- Withdraw the required amount of urine, for example, 3 mL for a urine culture or 30 mL for a routine urinalysis.
- Transfer the urine to the specimen container. If a sterile culture tube is used, make sure the needle or syringe (depending on the system) does not touch the outside of the container.
- Discard the syringe and needle or syringe (depending on the system) in an appropriate sharps container.
- Cap the container.
- Remove gloves and discard.
- Perform hand hygiene.
- Label the container, and send the urine to the laboratory immediately for analysis or refrigeration.
- Record collection of the specimen and any pertinent observations of the urine on the appropriate records.

Figure 34–5 ■ Obtaining a urine specimen from a retention catheter using a needleless port.

URINE TESTING

Several simple urine tests are often done by nurses on the nursing units. These include tests for specific gravity, pH, and the presence of abnormal constituents such as glucose, ketones, protein, and occult blood.

Nurses in a health care facility or clients in the home setting can use commercially prepared kits to test for abnormal constituents in the urine. These kits contain the required equipment and an appropriate reagent, which may be in the form of a tablet, fluid, or paper test strip or dipstick. When the urine contacts the reagent, a chemical reaction occurs, causing a color change that is then compared with a chart to interpret the significance of the color (Figure 34–6 ■). Specific directions for the amount of urine needed, the time required for the chemical reaction, and the meaning of the colors produced vary among manufacturers. Thus it is essential that nurses and clients read and follow directions supplied by each manufacturer. In addition, testing materials need to be checked to ascertain that they are not outdated.

Urine testing may be performed by UAP. It is important for the UAP to understand the specific specimen collection procedure and report the results of the test to the nurse. Inform the UAP to save the urine sample to allow the nurse to repeat the test if necessary.

SPECIFIC GRAVITY **Specific gravity** is an indicator of urine concentration, or the amount of solutes (metabolic wastes and electrolytes) present in the urine. The specific gravity of distilled water is 1.00; the specific gravity of urine normally ranges from 1.010 to 1.025. As urine becomes more concentrated, its specific

Figure 34–6 ■ After dipping the reagent strip (dipstick) into fresh urine, wait the stated time period and compare the results to the color chart.

gravity increases. Excess fluid intake or diseases affecting the ability of the kidneys to concentrate urine can result in low specific gravity readings. A high specific gravity may indicate fluid deficit or dehydration, or excess solutes such as glucose in the urine. Specific gravity can be measured with the use of a multiple-test dipstick that has a separate reagent area for specific gravity.

URINARY pH Urinary pH is measured to determine the relative acidity or alkalinity of urine and assess the client's acid–base status. Quantitative measurements of urine pH can be performed in the laboratory, but dipsticks or litmus paper often are used on nursing units or in clinics to obtain less precise pH measurements. Urine normally is slightly acidic, with an average pH of 6 (7 is neutral, less than 7 is acidic, greater than 7 is alkaline). Because the kidneys play a critical role in regulating acid–base balance, assessment of urine pH can be useful in determining whether the kidneys are responding appropriately to acid–base imbalances. In metabolic acidosis, urine pH should decrease as the kidneys excrete hydrogen ions; in metabolic alkalosis, the pH should increase (see Chapter 52 ∞).

GLUCOSE Urine is tested for glucose to screen clients for diabetes mellitus and to assess clients during pregnancy for abnormal glucose tolerance. Normally, the amount of glucose in the urine is negligible, although individuals who have ingested large amounts of sugar may show small amounts of glucose in their urine.

Testing urine for glucose is *not* a measure of current blood glucose level and is considered an inadequate measurement. The American Diabetes Association (ADA) (n.d.) states that testing urine for glucose is *only* for people who *cannot or will not* test their blood glucose levels. It is important for clients to understand that urine testing is considered an inadequate measurement of blood glucose.

KETONES Ketone bodies, a product of the breakdown of fatty acids, normally are not present in the urine. They may, however, be found in the urine of clients with poorly controlled diabetes. Urine testing for ketone level is advised for type 1 diabetics who are at home and not feeling well, who are running a fever, or who have blood glucose consistently over 300 mg/dL (ADA, n.d.). Urine ketone testing with reagent tablets or a dipstick is also used to evaluate ketoacidosis in clients with alcoholism or those who are fasting, starving, or consuming high-protein diets.

PROTEIN Protein molecules normally are too large to escape from glomerular capillaries into the filtrate. If the glomerular membrane has been damaged, however (e.g., because of an inflammatory process such as glomerulonephritis), it can become "leaky," allowing proteins to escape. Urine testing for the presence of protein generally is done with a reagent strip (commonly referred to as a *dipstick*).

OCCULT BLOOD Normal urine is free from blood. When blood is present, it may be clearly visible or not visible (occult). Commercial reagent strips are used to test for occult blood in the urine.

CLINICAL ALERT!

Blood in urine is indicative of damage to the kidney or urinary tract.

OSMOLALITY **Urine osmolality** is a measure of the solute concentration of urine that is a more exact measurement of urine concentration than specific gravity. It is also used to monitor fluid and electrolyte balance. The particles included are nitrogenous wastes, such as creatinine, urea, and uric acid. Normal values are 50 to 1,200 mOsm/kg. The average urine osmolality is 200 to 800 mOsm/kg. An increased urine osmolality indicates a fluid volume deficit; a decreased urine osmolality reflects fluid volume excess. This test is sent to the laboratory rather than being tested at the bedside like the previous tests.

Sputum Specimens

Sputum is the mucous secretion from the lungs, bronchi, and trachea. It is important to differentiate it from **saliva**, the clear liquid secreted by the salivary glands in the mouth, sometimes referred to as "spit." Healthy individuals do not produce sputum. Clients need to cough to bring sputum up from the lungs, bronchi, and trachea into the mouth in order to expectorate it into a collecting container.

A UAP can obtain a sputum specimen that is expectorated by a client. It is important to instruct the UAP on when to collect the specimen, how to position the client, and how to correctly collect the specimen. Obtaining a sputum specimen by use of pharyngeal suctioning, however, should be performed by the nurse because it is an invasive process requiring aseptic technique and knowledge application and problem solving. A "sputum trap" is used when the specimen is obtained by suctioning. (See Chapter 50 ∞, Skill 50–2.)

Sputum specimens are usually collected for one or more of the following reasons:

- For culture and sensitivity to identify a specific microorganism and its drug sensitivities.
- For cytology to identify the origin, structure, function, and pathology of cells. Specimens for cytology often require serial collection of three early-morning specimens and are tested to identify cancer in the lung and its specific cell type.
- For acid-fast bacillus (AFB), which also requires serial collection, often for 3 consecutive days, to identify the presence of tuberculosis (TB). Some agencies use a special glass container when the presence of AFB is suspected.
- To assess the effectiveness of therapy.

Sputum specimens are often collected in the morning. Upon awakening, the client can cough up the secretions that have accumulated during the night. Sometimes specimens are collected during postural drainage, when the client can usually produce sputum. When a client cannot cough, the nurse must sometimes use pharyngeal suctioning to obtain a specimen.

To collect a sputum specimen, the nurse follows these steps:

- Offer mouth care so that the specimen will not be contaminated with microorganisms from the mouth.
- Ask the client to breathe deeply and then cough up 1 to 2 teaspoons (4 to 10 mL) of sputum.
- Wear gloves and personal protective equipment to avoid direct contact with the sputum. Follow special precautions if tuberculosis is suspected. Obtain the specimen in a room equipped with a special airflow system or ultraviolet light, or outdoors. If these options are not available, wear a mask capable of filtering droplet nuclei.
- Ask the client to **expectorate** (cough up) the sputum into the specimen container. Make sure the sputum does not contact the outside of the container (Figure 34–7 ■). If the outside of the container does become contaminated, wash it with a disinfectant.

Figure 34–7 ■ Sputum specimen container.

