13 Special Phlebotomy Procedures

essential terms

A1c
aerobic
anaerobic
antibiotic removal device (ARD)
arterial puncture
autologous
bacteremia
biotinidase
cannula
congenital
culture media
cystic fibrosis
diabetes mellitus
differential
false-negative
false-positive
fistula
galactosemia
gestational diabetes
glycolysis
hemochromatosis
heparin lock
hypothyroidism
normal flora
phenylketonuria (PKU)
polycythemia vera
saline lock
septicemia
sickle cell disease
therapeutic phlebotomy

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Learning Outcomes

13.1 Describe special considerations and procedures needed to collect specimens for blood cultures.

13.2 Identify the various types of glucose tests and the indications and procedures for each.

13.3 Identify neonatal screening tests, including proper collection and handling procedures.

13.4 Explain the procedure for creating acceptable thin and thick blood smears.

13.5 Recognize the special requirements for carrying out blood collection for blood bank use.

13.6 Identify steps to competent and effective arterial puncture.

13.7 Classify venous access sites and their uses.

Related NAACLS Competencies

2.1 Demonstrate knowledge of infection control and safety.

4.1 Demonstrate understanding of the importance of specimen collection and specimen integrity in the delivery of patient care.

4.3 Describe the types of patient specimens that are analyzed in the clinical laboratory.

4.4 Define the phlebotomist's role in collecting and/or transporting these specimens to the laboratory.

4.5 List the general criteria for suitability of a specimen for analysis, and reasons for specimen rejection or re-collection.

4.6 Explain the importance of timed, fasting, and stat specimens, as related to specimen integrity and patient care.

5.1 Demonstrate knowledge of collection equipment, various types of additives used, special precautions necessary, and instances that can interfere in clinical analysis of blood constituents.

5.4 Describe the proper order of draw for specimen collections.

5.5 Describe substances that can interfere in clinical analysis of blood constituents and ways in which the phlebotomist can help avoid these occurrences.

6.1 Follow standard operating procedures to collect specimens.

6.3 Differentiate between sterile and antiseptic techniques.

6.4 Describe and demonstrate the steps in the preparation of a puncture site.

6.8 Describe the limitations and precautions of alternate collection sites for venipuncture and capillary (dermal) puncture.

7.1 Demonstrate understanding of requisitioning, specimen transport, and specimen processing.

7.4 Explain methods for transporting and processing blood specimens for routine and special testing.

9.8 Follow written and verbal instructions.

9.9 Define and use medico legal terms and discuss policies and protocol designed to avoid medico legal problems.

Introduction

Some laboratory tests require specimens collected in a manner that is different from routine venipuncture or dermal (capillary) puncture. This chapter describes tests that require specialized techniques, equipment, processes, or patient preparation for the collection of the required blood specimen. The procedure for making peripheral blood smears, which is sometimes part of the phlebotomist's duties, is also included.

Although routine blood collection is the procedure most commonly performed by phlebotomists, on occasion, special protocols must be followed depending on the reason for the collection or analyte (substance) to be tested. Special procedures that phlebotomists may perform include the following:

- Collection of specimens for blood cultures
- Collection of glucose tolerance specimens
- Collection of specimens for neonatal blood screening
- Preparation of blood smears
- Special identification procedures for type and cross-match specimens
- Collection of donor blood

Be sure to check your state scope of practice and facility policy before performing any special procedure. In some places, these procedures are performed by other healthcare personnel.

13.1 Blood Cultures

A blood culture is the testing of blood for the presence of **septicemia** (the presence of pathogenic microorganisms in the blood). Septicemia usually causes a fever, so blood culture samples are frequently requested for patients who have a fever of unknown origin (FUO). The purpose of a blood culture test is to isolate any microorganisms present in the patient's blood specimen to determine which organism is causing the fever. Strict sterile technique and attention to detail are required for preparation of the blood culture collection site. In additio n, blood cultures must be obtained in tubes or bottles that contain **culture media,** which enhance microorganism growth. The evacuated tubes designed for blood cultures are the yellow-stoppered SPS (sodium polyanethol sulfonate) tubes. Blood culture bottles are usually larger and more cumbersome

to handle than normal venipuncture tubes. However, blood culture bottles may be preferred, depending on the method used for blood cultures in the microbiology section.

Some blood culture containers include an **antibiotic removal device (ARD).** An ARD is a resin that absorbs any antibiotic present in the specimen. ARD bottles are used for patients who are on antibiotics at the time of collection and provide for more accurate results.

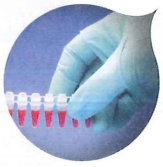
Blood is normally sterile, so the presence of microorganisms in the blood (**bacteremia**) can be very serious and result in death. The largest number of organisms will be present in the blood right before a patient has a sudden increase in temperature or spikes a fever. Because the number of microorganisms causing the fever is still very small, it is difficult to isolate them with only one specimen. Therefore, a licensed practitioner may order the blood cultures to be drawn in sets of two or three. These are usually drawn 30 minutes apart and from different sites. Specimens are placed in an incubator (an environmentally controlled device, usually set at 98.6° (37°C) to imitate normal body temperature) to allow time for microorganisms to grow, if present.

A B C D

Figure 13-1 Blood culture bottles from left to right: (A) aerobic, (B) anaerobic, (C) pediatric, and (D) *Mycobacterium.*
Lillian Mundt

Blood culture specimens are often collected into pairs of bottles (see Figure 13-1A and B). One bottle is an **aerobic** (with oxygen or air) and the other bottle is an **anaerobic** (without oxygen or air) specimen. Each subsequent set should be obtained from different sites and/or at different time intervals. A pediatric bottle is used to minimize the amount of blood drawn from an infant or child (see Figure 13-1C). Special blood culture bottles are sometimes used to test for *Mycobacterium* (the causative agent of tuberculosis, or TB) (see Figure 13-1D). Blood cultures are usually requested to be drawn STAT when a patient has a serious fever because antibiotics need to be administered as quickly as possible. The most effective antibiotic cannot be determined until the specimens are collected and processed to identify the pathogen.

Accurate Blood Cultures



Safety & Infection Control

A pathogenic (disease-producing) organism in the blood is a serious condition that must be treated. However, sometimes the blood culture result indicates the presence of a pathogen in the blood when the specimen was actually contaminated during the collection procedure. When a blood specimen is contaminated with organisms that did not originate in the blood, this result is called a **false-positive.** These organisms can get into the blood culture specimen by the following actions:

- Inadequately cleaning the puncture site
- Not allowing the cleaning agent to dry thoroughly
- Using contaminated equipment or specimen containers
- Touching the puncture site after it has been cleaned

The phlebotomist drawing the blood cultures is responsible for ensuring that the cultures are not contaminated during the process by strictly adhering to the blood culture procedure. Blood culture contamination is serious and may need to be reported to the state health department.

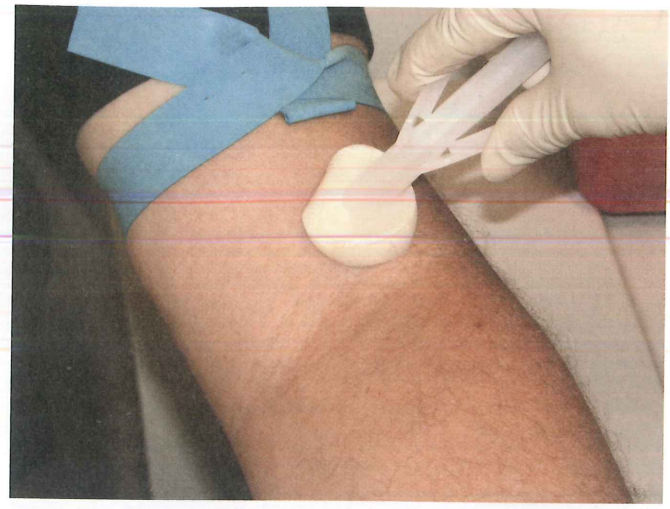


Figure 13-2 The blood culture site must be cleaned thoroughly using an approved cleanser, such as 0.5% chlorhexidine gluconate as pictured. Thorough cleaning helps prevent a false-positive test result due to contamination by the bacteria normally found on the skin.
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Blood cultures detect bacteria and yeast. If the isolated causative agent is identified as a bacterium, it can be from one of several groups of bacteria. The blood culture helps identify the specific microorganism that is causing the infection. For example, a culture helps differentiate between the bacterium *Streptococcus pyogenes,* which causes strep throat, and the bacterium *Streptococcus pneumoniae,* which is one agent responsible for pneumonia. Isolating the causative agent (microorganism) from the blood culture allows the healthcare provider to prescribe the antimicrobial that will work best to destroy the identified microorganisms.

Blood Culture Site Cleaning Procedure

The collection of a blood culture specimen is similar to routine venipuncture, with added steps to ensure that the skin is as clean as possible. Cleaning the venipuncture site is the most important part of this collection procedure. Once you have selected the site, release the tourniquet. Cleanse the site using sterile technique and the appropriate antiseptic. Routine venipuncture cleansing involves swabbing the area with a 70% alcohol prep pad. Sterile technique used for blood cultures typically requires a two-step process. If sterile technique is not followed, **normal flora** (skin surface microorganisms, such as normal bacteria and fungi) could be introduced into the blood culture sample and interfere with the patient's results. Learn How 13-1 describes the steps for cleaning a blood culture collection site.

Once the area is sterilized, it must not be touched, even with a glove. If touched, the site is considered contaminated and the entire cleaning procedure must be repeated. It is essential that the cleansing procedure be performed with great care. Patients requiring blood cultures are typically very

Learn How 13-1

Cleaning the Blood Culture Site*

1. Cleanse the site with 70% or 90% alcohol prep, or other cleansing agents, such as 0.5% chlorhexidine gluconate, 2% iodine, povidone-iodine (Betadine), or benzalkonium chloride (Zephiran Chloride) (see Figure 13-2). Be aware that some products are not used on infants and children. Follow the facility's policy and refer to the manufacturer's directions for commercially prepared packages.
2. Use a friction rub for a minimum of 30 seconds. Current studies suggest that a back-and-forth is superior to circles. When commercially prepared packages are used check and follow the directions.
3. Allow the site to air-dry, so that the antiseptic has time to kill the germs. Different disinfectants require different amounts of time to dry.
4. When using alcohol, once the initial cleansing area has air-dried, a second cleansing step may be required. This time with a swab or applicator containing 0.5% chlorhexidine gluconate, 2% iodine, povidone-iodine (Betadine), or benzalkonium chloride.
5. After disinfecting the site, never palpate the vein unless a sterile glove is worn or the disinfection process is repeated.

**Follow the policy at your facility and current product directions to ensure that the site is cleansed properly.*

sick, and preliminary results may take 24 to 48 hours. If the cleansing procedure is not done correctly, the patient can lose critical treatment time waiting for the procedure to be repeated.

Cleaning the Blood Culture Site

Communicate & Connect

As you are preparing a patient for blood culture collection, inform the patient about the procedure. If you plan to use iodine, ask about allergies and use another approved cleanser if the patient is allergic to iodine.

Explain the importance of a sterile puncture and why you are cleaning the puncture area. Sometimes patients have a tendency to touch a venipuncture site, and this must be avoided during blood culture collections. If you are collecting a blood culture and the patient touches the site, you have to clean the area again.

Butterfly Needles and Blood Cultures

Think It Through

The purpose of the anaerobic bottle is to allow bacteria that cannot survive in the presence of oxygen to grow in this medium. With this in mind, why should you *not* collect the anaerobic bottle first when using a butterfly assembly?

In many facilities, the tops of the blood culture bottles are also cleaned with alcohol. Some bottles from the manufacturer have protective covers that do not require the tops to be cleansed because they are sterile when opened. Check what is appropriate for the blood culture system your facility uses and follow the manufacturer's recommendations.

Blood Culture Volumes

The volume of blood collected for a blood culture is critical. Each manufacturer of blood culture bottles or tubes has determined the optimum amount of blood specimen needed to maximize the chance of growing the microorganisms in the laboratory. Usually, 8 to 10 milliliters (mL) per bottle or tube for an adult is sufficient, while lesser amounts are drawn on infants and children (see Table 13-1). Special blood culture bottles are available for use with pediatric patients (see Figure 13-1C).

The amount of blood drawn can have an impact on the test. For example, some bacteria, such as *Escherichia coli,* can exist in the blood in very low amounts; this requires a larger volume of blood to be drawn. If the volume is too low, the bacteria may not be seen in the culture; this produces a **false-negative** result.

In addition to getting the correct amount in each blood culture container, phlebotomists must be certain to draw from the appropriate site and in the proper sequence. As mentioned earlier, a typical blood culture order requires two bottles (one aerobic and one anaerobic). These two bottles can be drawn from the same site. With some patients, however, the healthcare provider may order "blood cultures × 2." The blood for two separate collections can be collected at the same time but must be collected from two different sites. If two sites cannot be used, the phlebotomist must wait for a period of time—between 15 and 45 minutes, depending on the order—before collecting the second set of blood culture containers at the same site. Collecting "blood cultures × 2" from two different sites, or "blood cultures × 2 fifteen minutes apart," is frequently done to help prevent a false-negative result.

TABLE 13-1 Recommended Blood Culture Volumes

Type of Patient	Aerobic Bottle Amount	Anaerobic Bottle Amount
Adult	8 to 10 mL	8 to 10 mL
Adult—low volume	All obtained	None
Pediatric (based on weight)	2.5 to 10 mL	2.5 to 10 mL
Infant	0.5 to 1 mL	0.5 to 1 mL

Think It Through

Butterfly Needles and Blood Cultures

The purpose of the anaerobic bottle is to allow bacteria that cannot survive in the presence of oxygen to grow in this medium. With this in mind, why should you *not* collect the anaerobic bottle first when using a butterfly assembly?

Collecting Blood Culture Specimens

Phlebotomists can perform the venipuncture procedure with an evacuated system, a syringe and transfer device, or a butterfly (winged) collection set. Special adapters may be used that accommodate both blood culture bottles and evacuated tubes (Figure 13-3). Once the site is selected and cleansed, the tourniquet is reapplied, taking extra care not to touch the clean site. If necessary, touch the cleansed skin no closer than 1 inch below the site.

