8 Blood Collection Equipment

essential terms

- acid citrate dextrose (ACD)
- additive
- aerosol
- aliquot
- antiglycolytic
- antiseptic
- bacteriostatic
- bevel
- capillary action
- citrate
- clot activator
- dermal (capillary) puncture
- ethylenediaminetetraacetic acid (EDTA)
- evacuated collection tube
- evacuated tube holder
- gauge
- heel warmer
- heparin
- lancet
- microcollection
- sharps container
- sterile
- thixotropic separator gel
- tourniquet
- venipuncture
- winged infusion set

Steve Allen/Getty Images

Learning Outcomes

8.1 Identify equipment used for both venipuncture and dermal (capillary) puncture.

8.2 Identify equipment specific for venipuncture procedures.

8.3 Identify equipment specific for dermal (capillary) puncture procedures.

8.4 Identify the various types of additives and color coding used in blood collection and explain the reasons for their use.

8.5 Implement the correct order of draw for venipuncture and dermal (capillary) puncture procedures.

8.6 Compare blood collection equipment from various manufacturers.

Related NAACLS Competencies

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

5.2 Identify the various types of additives used in blood collection, and explain the reasons for their use.

5.3 Identify the evacuated tube color codes associated with the additives.

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 to avoid these occurrences.

5.6 List and select the types of equipment needed to collect blood by venipuncture and capillary (dermal) puncture.

5.7 Identify special precautions necessary during blood collections by venipuncture and capillary (dermal) puncture.

9.11 Demonstrate basic understanding of age-specific or psychosocial considerations involved in the performance of phlebotomy procedures on various age groups of patients.

Introduction

This chapter presents the various types of equipment used in the collection of blood specimens. It also describes a commonly accepted sequence for collecting multiple specimens, as well as the tubes used for specimen collection in the same order of draw. These items are fairly standard, but phlebotomists must become familiar with the equipment used at their facilities and with any facility modification to the order of draw.

8.1 Common Blood Collection Equipment

For any blood test, collecting a blood specimen—by **venipuncture** (puncture of a vein) or **dermal (capillary) puncture** (puncture of the skin)—is first required. This process is often referred to as "drawing blood." The phlebotomist must become familiar with each item used in the collection of blood by venipuncture and dermal (capillary) puncture (Figure 8-1). Proper handling of phlebotomy equipment is of the utmost importance for the safety of both the phlebotomist and the patient. Equipment used by the phlebotomist is universal but may vary in appearance depending on its manufacturer. Although much of the equipment is used during both venipuncture and **microcollection** procedures (dermal [capillary] puncture), there are some items that are used only for specific types of collection. Table 8-1 lists each type of blood collection equipment and when it is most likely used.

Phlebotomy Tray or Cart

Phlebotomists use a tray or cart to store and transport blood collection equipment (Figure 8-2). Trays and carts should be clean, orderly, and well stocked with sufficient equipment for the number and types of tests ordered, as well as the types of patient situations that may be encountered. A phlebotomist should take the time to disinfect and restock the phlebotomy tray or cart as needed on a regular basis.

Gloves

Occupational Safety and Health Administration regulations (OSHA) require that gloves be worn during the phlebotomy procedure and changed after each patient. Nonsterile gloves are acceptable for blood collection because, unlike surgery, blood collection is not a sterile procedure. Gloves are used to prevent the spread of infection, but pathogens are not completely eliminated as they would be during a sterile procedure. Because the powder in gloves can contaminate the specimen or cause an allergic reaction during blood collection, powder-free gloves are recommended.

Figure 8-1 A variety of equipment is needed to perform routine blood collection.
Sandra Mesrine/McGraw Hill

TABLE 8-1 Blood Collection Equipment

Equipment	Routine Venipuncture	Difficult Venipuncture	Dermal (Capillary) Puncture
Phlebotomy tray or cart	Yes	Yes	Yes
Gloves	Yes	Yes	Yes
Hand sanitizer	Yes	Yes	Yes
Alcohol prep pads	Yes	Yes	Yes
Gauze pads	Yes	Yes	Yes
Adhesive bandage or tape	Yes	Yes	Yes
Sharps (needle disposal) container	Yes	Yes	Yes
Permanent fine-tipped marking pen	Yes	Yes	Yes
Labels (preprinted)	Yes	Yes	Yes
Specimen transport bags	Yes	Yes	Yes
Evacuated tube holder	Yes	Yes	No
Syringe	No	Yes	No
Evacuated tubes	Yes	Yes	No
Tourniquet	Yes	Yes	No
Needles	Yes	Yes	No
Winged infusion set	No	Yes	No
Syringe	No	Yes	No
Lancets	No	No	Yes
Capillary tubes and sealant	No	No	Yes
Microcollection tubes	No	No	Yes
Tissue warmers	No	Yes	Yes

A

B

C

Figure 8-2 (A) Blood collection tray. (B) Some trays are available with covers that are used for storage and during transport between departments. (C) Blood collection carts on wheels provide an ergonomic way for phlebotomists to transport all the equipment they may need during blood collection rounds. Some include computers so that phlebotomists have continuous access to the laboratory information system.
A: Sandra Mesrine/McGraw-Hill Education; B: BSIP SA/Alamy; C: Lillian Mundt

Figure 8-3 Several sizes and types of gloves.
Sandra Mesrine/McGraw-Hill Education

Figure 8-4 Alcohol-based hand sanitizer.
Lillian Mundt

Gloves are available in a variety of materials and in many sizes and styles. Nitrile, vitrile, synthetic vinyl, or other nonlatex gloves are frequently used (Figure 8-3). Although latex gloves were widely used in the past, most healthcare facilities have discontinued stocking them to protect employees and patients who may have latex allergies. Even when permitted by the healthcare facility, latex gloves should not be used when a patient has latex allergies.

Glove liners are available, but these are only for long-term glove use, such as specimen processing. They can make it difficult to palpate veins during blood collection. Thus, wearing well-fitting, nonlatex gloves is the best policy for the phlebotomist.