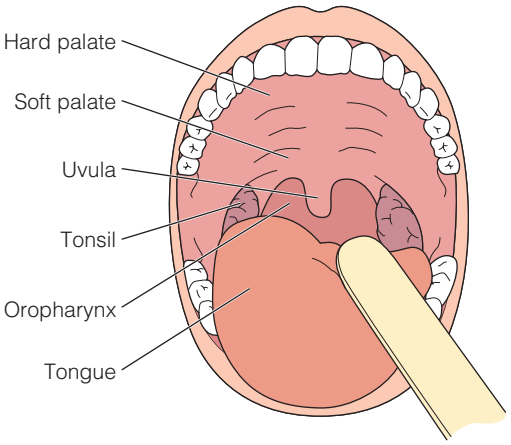


Figure 34–8 ■ Depressing the tongue to view the pharynx.

- Following sputum collection, offer mouthwash to remove any unpleasant taste.
- Label and transport the specimen to the laboratory. Ensure that the specimen label and the laboratory requisition contain the correct information. Arrange for the specimen to be sent to the laboratory immediately or refrigerated. Bacterial cultures must be started immediately before any contaminating organisms can grow, multiply, and produce false results.
- Document the collection of the sputum specimen on the client's chart. Include the amount, color, consistency (thick, tenacious, watery), presence of **hemoptysis** (blood in the sputum), odor of the sputum, any measures needed to obtain the specimen (e.g., postural drainage), and any discomfort experienced by the client.

Throat Culture

A throat culture sample is collected from the mucosa of the oropharynx and tonsillar regions using a culture swab. The sample is then cultured and examined for the presence of disease-producing microorganisms. Obtaining a throat culture is an invasive procedure that requires the application of scientific knowledge and potential problem solving to ensure client safety. Thus it is best for the nurse to perform this procedure.

To obtain a throat culture specimen, the nurse applies clean gloves, then inserts the swab into the oropharynx and runs the swab along the tonsils and areas on the pharynx that are reddened or contain exudate. The gag reflex, active in some clients, may be decreased by having the client sit upright if health permits, open the mouth, extend the tongue, and say "ah," and by taking the specimen quickly. The sitting position and extension of the tongue help expose the pharynx; saying "ah" relaxes the throat muscles and helps minimize contraction of the constrictor muscle of the pharynx (the gag reflex). If the posterior pharynx cannot be seen, use a light and depress the tongue with a tongue blade (Figure 34–8 ■).

VISUALIZATION PROCEDURES

Visualization procedures include *indirect visualization* (noninvasive) and *direct visualization* (invasive) techniques for visualizing body organ and system functions.

Clients with Gastrointestinal Alterations

Direct visualization techniques include **anoscopy**, the viewing of the anal canal; **proctoscopy**, the viewing of the rectum; **proctosigmoidoscopy**, the viewing of the rectum and sigmoid

LIFESPAN CONSIDERATIONS **Sputum and Throat Specimens**

INFANTS
- When taking a throat swab, avoid occluding an infant's nose because infants normally breathe only through the nose.

CHILDREN
- Have a parent stand the young child between the parent's legs with the child's back to the parent and the parent's arms gently but firmly around the child. As the parent tips the child's head back, ask the child to open wide and stick the tongue out. Assure the child that the procedure will be over quickly and may "tickle" but should not hurt.

OLDER ADULTS
- Older adults may need encouragement to cough because a decreased cough reflex occurs with aging.
- Allow time for older adults to rest and recover between coughs when obtaining a sputum specimen.

Home Care Considerations **Specimen Collection** **PATIENT-CENTERED CARE**

- If specimen collection is done on an outpatient basis or in the home, the nurse teaches the client how to obtain the specimens. Provide written instructions and specimen containers to ensure correct and safe performance of the procedure.
- Ensure that the laboratory knows where to send the test results.

Figure 34–9 ■ Enhanced color x-ray of the colon during a barium enema exam.
CNRI/Science Photo Library; Photo Researchers, Inc.

colon; and **colonoscopy**, the viewing of the large intestine. Indirect visualization of the gastrointestinal tract is achieved by roentgenography. X-rays of the gastrointestinal tract can detect strictures, obstructions, tumors, ulcers, inflammatory disease, or other structural changes such as hiatal hernias. Visualization of the tract is enhanced by the introduction of a radiopaque substance such as barium. For examination of the upper gastrointestinal tract or small bowel, the client drinks the barium sulfate. This examination is often referred to as a *barium swallow*. For examination of the lower gastrointestinal tract, the client is given an enema containing the barium. This examination is commonly referred to as a *barium enema*. These x-rays usually include fluoroscopic examination; that is, projection of the x-ray films onto a screen, which permits continuous observation of the flow of barium (Figure 34–9 ■). Nurses are responsible for preparing clients before these studies and for follow-up care.

Clients with Urinary Alterations

Visualization procedures also may be used to evaluate urinary function. An x-ray of the **kidneys/ureters/bladder** is commonly referred to as a **KUB**. **Intravenous pyelography (IVP)** and **retrograde pyelography** are also radiographic studies used to evaluate the urinary tract. In an IVP, contrast medium is injected intravenously; during retrograde pyelography, the contrast medium is instilled directly into the kidney pelvis via the urethra, bladder, and ureters. Following injection or instillation of the contrast medium, x-rays are taken to evaluate urinary tract structures. Renal **ultrasonography** is a noninvasive test that uses reflected sound waves to visualize the kidneys. During a **cystoscopy**, the bladder, ureteral orifices, and urethra can be directly visualized using a **cystoscope**, a lighted instrument inserted through the urethra. Nurses are responsible for preparing clients before these studies and for follow-up care.

Clients with Cardiopulmonary Alterations

A number of visualization procedures can be done to examine the cardiovascular system and respiratory tract.

Electrocardiography provides a graphic recording of the heart's electrical activity. Electrodes placed on the skin transmit the electrical impulses to an oscilloscope or graphic recorder. With the wave forms recorded, the **electrocardiogram (ECG)** can then be examined to detect dysrhythmias and alterations in conduction indicative of myocardial damage, enlargement of the heart, or drug effects.

Stress electrocardiography uses ECGs to assess the client's response to an increased cardiac workload during exercise. As the body's demand for oxygen increases with exercising, the cardiac workload increases, as does the oxygen demand of the heart muscle itself. Clients with coronary artery disease may develop chest pain and characteristic ECG changes during exercise.

Angiography is an invasive procedure requiring informed consent of the client. A radiopaque dye is injected into the vessels to be examined. Using fluoroscopy and x-rays, the flow through the vessels is assessed and areas of narrowing or blockage can be observed. Coronary angiography is performed to evaluate the extent of coronary artery disease; pulmonary angiography may be performed to assess the pulmonary vascular system, particularly if pulmonary emboli are suspected. Other vessels that may be studied include the carotid and cerebral arteries, the renal arteries, and the vessels of the lower extremities.

An **echocardiogram** is a noninvasive test that uses ultrasound to visualize structures of the heart and evaluate left ventricular function. Images are produced as ultrasound waves are reflected back to a transducer after striking cardiac structures. The nurse should tell the client that this test causes no discomfort, although the conductive gel used may be cold.

X-ray examination of the chest is done both to diagnose disease and to assess the progress of a disease. For an x-ray examination, the nurse needs to inform the client that jewelry and clothing from the waist up must be removed.

A **lung scan**, also known as a V/Q (ventilation/perfusion) scan, records the emissions from radioisotopes that indicate how well gas and blood are traveling through the lungs. The *perfusion scan* (Q scan—P usually stands for "pulmonary," so apparently the next letter in the alphabet was used for "perfusion") is used to assess blood flow through the pulmonary vascular system. For this, the radioisotope is injected intravenously and measured as it circulates through the lung. The *ventilation scan* (V scan) detects ventilation abnormalities, particularly in clients with emphysema. For this scan, the client inhales a radioactive gas through a mask and then exhales it into room air. The client needs to be informed that no radiation precautions are necessary because the amount of radioactivity is very small. The scan may take 20 to 40 minutes. Laryngoscopy and bronchoscopy are sterile procedures that are conducted with a laryngoscope and bronchoscope, respectively. Tissue samples may also be taken for biopsy. A local anesthetic is usually given before the examination. A local anesthetic is sprayed on the client's pharynx to prevent gagging; alternatively, the client gargles with an anesthetic to anesthetize the throat. The bronchoscope is then inserted to visualize the larynx or bronchi (Figure 34–10 ■). Informed consent is required for these procedures.