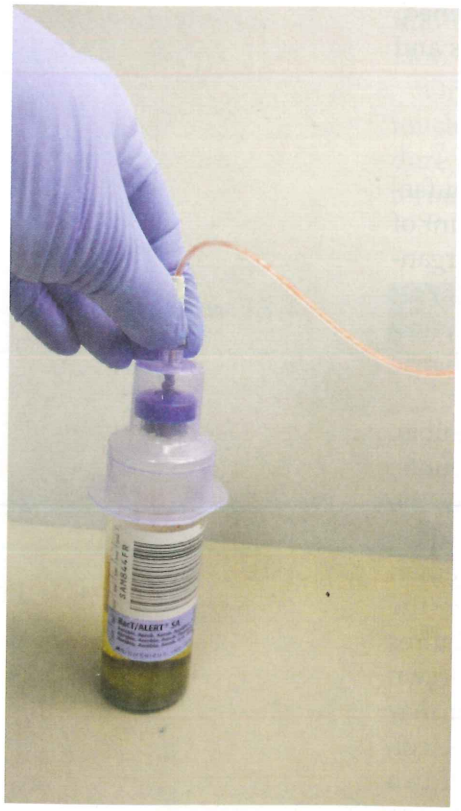


Figure 13-3 Blood culture transfer devices may be used with a butterfly needle to deliver blood directly into blood culture bottles.
Lillian Mundt

When collecting blood for culture with a syringe, make sure to use one that will hold an adequate volume for both tubes and bottles (a 20-mL syringe for adults). Once enough blood is obtained, remove the needle from the patient and engage the safety mechanism. Remove the covered needle and attach the syringe to a transfer device. When using a syringe draw, fill the anaerobic bottle first to prevent air from entering the specimen. Next, fill the aerobic bottle and any other tubes required. If using an evacuated tube assembly, use the correct type of tube holder to prevent culture media from accidentally entering the patient's blood. Review the manufacturer's directions.

When using a butterfly assembly, draw the aerobic sample first to clear the air from the butterfly tubing before drawing the anaerobic culture specimen. Learn How 13-2 compares the procedures for blood culture collection using the syringe method and butterfly assembly method.

After the blood is collected in the culture containers, label each with patient identification information, date, time, and phlebotomist's initials or identification code. When collecting more than one set of cultures, label each set with the location of the draw and the order of draw—for example, #1 Lt hand and #2 Rt arm. This information is important because additional blood cultures may be ordered. If iodine was used, remove it from the patient's arm using a new alcohol prep pad to prevent absorption into the patient's skin. Use the competency checklist *Blood Culture Procedure* at the end of this chapter to review and practice the procedure.

Learn How 13-2

Blood Culture Collection Comparison of Procedures	
Syringe Transfer Method	**Butterfly Assembly Method**
1. Greet the patient.	**1.** Greet the patient.
2. Properly identify the patient.	**2.** Properly identify the patient.
3. Explain the specimen collection procedure to the patient.	**3.** Explain the specimen collection procedure to the patient.
4. Wash your hands, put on gloves, and other PPE if needed, and prepare the equipment.	**4.** Wash your hands, put on gloves, and other PPE if needed, and prepare the equipment.
5. Select the venipuncture site and release the tourniquet.	**5.** Select the venipuncture site and release the tourniquet.
6. Cleanse the site using sterile technique and the appropriate antiseptic.	**6.** Cleanse the site using sterile technique and the appropriate antiseptic.
7. Allow the site to air-dry.	**7.** Allow the site to air-dry.
8. Cleanse the tops of the blood culture bottles (if required by facility policy).	**8.** Cleanse the tops of the blood culture bottles (if required by facility policy).
9. Reapply the tourniquet.	**9.** Reapply the tourniquet.
10. Perform the venipuncture.	**10.** Perform the venipuncture.
11. Fill syringe to the required volume.	**11.** Fill the aerobic bottle.
12. Release the tourniquet, withdraw the needle, engage the safety device, and apply pressure to the site.	**12.** Fill the anaerobic bottle.
13. Safely remove the needle and attach the syringe to the transfer device.	**13.** Release the tourniquet, withdraw the needle, engage the safety device, and apply pressure to the site.
14. Fill the anaerobic bottle.	**14.** Safely dispose of the used needle and syringe.
15. Fill the aerobic bottle.	**15.** Label the bottles with patient and collection information.
16. Safely dispose of the used butterfly assembly.	**16.** Complete postpuncture patient care.
17. Label the bottles with patient and collection information.	**17.** Thank the patient.
18. Complete postpuncture patient care.	
19. Thank the patient.	

Checkpoint Questions 13.1

1. Explain why the procedure for blood culture site cleansing is different from that for routine venipuncture.
2. Why are blood culture bottles filled in different orders depending on the method used?

13.2 Glucose Testing

Glucose testing is probably the most frequently ordered laboratory test and is used to diagnose disorders of carbohydrate metabolism. The most common carbohydrate metabolism disorders include

- **diabetes mellitus** (insufficient production of insulin)
- gestational diabetes (high blood sugar during pregnancy)
- hyperinsulinism (increased levels of insulin, resulting in low blood sugar known as hypoglycemia)

If untreated, diabetes mellitus can lead to many complications, including blindness, kidney failure, and amputation due to problems in the lower limbs. Although an increase in blood glucose is an indicator of this disease, the patient's fasting glucose level may be within normal limits. A healthcare provider may order a glucose tolerance test, an insulin level, or a series of tests to determine the patient's medical problem. See Table 13-2 for the types of glucose tests. If diabetes is suspected, a hemoglobin **A1c** test—a test for glycosylated hemoglobin—may be ordered. According to the American Diabetes Association, an A1c value equal to or greater than 6.5 is one criterion for a diagnosis of diabetes.

Two-Hour Postprandial Glucose

A 2-hour postprandial glucose test is sometimes ordered to assist in diagnosing diabetes mellitus. Glucose levels obtained 2 hours after a meal can be elevated in patients with diabetes but are generally within normal range for most of the

TABLE 13-2 Glucose Tests

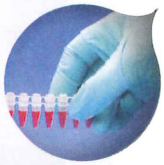
Name	Purpose	Test and Timing
Fasting blood sugar (FBS)	To identify risk for diabetes	Single blood sample after no intake of food or drink for 8 to 12 hours
2-hour postprandial blood sugar (2-hour PP)	To identify risk for diabetes	Taken exactly 2 hours after a meal; used less frequently because of inconsistent results
Random blood sugar (RBS)	To identify risk for diabetes or hypoglycemia	Taken randomly throughout the day; a wide variety of results indicates possible problem
2- or 3-hour oral glucose tolerance test (OGTT)	To diagnose gestational diabetes, diabetes mellitus, hypothalamic obesity, and reactive hypoglycemia	Fasting blood sugar, 30 minutes, 1 hour, 2 hours, and 3 hours after oral glucose ingestion
Glucose challenge screening test	To identify risk for gestational diabetes (1-hour) or polycystic ovary syndrome (2-hour)	Blood sample 1 or 2 hours after oral glucose ingestion
Intravenous glucose tolerance test (IVGTT)	To evaluate insulin secretion in patient with prediabetes	Blood samples after glucose is administered directly into the bloodstream

population. Ideally, in 2 hours the glucose level will have returned to normal. Correct timing is important because, if the sample is collected too early, the glucose level may still be elevated and may lead to misinterpretation of the test results by the healthcare provider. A 2-hour postprandial glucose test result of 200 or over as part of the oral glucose tolerance test (OGTT) is another criterion for a diagnosis of diabetes.

Glucose Challenge

A glucose challenge screening test, also known as the O'Sullivan Test is frequently done to test for **gestational diabetes.** Gestational diabetes is elevated glucose that occurs during pregnancy. The cause for gestational diabetes is not well understood, but it may be influenced by a hormone from the placenta that makes the mother resistant to insulin. During a glucose challenge test, the patient receives a dose of 50 or 75 grams of oral glucose in the form of a sugary drink (Glucola). A blood sample is drawn 1 hour later. If this test is positive, then a complete OGTT is done.

High Fasting Glucose Levels



Safety & Infection Control

It is unsafe to give a patient with elevated glucose additional glucose, as this can cause nausea or extremely elevated blood glucose. If the fasting glucose level is over 200 milligrams per deciliter (mg/dL) (some facilities use a cutoff of 126 mg/dL), the glucose tolerance test (GTT) must be discontinued immediately and the patient's healthcare provider notified of the fasting result. Additionally, according to the American Diabetes Association (ADA), if the fasting blood glucose is 126 mg/dL or over, a GTT should not be utilized.

Oral Glucose Tolerance Test (OGTT)

An oral glucose tolerance test measures a patient's ability to metabolize a large oral dose of glucose (75 grams in liquid form, about ½ cup of glucose dissolved in water). A classic oral glucose tolerance test measures blood glucose levels five times over a period of 3 hours. Some healthcare providers order a shorter version of the OGTT that includes a baseline blood sample followed by a sample 2 hours after drinking the glucose solution. This is similar to the 2-hour postprandial and is used as a screening test rather than a diagnostic procedure.

Patient Restrictions During the GTT

Communicate & Connect

During the GTT procedure, the consumption of food, drinks (even those without sugar), or alcohol is not allowed. Smoking and gum chewing are also not allowed for the duration of the tolerance test. All of these affect the way the body metabolizes glucose and can alter test results. Patients may consume sips of water during the test if they are thirsty.

Life Span Considerations

Children and Glucose Tolerance Tests

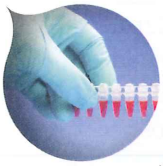
If a GTT is to be performed on a child, follow glucose manufacturer instructions and the facility's protocol for the amount of glucose to administer. Children are typically given a certain number of ounces of glucose solution according to their body weight.

Figure 13-4 Commercial glucose drinks are available in several flavors and glucose doses.
Lillian Mundt

To perform a complete OGTT, ensure that the patient has been fasting for at least 8 to 12 hours. Once this is confirmed, collect a fasting blood specimen and test it for glucose. If the blood glucose level is over 200 mg/dL, no further testing is required.

If the screening blood glucose level is less than 200 mg/dL, the OGTT procedure may continue. The patient receives a loading dose of glucose, taken orally as a drink purchased by laboratories (see Figure 13-4). These drinks are available in a variety of flavors such as orange, grape, and lemon-lime. Commercially available glucose drinks contain a known concentration of dissolved glucose, and the proper amount must be measured out according to the dose required. For example, if the bottle of glucose drink contains 100 grams of glucose in a 100-mL bottle and the required dose is 75 grams, measure out 75 mL to give to the patient. The phlebotomist must ensure that the patient swallows all of the glucose solution within 5 minutes and that no vomiting occurs. The exact time of consumption is recorded as the "start time." If the patient vomits, the test is stopped and the primary care provider is notified.

Safety & Infection Control



Glucose Tolerance Test

Patients who arrive for a glucose tolerance test must be fasting. During this visit, they receive a large dose of glucose (sugar), which makes them prone to syncope (fainting). It is imperative that these patients not leave the facility during the test. The phlebotomist must go out to the waiting area to meet patients and walk with them to the blood drawing area. The phlebotomist should also escort patients back to the waiting area after the draw and make sure they are settled and feeling stable. Additionally, the phlebotomist should be ready to steady the patient if needed and to react appropriately should the patient faint. Patients can fall and hurt themselves, putting the phlebotomist at risk for a lawsuit. It is also recommended that the phlebotomist have a large container close by in case the patient becomes nauseated and vomits. Due to the high load of glucose on an empty stomach, this is a very common occurrence. Patients should be monitored to ensure that they do not snack, drink, smoke a cigarette, or chew gum during the testing time, which can interfere with the results.

Next, collect blood and urine (if required) at specific time intervals of 30 minutes, 1 hour, 2 hours, and 3 hours. Be careful to label each sample (blood and urine) with both the time collected and the time interval (e.g., 8:30 a.m., 30 minutes; 9:00 a.m., 1 hour; 10:00 a.m., 2 hours; and so on). Also, make sure the patient understands what restrictions need to be followed during the course of the test.

A gray-topped tube is usually used for GTT specimens. As explained in the chapter *Blood Collection Equipment,* the sodium fluoride in this tube prevents **glycolysis** (the breakdown of glucose into an acid).

Glucose testing should be performed as soon after collection as possible. If the test is performed immediately, a gold- or light-green–topped tube may be used for collection. The laboratory sends the ordering healthcare provider the GTT results, which assists the healthcare provider in determining the presence and type of diabetes, as well as the appropriate treatment. Learn How 13-3 describes the steps for glucose testing.

Learn How 13-3

Glucose Testing
1. Identify the patient.
2. Explain the specimen collection procedure to the patient.
3. Ensure that the patient has been fasting for at least 8 to 12 hours.
4. Wash your hands, put on gloves, and prepare the equipment.
5. Collect a fasting blood specimen using proper venipuncture technique.
6. Perform a POCT glucose test or obtain a glucose level of the specimen from the chemistry department.
7. Verify that the screening blood glucose level is less than 200 mg/dL, or that it is within your facility's guidelines for normal glucose levels.
8. Prepare the glucose drink according to the requirements of the type of glucose test.
9. Observe the patient consume it within 5 minutes and confirm no vomiting has occurred.
10. Collect blood (and urine if required by your facility's testing protocol) at the specified time intervals.
11. Properly label each sample with both the time collected and the time interval.

Checkpoint Questions 13.2

1. What is the purpose of the oral glucose tolerance test (OGTT)?
2. A physician has ordered a glucose challenge for a pediatric patient and has specified that the child be given 25 grams of glucose. The commercially prepared oral glucose solution contains 100 grams of glucose per 100-mL bottle. How many milliliters of the solution should be given to the child?
3. What is the purpose of an A1c test?