Hand Sanitizers

Phlebotomists must wash their hands after removing their used gloves and prior to donning new gloves for procedures with the next patient. If soap and running water are not available, a suitable alcohol-based hand sanitizer may be used to cleanse hands between patients (Figure 8-4). However, if your hands show any type of visible contamination or soilage, you should wash your hands rather than use an alcohol-based hand sanitizer.

Alcohol Prep Pads

To prevent infection, the blood collection site must be cleaned using an **antiseptic**—a germicidal solution—before the blood specimen is collected. *Alcohol prep pads* are a frequently used type of antiseptic. These sterile pads are saturated with 70% isopropyl alcohol (Figure 8-5). Seventy percent isopropyl alcohol is a **bacteriostatic** antiseptic, meaning that it inhibits the growth of bacteria. This prevents contamination by normal skin bacteria during a venipuncture procedure.

Not all blood collection sites are cleaned using alcohol. Stronger antiseptics may be used depending on the site or collection procedure. A blood culture

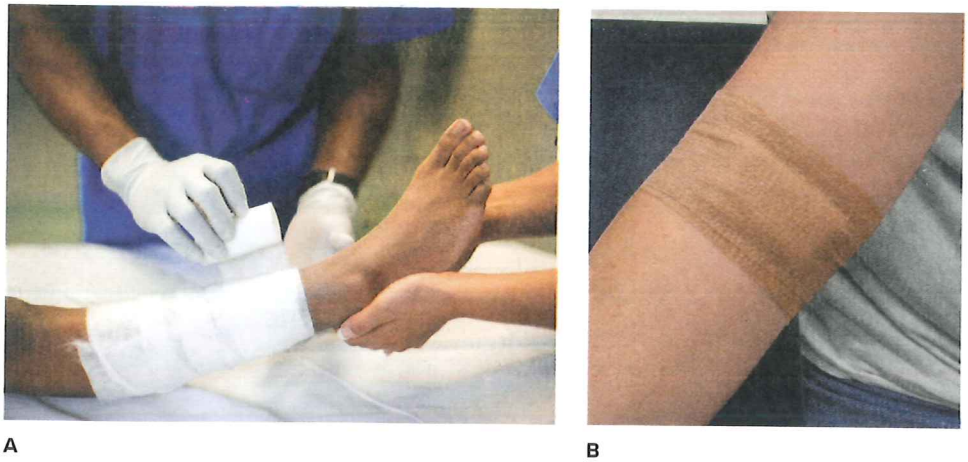
Figure 8-5 Alcohol prep pads.
Freer Law/Alamy Stock Photo

Figure 8-6 Gauze pads.
Sandra Mesrine/McGraw-Hill Education

collection or an arterial puncture requires additional sterility. For these procedures, antiseptics such as Betadine®, iodine, or chlorhexidine gluconate are used to clean the puncture site. Collection sites for blood alcohol levels are not cleaned with alcohol prep pads due to possible contamination. Another type of antiseptic is used based on facility policy.

Gauze Pads

Gauze is a loosely woven cotton fabric used to cover the puncture site when applying pressure immediately upon completion of the procedure. Gauze pads are available in several sizes, including the 2-inch by 2-inch squares normally used after a blood collection procedure (Figure 8-6). If needed, gauze can be folded into quarters and taped to the patient's skin to serve as a pressure bandage, which will maintain a firm amount of pressure to the site. Note that cotton balls are not recommended for postprocedure care of a blood collection site because the cotton may adhere to the site and cause the site to reopen when the cotton ball is removed.



A B

Figure 8-7 (A) Roller gauze dressing. (B) Coban® bandage.
A: ERproductions Ltd/Blend Images LLC; B: Total Care Programming, Inc.

Adhesive Bandages

An adhesive bandage or gauze held by paper tape is placed over the puncture site to stop the bleeding. Adhesive bandages should not be used on patients with fragile skin, such as elderly patients. In some facilities, paper tape may be used on patients with fragile skin. However, applying bandages of any type is not advisable for infants and small children because they may remove and place the bandage in their mouth and possibly aspirate and choke on it. You may ask the patient to hold pressure on the gauze while you are finishing the collection procedure. It is always your responsibility to ensure that bleeding has stopped before releasing the patient. Advise the patient to watch the site and remove the bandage in 15 to 30 minutes.

Figure 8-8 A variety of adhesive bandages.
Lillian Mundt

In many cases a roller gauze is wrapped entirely around the arm, so tape is not placed on the skin. A Coban® bandage can also be used to apply pressure (Figure 8-7). Acute care facilities may not use Coban® because certain patients may be unable to remove the bandage after 15 to 20 minutes. Leaving a Coban® or other pressure dressing in place too long can cause constriction of the tissues and possible circulation issues. The patient should also be instructed to avoid lifting and frequent bending of the elbow to prevent the return of bleeding. Select a bandage size appropriate to the type of puncture performed and the patient's situation (Figure 8-8).

A Tabletop

B Wall-mounted

Figure 8-9 Biohazard sharps containers.
A: Total Care Programming, Inc.; B: Total Care Programming, Inc.

Sharps Container

Needle disposal containers, also known as **sharps containers,** are designed to protect healthcare personnel from accidental needlesticks by contaminated needles (Figure 8-9). Sharps containers are rigid, leakproof, puncture resistant, and clearly marked with the biohazard symbol. These containers are usually red and are available in a variety of shapes and sizes. Used needles, lancets, and other sharp items must be disposed of immediately in these special containers. To prevent possible needlesticks, the needle should not be removed from the holder. Dispose of the needle holder in the sharps container as well. Never reach into, tamper with, or attempt to pry open a sealed sharps container. These disposal units are marked with a biohazard label and are to be disposed of according to the biohazard guidelines established by OSHA.

Tissue Warmers

Tissue warmers, such as a warm towel, cloth, or chemical warmer packet, are used to increase the blood flow to the intended puncture site. A **heel warmer** packet (Figure 8-10) is commonly used for dermal (capillary) puncture on infants. Larger tissue warmers are used on adults during venipuncture. Prewarming the intended venipuncture site will help when locating a vein especially with older patients or patients with cancer or obesity.