Computed Tomography

Computed tomography (CT), also called *CT scanning*, *computerized tomography*, or *computerized axial tomography (CAT)*, is a painless, noninvasive x-ray procedure that has the unique capability of distinguishing minor differences in the density of tissues. The CT produces a three-dimensional image of the organ or structure, making it more sensitive than the x-ray machine.

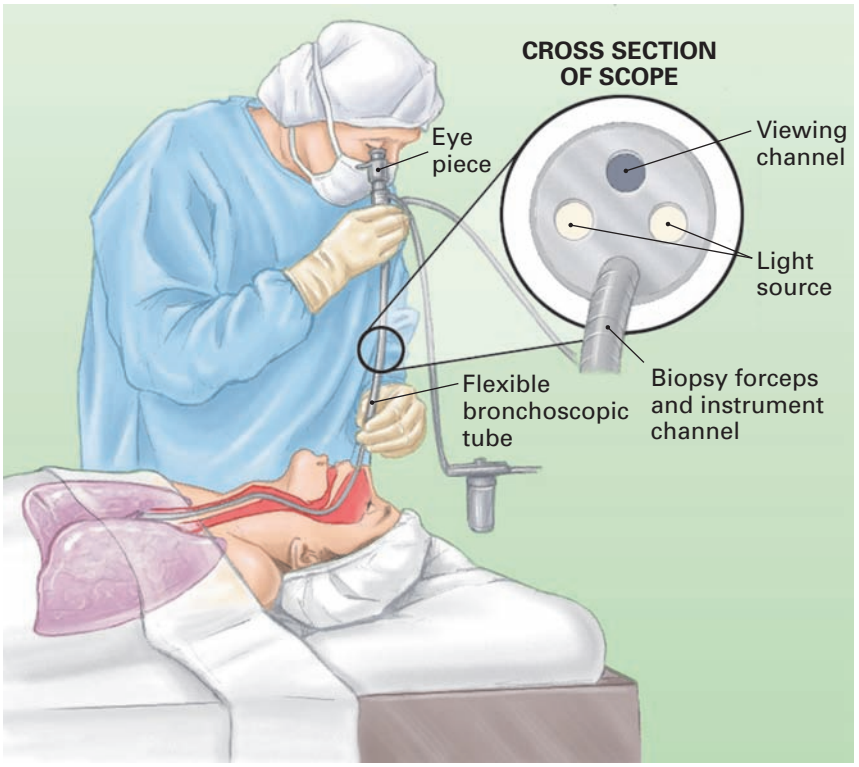


Figure 34–10 ■ Bronchoscopy.
From *Medical Terminology: A Living Language*, 5th ed. (p. 239), by B. Fremgen and S. Frucht, 2013. Reprinted and electronically reproduced by permission of Pearson Education, Inc., Upper Saddle River, NJ.

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is a noninvasive diagnostic scanning technique in which the client is placed in a magnetic field. Clients with implanted metal devices (e.g., pacemaker, metal hip prosthesis) cannot undergo an MRI because of the strong magnetic field. There is no exposure to radiation. If a contrast media is injected during the procedure, it is not an iodine contrast. Another advantage to the MRI is that it provides a better contrast between normal and abnormal tissue than the CT scan. It is, however, more costly.

All removable metallic objects (e.g., rings, watches, cell phones, body jewelry) should be removed before entering the area of the magnet. Body jewelry made of titanium, niobium, or surgical stainless steel, however, will not be attracted to the magnet. Assess for body tattoos, especially red in color, because they may get warm during an MRI (Kee, 2013, p. 507). Recent reports have shown that in a very few instances, people with tattoos or permanent cosmetics have experienced edema or burning in the tattoo during an MRI.

Transdermal patches containing a foil backing may cause burning or injury. It is important to ask clients if they are using a transdermal patch so it can be removed before undergoing an MRI. Because the patch may lose its adhesiveness, advise the client to apply a new patch after the MRI.

SAFETY ALERT! SAFETY

Advise clients to inform the MRI operator if they have a tattoo or permanent makeup and to let the operator know of any unusual sensations felt at the site of the tattoo during the MRI.

The MRI is commonly used for visualization of the brain, spine, limbs and joints, heart, blood vessels, abdomen, and pelvis. The procedure involves the client lying on a platform that moves into either a narrow, closed, high-magnet scanner, or into an open, low-magnet scanner. The client must lie very still. A two-way communication system is used to monitor the client's response and to help relieve feelings of claustrophobia. Earplugs are offered to the client to reduce the discomfort from the loud noises that occur during the test. The procedure lasts between 60 and 90 minutes (Figure 34–11 ■).

Nuclear Imaging Studies

Nuclear imaging studies involve the therapeutic use of radioactive isotopes for diagnostic purposes. A **radiopharmaceutical**,

Figure 34–11 ■ MRI laboratory.
Will and Deni McIntyre/Photo Researchers, Inc.

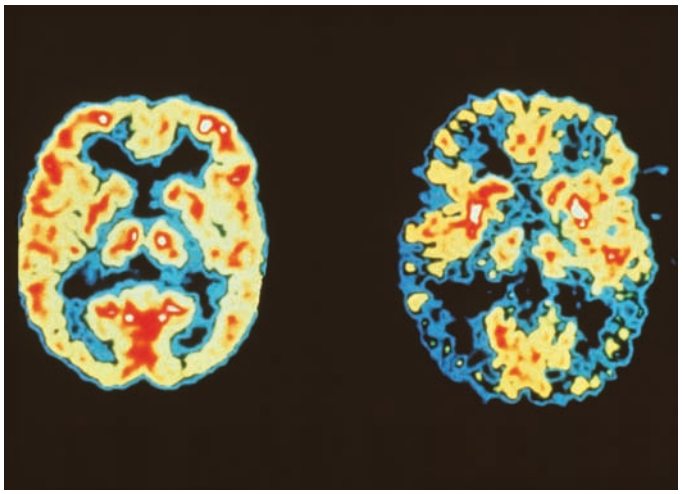


Figure 34–12 ■ PET scan comparing the metabolic activity levels of the brain of an individual with Alzheimer's disease and a normal brain. Red and yellow colors indicate high activity levels; blue colors represent low activity levels.
Dr. Robert Friedland/Science Source/Photo Researchers.

a pharmaceutical (targeted to a specific organ) with an embedded radioisotope, is administered through various routes for the test. The distribution of the isotope is different in normal tissue than it is in diseased tissue. For example, the distribution of the isotope in normal tissue is equal, uniform, and gray. Hyperfunction of an organ shows darker images that are referred to as "hot" spots. In contrast, hypofunctioning of an organ appears as lighter images that are called "cold" spots.

Positron emission tomography (PET) is a noninvasive radiologic study that involves the injection or inhalation of a radioisotope. Images are created as the radioisotope is distributed in the body. This allows study of various aspects of organ function and may include evaluation of blood flow and tumor growth, for example (Figure 34–12 ■).

ASPIRATION/BIOPSY

Aspiration is the withdrawal of fluid that has abnormally collected (e.g., pleural cavity, abdominal cavity) or the obtaining of a specimen (e.g., cerebrospinal fluid). A **biopsy** is the removal and examination of tissue. Biopsies are usually performed to determine a diagnosis or to detect malignancy. Both aspiration and biopsy are invasive procedures and require strict sterile technique.

CLINICAL ALERT!

Determine if the facility requires a signed consent form for an aspiration/biopsy procedure.