13.3 Neonatal Screening

Neonatal or newborn screening is a state-based program to test for the presence of various metabolic and genetic disorders is performed on newborns. Blood is drawn after the baby reaches the minimum age of 24 hours. If the infant's blood is collected before they are at least 24 hours old, the infant's

blood will need to be redrawn. All states have mandatory screening, although the number of tests varies by state. Common screening tests include

- **biotinidase**—deficiency of the enzyme that breaks down the vitamin biotin
- **cystic fibrosis**—mucous secretions accumulating in various organs
- **galactosemia**—the inability to break down the milk sugar galactose
- **hypothyroidism**—a decrease in thyroid function
- **phenylketonuria (PKU)**—a buildup of phenylketone due to decreased metabolism of phenylalanine
- **sickle cell disease**—abnormal hemoglobin structure

Testing may also be performed for the infectious diseases of toxoplasmosis and human immunodeficiency virus (HIV) as well as other less common metabolic disorders. A phlebotomist should know the tests performed within his or her state and the procedures for obtaining the blood specimens.

Biotinidase Deficiency

A deficiency in the enzyme biotinidase impairs the activity of other enzymes that depend on the vitamin biotin. Biotin assists other enzymes in many functions, such as the synthesis of fatty acids and breakdown of amino acids. If not diagnosed or if left untreated, this disorder can result in neurological damage, such as hearing and vision loss, and problems with movement and balance. Biotinidase deficiency is treatable with biotin supplements.

Cystic Fibrosis

Cystic fibrosis (CF) affects many body systems, particularly causing damage to the respiratory system and producing digestive system problems. The mucus normally lining many body systems accumulates abnormally in people with cystic fibrosis. If not diagnosed or if left untreated, cystic fibrosis can be fatal at an early age. Treatments for cystic fibrosis do exist, and new treatments are currently under development that may help these patients reach adulthood and live fairly normal lives.

Neonate screening for CF includes performing a dermal (capillary) puncture and collecting blood on a special card called a Guthrie card. If this screening test is positive, a chloride sweat test may be performed to confirm the diagnosis. The chloride sweat test, performed by pilocarpine iontophoresis, measures the amount of salt in a newborn's sweat and is not performed by a phlebotomist. DNA testing of blood from symptomatic infants is recommended by the American College of Medical Genetics (ACMG) for at least the 23 most common mutations. Some physicians now screen expectant mothers for these same mutations.

Galactosemia

The sugar galactose (part of a larger sugar, lactose) is present in small amounts in many foods, especially dairy products such as milk, cheese, and ice cream. Galactosemia is a disorder in which the body lacks the ability to use galactose as an energy source. Infants with galactosemia fail to gain weight, develop improperly, and have liver damage and bleeding problems. This disorder can be life threatening to infants if undiagnosed or left untreated. A diet low in lactose may help minimize the effects of this disorder.

Hypothyroidism

Hypothyroidism is a partial or complete loss of thyroid function. Hypothyroidism can be acquired but also can be **congenital** (existing at birth). The thyroid is responsible for making many iodine-containing hormones needed

for growth, brain development, and the regulation of metabolism (chemical reactions in the body). If undiagnosed or left untreated, congenital hypothyroidism can delay normal growth and cause intellectual disabilities. Treatment for hypothyroidism is an oral dose of thyroxine (thyroid hormone).

Phenylketonuria (PKU)

PKU occurs due to a buildup of phenylketone in the blood when the body is deficient in the enzyme that breaks it down. If metabolized to a point where they are water soluble, phenylketones can be found in the urine, hence the word *phenylketonuria.* Phenylalanine, which is one of the amino acids found in many foods (proteins and artificial sweeteners), can cause damage to brain tissue if left untreated. Children with PKU may also have heart problems, have microcephaly (small head size), and be prone to skin disorders such as eczema. In addition to the first blood collection for neonatal screening, PKU should be retested when the infant is 10 to 15 days old. If diagnosed early, PKU is treatable with a diet low in phenylalanine.

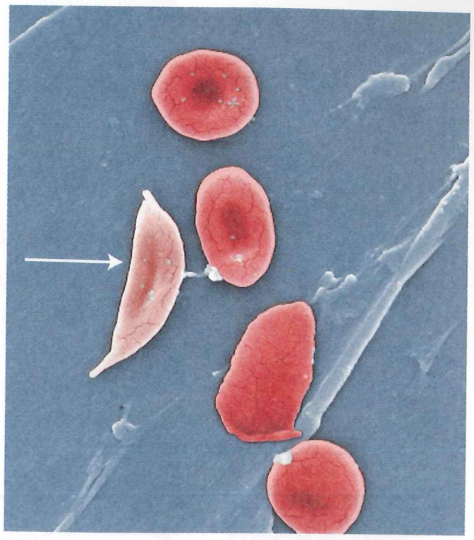


Figure 13-5 Cells containing sickle cell hemoglobin will deform to take on this characteristic shape (at arrow) when the cell loses oxygen.
Janice Haney Carr/CDC

Sickle Cell Disease

Sickle cell disease is a group of disorders in which hemoglobin has an abnormal structure due to a genetic mutation. In some forms of sickle cell disease, this abnormal structure causes the hemoglobin molecules to distort into a sickle, or crescent, shape (see Figure 13-5). These distorted cells can block small blood vessels and create organ pain. As these cells are removed from circulation, the red blood cell count decreases, resulting in anemia. Treatment for sickle cell disease includes closely monitoring the symptoms, staying well hydrated, and avoiding exposure to low-oxygen environments, such as high altitudes and anesthesia during surgery.

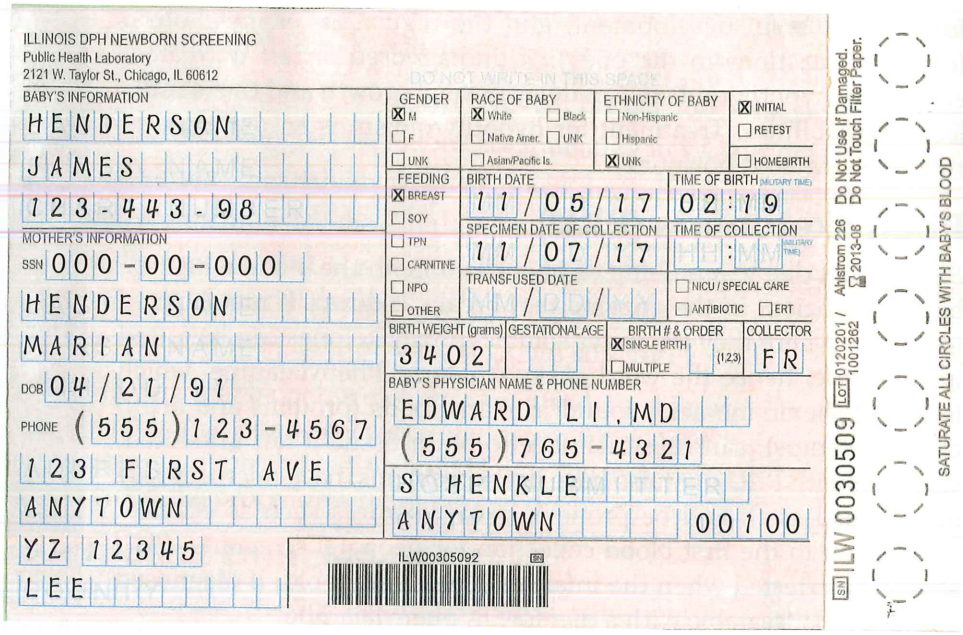
State Testing Specimen Collection

State-required blood tests are collected onto special forms that include an absorbent area for collecting specimens (see Figure 13-6). Be sure to check the expiration date on the form and provide all the required information. The general steps for performing a dermal puncture on infants for state testing are shown in Learn How 13-4. Follow the facility's protocol for gowning, handwashing, and donning of PPE prior to entering the neonatal nursery. Identify the patient according to facility guidelines. Be certain to use the correct form for the test to be collected.

Specimens may be unsatisfactory if

- all circles are not completely filled
- a circle is oversaturated (layering)
- the specimen is not allowed to dry thoroughly
- the specimen is contaminated with a foreign substance
- an expired form is used
- the form is not received within 14 days of collection
- circles are filled from top and bottom (they should only be filled from the top)

Most states use similar collection forms for their mandated testing of newborns. Once the specimens have been collected, these forms are mailed to the appropriate state laboratory for testing. Use the competency checklist *Neonatal Testing* at the end of this chapter to review and practice the procedure.


ILLINOIS DPH NEWBORN SCREENING
Public Health Laboratory
2121 W. Taylor St., Chicago, IL 60612

DO NOT WRITE IN THIS SPACE

BABY'S INFORMATION
HENDERSON
JAMES
123-443-98

GENDER: [X] M [ ] F [ ] UNK
RACE OF BABY: [X] White [ ] Black [ ] Native Amer. [ ] UNK [ ] Asian/Pacific Is.
ETHNICITY OF BABY: [ ] Non-Hispanic [ ] Hispanic [X] UNK
[X] INITIAL [ ] RETEST [ ] HOMEBIRTH

FEEDING: [X] BREAST [ ] SOY [ ] TPN [ ] CARNITINE [ ] NPO [ ] OTHER
BIRTH DATE: 11/05/17
TIME OF BIRTH (MILITARY TIME): 02:19
SPECIMEN DATE OF COLLECTION: 11/07/17
TIME OF COLLECTION (MILITARY TIME): HH:MM
TRANSFUSED DATE: MM/DD/Y
[ ] NICU / SPECIAL CARE [ ] ANTIBIOTIC [ ] ERT

MOTHER'S INFORMATION
SSN 000-00-000
HENDERSON
MARIAN
DOB 04/21/91
PHONE (555)123-4567
123 FIRST AVE
ANYTOWN
YZ 12345
LEE

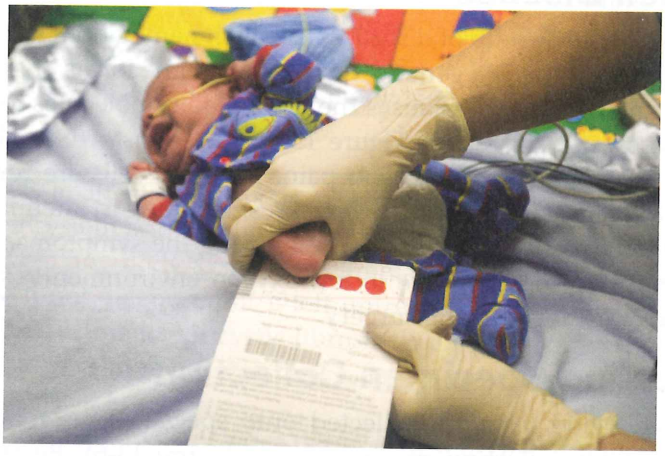
BIRTH WEIGHT (grams): 3402
GESTATIONAL AGE:
BIRTH # & ORDER: [X] SINGLE BIRTH [ ] MULTIPLE (1,2,3)
COLLECTOR: FR

BABY'S PHYSICIAN NAME & PHONE NUMBER
EDWARD LI, MD
(555)765-4321
SHENKLE
ANYTOWN 00100

ILW00305092

Ahlstrom 226 © 2013-08
01202011 / 1001262
LOT ILW 0030509
Do Not Use If Damaged.
Do Not Touch Filter Paper.
SATURATE ALL CIRCLES WITH BABY'S BLOOD

A



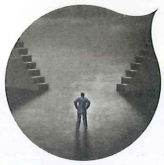
B

Figure 13-6 (A) Each state has its own form designed to screen newborns for various inherited disorders. (B) Blood must saturate all of the circles during collection.
A: Lillian Mundt B: Marmaduke St. John/Alamy Stock Photo

Learn How 13-4

Dermal (Capillary) Puncture State Testing on Infants

1. Check the patient identification band (usually on the infant's ankle) and verify the patient's identity with nursing staff. Explain the procedure and obtain consent from the parents, if present.
2. Wash your hands, put on gloves, and prepare the equipment.
3. Select the appropriate area for dermal (capillary) puncture on the infant's heel.
4. Sterilize the site. If the manufacturer's procedure indicates drying the skin, use sterile gauze to dry the skin. Otherwise, allow the site to air-dry.
5. Puncture the heel with a sterile lancet.
6. Allow a large blood droplet to form.
7. Touch the filter paper to the blood and allow the blood to soak through completely, using one drop of blood for each circle. Total saturation of the circles must be evident when the paper is viewed on both sides. Do not apply blood to both sides.
8. Allow blood spots to air-dry thoroughly for 3 hours at room temperature. Keep away from direct sunlight and heat. Never place one wet filter paper on top of another until both filter papers are thoroughly dry.



Think It Through

Handle with Care

The forms used for state-required newborn screening tests are made from a delicate material and must be treated gently. States have their own requirements for how designated areas on the form should be filled. Strictly follow the directions on the form for applying blood to the form.

Considering the delicate nature of the form, why might the directions for most states say that you should *not* use a capillary tube to collect and transfer the baby's blood to the form?

Checkpoint Questions 13.3

1. When collecting blood from a neonate for state-required tests, why is it important not to touch the paper to the skin or capillary tube?
2. Name five conditions for which neonatal screening is commonly performed.