Figure 8-10 Heel warmer.
Sandra Mesrine/McGraw-Hill Education

Computer Label/Permanent Marking Pen

Each evacuated tube must be labeled at the time of specimen collection, immediately after drawing each patient's blood. Tubes must be labeled before the phlebotomist leaves the patient's side but never

Figure 8-11 Computer labels.
Lillian Mundt

before the specimen is drawn. Tubes may be labeled with a computer-generated label or with a permanent marker or pen. A computer-generated label usually includes a bar code that provides specimen information to laboratory information systems within the EHR (Figure 8-11). Place the computer-generated label over the original tube label, not over the clear area of the tube. This will allow the amount and condition of the blood to be viewed during testing. Any label, whether computer generated or handwritten, should contain the patient's full name, a unique patient identifier (such as a date of birth or medical record number), the specimen collection time and date, and the collector's identification (initials, signature, or code).

When using a computer label, the phlebotomist must initial and add the date and time to the label, being careful not to write over the bar code, and affix it to the tube after collection. If computer labels are not provided, the same required patient identification information and collection information must be written on specimen labels of all tubes collected. Specimens for the blood bank (such as type and cross-match) may have other special requirements, including patient banding procedures. Identification of specimens for the blood bank's transfusion service is explained in the chapter *Special Phlebotomy Procedures*.

Figure 8-12 Specimen transport bags (biohazard bags).
Lillian Mundt

Specimen Transport Bags

Specimen transport bags are plastic, ziplocked bags that display a biohazard symbol and include a separate outer pocket in which paperwork is placed (Figure 8-12). These bags not only identify the contents as being a biohazard but also help contain specimen spills if the collection container breaks. A specimen bag must be used to transport blood from the collection location to the testing location. The specific type of transport bag varies, depending on your place of employment. For transport between facilities, adding an absorbent pad in the specimen containment portion of the transport bag will provide extra safety from spills and breakage.

The specimen bag protects the person handling the specimens from biohazard exposure. Blood and other laboratory specimens may contain disease-producing organisms, and preventing exposure is part of standard precautions. Once you place a specimen in the bag, handle it gently and keep it vertical, with the tube cap or closure on top. For blood specimens, this will prevent *hemolysis* (destruction of red blood cells) caused by excessive agitation.

Checkpoint Questions 8.1

1. What is the purpose of alcohol prep pads in blood collection procedures?
2. What items should be placed in a sharps container?
3. What type of gloves should be worn during a phlebotomy procedure?
4. When should a hand sanitizer *not* be used for hand hygiene?
5. What information must be included on the label of a specimen tube?

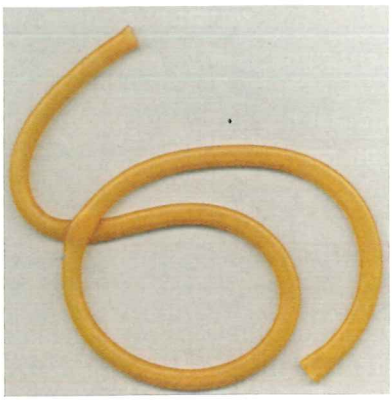
8.2 Equipment Unique to Venipuncture

Blood collection involving various venipuncture procedures requires equipment designed specifically for these procedures. This section describes the equipment used in venipuncture procedures. The actual procedures are discussed in the chapter *Venipuncture*.

Tourniquets

A **tourniquet** is a length of rubber tubing or strapping that is wrapped around the arm to slow the flow of venous blood (blood in the veins), causing a backup of blood and increased pressure. Tourniquets are used during venipuncture to make it easier to locate a patient's veins. A tourniquet is applied 3 to 4 inches above the puncture site, tightly enough to slow the blood flow but not stop it. As a result, the veins become enlarged, making them easier to find and penetrate with a needle. Several styles of tourniquets are available, and each phlebotomist must decide their preference. The most commonly used is soft and pliable, measuring 1 inch wide by 18 inches long. Common types are rubber tubes, thin rubber bands, and strips of elastic fabric (Figure 8-13). The Clinical and Laboratory Standards Institute (CLSI) and The Joint Commission (TJC) require that a new tourniquet be used on each patient. Nonlatex tourniquets are preferred to avoid any chance of a latex allergic reaction.

Whatever type of tourniquet is used, it must be disposed of after the procedure or used again *only* on the same patient and only if it is not visibly contaminated. For example, when a patient at an inpatient facility requires multiple blood collections, a tourniquet may be kept at the bedside and reused only if it is not visibly contaminated. Tourniquets should *not* be cleaned and reused.



A Tubing-type tourniquet

B Flat latex-free band-type tourniquet

Figure 8-13 Tourniquet examples.
A: Lillian Mundt; B: Lillian Mundt

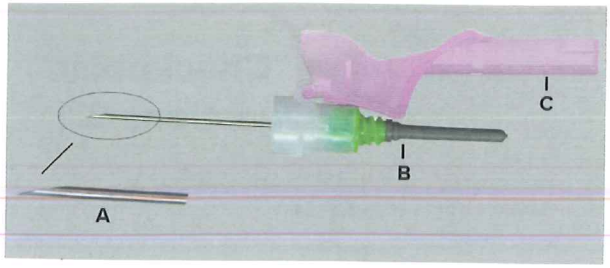


Figure 8-14 Needles showing (A) enlarged bevel, (B) rubber sleeve, and (C) safety device.
Lillian Mundt

Needles

The needle is composed of the hub, or plastic section; the shaft; and the **bevel**, or slanted tip at the point. The bevel should always be facing upward (you should be able to see the bevel when looking down) before the needle is inserted into the skin to puncture the vein (Figure 8-14A). **Sterile** needles (those free of microorganisms) are available in peel-apart packages or plastic cases. The tip of the needle should be checked for damage and for burrs, which are small imperfections or rough edges on the end of the needle. These burrs will cause unnecessary pain for the patient. Also, a blunt or bent tip can be harmful to the patient and interfere with collecting a blood sample. It is rare that disposable needles display these defects; however, you may occasionally encounter a "bad" needle. If you find a damaged needle, discard it in the sharps container and get a new one.