Lumbar Puncture

In a **lumbar puncture** (LP, or spinal tap), cerebrospinal fluid (CSF) is withdrawn through a needle (Figure 34–13 ■) inserted into the subarachnoid space of the spinal canal between the third and fourth lumbar vertebrae or between the fourth and fifth lumbar vertebrae. At this level the needle avoids damaging the spinal cord and major nerve roots (Figure 34–14 ■). The client is positioned laterally with the head bent toward the chest, the knees flexed onto the abdomen, and the back at the edge of the bed or examining table (Figure 34–15 ■).

Figure 34–13 ■ A spinal needle with the stylet protruding from the hub.

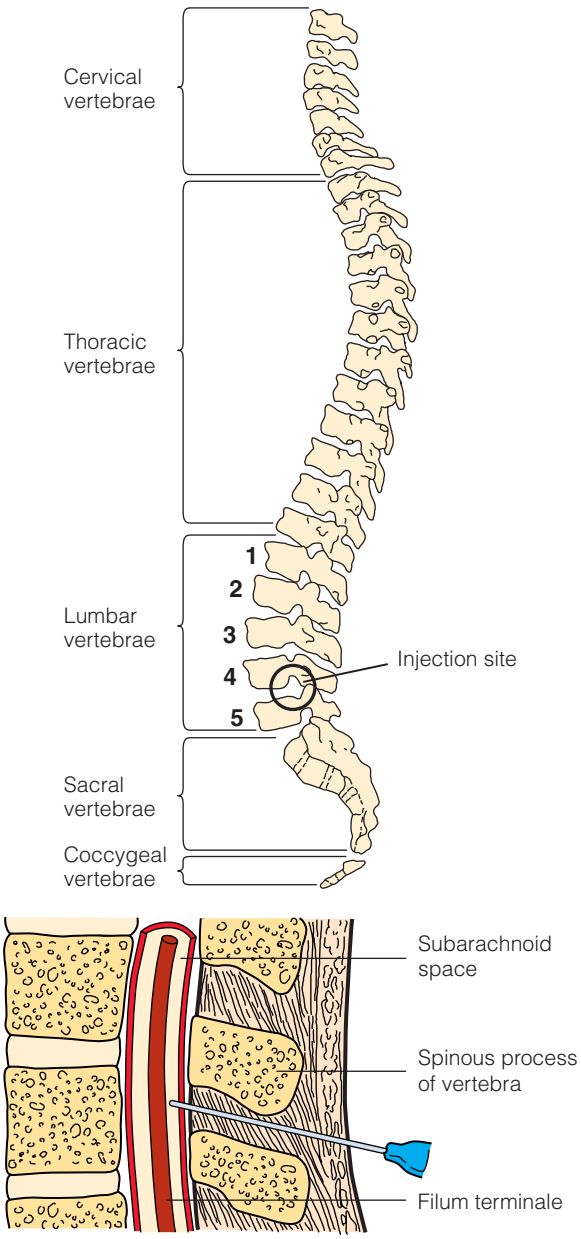


Figure 34–14 ■ A diagram of the vertebral column, indicating a site for insertion of the lumbar puncture needle into the subarachnoid space of the spinal canal.

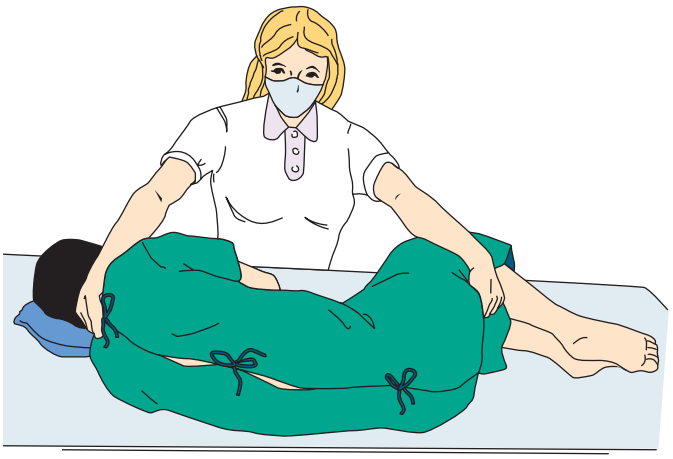


Figure 34–15 ■ Supporting the client for a lumbar puncture.

Figure 34–16 ■ A preassembled lumbar puncture set. Note the manometer at the top of the set.

LIFESPAN CONSIDERATIONS Lumbar Puncture

CHILDREN

- Briefly demonstrate the procedure on a doll or stuffed animal. Allow time to answer questions.
- One member of the health care team should stay in close physical contact with the child, maintain eye contact, and talk to and reassure the child during the procedure.

OLDER ADULTS

- Some clients need help maintaining the flexed position due to arthritis, weakness, or tremors.
- Provide an extra blanket to keep the client warm during the procedure. Older adults have a decreased metabolism and less subcutaneous fat.
- If the client has a hearing loss, speak slowly, distinctly, and loud enough, especially when unable to make eye contact.

In this position the back is arched, increasing the spaces between the vertebrae so that the spinal needle can be inserted readily. During a lumbar puncture, the primary care provider frequently takes CSF pressure readings using a **manometer**, a glass or plastic tube calibrated in millimeters (Figure 34–16 ■).

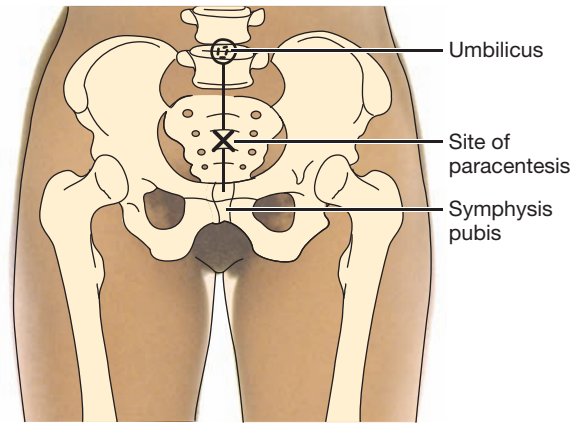


Figure 34–17 ■ A common site for an abdominal paracentesis.

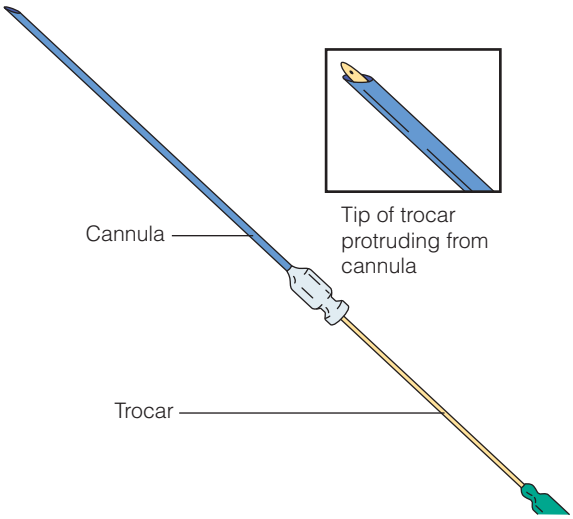


Figure 34–18 ■ A trocar and cannula may be used for an abdominal paracentesis.

Abdominal Paracentesis

Normally the body creates just enough peritoneal fluid for lubrication. The fluid is continuously formed and absorbed into the lymphatic system. However, in some disease processes, a large amount of fluid accumulates in the abdominal cavity; this condition is called **ascites**. Normal ascitic fluid is serous, clear, and light yellow in color. An **abdominal paracentesis** is carried out to obtain a fluid specimen for laboratory study and to relieve pressure on the abdominal organs due to the presence of excess fluid.

A primary care provider performs the procedure with the assistance of a nurse. Strict sterile technique is followed. A common site for abdominal paracentesis is midway between the umbilicus and the symphysis pubis on the midline (Figure 34–17 ■). The primary care provider makes a small incision with a scalpel, inserts the **trocar** (a sharp, pointed instrument) and **cannula** (tube), and then withdraws the trocar, which is inside the cannula (Figure 34–18 ■). Tubing is attached to the cannula and the fluid flows through the tubing into a receptacle. If the purpose of the paracentesis is to obtain a specimen, the primary care provider may use a long aspirating needle attached to a syringe rather than making an incision and using a trocar and cannula. Normally about 1,500 mL is the maximum amount of fluid drained at one time to avoid hypovolemic shock.