13.4 Peripheral Blood Smears

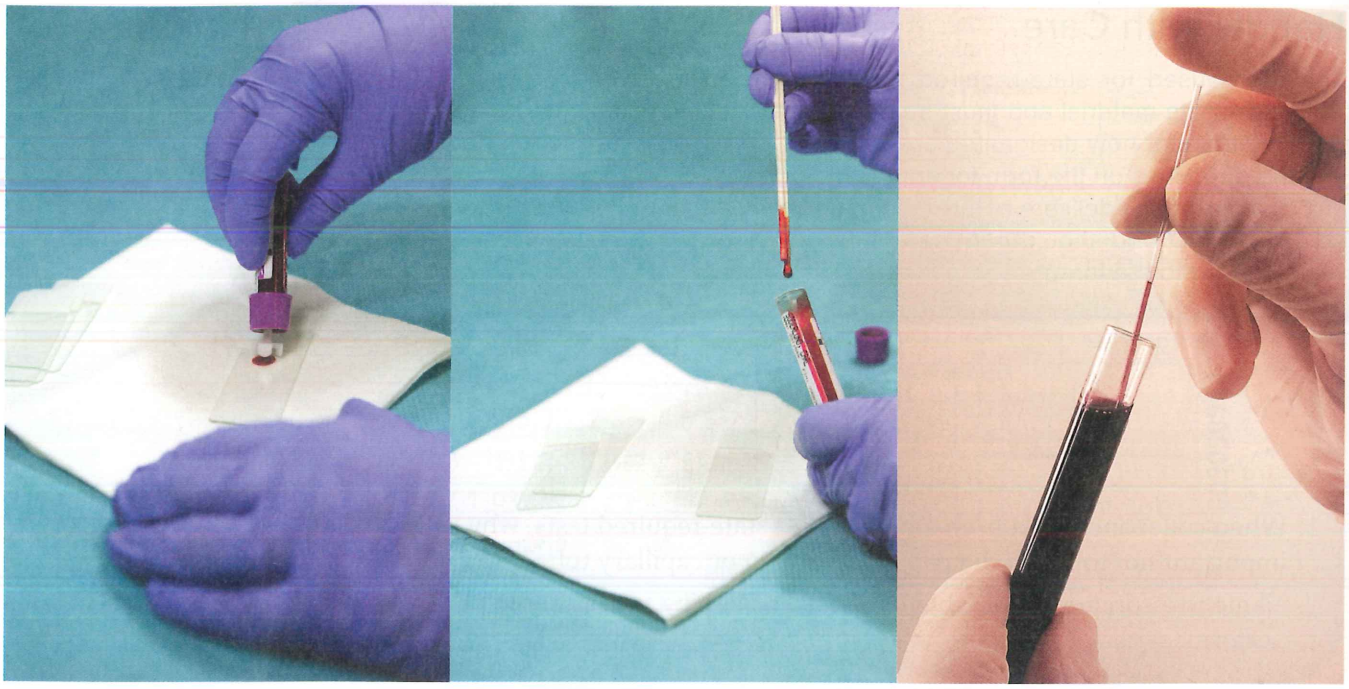
A blood smear (a thin film of blood spread onto a glass slide) is used for the microscopic examination of blood. Either venous blood or capillary blood may be used to prepare a blood smear. A blood smear may also be prepared by applying blood directly from the finger to the slide. Some of the most valuable information about a patient's health can be obtained through a well-made peripheral blood smear.

A complete blood count with **differential** is a hematology test performed by technicians and scientists using a stained blood smear. They examine the smear under a microscope and count the number of each type of white blood cells. In addition, they note any abnormalities in the morphology (size, shape, and color) of red blood cells and platelets as well as any abnormalities in the appearance of white blood cells.

The information obtained from blood smears, along with CBC results, is used to diagnose hematological disorders, such as anemia and leukemia. Screening for blood parasites, such as *Plasmodium* species that cause malaria, is also performed using blood smears. Some facilities may require phlebotomists to assist laboratory personnel by preparing blood smears. In addition, blood smears may need to be made at facilities such as physician offices when a smear is needed to confirm abnormal findings.

Thin Blood Smears

Blood smears for differentials are prepared on glass slides using a wedge method (two slides touching each other at an angle to form a wedge shape) and are referred to as *thin smears.* The blood smear should be made from fresh, noncoagulated drops of blood. To perform this procedure, first assemble the equipment needed for a dermal (capillary) puncture or obtain a tube of uncoagulated blood, usually collected into EDTA. At least two microscope slides are needed to perform a blood smear. Select clean glass slides, ensuring that there



A B C

Figure 13-7 Methods for delivering a drop of blood to a slide. (A) A safety device is the preferred method to deliver a drop of blood to a glass slide for smear making. If unavailable, (B) a wooden applicator stick or (C) a capillary tube can be used to obtain the drop of blood.
A–B: Sandra Mesrine/McGraw-Hill Education; C: Terry Wild Studio

are no chipped edges, and handle them so as not to leave fingerprints. Frosted slides may be labeled prior to making the blood smear; however, this may lead to the same specimen identification problems as labeling tubes before blood collection. Most facilities require slides to be labeled *after* a blood film is made. In the case of slides that do not have frosted ends, you must wait until the smear has dried and write the name on the thick end of the smear. Always check with your facility's protocol for the required procedure.

If you are performing a dermal (capillary) puncture, wipe away the first drop of blood using a piece of gauze. Squeeze the punctured area to create a free-flowing drop of blood. Allow the drop of blood to fall onto the glass slide toward one end.

When preparing smears from tubes of blood, check the specimen for proper labeling. Use a safety device to access the blood without removing the cap (see Figure 13-7A). If these devices are not available, carefully uncap the specimen tube behind a safety shield; use a wooden applicator stick or capillary tube to remove some of the blood and place a drop on the slide toward one end (see Figure 13-7B and C). A disposable pipet/plastic dropper may be used in some cases. Follow the steps in Learn How 13-5 and the competency checklist *Preparation of Blood Smears* at the end of this chapter to master the thin blood smear.

Figure 13-8 shows the steps in the thin blood smear procedure. Most of the drop should be spread out onto the glass slide. The smear will be thick at the drop end and thin at the opposite end. A properly made blood film will have

Thin Blood Smear

Learn How 13-5

1. Wash your hands and put on gloves. Wear a face shield or work behind a tabletop shield.
2. Verify the identity of the specimen requiring a blood smear.
3. With the slide on the work surface, hold the capillary tube or applicator stick in one hand and the frosted end of the slide against the work surface with the other.
4. Apply a drop of blood to the slide, about ½ inch from the frosted end.
5. Dispose of contaminated equipment in a biohazardous waste container. Capillary tubes must be placed in a sharps container.
6. Pick up the spreader slide with your dominant hand and hold it at a 30- to 35-degree angle.
7. Place the edge of the spreader slide on the smear slide close to the unfrosted end.
8. Pull or back up the spreader slide toward the frosted end until the spreader slide touches the blood drop. Capillary action will spread the droplet along the edge of the spreader slide.
9. Allow the blood drop to spread almost to the edges of the spreader slide.
10. With one light, smooth, fluid motion, push the spreader slide toward the other, clear end of the slide until you come off the end, maintaining the 30- to 35-degree angle.
11. Immediately label the frosted end with two patient identifiers, the date, and the accession number of the specimen (if available).
12. Allow the smear to air-dry before staining.

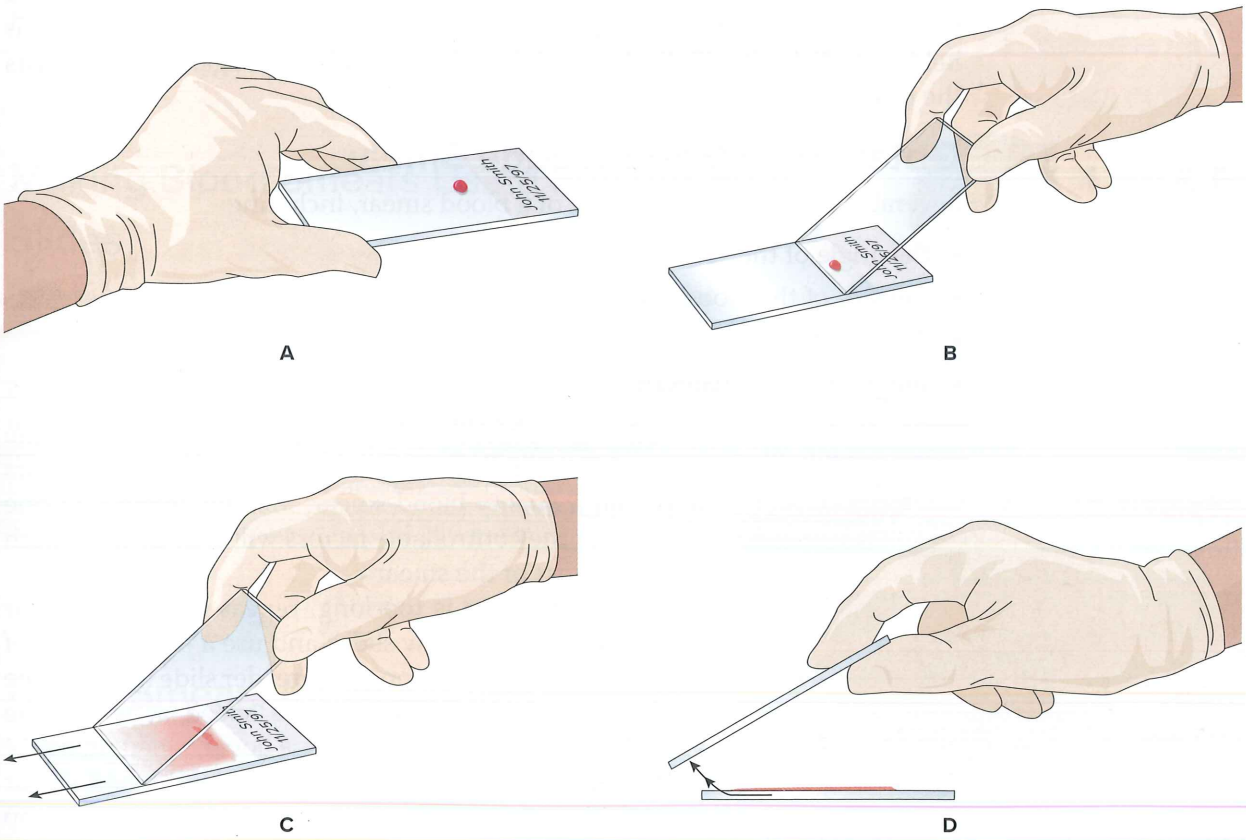


Figure 13-8 Making a blood smear. (A) Apply a drop of blood to the slide about ½ inch from the frosted end. (B) Hold the spreader slide at a 30- to 35-degree angle. Pull the spreader slide toward the frosted end until it touches the drop of blood. (C) When the drop finishes flowing along the edge of the spreader slide, push the spreader slide toward the unfrosted end of the smear slide. (D) Continue the steady motion past the edge of the smear slide and lift the spreader slide away from the smear slide, maintaining a 30- to 35-degree angle. The smear should be thicker at the frosted end of the slide.

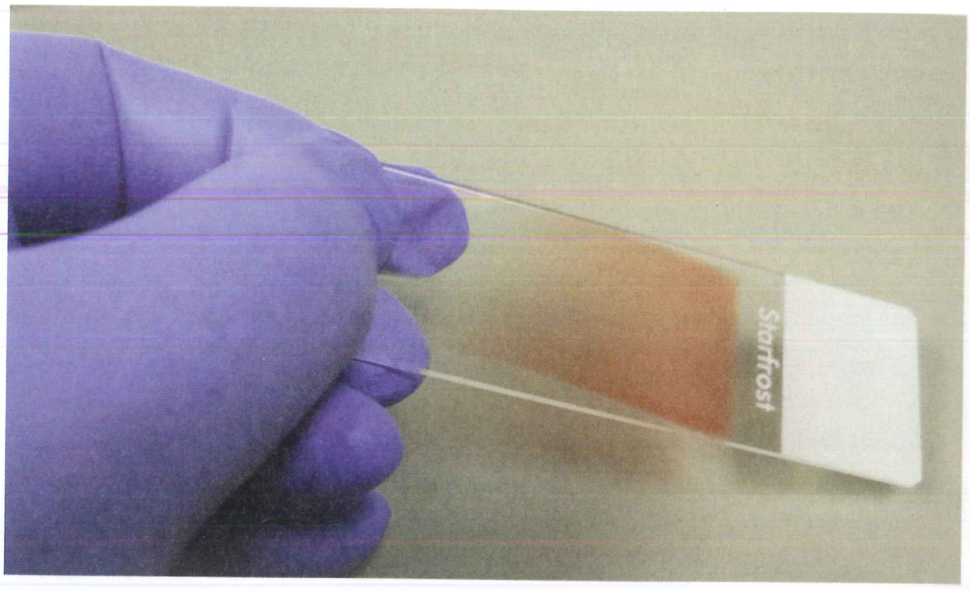


Figure 13-9 A correctly prepared blood smear should appear smooth, without irregularities, and should have a feathered edge.
Total Care Programming, Inc.

a thick portion, a thin portion, a critical area used for performing the differential, and a tail with a feathered edge that is straight to slightly rounded (see Figures 13-9 and 13-10).

The blood smear should not touch the edges of the glass slide and should appear smooth, with no irregularities, streaks, or holes. When the smear is held up to light, it will display a rainbow in the feathered edge. Table 13-3 lists the criteria to ensure quality blood smears.

Obtaining a Good Wedge Smear

Several factors affect the quality of a blood smear, including

- the angle of the spreader slide
- the size of the blood drop
- the speed of pushing the spreader slide
- the patient's hematocrit

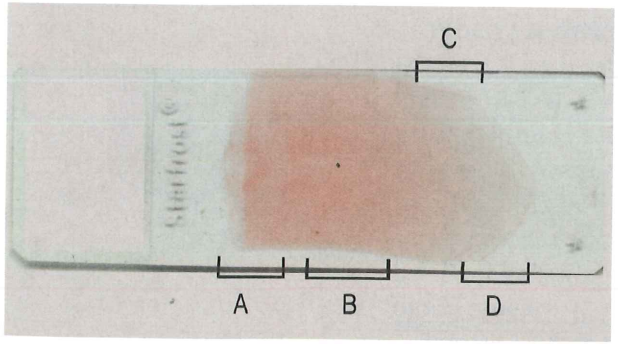


Figure 13-10 Portions of a properly prepared blood smear include (A) the head, or thick, portion; (B) the body, or thin, portion; (C) the critical area; and (D) the tail portion with a feathered edge.
Lillian Mundt

Although phlebotomists have no control over the patient's hematocrit, they can control the other factors to obtain a quality blood smear. Making changes to one or more of the controllable factors will change the length and thickness of the smear.

If a blood smear is too long, repeat the blood smear procedure with two new slides and use a smaller drop of blood or a steeper angle on the spreader slide (a 45-degree angle or greater), or increase the speed at which the spreader slide is pushed.