The double-pointed needle has a rubber sleeve over one end with a screw hub encircling the needle: one end is designed for the venipuncture and the other is used to puncture the evacuated collection tube's rubber stopper (Figure 8-14B). This rubber sleeve makes it easier to draw multiple tubes because the sleeve covers the needle inside the tube holder (adapter), preventing blood from dripping into the holder before another tube is inserted.

Because of the large number of documented needlestick injuries, the Needlestick Safety and Prevention Act was put into place in 2001. This act states that needles used in phlebotomy should have safety features, known as *engineering devices,* to protect the phlebotomist from accidental puncture with a contaminated needle. In most cases, the user must actively engage the safety feature. The safety device is attached to either the needle or the holder (Figure 8-14C). These safety features should be activated as soon as the procedure is completed. Some safety devices are designed to be activated just before the needle is removed from the collection site, whereas others are designed to be activated immediately after removing the needle from the site. In either case, the entire assembly is disposed of in one piece as a safety measure. Use a one-handed technique when activating the safety device. Do not attempt to activate the device with your other hand. Always keep your fingers away from the point of the needle. An audible click or color change will occur to indicate that the safety feature is engaged. Table 8-2 provides examples of safe needle devices for phlebotomy.

A phlebotomist generally uses three types of needles: (1) a multiple-sample needle, used as part of an evacuated collection system (a double-pointed needle and collection tube that contains a vacuum); (2) a hypodermic needle, used with a *syringe;* and (3) a **winged infusion set** (*butterfly needle*) that can be used with either syringe or evacuated tube systems.

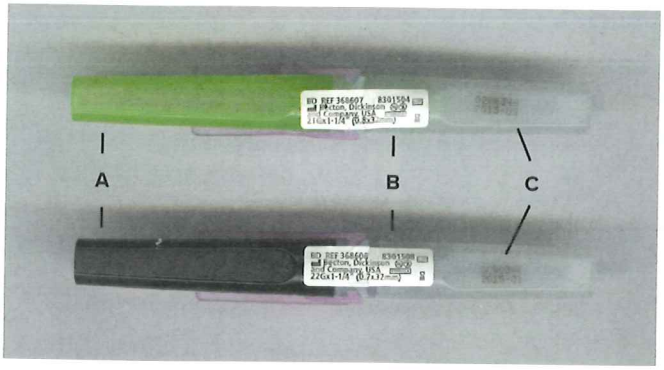
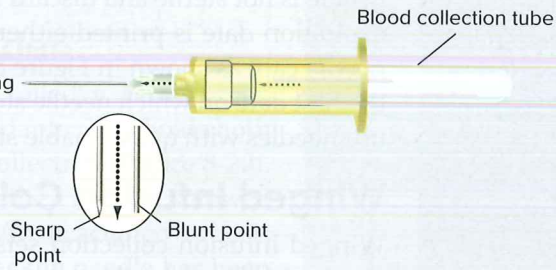
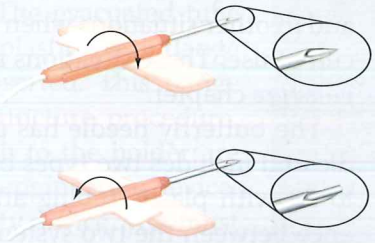
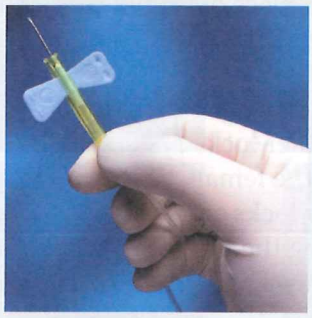
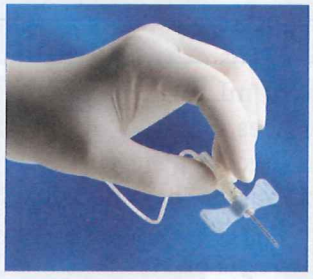


Figure 8-15 Needles showing (A) gauge-related color-coded caps, (B) a needle safety label, and (C) a needle sterility expiration date.
Lillian Mundt

Needles vary in length from ¾ to 1½ inches. The bore size, lumen, or **gauge** of the needle also varies from large, 16-gauge needles used to collect units of blood to smaller, 23-gauge needles used for very small veins. The smaller the number assigned to the gauge, the larger the lumen size, or inside diameter, of the needle. As a safety precaution, the caps of the needles are usually color-coded to aid in quick identification of the needle's gauge (Figure 8-15A). The most commonly used sizes and coded colors of needles for venipuncture on adults are 20 gauge (yellow), 21 gauge (green), and 22 gauge (black) in 1- to 1½-inch lengths.

TABLE 8-2 Safe Needle Devices

Feature	Example	Activation
Self-blunting needle		After the blood is drawn, a push on the collection tube moves the blunt needle forward through the outer shell and past the needle point. The blunt point can be activated before it is removed from the vein or artery.
Self-blunting butterfly needle		After collection and before the removal of the needle, the wing is flipped to the other side, blunting the needle.
Hinged cap	 Becton Dickinson	Using the thumb, a protective hinged cap is flipped over the needle and locks into place.
Protective shield	 Becton Dickinson	The user slides a plastic cover over the needle and locks it in place. Syringes also have this device.
Retractable needle	 Becton Dickinson	The needle is spring-loaded and retracts into the barrel when a button is pushed to activate.