LIFESPAN CONSIDERATIONS **Abdominal Paracentesis**

OLDER ADULTS

- Provide pillows and blankets to help older adults remain comfortable during the procedure.
- Ask the client to empty the bladder just before the procedure. Older adults may need to void more frequently and in smaller amounts.
- Remove ascitic fluid slowly and monitor the client for signs of hypovolemia. Older adults have less tolerance for fluid loss and may develop hypovolemia if a large volume of fluid is drained rapidly.

The fluid is drained very slowly for the same reason. Some fluid is placed in the specimen container before the cannula is withdrawn. The small incision may or may not be sutured; in either case, it is covered with a small sterile bandage.

Thoracentesis

Normally, only sufficient fluid to lubricate the pleura is present in the pleural cavity. However, excessive fluid can accumulate as a result of injury, infection, or other pathology. In such a case or in the case of pneumothorax, a primary care provider may perform a **thoracentesis** to remove the excess fluid or air to ease breathing. Thoracentesis is also performed to introduce chemotherapeutic drugs intrapleurally.

The nurse assists the client to assume a position that allows easy access to the intercostal spaces. This is usually a sitting position with the arms above the head, which spreads the ribs and enlarges the intercostal space. Two positions commonly used are one in which the arm is elevated and stretched forward (Figure 34–19*A* ■) and one in which the client leans forward over a pillow (Figure 34–19*B*). To make sure that the needle is inserted below the fluid level when fluid is to be removed (or above any fluid if air is to be removed), the primary care provider will palpate and percuss the chest and select the exact site for insertion of the needle. A site on the lower posterior chest is often used to remove fluid, and a site on the upper anterior chest is used to remove air (Figure 34–20 ■). A chest x-ray prior to the procedure will help pinpoint the best insertion site.

The primary care provider and the assisting nurse follow strict sterile technique. The primary care provider attaches a syringe and/or stopcock to the aspirating needle. The stopcock must be in the closed position so that no air can enter the pleural space. The primary care provider inserts the needle through the intercostal space to the pleural cavity. In some instances, the primary care provider threads a small plastic tube through the needle and then withdraws the needle. (The tubing is less likely to puncture the pleura.)

If a syringe is used to collect the fluid, the plunger is pulled out to withdraw the pleural fluid as the stopcock is opened. If a large container is used to receive the fluid, the tubing is attached from the stopcock to the adapter on the receiving bottle. When the adapter and stopcock are opened, gravity allows fluid to drain from the pleural

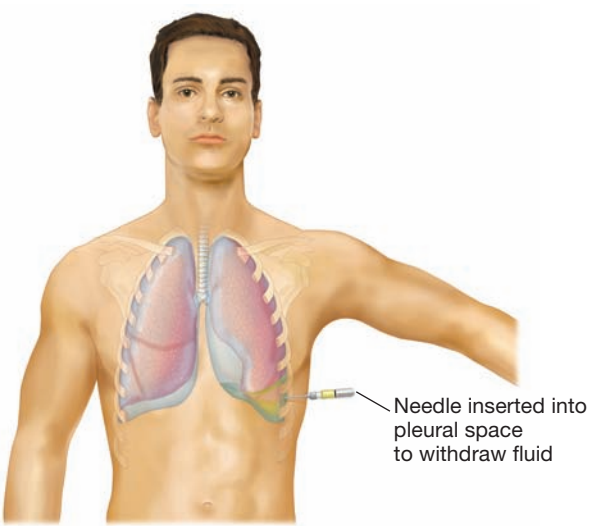


Figure 34–20 ■ Needle is inserted into the pleural space on the lower posterior chest to withdraw fluid.
From *Medical Terminology: A Living Language*, 5th ed. (p. 241), by B. Fremgen and S. Frucht, 2013. Reprinted and electronically reproduced by permission of Pearson Education, Inc., Upper Saddle River, NJ.

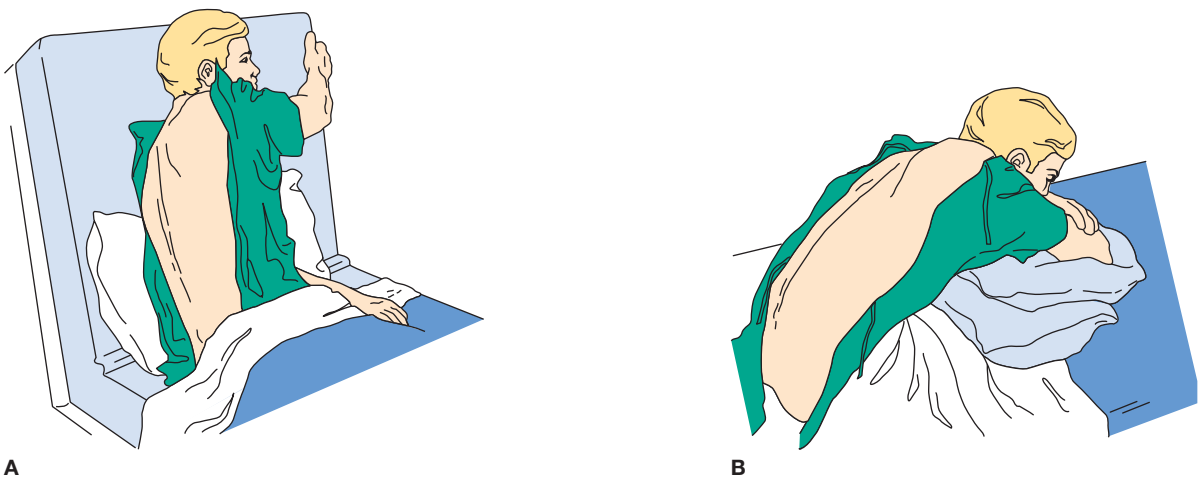


Figure 34–19 ■ Two positions commonly used for a thoracentesis: *A*, sitting on one side with arm held to the front and up; *B*, sitting and leaning forward over a pillow.

LIFESPAN CONSIDERATIONS Thoracentesis

OLDER ADULTS
- Some older clients will need help maintaining the proper position due to arthritis, tremors, or weakness.
- Provide support with pillows during the procedure.
- Absence of body fat in older adults can help the primary care provider locate the intercostal spaces.
- Provide an extra blanket to keep your client warm during the procedure. Older adults have a decreased metabolism and less subcutaneous fat.

cavity into the container, which should be kept below the level of the client's lungs. After the fluid has been withdrawn, the primary care provider removes the needle or plastic tubing.

Bone Marrow Biopsy

Another type of diagnostic study is the *biopsy*. A biopsy is a procedure whereby tissue is obtained for examination. Biopsies are performed on many different types of tissues, for example, bone marrow, liver, breast, lymph nodes, and lung.

A bone marrow biopsy is the removal of a specimen of bone marrow for laboratory study. The biopsy is used to detect specific diseases of the blood, such as pernicious anemia and leukemia. The bones of the body commonly used for a bone marrow biopsy are the sternum, iliac crests, anterior or posterior iliac spines, and proximal tibia in children. The *posterior superior iliac crest* is the preferred site with the client placed prone or on the side (Figure 34–21 ■).