If a blood smear is too short, repeat the blood smear procedure with two new slides and use a larger drop of blood or a shallower angle on the spreader slide (a 25-degree angle or less), or decrease the speed at which the spreader slide is pushed. Table 13-4 provides an explanation for causes of poorly prepared blood smears.

TABLE 13-3 Criteria to Ensure Quality Blood Smears

- Glass slides must be clean and free of chipped edges.
- The drop of blood should be about 2 millimeters (mm) in diameter.
- The smear should be made immediately after placing the blood on the slide.
- The spreader slide angle should be correct, normally at a 30- to 35-degree angle.
- The pushing motion should be smooth and fluid.
- The smear should be allowed to air-dry.
- The smear should cover two-thirds to three-fourths of the length of the slide (approximately 1½ inches).
- The smear should have a "rainbow" in the feathered edge when held up in the light.
- The smear should not touch any edge of the slide.

Thick Blood Smears

Malarial parasites may be present in peripheral blood in amounts too small to be detected easily on a routine blood smear examination. Preparation of thick smears allows for quick screening to detect the presence of malarial parasites, which can then be further examined using a thin smear. Thick smears for malaria screening are best prepared directly from a dermal (capillary) puncture. Collect one large drop of blood by allowing it to drop freely onto the center of a clean glass slide. Place the corner of another glass slide or the tip of an applicator stick into the center of the drop. Prepare the smear by drawing a spiral from the center outward, spreading the blood into a thick circle.

Law & Ethics

Making Blood Smears Using Frosted-End Slides

If you are preparing smears using slides with a frosted end, be sure the frosted side is facing upward. Place the drop of blood near, but not on, the frosted end.

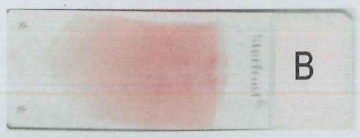
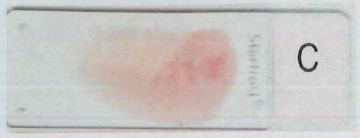
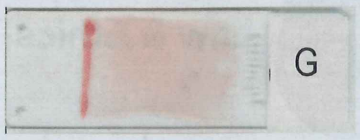
This frosted area is used to label the slide. Label the slide on this area either by writing the patient's information on the slide or by affixing a small preprinted label. Labeling is performed after the blood smear is made; however, some facilities may have you label the slide before the smear is made. Always follow the protocol at your facility and ensure proper slide identification.

Life Span Considerations

Blood Smears for Newborns

When preparing blood smears from newborns, remember that their hematocrits may be high, which will result in smears that are too short. Using a normal to slightly large drop of blood with a decreased angle and pushing the spreader slide slowly will allow you to make a longer blood smear. At facilities that require blood smears to be made directly from the heelstick, prepare the smears first; then collect the blood into microcollection containers.

TABLE 13-4 Causes for Various Appearances of Blood Smears

Smear	Description	Cause
 A	Good blood smear has a straight, or slightly curved feathered edge.	Proper control was used over the blood drop size, angle of spreader slide, and speed at which the spreader slide was pushed.
 B		
 C	Blood smear is too rounded.	The drop of blood was not allowed to form a uniform line along the spreader slide before it was pushed.
 D	Blood smear has a sharp angle on one side.	Uneven pressure was used when pushing the spreader slide.
 E	Blood smear is too short.	The spreader slide was used at too steep an angle, was pushed too quickly, or both.
 F	Blood smear is too long.	The spreader slide was used at too shallow an angle, was pushed too slowly, or both.
 G	Blood smear does not have a critical area or feathered edge.	The spreader slide was not pushed all the way off the bottom slide; it was lifted off midway during pushing.
 H	Blood smear has a back-and-forth, wavy appearance and is too long.	A stop-and-start movement was used during pushing.
 I	Blood smear has areas where no blood is visible on the slide.	A stop-and-start, shaky movement was used during pushing.
 J	Blood smear has a jagged edge and a large amount of blood remaining at the head.	The entire drop of blood was not allowed to flow along the spreader slide edge and the spreader slide edge was not clean.
 K	Blood smear has holes in it.	The slide has fingerprints on it. Slides should be clean and handled only by the edges.

(all) Lillian Mundt

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The resulting smear should be thick and circular to oval (see Figure 13-11). Label the frosted end with patient information. Protocols may state to label slides prior to making the blood smear. Always check with your facility's protocol for the required procedure. A well-prepared thick smear is dense yet allows newsprint to be seen through it when still wet. If a smear is too thick, it may peel away from the slide during drying or staining. Allow the smear to air-dry for at least 30 minutes. If preparing thick smears from an EDTA specimen, prepare them no more than 1 hour after collection.

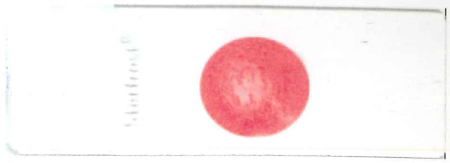


Figure 13-11 A thick smear, used for malaria parasite screening, should be circular to oval and be thin enough to visualize newsprint through it when still wet.
Lillian Mundt

Checkpoint Questions 13.4

1. Describe the characteristics of a well-made thin blood smear.
2. What is the major purpose of a thick blood smear?

13.5 Blood Collection for the Blood Bank

Patients who require a blood transfusion or blood products must have certain tests to prepare for receiving blood. Blood collection for the transfusion services of the immunohematology department includes specimens for transfusion as well as antibody screening. The order may read *type and cross-match* or *type and screen.* Sometimes blood group and type are tested without the need to crossmatch blood or screen for antibodies. These tests are referred to as ABO (group) and Rh (type). Special procedures must be followed when collecting blood from patients who need or potentially may need a transfusion.

Type and Cross-Match/Type and Screen Blood Specimens

For all blood tests, phlebotomists must follow a standard procedure for patient identification and documentation on specimen tubes and requisitions. However, more complete identification is required for specimens from patients who may receive blood products. Hospital transfusion services and blood banks have strict protocols for patient identification prior to blood collection for transfusion testing and immediately prior to transfusing a blood product. A special identification wristband may be used, in addition to the hospital admission band and tube labeling systems may be used. Because these systems vary by hospital, phlebotomists must become familiar with the system used by their facility. Both the patient wristband and the tubes must display special transfusion numbers. For example, the requisition shown in Figure 13-12 displays the number R165146. This number is on the patient's blood bank wristband, on the patient's blood specimen, on the requisition, and on the blood product tag. It is a number used only once, for only one patient.

Facilities using bar codes for patient identification may use a blood bank identification system similar to that shown in Figure 13-13. The phlebotomist places an armband that displays the order for type and screen or type and cross-match on the patient's arm. This special blood bank armband must also display the transfusion number and its bar code. The same transfusion number and corresponding bar code must appear on the specimen tube; additional stickers are available for labeling units of blood and/or accompanying paperwork. This type of bar code identification system helps reduce errors in blood transfusion administration.

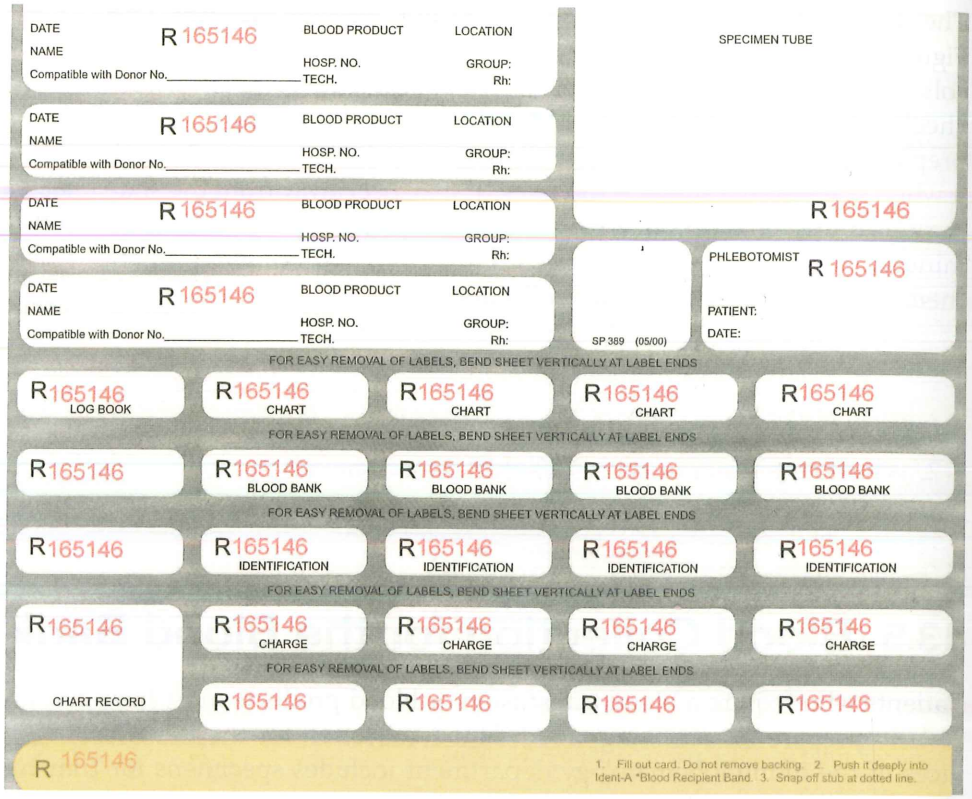


Figure 13-12 Labels with unique numbers are used to identify patients, their blood specimens, and the units of blood that have been cross-matched for them. The highlighted area becomes an armband that the phlebotomist must put on the patient.
Lillian Mundt

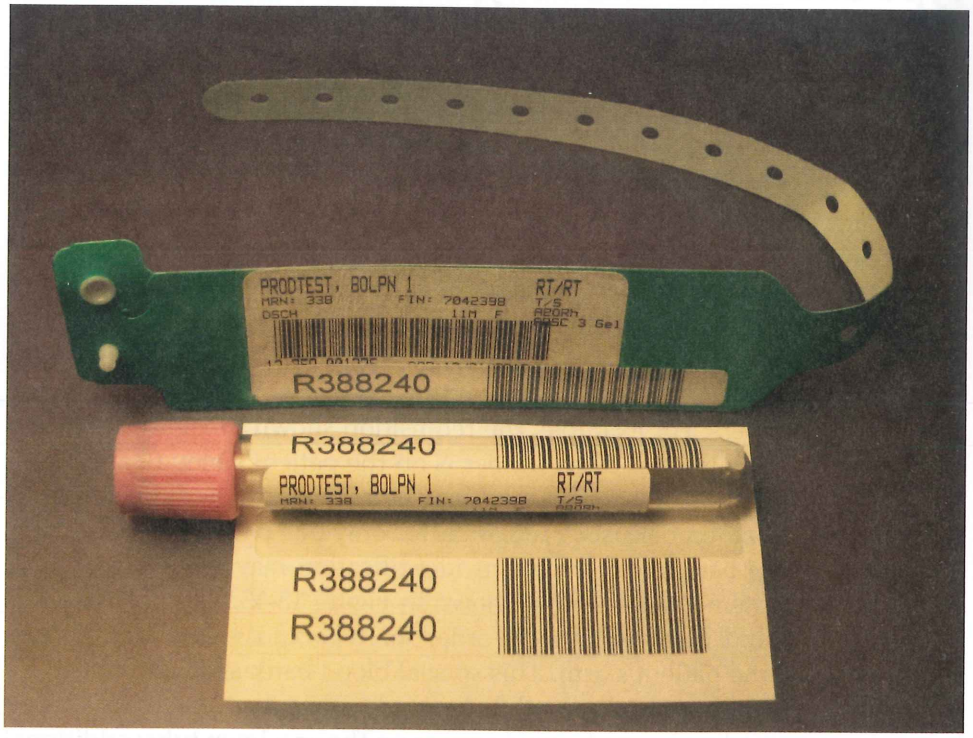


Figure 13-13 Bar code systems are available for blood bank identification. The reference number R388240 on the unit of blood must match the one on the patient's armband as well as the one on the tube used for the type and cross-match specimen.
Lillian Mundt

A specimen drawn for type and cross-match or type and screen is usable for 72 hours. Once the specimen expires, if additional products are required for the patient, a new specimen must be drawn. Generally, a new unique number is assigned at that time, although some protocols allow patients to maintain the same number for the length of their hospital stay.

The steps in Learn How 13-6 help ensure that this procedure is performed correctly. However, procedures vary from facility to facility, so always follow the policy at the facility where you are employed.

Learn How 13-6

Type and Cross-Match
1. Identify the patient by asking the patient state and spell their name and date of birth, or use other acceptable forms of identification.
2. Compare this information with that on the blood bank requisition and labels.
3. Compare this information with that on the hospital wristband. If they are different, contact the patient's nurse immediately for clarification of the patient's identity. Discrepancies must be resolved before blood is drawn.
4. Attach the identification bracelet to the patient's wrist above or below the hospital band.
5. Wash your hands, put on gloves, and prepare the equipment.
6. Perform the venipuncture procedure and collect the appropriate tubes (usually one or two pink-topped EDTA tubes).
7. Label the specimens with the special blood bank labels and recheck information by comparing the labels on the tubes with the blood bank identification band. Be sure to complete all of the information required on the blood bank labels. Such as the phlebotomist's initials and date.
8. Carry out post venipuncture patient care.
9. Deliver the specimens and blood bank requisition to the blood bank or transfusion service at your facility.

Use the competency checklist *Specimen Collection for Type and Cross-Match* at the end of this chapter to review and practice the procedure.