(Images 3-5) Source: Becton Dickinson

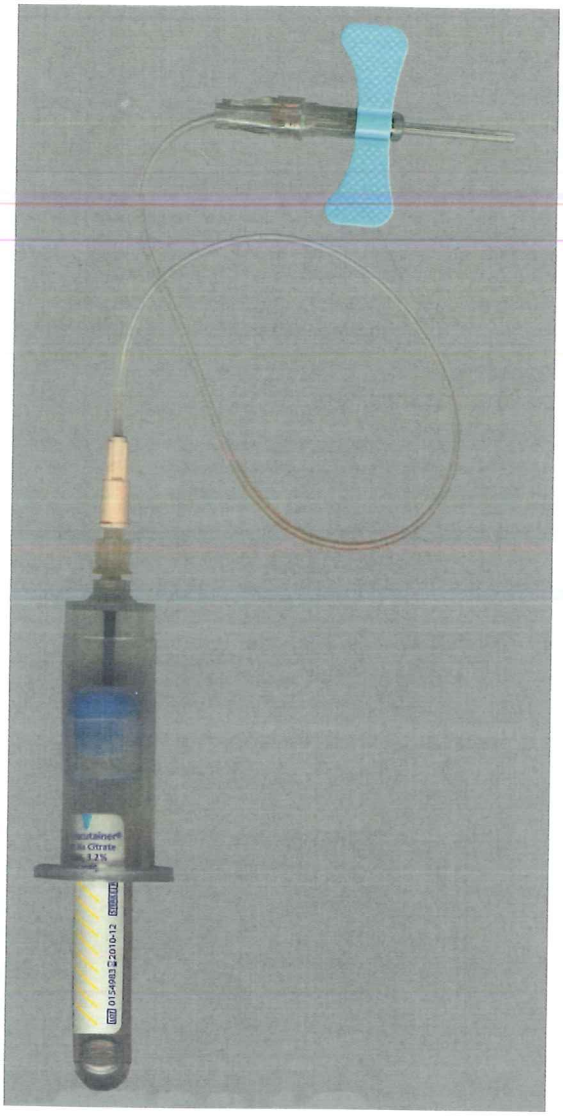


Figure 8-16 Winged infusion, or butterfly, assembly.
Lillian Mundt

Needles have a manufacturer's label, which identifies the needle's gauge and seals the caps of both ends. On assembly, if the needle already has a broken seal, you should assume that the needle is not sterile and discard it (Figure 8-15B). In addition, an expiration date is printed either on the label or on the smaller needle cap, as shown in Figure 8-15C. Expiration dates indicate the first date on which needle sterility cannot be ensured. Never use needles with questionable sterility on patients.

Winged Infusion Collection Set

Winged infusion collection sets, also called butterfly needles, are used for blood collection from infants, from small children, and in other situations when routine equipment might be difficult to use. These situations are discussed in detail in the *Venipuncture* chapter.

The butterfly needle has plastic wings attached to the needle and includes two types of systems. The needle gauge is 21 to 23 with plastic tubing attached to the needle. The difference between the two systems is at the end of the plastic tubing. There is a hub end, designed to attach to a syringe, or a rubber sleeve end, designed to insert into a holder just like the evacuated needles. The butterfly needle has a safety device attached to the plastic wing end. When disposing of the butterfly assembly, the best way to avoid a needlestick injury is to place the needle end into the sharps container first and then let the rest of the assembly drop into the sharps container.

The "wings" of the butterfly needle are used to hold the needle during insertion into the vein (Figure 8-16). Butterfly needles are typically ¾ inch long and have a protective shield that slides in place on completion of the procedure. The butterfly set is not used as extensively as the evacuated blood collection system.

Winged sets can be used with an evacuated tube holder or a syringe. Commonly the winged sets are attached using a "luer lock" system. Luer lock fittings are securely joined using a tabbed hub on the female fitting which screws into threads in a sleeve on the male fitting. Luer locks are preferred because there is no danger of the syringe slipping off during the procedure. One of the main reasons for butterfly sets is to have more control with nonstable patients.

Syringe

A syringe consists of a barrel and a plunger. The barrel is usually graduated in milliliters or fractions of a milliliter. Common sized syringes include 1 mL, 3 mL, 5 mL, and 10 mL. Two types of hypodermic needles are available for attachment to syringes, the "slip tip" and the "luer lock." Some syringes come with a preattached needle (Figure 8-17A). Syringes may also be used with butterfly needles; the hub at the end of the butterfly tubing slips over the tip of the syringe (Figure 8-17B).

Syringe Transfer Adapters

Syringe transfer adapters provide a safe and easy way to transfer blood from a syringe to evacuated tubes. Syringe transfer adapters can also be used when collecting samples using butterfly needles. Syringe transfer adapters are available with female or male connectors, allowing for coupling with equipment that has the opposite gender connector. Figure 8-18 shows various types of couplings

using these connectors. Some syringe transfer adapters are designed to accommodate evacuated tubes as well as blood culture bottles, which are explained in the *Special Phlebotomy Procedures* chapter. See Figure 8-19.

Evacuated Tube Holder

An **evacuated tube holder**, called a *barrel* or an *adapter,* is a specialized plastic adapter that holds both a needle and a tube for blood collection (Figure 8-20). Needles are designed so that they can be screwed onto one end of the holder. An evacuated tube is inserted into the other end after the needle has been inserted into the patient's vein. The evacuated tube holder, often made of clear, rigid plastic, has a flange at the end where the tube is inserted. This flange area is helpful during the venipuncture procedure. The evacuated needles that attach to the holder are designed with or without a safety engineering device. If the needle does not have a safety device, you must use a holder that has a built-in safety device, such as a holder that snaps a cover over the needle. These holders are to be discarded after use. If a safety needle is used, it is activated immediately after the needle is removed from the skin. After use, this entire assembly is disposed of in one piece as a safety measure.