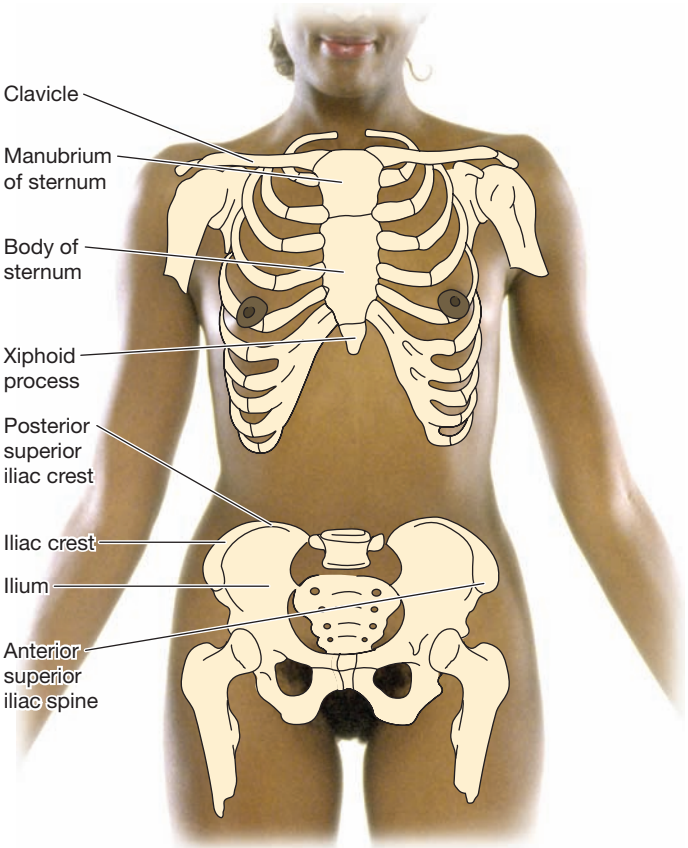


Figure 34–21 ■ The sternum and the iliac crests are common sites for a bone marrow biopsy.

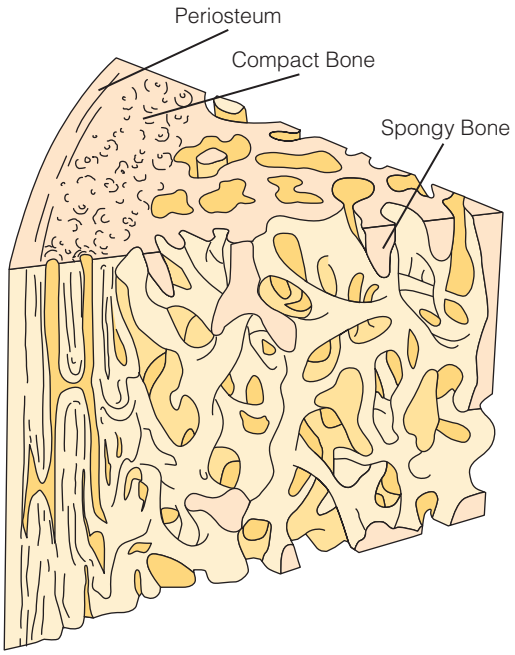


Figure 34–22 ■ A cross section of a bone.

After injecting a local anesthetic, a small incision may be made with a scalpel to avoid tearing the skin or pushing skin into the bone marrow with a needle. The primary care provider then introduces a bone marrow needle with stylet into the red marrow of the spongy bone (Figure 34–22 ■).

Once the needle is in the marrow space, the stylet is removed and a 10-mL syringe is attached to the needle. The plunger is withdrawn until 1 to 2 mL of marrow has been obtained. The primary care provider replaces the stylet in the needle, withdraws the needle, and places the specimen in test tubes and/or on glass slides.

Liver Biopsy

A liver biopsy is a short procedure, generally performed at the client's bedside, in which a sample of liver tissue is aspirated. A primary care provider inserts a needle in the intercostal space between two of the right lower ribs and into the liver (Figure 34–23 ■) or through the abdomen below the right rib cage (subcostally).

The client exhales and is instructed to hold his or her breath while the primary care provider inserts the biopsy needle, injects a small amount of sterile normal saline to clear the needle of blood

LIFESPAN CONSIDERATIONS Bone Marrow Biopsy

CHILDREN
- Young clients need emotional support due to the pain and pressure associated with this procedure.
- Young clients may require gentle restraint to prevent movement during the procedure.

OLDER ADULTS
- Older adults with osteoporosis will experience less needle pressure.
- Ask the client to empty the bladder for comfort before the procedure.
- Provide pillows and blankets to help older adults remain comfortable during the procedure.

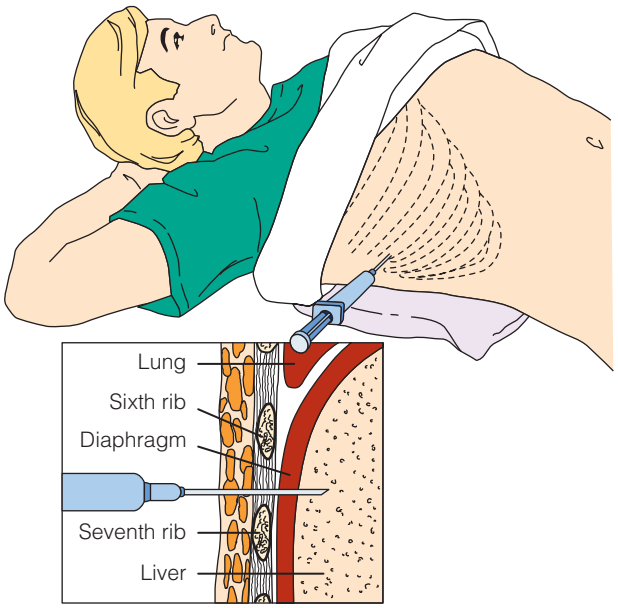


Figure 34–23 ■ A common site for a liver biopsy.

or particles of tissue picked up during insertion, and aspirates liver tissue by drawing back on the plunger of the syringe. After the needle is withdrawn, the nurse applies pressure to the site to prevent bleeding, often by positioning the client on the biopsy site (Figure 34–24 ■).

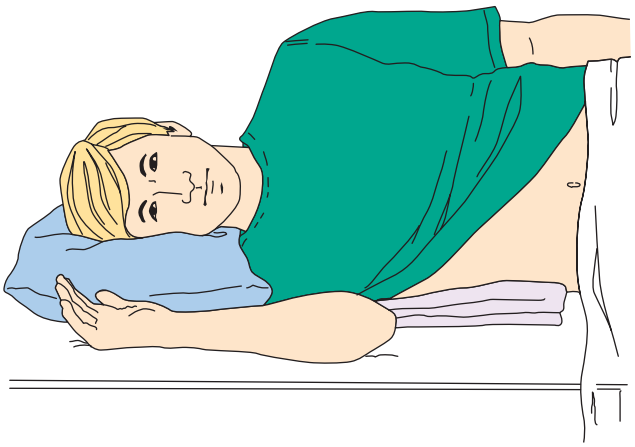


Figure 34–24 ■ The position to provide pressure on a liver biopsy site.

Because many clients with liver disease have blood clotting defects and are prone to bleeding, prothrombin time and platelet count are normally taken well in advance of the test. If the test results are abnormal, the biopsy may be contraindicated.

Table 34–3 describes how the nurse assists with the above aspiration/biopsy procedures.

TABLE 34–3 Assisting with Aspiration and Biopsy Procedures

Procedure	Preprocedure	During the Procedure	Postprocedure
Lumbar puncture	Prepare the client: • Explain the procedure to the client and support people. The primary care provider will be taking a small sample of spinal fluid from the lower spine. A local anesthetic will be given to minimize discomfort. Explain when and where the procedure will occur (e.g., the bedside or in a treatment room) and who will be present (e.g., the primary care provider and the nurse). Explain that it will be necessary to lie in a certain position without moving for about 15 min. A slight pinprick will be felt when the local anesthetic is injected and a sensation of pressure as the spinal needle is inserted. • Have the client empty the bladder and bowels prior to the procedure to prevent unnecessary discomfort. • Position and drape the client. • Open the lumbar puncture set.	Support and monitor the client throughout: • Stand in front of the client and support the back of the neck and knees if the client needs help remaining still. • Reassure the client throughout the procedure by explaining what is happening. Encourage normal breathing and relaxation. • Observe the client's color, respirations, and pulse during the procedure. Ask the client to report headache or persistent pain at the insertion site. Handle specimen tubes appropriately: • Wear gloves when handling test tubes. • Label the specimen tubes in sequence. • Send the CSF specimens to the laboratory immediately. Place a small sterile dressing over the puncture site.	Ensure the client's comfort and safety: • Assist the client to a dorsal recumbent position with only one head pillow. The client remains in this position for 1–12 h, depending on the primary care provider orders. • Determine whether analgesics are ordered and can be given for headaches. • Offer oral fluids frequently, unless contraindicated, to help restore the volume of CSF. Monitor the client: • Observe for swelling or bleeding at the puncture site. • Monitor changes in neurologic status. • Determine whether the client is experiencing any numbness, tingling, or pain radiating down the legs. Document the procedure on the client's chart: • Include date and time performed; the primary care provider's name; the color, character, and amount of CSF; and the number of specimens obtained. Also document CSF pressure and the nurse's assessments and interventions.