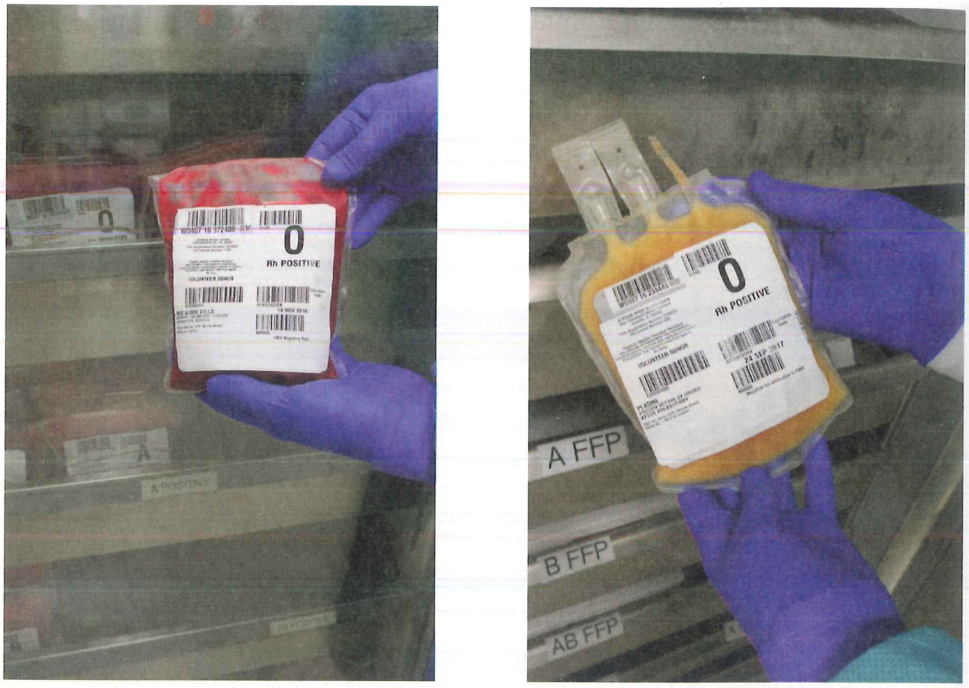
Donor Blood Collection

Another aspect of blood bank phlebotomy is collecting blood from donors. Certified phlebotomists can obtain training to perform blood collection in donor collection centers, where blood is donated for patient use. Donations can occur at a blood collection center, such as the American Red Cross or LifeSource; at the blood bank section of a hospital laboratory; or at community drives arranged by hospitals or blood centers. Blood donor vans travel to many locations, such as schools, civic organizations, places of worship, and places of employment.

Blood components are usually processed at the donor center's testing laboratory or facility. Collected units of blood may be processed to provide any of the following products:

- Red blood cells (see Figure 13-14A)
- Plasma (see Figure 13-14B)
- Platelets

Blood products such as platelets, plasma, and granulocytes can be collected using *apheresis* techniques, in which one or more of these blood products is removed during blood collection through a special apparatus. For example, plasmapheresis removes blood plasma. All blood products require meticulous labeling so that each unit is identified correctly and can be traced back to the blood donor.



A B

Figure 13-14 Donated blood can be processed into a number of products, such as (A) red blood cells and (B) plasma.
A–B: Lillian Mundt

Communicate & Connect

Donor Communication

People who volunteer to donate blood are screened both orally and using a detailed questionnaire. The information they provide helps screen for diseases such as malaria, hepatitis C virus, and variant Creutzfeldt-Jakob disease (vCJD), which may have been picked up during travel to Europe. Questions about sexual activity are necessary to screen for sexually transmitted infections (STIs), such as human immunodeficiency virus (HIV) infection and syphilis. Donors may be surprised at the depth of these questions and need to be assured that their information is maintained with the strictest confidence.

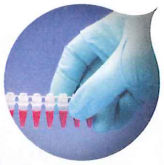
Blood donation candidates must meet strict guidelines and requirements for blood donation, which have been developed by the FDA and other regulatory bodies. Donor collection facilities are periodically subjected to unannounced inspections to ensure compliance with guidelines and regulations.

To qualify for blood donation, a person must

- be at least 16 years old (written parental consent is required for minors)
- weigh at least 110 pounds
- be in good general health
- have eaten within 4 hours prior to donation
- *not* have donated blood in the past 8 weeks

In addition, a mini-physical is given. The donor's temperature, blood pressure, and pulse are taken. The donor's hematocrit or hemoglobin is often determined by using a fingerstick technique (explained in the *Waived Testing* chapter). The donor must be healthy enough to donate, and the donor unit must be of the highest quality.

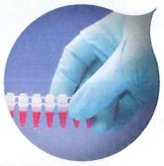
Donor Well-Being



Safety & Infection Control

During and following any type of blood donation, donors must be monitored for potential side effects, such as dizziness and nausea. If dizziness occurs, keep the donor in a reclining position, preferably with the head lower than the heart. Do not allow the donor to stand or walk, as this may lead to injury as a result of falling or fainting. After the donation, a small snack and fruit juice usually prevent these common side effects. The donor's blood glucose level might be lower than normal, and the snack and fruit juice help increase glucose level quickly before the donor leaves the area.

Ensuring a Safe Blood Supply



Safety & Infection Control

It is crucial that donors be made aware of the need to ensure a safe blood supply. Pressure to donate through work, school, and church can put donors in an awkward position when answering questions. It is difficult for some people to admit to others that they may have put themselves at risk due to some past experiences, so it is very important to let them know that they will have another opportunity to alert the staff to possible contamination without others being made aware of it. This opportunity will occur later as part of a private screening process.

Donors must also complete a health history form that includes questions about recent travel out of the country, sexual activity, and the medications they are taking. These questions are asked to screen for diseases that may have been acquired in a foreign land and to screen for the possibility of transfusing sexually transmitted infections (STIs) or drugs that may cause patients to have an adverse reaction. The donor then signs a consent, which gives permission for the blood bank to use the blood.

Once the initial screenings are completed, donors are placed in a comfortable sitting or reclining position. It takes several minutes to collect one donor unit of 450 to 500 mL. The preferred site of venipuncture is from a large vein in the antecubital area, such as the median cubital vein. A two-step skin cleansing process, similar to the process for blood culture collection, is followed. Blood units are collected in a sterile, closed collection system consisting of the blood collection bag to collect the blood, tubing, and a 16-gauge needle. Once the vein is accessed, blood flows via gravity into the collection bag, which is placed lower than the donor's arm.

An anticoagulant—citrate phosphate dextrose (CPD or CPDA1)—is present in the blood collection bag. The amount of CPD present anticoagulates and preserves 450 mL (about a pint) of blood for 21 days. During the collection process, the phlebotomist can place the bag on a mixing unit next to the donor. The mixing unit agitates the contents, which ensures that the blood is being mixed properly with the anticoagulant. In some facilities, the phlebotomist performs manual mixing by gently manipulating the bag as the blood flows into it.

This sterile, closed blood collection unit must be used only once. If for some reason the bag does not fill with blood, the needle and the blood collection bag must be discarded because it will be affected by the presence of too much CPD for the amount of blood collected. If this occurs, the entire process will have to be repeated, using another blood donor collection setup. This is done to maintain the sterility of the donor unit.

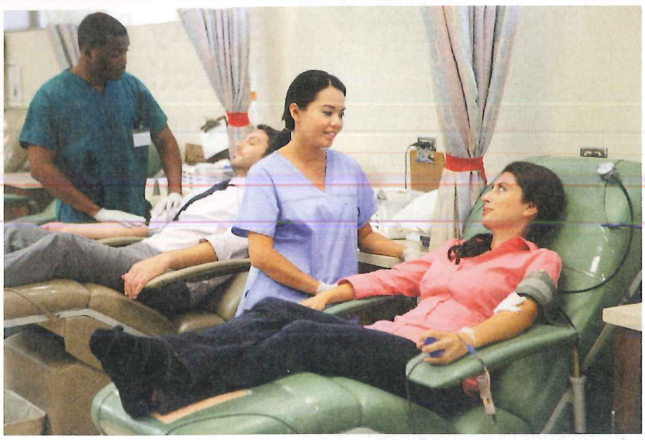


Figure 13-15 Collecting large amounts of blood requires careful monitoring of donors, especially patients undergoing therapeutic blood collection.
stockbroker/123RF

Autologous Blood Collection

In addition to donating blood to help others, individuals can donate blood for their own future use. Their blood may be drawn at outpatient settings so that it can be stored in a blood bank to be used later. When this pre-drawn, donated blood is given back to the patient, this is referred to as **autologous** blood donation.

Autologous blood can be placed on reserve for the individual to use within a certain amount of time. If, however, the patient is donating blood prior to a surgical procedure, certain prerequisites must be met. First, the patient must have a written order from a healthcare provider and be capable of regenerating red blood cells. In other words, the patient must be in good enough health to replace the blood donation. In addition, the individual's hemoglobin must be at least 11 grams or hematocrit at least 33%. In addition the surgical procedure must be scheduled for more than 72 hours from the time of autologous donation. The collection process for an autologous unit of blood is the same as for donor blood collection.

Another form of autologous blood transfusion can occur during surgical procedures where extensive blood may be lost. Patients can be readministered some of the blood lost during the surgery. A patient's blood is collected from body cavities into special reservoirs on an instrument called a Cell Saver. Blood is delivered to the Cell Saver through tubing. The blood is then cleaned by washing with a saline solution and removing impurities by spinning the blood–saline mixture to separate the cleaned blood from the impurities. The blood is then infused back into the patient. Similar to the Cell Saver, but smaller, an OrthoPAT is used to collect blood lost primarily during knee surgery. Highly trained surgical staff or blood transfusion specialists perform these procedures.

Therapeutic Phlebotomy

Therapeutic phlebotomy is the intentional removal of a large amount of blood to lower the red blood cell concentration. Unlike blood donation, which benefits the recipient, therapeutic phlebotomy is performed for the benefit of the person from whom the blood is removed. Therapeutic phlebotomies are performed for many medical reasons, including overproduction of iron or red blood cells or an abnormal storage mechanism of iron. Therapeutic phlebotomy is most commonly used as a method of treatment for **polycythemia vera** (a disease that causes an overproduction of red blood cells) and **hemochromatosis** (a disease in which the body stores iron in abnormal amounts). Patients undergoing therapeutic phlebotomy may not be as healthy as normal blood donors, so they require closer monitoring (see Figure 13-15). The blood from patients with polycythemia is not suitable for use in a blood transfusion, so it is discarded. However, some patients with hemochromatosis are eligible to have their units crossed over for patient use.

Checkpoint Questions 13.5

1. What is the purpose of the extensive screening process for voluntary blood donors?
2. Besides whole blood, what other blood products may be collected by a donor phlebotomist and by what procedure?
3. How is autologous blood donation different from regular blood donation?

13.6 Arterial Blood Collection

Arterial blood is collected directly from an artery for special tests that determine the ability of the lungs to exchange oxygen and carbon dioxide. An **arterial puncture** (procedure used to collect arterial blood) is usually performed to test arterial blood gases (ABGs). ABGs measure the ability of the lungs to exchange oxygen and carbon dioxide. They are commonly used to test the partial pressure of oxygen (PO_2) and carbon dioxide (PCO_2) present in arterial blood, along with the pH level. Phlebotomists do not normally perform arterial punctures; special training is required for any medical personnel who perform this procedure. Arterial puncture training must cover the complications associated with arterial puncture, precautions for patient safety, and specimen handling procedures. In many institutions, the respiratory therapy department is responsible for performing arterial punctures. Other licensed professionals (physicians, nurses, and medical laboratory scientists) may also be trained to perform this procedure.

Several conditions require the measurement of arterial blood gases, including

- chronic obstructive pulmonary disease (COPD)
- cardiac failure
- respiratory failure
- severe shock
- lung cancer
- coronary bypass
- open-heart surgery
- respiratory distress syndrome

Scope of Practice

Law & Ethics

Phlebotomists do not normally perform an arterial puncture because it is outside a phlebotomist's scope of practice. Special training is required to perform this procedure. Compared with venipuncture, an arterial puncture is far more dangerous to the patient. If performed improperly, a nerve can be accidentally damaged. A sterile cleansing procedure similar to blood culture collection must be used because the risk of infection is greater in arterial punctures. Many complications can occur, such as hematoma formation, thrombosis, hemorrhage, infection, and permanent nerve damage. A phlebotomist should *never* attempt an arterial puncture until professionally trained.

Usually, patients who have arterial blood gases drawn are critically ill. Therefore, when an arterial specimen is drawn, it must be tested immediately. A phlebotomist may be asked to transport an arterial specimen to the laboratory for testing and must handle this specimen as a STAT.

Arterial Puncture Procedure

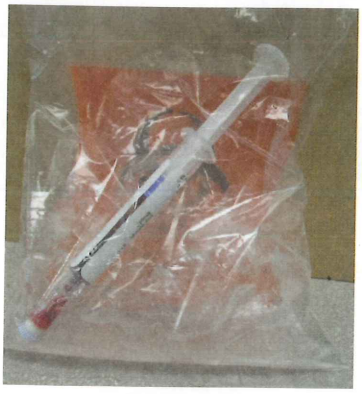
Phlebotomists receive specialized training for the performance of an arterial puncture. Before an arterial puncture is performed, an Allen test or modified Allen test is done to ensure that the blood supply to the wrist is adequate for the puncture. In this test, the patient makes a fist while the healthcare worker applies pressure to the major arteries to the hand (the ulnar and radial arteries) to stop the blood flow. The patient then relaxes the fist. At this point,

the palm and fingers should be pale from lack of blood flow. The healthcare worker releases the pressure on the artery that will not be used for arterial puncture (usually the ulnar artery), while keeping the other artery occluded. If the blood returns to the palm and fingers within 5 to 15 seconds, the modified Allen test is positive. The hand can be sufficiently supplied with blood by one artery while the other is being used to draw blood. If blood return requires more than 15 seconds, the modified Allen test is negative and arterial puncture should not be attempted on the hand.

After making positive patient identification and ensuring a positive Allen test, the arterial puncture is explained to the patient and equipment is prepared. A local anesthetic may be administered at the site before blood collection. Arterial blood for blood gas analysis is collected with a short needle into a heparinized syringe, then labeled and placed immediately on ice. The syringe and ice bath should be prepared ahead of time. In order to properly perform an arterial procedure, the steps in Learn How 13-7 need to be followed in order.