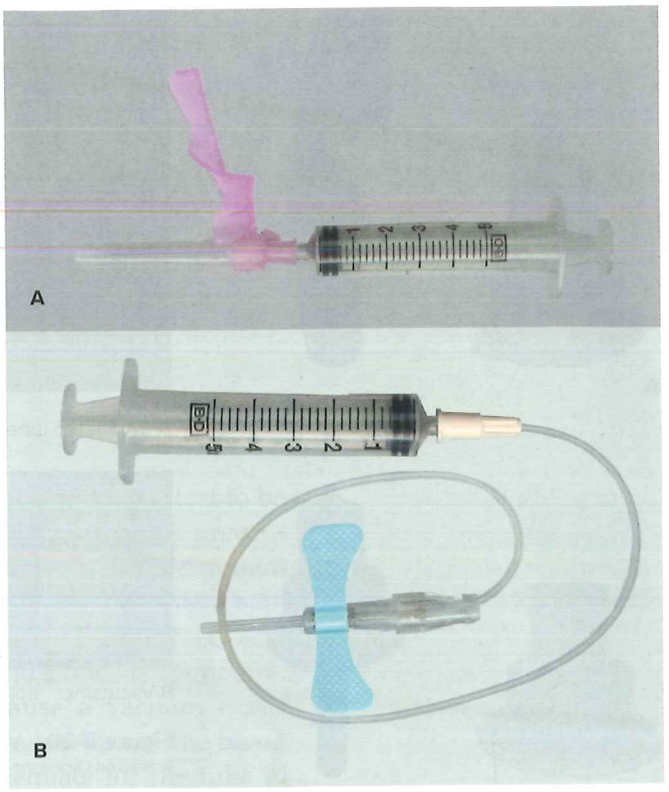


Figure 8-17 Syringe with (A) a hypodermic needle and (B) a butterfly needle.
A. Sandra Mesrine/McGraw-Hill Education; B. Sandra Mesrine/McGraw-Hill Education

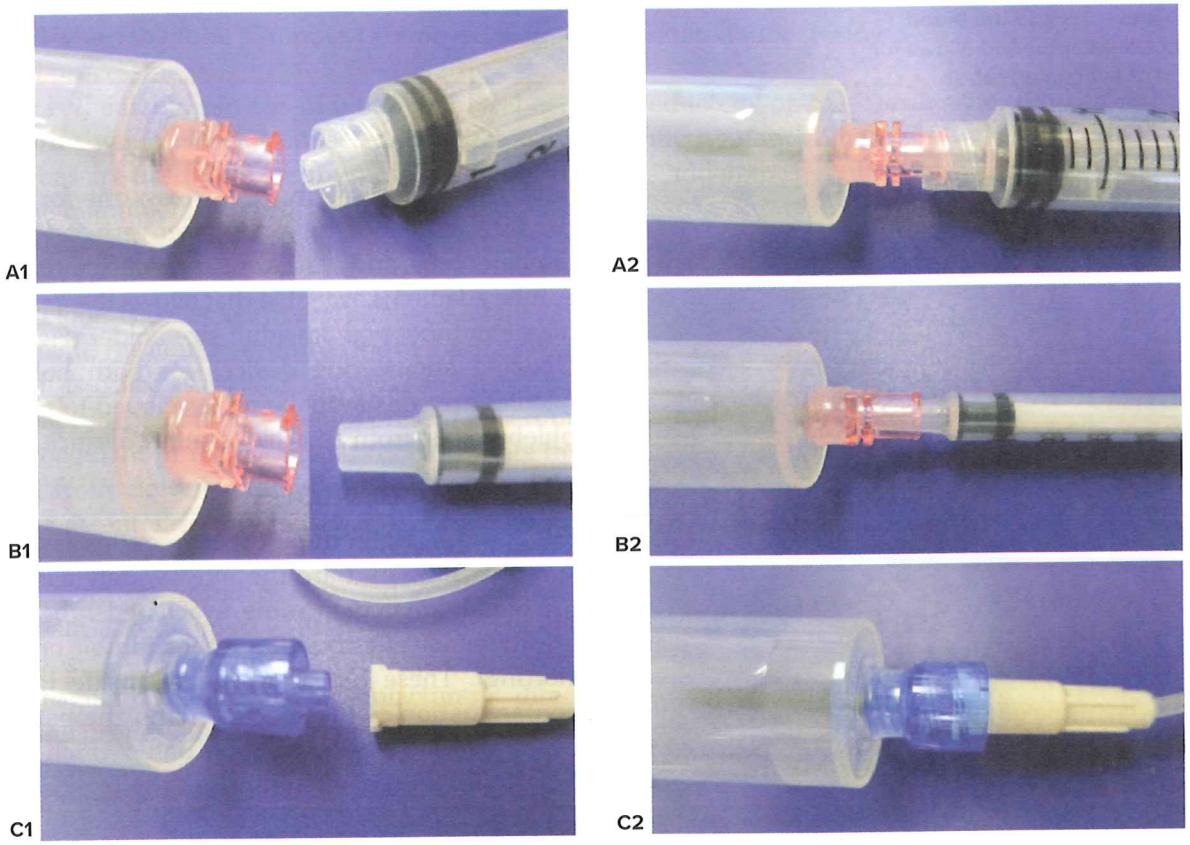


Figure 8-18 A syringe transfer adapter with a female connector can couple with a syringe that has a male luer-lock end (A1 and A2) as well as a syringe with a plain male end (B1 and B2). A transfer adapter with a male connector can couple with a butterfly needle that has a female-ended tubing (C1 and C2).
(A1) Lillian Mundt; (A2) Lillian Mundt; (B1) Lillian Mundt; (B2) Lillian Mundt; (C1) Lillian Mundt; (C2) Lillian Mundt

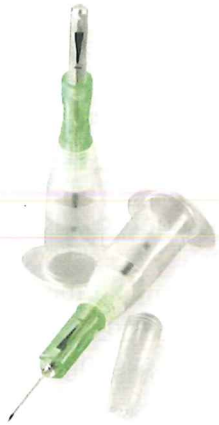
A

B

Figure 8-19 Specialized syringe transfer adapter: (A) Adapter as used with blood culture bottles. (B) The adapter sleeve fits into the blood culture bottle adapter and allows for collection of evacuated tubes.
(A1) Lillian Mundt; (A2) Lillian Mundt; (B1) Lillian Mundt; (B2) Lillian Mundt