TABLE 34–3 **Assisting with Aspiration and Biopsy Procedures—*continued***

Procedure	Preprocedure	During the Procedure	Postprocedure
Abdominal paracentesis	Prepare the client: • Explain the procedure: obtaining the specimen usually takes about 15 min. Emphasize the importance of remaining still during the procedure. Tell the client when and where the procedure will occur and who will be present. • Have the client void just before the paracentesis to reduce the possibility of puncturing the urinary bladder. • Help the client assume a sitting position in bed, in a chair, or on the edge of the bed supported by pillows. • Maintain the client's privacy and provide blankets for warmth.	Assist and monitor the client: • Support the client verbally and describe the steps of the procedure as needed. • Observe the client closely for signs of distress (e.g., abnormal pulse rate, skin color, and blood pressure). • Observe for signs of hypovolemic shock induced by the loss of fluid: pallor, dyspnea, diaphoresis, drop in BP, and restlessness or increased anxiety. Place a small sterile dressing over the site of the incision after the cannula or aspirating needle is withdrawn.	Monitor the client closely: • Observe for hypovolemic shock. • Observe for scrotal edema with male clients. • Monitor VS, urine output, and drainage from the puncture site every 15 min for at least 2 h and every hour for 4 h or as the client's condition indicates. • Measure the abdominal girth at the level of the umbilicus. Document all relevant information: • Include date and time performed; the primary care provider's name; abdominal girth before and after; the color, clarity, and amount of drained fluid; and the nurse's assessments and interventions. Transport the correctly labeled specimens to the laboratory.
Thoracentesis	Prepare the client: • Explain the procedure to the client. Normally, the client may experience some discomfort and a feeling of pressure when the needle is inserted. The procedure may bring considerable relief if breathing has been difficult. The procedure takes only a few minutes, depending primarily on the time it takes for the fluid to drain from the pleural cavity. To avoid puncturing the lungs, it is important for the client not to cough while the needle is inserted. Explain when and where the procedure will occur and who will be present. • Help position the client and cover the client as needed with a bath blanket.	Support and monitor the client throughout: • Support the client verbally and describe the steps of the procedure as needed. • Observe the client for signs of distress, such as dyspnea, pallor, and coughing. Collect drainage and laboratory specimens. Place a small sterile dressing over the site of the puncture.	Monitor the client: • Assess pulse rate, respiratory rate, and skin color. • Do not remove more than 1,000 mL of fluid from the pleural cavity within the first 30 min. • Observe changes in the client's cough, sputum, respiratory depth, and breath sounds, and note complaints of chest pain. Position the client appropriately: • Some agency protocols recommend that the client lie on the unaffected side with the head of the bed elevated 30° for at least 30 min because this position facilitates expansion of the affected lung and eases respirations. Document all relevant information: • Include date and time performed; the primary care provider's name; the amount, color, and clarity of fluid drained; and nursing assessments and interventions provided. Transport the correctly labeled specimens to the laboratory.
Bone marrow biopsy	Prepare the client: • Explain the procedure. The client may experience pain when the marrow is aspirated and hear a crunching sound as the needle is pushed through the cortex of the bone. The procedure usually takes 15–30 min. Explain when and where the procedure will occur, who will be present, and which site will be used.	Monitor and support the client throughout: • Describe the steps of the procedure as needed and provide verbal support. • Observe the client for pallor, diaphoresis, and faintness due to bleeding or pain. Place a small dressing over the site of the puncture after the needle is withdrawn:	Monitor the client: • Assess for discomfort and bleeding from the site. The client may experience some tenderness in the area. Bleeding and hematoma formation need to be assessed for several days. Report bleeding or pain to the nurse in charge. • Provide an analgesic as needed and ordered.

Continued on page 746

TABLE 34–3 Assisting with Aspiration and Biopsy Procedures—*continued*

Procedure	Preprocedure	During the Procedure	Postprocedure
	• Administer a sedative as ordered. • Help the client assume a supine position (with one pillow if desired) for a biopsy of the sternum (sternal puncture) or a prone position for a biopsy of either iliac crest. Fold the bedclothes back or drape the client to expose the area.	• Some agency protocols recommend direct pressure over the site for 5–10 min to prevent bleeding. Assist with preparing specimens as needed.	Document all relevant information: • Include date and time of the procedure; the primary care provider's name; and any nursing assessments and interventions. • Document any specimens obtained. Transport the correctly labeled specimens to the laboratory.
Liver biopsy	Prepare the client: • Give preprocedural medications as ordered. Vitamin K may be given for several days before the biopsy to reduce the risk of hemorrhage. • Explain the procedure and tell the client that the primary care provider will take a small sample of liver tissue by putting a needle into the client's side or abdomen. Explain that a sedative and local anesthetic will be given, so the client will feel no pain. Explain when and where the procedure will occur, who will be present, the time required, and what to expect as the procedure is being performed (e.g., the client may experience mild discomfort when the local anesthetic is injected and slight pressure when the biopsy needle is inserted). • Ensure that the client fasts for at least 2 h before the procedure. • Administer the appropriate sedative about 30 min beforehand or at the specified time. • Help the client assume a supine position with the upper right quadrant of the abdomen exposed. Cover the client with the bedclothes so that only the abdominal area is exposed.	Monitor and support the client throughout: • Support the client in a supine position. • Instruct the client to take a few deep inhalations and exhalations and to hold the breath after the final exhalation for up to 10 sec as the needle is inserted, the biopsy obtained, and the needle withdrawn. Holding the breath after exhalation immobilizes the chest wall and liver and keeps the diaphragm in its highest position, avoiding injury to the lung and laceration of the liver. • Instruct the client to resume breathing when the needle is withdrawn. • Apply pressure to the site of the puncture to help stop any bleeding. Apply a small dressing to the site of the puncture.	Position the client appropriately: • Assist the client to a right side-lying position with a small pillow or folded towel under the biopsy site. Instruct the client to remain in this position for several hours. Monitor the client: • Assess the client's VS every 15 min for the first hour following the test or until the signs are stable. Then monitor vital signs every hour for 24 h or as needed. • Determine whether the client is experiencing abdominal pain. Severe abdominal pain may indicate bile peritonitis. • Check the biopsy site for localized bleeding. Pressure dressings may be required if bleeding does occur. Document all relevant information: • Include date and time performed; the primary care provider's name; and all nursing assessments and interventions. Transport the correctly labeled specimens to the laboratory.

LIFESPAN CONSIDERATIONS Liver Biopsy

OLDER ADULTS

- Observe for skin irritation from tape applied to the sterile dressing. Older adults often have fragile skin.
- Ask the client to empty the bladder before the procedure. Older adults may need to void more often and in smaller amounts.

LIFESPAN CONSIDERATIONS General Considerations

CHILDREN

- Children may be frightened of even noninvasive procedures to collect specimens if they are not sure what is going to happen. Cooperation can be maximized by:
  - Demonstrating on dolls or teddy bears.
  - Allowing the child to examine and explore the collection materials being used.
  - Explaining in age-appropriate language what will be done.
  - Having parents actively involved in gently holding and comforting the child during and after the procedure.
  - Being well prepared to conduct the procedure.
  - Performing the procedure quickly, competently, and as gently as possible.