Learn How 13-7

A



B

Figure 13-16 (A) Specimen in a biohazard bag placed on ice slurry. (B) Specimen in outer pocket of biohazard bag with ice slurry contained in zippered portion.
A-B: Lillian Mundt

Arterial Puncture
1. Identify the patient and perform the Allen test. If the Allen test is positive, proceed with the arterial puncture.
2. Wash your hands, put on gloves, and prepare the equipment.
3. Position the patient comfortably, with their arm resting on a flat surface, and hyperextend the wrist over a rolled towel or an armboard.
4. Select a site by palpating the path of the radial artery. Note that a tourniquet is not used.
5. Cleanse the site according to facility policy and procedure. Special cleansing may be required.
6. Palpate the artery again using both the index and middle fingers separated by a space of approximately 2 to 4 cm. Leave fingers in place.
7. Hold the syringe near the needle hub end of the syringe barrel at a 45-degree angle or slightly steeper.
8. Puncture the artery midway between the fingers with a smooth, forward motion.
9. A flash of blood will appear in the hub of the needle when the artery is punctured. Do not advance the needle any farther.
10. Do not pull on the syringe plunger; the syringe will fill automatically in a pulsating fashion. Allow the syringe to fill to the required level.
11. Withdraw the needle and immediately apply pressure directly to the puncture site with a clean gauze pad. Direct pressure must be applied for a minimum of 5 minutes.
12. While still applying pressure, quickly complete the specimen handling procedure.
13. Follow the facility's procedure for removing any air from the syringe, engaging the safety device and capping the syringe, as needed.
14. Gently roll or invert the syringe to mix the blood with the heparin coating the syringe.
15. Label the syringe with the specimen label and place the syringe immediately on ice (see Figure 13-16).
16. After 5 minutes, check to see if the bleeding has stopped. If it has, cover the puncture site with a sterile bandage. If bleeding has not stopped, continue to hold pressure for several minutes more, until the bleeding stops.
17. Before leaving the patient, label the syringe with any additional information required by the facility.
18. Thank the patient and transport the specimen to the laboratory immediately.

Specimen Labeling and Ice Baths/Slurries

Think It Through

Specimens, whether collected in evacuated tubes, microcollection containers, or syringes, must be labeled with all the required information explained in the chapter *Patient and Specimen Requirements*. When a specimen must be transported on ice, it is important not to place it directly into ice, which may lower the specimen's temperature too far. An ice slurry (melting ice or ice water mixture) in a cup or biohazard bag should be used. Specimens should be placed in a plastic biohazard bag before being placed on the ice slurry to prevent the label from getting wet and smearing or falling off the specimen. Many facilities require specimens both the specimen and the cup that contains the ice water mixture to be labeled with the required information.

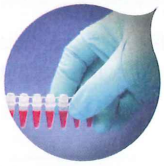
Why are these techniques important when an ice water mixture is required?

Addressing Anxiety

Communicate & Connect

Patients may be uneasy or nervous when anticipating an arterial puncture procedure. Instill confidence by answering questions appropriately. Pay close attention to see if the patient is excessively anxious. Anxious patients have the tendency to hyperventilate, grit their teeth, or hold their breath. These actions will alter blood gas values and therefore not give a true assessment of a patient's cardiopulmonary status. Keeping calm and confident will help relax the patient.

Outpatient Arterial Punctures



Safety & Infection Control

Although an arterial puncture is rarely performed on an outpatient, if you do, you must be careful to ensure that bleeding has stopped before allowing the patient to leave. Because blood flow is more forceful in arteries than veins, pressure must be applied to the arterial puncture site for a minimum of 5 minutes. The patient should remain in the outpatient drawing area with strict instructions not to leave until the site is rechecked to ensure that bleeding has completely stopped. The patient should remain in the area for at least 30 minutes. After 30 minutes, check the site for any abnormalities, such as continued bleeding, swelling, hematoma formation, or redness. Once all bleeding has completely stopped, the patient is allowed to leave the area.

Checkpoint Questions 13.6

1. What equipment preparations must be made before collecting arterial blood?
2. At what angle should the needle be inserted to draw arterial blood?

13.7 Venous Access Devices

A venous access device, also known as a vascular access device (VAD), is typically a hollow tube, known as a **cannula,** inserted and left in a vein. A **saline lock,** also known as a **heparin lock,** is a venous access device (VAD) that is commonly used for obtaining blood specimens. The saline or heparin lock is typically a one-inch winged catheter that may remain in a patient's vein for up to 96 hours, depending on institutional policy. A saline or heparin lock may be inserted into a patient's vein when obtaining blood is difficult or when a patient must have multiple draws in a short period of time (Figure 13-17).

Licensed practitioners may also use this device to administer certain medications. After blood is drawn or medication is administered, the cannula is flushed per the facility protocol. In some cases, blood is drawn also from an IV. A device called a PIVO may be attached to the peripheral IV catheter that allows for fresh venous blood to be drawn so as to not contaminate the specimen.

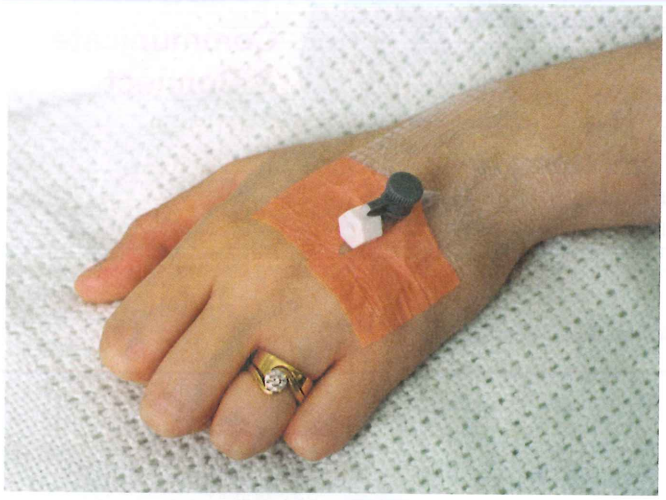


Figure 13-17 A cannula left in place must be flushed with normal saline between blood collections to ensure an accurate specimen.
Total Care Programming, Inc.

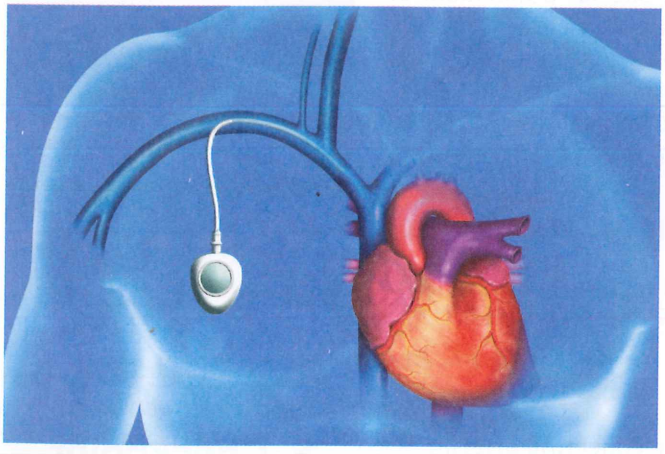


Figure 13-18 A central line is a port that allows for easy venous delivery of medication or collection of blood samples.
BSIP SA/Alamy Stock Photo

Although drawing blood through venous access lines is not a procedure normally performed by phlebotomists, a phlebotomist may be present during this collection process and may need to provide evacuated tubes for the procedure and transport the specimens to the laboratory. Only specially trained personnel should draw blood from a heparin lock, saline lock or peripheral IV catheter assembly, as determined by each facility. Facility-specific procedures must be followed when collecting blood from these devices for blood cultures (ensuring sterility of the collection procedure). The first 5 mL of blood must be discarded before specimens are collected to reduce contamination with heparin or saline. It is also recommended that if blood cultures are drawn from a VAD, the cultures are paired with another set drawn through venipuncture.

Other types of VADs used to collect a specimen include central venous therapy ports and shunts (see Figure 13-18) or peripherally inserted central catheters (PICC). A PICC is introduced into a vein in the arm and threaded into a central vein such as the inferior or superior vena cava. An arterial venous **fistula** is a surgically inserted shunt (usually a U-shaped tube) connecting an artery and a vein, usually in the forearm, to allow for hemodialysis (a procedure for removing waste products from the blood). In hemodialysis (typically done for patients with severe kidney disease), the shunt is connected to a machine that filters the blood. It is important to note that a phlebotomist *never* accesses shunts or central venous lines or collects blood from arms that have venous access devices installed.

Even with proper care, the potential for hemolysis increases when blood is collected through a venous access device. Blood is collected using a special Huber needle and syringe and must be transferred to tubes

immediately and mixed adequately. Being pulled into the syringe and then pulled into an evacuated tube may cause enough turbulence to hemolyze the blood. Blood should *never* be forced out of the syringe by pushing hard on the plunger during the transfer procedure.

1. For what reasons might a venous access device be ordered for a patient?
2. Explain the purpose of a heparin lock.

Checkpoint Questions 13.7

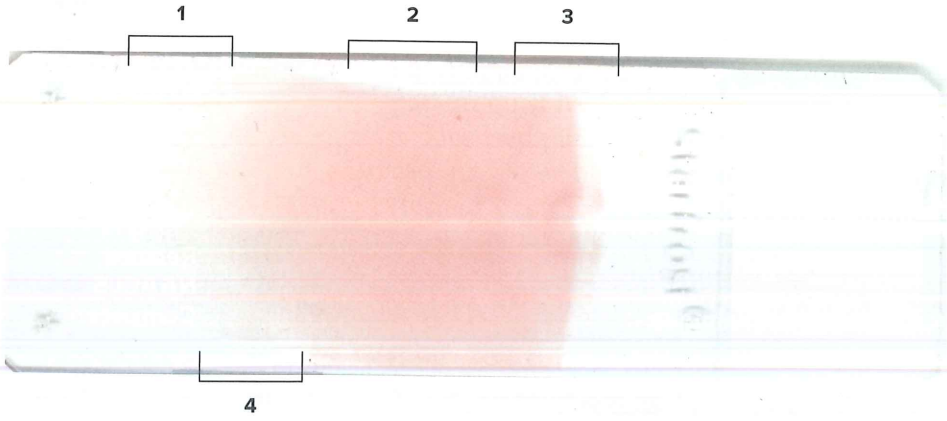
Chapter Summary

Learning Outcome	Key Concepts/Examples	Related NAACLS Competency
13.1 Describe special considerations and procedures needed to collect specimens for blood cultures.	Blood cultures must be drawn under strict aseptic technique to prevent false-positives. A set of cultures may include one aerobic and one anaerobic specimen, and more than one set of cultures are frequently taken to ensure against false-negatives.	2.1, 4.1, 4.4, 4.5, 5.1, 5.4, 6.1, 6.4, 6.8, 7.1
13.2 Identify the various types of glucose tests and the indications and procedures for each.	Various types of glucose tests include fasting blood glucose, 2-hour postprandial blood glucose, random blood glucose, 2- or 3-hour oral glucose tolerance test, glucose challenge screening test, and intravenous glucose tolerance test.	4.1, 4.3, 4.4, 4.6, 5.1, 6.1, 7.1
13.3 Identify neonatal screening tests, including proper collection and handling procedures.	Newborns are screened for many disorders, including cystic fibrosis, galactosemia, hypothyroidism, phenylketonuria, biotinidase deficiency, and sickle cell disease. Testing varies among states; however, the blood must be drawn after the infant is 24 hours old.	4.1, 4.4, 4.5, 5.1, 6.1, 7.1, 9.8, 9.9
13.4 Explain the procedure for creating acceptable thin and thick blood smears.	Peripheral blood smears require a drop of blood on a slide that is spread across the slide using a spreader slide. A thin smear (used for differentials) has a straight or slightly rounded, feathered edge. A thick smear (used for malaria screening) is circular and requires a long time to dry.	2.1, 7.1, 7.4, 9.8
13.5 Recognize the special requirements for carrying out blood collection for blood bank use.	• Collecting blood for cross-matching units required for transfusion must follow a special patient identification procedure. • Only specially trained personnel may perform donor collection procedures. Donors must meet strict criteria to be eligible to donate. • Patients may donate blood for their own future use (autologous donation) or may have blood drawn to treat a disease or disorder of the blood (therapeutic phlebotomy).	2.1, 4.1, 4.4, 4.5, 5.1, 6.1, 6.4, 7.1, 7.4, 9.9
13.6 Identify steps to competent and effective arterial puncture.	Specially trained personnel may perform arterial punctures using the radial artery and specific arterial puncture procedures.	4.3, 4.4, 9.9
13.7 Classify venous access sites and their uses.	Although not accessed by phlebotomists, other sites for blood specimen collection include heparin lock, arterial venous shunt, and central venous therapy lines.	6.8, 7.1, 7.4, 9.9

Chapter Review

A: Labeling

Label the parts of a well-made blood smear.



Lillian Mundt

1. [LO 13.4] _____
2. [LO 13.4] _____
3. [LO 13.4] _____
4. [LO 13.4] _____

B: Matching

Match each disorder with its description.

5. [LO 13.3] biotinidase deficiency
6. [LO 13.3] cystic fibrosis
7. [LO 13.3] galactosemia
8. [LO 13.3] hypothyroidism
9. [LO 13.3] phenylketonuria
10. [LO 13.3] sickle cell disease

a. failure to break down milk sugars
b. deficiency that causes hearing and vision loss
c. symptoms include respiratory problems
d. cannot make iodine-containing hormones
e. failure to break down an amino acid, which spills into the urine
f. abnormal structure of hemoglobin molecule

C: Fill in the Blank

Write in the word(s) to complete the statement.

11. [LO 13.7] _____ devices may be used when the patient needs multiple blood collections in a short period of time.
12. [LO 13.3] Newborn screening tests required by all states include _____, _____, _____, and _____.

13. [LO 13.4] Qualities of a good blood smear slide include _____, _____, and _____.

14. [LO 13.5] Components that can be obtained from a unit of donated blood include _____, _____, and _____.

D: Sequencing

Place the procedural steps for a blood culture collection using a butterfly assembly in the correct order (from 1 to 12).