A Evacuated tube holders

B Vacutainer® holder



C BD Vacutainer®

Figure 8-20 Various types of tube holders.
A: Becton Dickinson; B: Becton Dickinson; C: Becton Dickinson

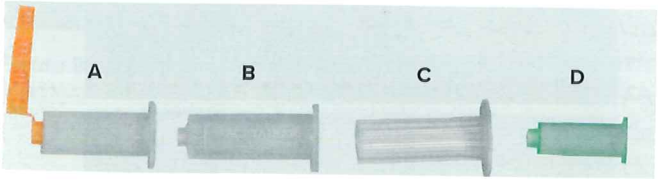


Figure 8-21 Various tube holders and adapter types.
Lillian Mundt

Figure 8-22 Evacuated tubes.
Lillian Mundt

Safety holders come in three sizes: one for the standard-size collection tube, a smaller version for a small-diameter tube, and a large one for blood culture bottles. A tube adapter is available that allows the use of small-diameter tubes with an adult-size holder (Figure 8-21). Updated engineering devices for both holders and needles are constantly being developed to protect the phlebotomist from an accidental needlestick.

Evacuated Tubes

Evacuated collection tubes contain a premeasured vacuum and are the most widely used system for blood collecting. Some evacuated tubes contain **additives** (substances that either inhibit or promote clotting). These tubes are sterile inside to prevent contamination of the specimen and the patient. The tubes also have an expiration date, which indicates that, at the end of the month of the expiration date, the tube should no longer be used because the additives and vacuum are not guaranteed to perform as intended. Tubes are available in a variety of sizes and colors and are made of glass or plastic. Sizes range from 2 to 15 milliliters (Figure 8-22). The colors of the

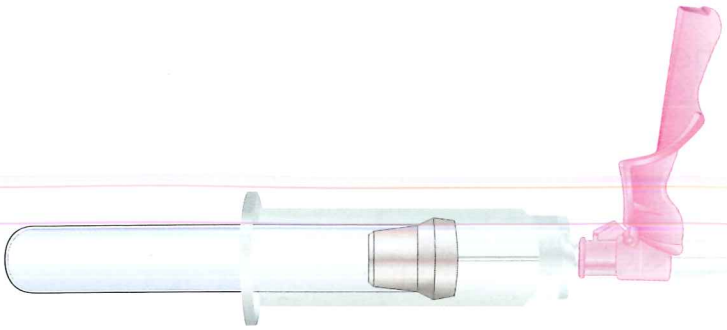


Figure 8-23 Evacuated collection tube assembly.

stoppers vary based on the additives inside the tube and the type of test to be completed. Plastic tubes have less chance of breakage, which helps prevent spillage and possible exposure to bloodborne pathogens. In the closed system of evacuated tubes, the patient's blood goes directly from the vein into a rubber-stoppered tube without being exposed to the air (Figure 8-23). The evacuated tube system allows many tubes to be collected with just one venipuncture.

Evacuated tubes fill automatically with blood because a vacuum exists inside the tube. The vacuum inside the collection tube helps "draw" the blood out of the patient's vein. The amount of vacuum is adequate for the tube to fill to the required amount for testing. Some evacuated collection tubes have a plastic splashguard that covers the sides of the tube. For example, the BD tubes splashguard is called a hemoguard. This splashguard is a safety device that helps reduce the **aerosol** mist (particles suspended in the air) that may be generated when the tube's stopper is removed from the evacuated tube during specimen processing.

Serum is the liquid portion of blood that has been allowed to clot or coagulate. It forms when blood is collected in a tube with no anticoagulant. When plastic tubes are used for a serum sample, a clot activator is added to the tube during the manufacturing process because blood takes longer to clot in a plastic tube. The clotted cells and serum separate when the blood is centrifuged.

When blood is collected in a tube that contains an anticoagulant, the liquid portion of the blood after centrifugation is called *plasma.* It is similar to serum but contains clotting factors that are not present in serum. The anticoagulant in the evacuated tube prevents the specimen from clotting by neutralizing or removing one of the essential factors necessary for the clotting or coagulation process. Tubes containing an anticoagulant should be mixed or inverted gently several times (usually 8 to 10 times) immediately after drawing blood to ensure uniform mixing of the specimen with the anticoagulant. Check the manufacturer's directions for the proper number of inversions to perform.

Some tubes contain a **thixotropic separator gel** to separate serum and plasma from cells (Figure 8-24). When the specimen tube is centrifuged, this gel creates a barrier between cells and either plasma or serum. Cells, which are heavier than the gel, descend to the bottom of the tube, while the liquid portion of the blood (plasma or serum) remains above the gel.

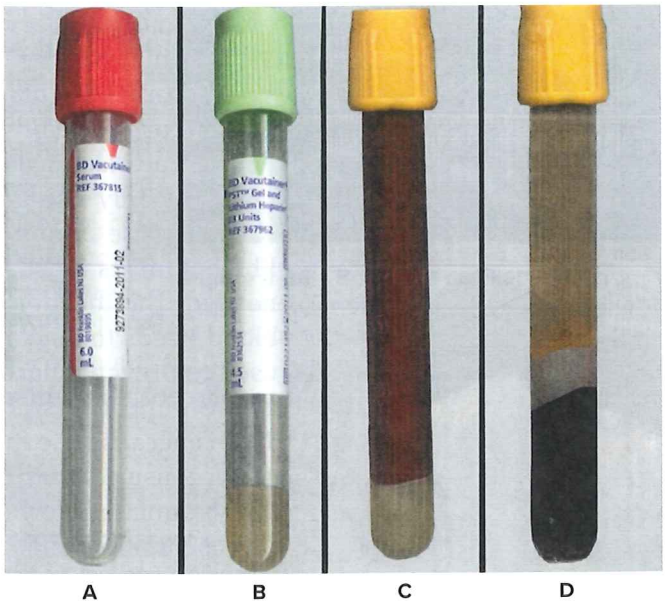
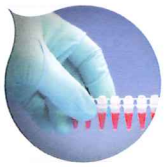


Figure 8-24 Evacuated tubes: (A) no separator gel, (B) with separator gel, (C) filled tube uncentrifuged, and (D) filled tube centrifuged.
Lillian Mundt

Safety & Infection Control



Check the Expiration Dates

Manufacturers print an expiration date on each tube label. As tubes age, the vacuum may be lost and the effectiveness of the additives deteriorates. Do not use tubes past their expiration date. Using an expired tube with loss of vacuum interferes with the collection. If the tube has loss of vacuum or the tube additive has deteriorated, then any specimen collected in the tube will be unacceptable and could result in error in patient treatment.