OLDER ADULTS

- In older adults, homeostatic mechanisms are not as efficient as in the younger person. When undergoing diagnostic tests that challenge these functions, care must be taken to accurately monitor functions and note any changes. Examples:
  - Dehydration and electrolyte imbalance can occur from laxative preps given before bowel diagnostic tests, such as a colonoscopy.
  - Fluid restrictions and NPO status for a length of time can lead to hypovolemia and electrolyte imbalances.
  - Many dye contrasts used for x-rays and scans can cause renal damage (especially in clients with diabetes).
  - Sedation used for certain procedures may require a longer recovery time for older clients.
  - Having several tests at a time or for several days compounds these potential problems and increases fatigue.

Critical Thinking Checkpoint

A 68-year-old woman is admitted with fever, nausea, vomiting, and abdominal pain. She informs you that she is a "borderline diabetic" and "only has to watch what she eats." She tells you that she has not eaten for 3 days and has had difficulty "keeping liquids down." While doing the nursing history, she describes her urine as dark and foul smelling. Upon further questions, she states she does have some burning upon urination. She describes her abdominal pain as constant, generalized, and rates it as a 5 or 6 on a scale of 0 to 10. The primary care provider called in the following orders:

CBC and electrolytes STAT
Capillary blood glucose STAT and q4h
VS and TPR q4h
Urine specimen for C&S
CXR
Flat plate abdominal x-ray.

1. When measuring the client's capillary blood glucose, you do not obtain enough blood to cover the indicator square on the reagent strip. What could be possible reasons and what should you do?
2. The laboratory work returns with the following results: WBC $=17 \times 10^3/mL^3$ with neutrophils $= 80\%$; Hct $= 43.2$. Based on these results, what are your nursing interventions?
3. The primary care provider orders IV fluids and an antibiotic with the first dose to be given STAT. You have not obtained the urine specimen yet. Which has priority (e.g., starting the IV, administrating the antibiotic, or obtaining the urine specimen) and why?
4. Three days later, the client has the following laboratory results: Hct $= 39.2$ and WBC $= 10.8 \times 10^3/mL^3$. What do those results indicate to you?
5. The abdominal x-ray shows a possible mass. An MRI of the abdomen is ordered. The client is quite anxious because she has heard from her friend that the procedure is difficult for people who are claustrophobic. How will you respond?

See Critical Thinking Possibilities on student resource website.

Chapter 34 Review

CHAPTER HIGHLIGHTS

- Diagnostic testing involves three phases. Client preparation is the focus during the pretest phase. During the intratest phase, the nurse performs or assists with the diagnostic test and collects the specimen. Providing nursing care of the client and follow-up activities and observations are the role of the nurse during the post-test phase.
- Blood tests are commonly used diagnostic tests. Routinely ordered blood tests can include complete blood count (CBC) and serum electrolytes.
- A capillary blood glucose is a frequent test performed by nurses and clients. This test is used to monitor glucose levels of clients at risk for hyper- and hypoglycemia. It also evaluates the effectiveness of insulin administration.
- Nursing responsibilities associated with specimen collection include (a) providing client comfort, privacy, and safety; (b) explaining the purpose of and procedure for the specimen collection; (c) using correct procedure for obtaining the specimen; (d) noting relevant information on the laboratory requisition slip; (e) transporting the specimen promptly; and (f) reporting abnormal findings.

- The nurse is responsible for obtaining stool specimens ordered for laboratory analysis.
- Nurses collect urine specimens for a number of tests. A clean voided specimen is used for routine examination. A clean-catch or midstream voided specimen is collected when a urine culture is ordered to identify microorganisms. Timed urine specimens are collected for a variety of tests, depending on the client's health problem. Nurses can complete some simple urine tests (e.g., specific gravity, pH, glucose, ketones, protein, and occult blood) by using a reagent strip.
- Sputum and throat culture specimens help determine the presence of disease-producing organisms.
- Visualization procedures include indirect visualization or noninvasive procedures such as lung scan, echocardiogram, electrocardiography, x-ray, CT, and MRI. In contrast, direct visualization or invasive techniques visualize body organs and system functions. Examples of invasive procedures include colonoscopy, barium enema, intravenous pyelography, and angiography.
- Examples of aspiration/biopsy tests include lumbar puncture, abdominal paracentesis, thoracentesis, bone marrow biopsy, and liver biopsy. These tests are invasive procedures and require strict sterile technique. After the procedure, the nurse assesses the client for possible complications and provides appropriate nursing interventions as needed.

TEST YOUR KNOWLEDGE

1. The nurse would call the primary care provider immediately for which laboratory result?
   1. Hgb = 16 g/dL for a male client
   2. Hct = 22% for a female client
   3. WBC = $9 \times 10^3/mL^3$
   4. Platelets = $300 \times 10^3/mL^3$

2. A 78-year-old male client needs to complete a 24-hour urine specimen. In planning his care, the nurse realizes that which measure is most important?
   1. Instruct the client to empty his bladder and save this voiding to start the collection.
   2. Instruct the client to use sterile individual containers to collect the urine.
   3. Post a sign stating "Save All Urine" in the bathroom.
   4. Keep the urine specimen in the refrigerator.

3. The client has a urinary health problem. Which procedure is performed using indirect visualization?
   1. Intravenous pyelography (IVP)
   2. Kidneys, ureter, bladder (KUB)
   3. Retrograde pyelography
   4. Cystoscopy

4. Which noninvasive procedure provides information about the physiology or function of an organ?
   1. Angiography
   2. Computerized tomography (CT)
   3. Magnetic resonance imaging (MRI)
   4. Positron emission tomography (PET)

5. When assisting with a bone marrow biopsy, the nurse should take which action?
   1. Assist the client to a right side-lying position after the procedure.
   2. Observe for signs of dyspnea, pallor, and coughing.
   3. Assess for bleeding and hematoma formation for several days after the procedure.
   4. Stand in front of the client and support the back of the neck and knees.

6. During an assessment, the nurse learns that the client has a history of liver disease. Which diagnostic tests might be indicated for this client? Select all that apply.
   1. Alanine aminotransferase (ALT)
   2. Myoglobin
   3. Cholesterol
   4. Ammonia
   5. Brain natriuretic peptide or B-type natriuretic peptide (BNP)

7. The nurse practitioner requests a laboratory blood test to determine how well a client has controlled her diabetes during the past 3 months. Which blood test will provide this information?
   1. Fasting blood glucose
   2. Capillary blood specimen
   3. Glycosylated hemoglobin
   4. GGT (gamma-glutamyl transferase)

8. The client is supposed to have a fecal occult blood test done on a stool sample. The nurse is going to use the Hemoccult test. Which of the following indicates that the nurse is using the correct procedure? Select all that apply.
   1. Mixes the reagent with the stool sample before applying to the card.
   2. Collects a sample from two different areas of the stool specimen.
   3. Assesses for a blue color change.
   4. Asks a colleague to verify the pink color results.
   5. Asks the client if he has taken vitamin C in the past few days.

9. A primary care provider is going to perform a thoracentesis. The nurse's role will include which action?
   1. Place the client supine in the Trendelenburg position.
   2. Position the client in a seated position with elbows on the overbed table.
   3. Instruct the UAP to measure vital signs.
   4. Administer an opioid analgesic.

10. The nurse needs to collect a sputum specimen to identify the presence of tuberculosis (TB). Which nursing action(s) is/are indicated for this type of specimen? Select all that apply.
   1. Collect the specimen in the evening.
   2. Send the specimen immediately to the laboratory.
   3. Ask the client to spit into the sputum container.
   4. Offer mouth care before and after collection of the sputum specimen.
   5. Collect a specimen for 3 consecutive days.

See Answers to Test Your Knowledge in Appendix A.

READINGS AND REFERENCES

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Related Research

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