15. [LO 13.1] _____ Allow the site to air-dry.

16. [LO 13.1] _____ Cleanse the site using sterile technique and the appropriate antiseptic.

17. [LO 13.1] _____ Complete postpuncture patient care.

18. [LO 13.1] _____ Fill the aerobic bottle.

19. [LO 13.1] _____ Fill the anaerobic bottle.

20. [LO 13.1] _____ Identify the patient, wash your hands, and put on gloves.

21. [LO 13.1] _____ Label the bottles with patient and collection information.

22. [LO 13.1] _____ Perform the venipuncture.

23. [LO 13.1] _____ Reapply the tourniquet.

24. [LO 13.1] _____ Release the tourniquet and apply pressure to the site.

25. [LO 13.1] _____ Select the venipuncture site and release the tourniquet.

26. [LO 13.1] _____ Sterilize the tops of the blood culture bottles.

Place the steps for an oral glucose tolerance test in the correct order (from 1 to 10).

27. [LO 13.2] _____ Collect blood and have the patient provide a urine specimen (if required) at specific time intervals.

28. [LO 13.2] _____ Collect a fasting blood specimen using proper venipuncture technique.

29. [LO 13.2] _____ Ensure that the patient has been fasting for at least 8 to 12 hours.

30. [LO 13.2] _____ Explain the procedure to the patient.

31. [LO 13.2] _____ Identify the patient.

32. [LO 13.2] _____ Label each sample (blood and urine) with both the time collected and the time interval.

33. [LO 13.2] _____ Observe the patient drinking the glucose dose within 5 minutes.

34. [LO 13.2] _____ Perform a POCT glucose test or obtain a glucose level on the specimen from the chemistry department.

35. [LO 13.2] _____ Prepare the glucose drink according to procedure requirements.

36. [LO 13.2] _____ Verify that the screening blood glucose level is less than 200 mg/dL.

E: Case Studies/Critical Thinking

37. [LO 13.6] As a phlebotomist, you're asked to perform arterial blood gases on your first official day as a phlebotomist. You have not had any further training and development. How would you handle this situation?

38. [LO 13.1] You have orders to obtain blood cultures × 2. You have finished the procedure for one site but cannot use the other arm for the second site. What should you do?

39. [LO 13.2] You are about to draw an outpatient's 2-hour postprandial glucose. He informs you that it has been only 1½ hours since he ate his lunch. You are on a tight schedule because, of the three phlebotomists scheduled to work today, you are the only one who showed up. What should you do?

40. [LO 13.3] When collecting blood on a newborn for state-required testing, the baby kicks the form, scraping the form with her heel and scraping the area where blood is being collected. What should you do?

41. [LO 13.4] When instructing a phlebotomy student who is preparing blood smears, you notice that his smears are too short. What should you ask him to do the next time he makes smears?

F: Exam Prep

Choose the best answer for each question.

42. [LO 13.7] A heparin lock is used when
    - **a.** patients need blood drawn several times in a short period of time.
    - **b.** phlebotomists collect blood into a green-topped tube.
    - **c.** certain medications must be administered on a regular basis.
    - **d.** all sites for blood collection have already been accessed.

43. [LO 13.6] Arterial puncture is used to assess *(Choose all that apply.)*
    - **a.** blood counts.
    - **b.** blood gases.
    - **c.** blood glucose.
    - **d.** blood pH.

44. [LO 13.1] *Aerobic* means
    - **a.** air loving.
    - **b.** nothing to eat.
    - **c.** room air.
    - **d.** without air.

45. [LO 13.1] The aseptic collection of blood cultures requires that the skin be cleaned with
    - **a.** soap and water.
    - **b.** 70% alcohol and then 95% alcohol.
    - **c.** 70%–90% alcohol and then 2% iodine.
    - **d.** 95% alcohol only.

46. [LO 13.1] Specimen collection containers that are appropriate for blood cultures include *(Choose all that apply.)*
    - **a.** anaerobic ARD bottles.
    - **b.** non-ARD aerobic bottles.
    - **c.** yellow-topped SPS tubes.
    - **d.** yellow-topped ACD tubes.

47. [LO 13.2] Glucose testing includes *(Choose all that apply.)*
    - **a.** fasting blood draw.
    - **b.** 3-hour tolerance.
    - **c.** 2-hour postprandial.
    - **d.** 1-hour challenge.

48. [LO 13.2] Specimens for glucose testing that may be delayed are *best* collected in
    - **a.** a gold-topped serum separator tube.
    - **b.** a mint-topped plasma separator tube.
    - **c.** a gray-topped tube.
    - **d.** none of these.

49. [LO 13.2] When outpatients are having a glucose tolerance performed, they may
    - **a.** smoke.
    - **b.** drink black coffee.
    - **c.** chew gum.
    - **d.** drink sips of water.

50. [LO 13.3] All states in the United States require which of the following tests to be performed on neonates? *(Choose all that apply.)*

a. Cystic fibrosis

b. Galactosemia

c. Hypothyroidism

d. Phenylketonuria

51. [LO 13.3] Galactosemia results from the body's inability to metabolize

a. fatty acids.

b. milk sugar.

c. proteins.

d. vitamins.

52. [LO 13.3] A common defect in hemoglobin structure is screened for by which test?

a. Phenylketonuria

b. Biotinidase

c. Galactosemia

d. Sickle cell disease

53. [LO 13.4] Which of the following procedures would help diagnose an infection caused by a blood parasite?

a. Blood cultures

b. Blood smear

c. Bleeding time

d. Cold agglutinins

54. [LO 13.4] The most common angle used to make a blood smear is

a. 10 degrees.

b. 20 degrees.

c. 30 degrees.

d. 45 degrees.

55. [LO 13.4] What factors can a phlebotomist control when preparing blood smears? *(Choose all that apply.)*

a. Drop size

b. Hematocrit

c. Spreading angle

d. Spreading speed

56. [LO 13.5] Blood collection for type and screen requires

a. sterile blood collection technique.

b. special consideration for specimen temperature.

c. special patient identification and banding.

d. special capillary blood collection procedure.

57. [LO 13.5] Removal of large amounts of blood is required for *(Choose all that apply.)*

a. autologous blood donation and transfusion to self.

b. donation of red blood cells for use by other patients.

c. donation of a component of blood other than red blood cells.

d. removal of blood for therapeutic treatments.

58. [LO 13.1, 13.3, 13.5, 13.6] Sterile blood collection procedures are required for *(Choose all that apply.)*

a. arterial punctures.

b. blood cultures.

c. blood donor draws.

d. neonatal screening.

59. [LO 13.6] Performing an arterial puncture is a procedure requiring specialized training because arteries

a. are not easily palpated.

b. lie close to nerves, which may be accidentally damaged.

c. are not found in the antecubital area.

d. have lower pressures than veins.

60. [LO 13.1] An antibiotic removal device is

a. a resin found in some blood culture bottles.

b. any antiseptic used for cleansing the venipuncture site.

c. given to a patient who has a bacterial infection.

d. used to clean a surface after a biohazard spill.

61. [LO 13.1, 13.2, 13.3, 13.5] Special blood collection procedures for which most phlebotomists are trained include all of these *except*

a. collection of blood cultures.

b. glucose tolerance collections.

c. neonatal blood screening collection.

d. collection of units from blood bank donors.

62. [LO 13.1] How much blood should be drawn on a 2-year-old for blood culture?

a. 0.5 cc

b. 1.0–2.0 cc

c. 2.0–5.0 cc

d. 8.0 cc.

63. [LO 13.1] What bottle(s) should be collected for blood cultures on a 5-year-old? (*Choose all that apply.*)

a. 5 cc in aerobic bottle

b. 5 cc in anaerobic bottle

c. 5 cc in pediatric bottle

d. 5cc in mycobacterium bottle

64. [LO 13.6] How should an arterial puncture be transported to the laboratory?

a. Placed into a cup of solid ice cubes.

b. Placed into a bag of ice slurry.

c. Placed into a bag then onto a cup of solid ice cubes.

d. Placed into a bag then onto an ice slurry in another bag.

65. [LO 13.3] Which conditions of specimens on State neonatal testing forms may cause the form to be rejected? (*Choose all that apply.*)

a. Under-filled test circle

b. Over-filled test circle

c. Skin contamination

d. Scratches on the test circles

NAME: _____ DATE: _____

COMPETENCY CHECKLIST: BLOOD CULTURE PROCEDURE

Procedure Steps	Practice 1	Practice 2	Practice 3	Performed Yes	Performed No	Performed Master
Preprocedure						
1. Examines the requisition.						
2. Verifies the timing of blood cultures (two sites same time in different arms, or the same site at two different times).						
3. Greets the patient; introduces self.						
4. Identifies the patient verbally using two identifiers, including comparing the identification band with the requisition.						
5. Explains the procedure to the patient.						
6. Washes hands and puts on gloves.						
7. Correctly selects and assembles the equipment.						
8. Applies a tourniquet, identifies the venipuncture site, and releases the tourniquet.						
9. Performs site sterilization according to facility policy.						
10. Allows the site to air-dry (does not blot or wipe dry).						
11. Marks the minimum and maximum fill levels on the culture bottles.						
12. If recommended by the manufacturer, cleanses the culture bottle stoppers while the site is drying.						
Procedure						
13. Reapplies the tourniquet without touching the site.						
14. Performs venipuncture without touching or palpating the site.						
15. Inoculates the blood culture media as required (yellow-topped SPS tubes or blood culture bottles).						
16. Inoculates the blood culture bottles in the correct sequence (aerobic first if using winged-infusion butterfly assembly).						
17. Releases the tourniquet.						
18. Covers the puncture site with gauze.						
19. Withdraws the needle smoothly.						
20. Activates the safety engineering control device.						
21. Applies pressure to the venipuncture site.						
22. Disposes of the collection unit (vacuum or butterfly assembly) in the correct container.						
23. Mixes the blood culture bottles as recommended by the manufacturer.						

(continued)

Procedure Steps	Practice			Performed		
	1	2	3	Yes	No	Master
Postprocedure						
24. Properly labels the blood culture bottles (including the date, time, site of collection, and phlebotomist identification).						
25. Cleans the patient's skin.						
26. Checks the venipuncture site.						
27. Applies a bandage.						
28. Thanks the patient.						
29. Disposes of used supplies appropriately.						
30. Removes gloves and washes hands.						
31. Transports the specimens to the laboratory.						
32. Documents the specimen collection.						

COMMENTS: _____

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SIGNED

EVALUATOR: _____

STUDENT: _____

NAME: _____ DATE: _____

COMPETENCY CHECKLIST: NEONATAL TESTING

Procedure Steps	Practice 1	Practice 2	Practice 3	Performed Yes	Performed No	Performed Master
Preprocedure						
1. Examines the requisition.						
2. Obtains state neonatal blood collection form.						
3. Follows facility's procedure for access to neonatal unit (in the case of outpatients, performs proper handwashing and donning of PPEs).						
4. Identifies the patient using two identifiers, including comparing the identification band with the requisition.						
5. Washes hands and puts on gloves.						
6. Selects appropriate site for dermal (capillary) puncture on heel.						
7. Properly prepares the puncture site.						
Procedure						
8. Correctly performs a dermal (capillary) puncture on the heel.						
9. Follows the instructions on the state form for properly filling the specimen circles.						
Postprocedure						
10. Correctly performs postpuncture care.						
11. Correctly maintains specimen integrity while drying (air-dry 3 hours, room temperature, out of direct sunlight, *not* overlapping another form).						

COMMENTS: _____

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EVALUATOR: _____

STUDENT: _____

NAME: _____ DATE: _____

COMPETENCY CHECKLIST: PREPARATION OF BLOOD SMEARS

Procedure Steps	Practice			Performed		
	1	2	3	Yes	No	Master
Preprocedure						
1. Washes hands and wears protective clothing.						
2. Inspects the slides for chips, cracks, fingerprints, and other abnormalities.						
3. Uses the equipment correctly (Diff Safe, hematocrit tubes, applicator sticks, etc.).						
4. Prepares slides behind a safety shield.						
5. Uses samples from EDTA tubes to prepare smears.						
6. Inspects the specimen for clots.						
Procedure						
7. Places the correct size drop on slide.						
8. Prepares the smears, using the slide wedge technique.						
9. Uses the appropriate angle of the spreader slide.						
10. Uses the appropriate speed of the spreader slide.						
11. Inspects the smear for acceptability.						
12. Repeats, if necessary, adjusting the technique to create an acceptable smear.						
Postprocedure						
13. Labels the smear from the patient information off the tube.						
14. Allows the smear to air-dry.						
15. Removes protective gear and washes hands as needed.						

COMMENTS: _____

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EVALUATOR: _____

STUDENT: _____

NAME: _____ DATE: _____

COMPETENCY CHECKLIST: SPECIMEN COLLECTION FOR TYPE AND CROSS-MATCH

Procedure Steps	Practice 1	Practice 2	Practice 3	Performed Yes	Performed No	Performed Master
Preprocedure						
1. Examines the requisition.						
2. Greets the patient; introduces self.						
3. Identifies the patient verbally using two identifiers, including comparing the identification band with the requisition.						
4. Explains the procedure to the patient.						
5. Properly attaches the blood bank identification bracelet to the patient's wrist alongside the hospital identification band.						
6. Washes hands and puts on gloves.						
7. Properly performs the equipment selection and assembly process.						
8. Correctly performs the site selection and preparation procedures.						
9. Reassures the patient.						
Procedure						
10. Reapplies the tourniquet.						
11. Correctly performs the venipuncture procedure.						
12. Properly performs the tube filling procedure.						
13. Releases the tourniquet and safely performs the needle withdrawal procedure.						
Postprocedure						
14. Properly performs postprocedure patient care.						
15. Labels the specimens with the special blood bank labels.						
16. Rechecks the information by comparing the labels on the tubes with the blood bank identification band.						
17. Properly performs postprocedure supply disposal.						
18. Transports the specimens to the laboratory.						
19. Documents the specimen collection.						

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EVALUATOR: _____

STUDENT: _____