Checkpoint Questions 8.2

1. List five types of needle safety devices that help prevent needlestick injuries.
2. What is the purpose of the vacuum in evacuated tubes?
3. What is the purpose of a transfer adapter?

8.3 Equipment Unique to Microcollection

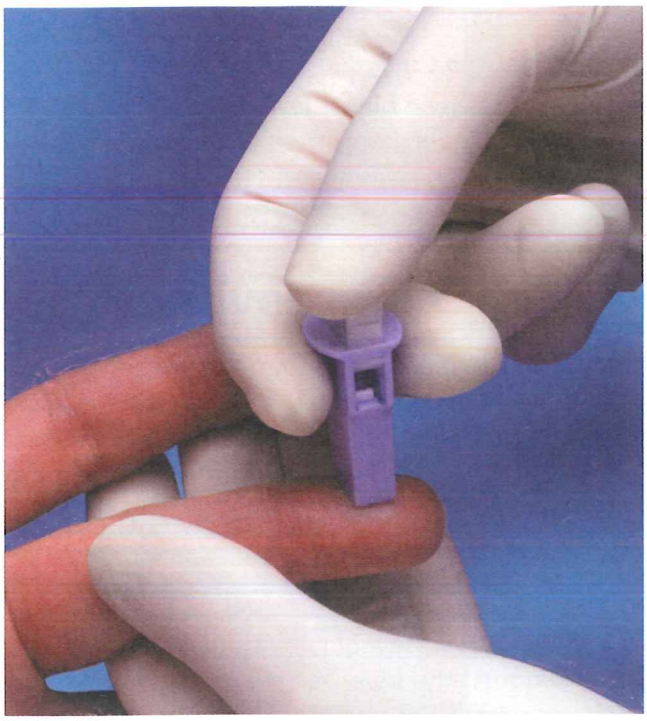
Although venipuncture is the most frequently performed phlebotomy procedure, current laboratory instruments and procedures enable phlebotomists to use smaller and smaller amounts of blood. Thus, obtaining microspecimens by dermal (capillary) puncture is also popular. This section describes the equipment used specifically for microcollection procedures. The actual microcollection procedures are discussed in the chapter *Dermal (Capillary) Puncture*.

Lancets

Lancets are small cutting instruments designed to control the depth of the dermal (capillary) puncture. Lancets come in several depths from 1.5 to 2.5 mm. The depth controls the blood flow for example low blood flow, 1.5 mm; medium blood flow, 1.8 mm; and high blood flow, 2.0 to 2.5 mm. Lancets over 2.5 mm are avoided to prevent injuring the underlying bone, Lancets are also available in varying widths, from a low-flow lancet that produces only a single drop of blood to medium- and high-flow widths that allow for the amount of blood needed to fill microcollection containers. Phlebotomists must select the correct lancet based on the amount of blood needed, the location of the puncture site, and the type of patient whose blood needs to be collected. Safety lancets with retracting blades should be used to prevent sharps injuries. To produce adequate blood flow, the depth of the puncture is actually less important than the width of the incision. This is because the major vascular area of the skin is located near the skin's surface, usually within 2 to 2.5 mm of the surface. A variety of dermal (capillary) puncture devices are available (Figure 8-25). Once used all lancets are disposed of in a sharps container.

Capillary Tubes and Sealant

Capillary tubes, also called *microhematocrit tubes,* may be used to collect blood from a dermal (capillary) puncture when only a small amount of blood is required (Figure 8-26). Capillary tubes are small plastic or glass tubes with



A

B

C

Figure 8-25 Dermal (capillary) puncture devices.
A: Total Care Programming; Inc.; B: Becton Dickinson; C: Becton Dickinson

a thin Mylar filament wrapping (a clear, nonstick coating). Mylar-wrapped glass and plastic tubes are used to avoid easy breakage. Capillary tubes use **capillary action**, which is the physical process of a fluid flowing, or being pulled, into a very thin tube. Capillary action eliminates the need to tip the tube downward, thus reducing the risk of getting air bubbles in the sample.

Three types of capillary tubes are available: red-tipped tubes, blue-tipped tubes, and black-tipped tubes. Red-tipped capillary tubes have an anticoagulant (heparin) coating on the inside to prevent specimen clotting and are used to measure the hematocrit. When the phlebotomist has collected sufficient blood in the red-tipped capillary tube, one end of this tube can then be closed by embedding it in a clay sealant (Figure 8-27). Also available are self-sealing capillary tubes that require no clay sealant after collection; however, care must be taken to collect from the opposite end of the sealant (Figure 8-28). Blue-tipped capillary tubes have no anticoagulant coating on the inside, so specimens will clot in these tubes. Blue-tipped capillary tubes are used when no anticoagulant is required. Black-tipped tubes have a smaller diameter in order to collect a smaller amount of blood.

Figure 8-26 Bottles of capillary tubes.
Total Care Programming, Inc.

Microcollection Tubes

Microcollection containers are usually plastic tubes that provide a larger collection volume than capillary tubes (Figure 8-29). Some containers are designed for a specific test, whereas others are used for multiple purposes. For example, some containers have a capillary tube end, whereas others have a scoop or a wide-mouth opening to collect drops of blood. Microtainers®, manufactured by Becton Dickinson, are one such type of collection device.

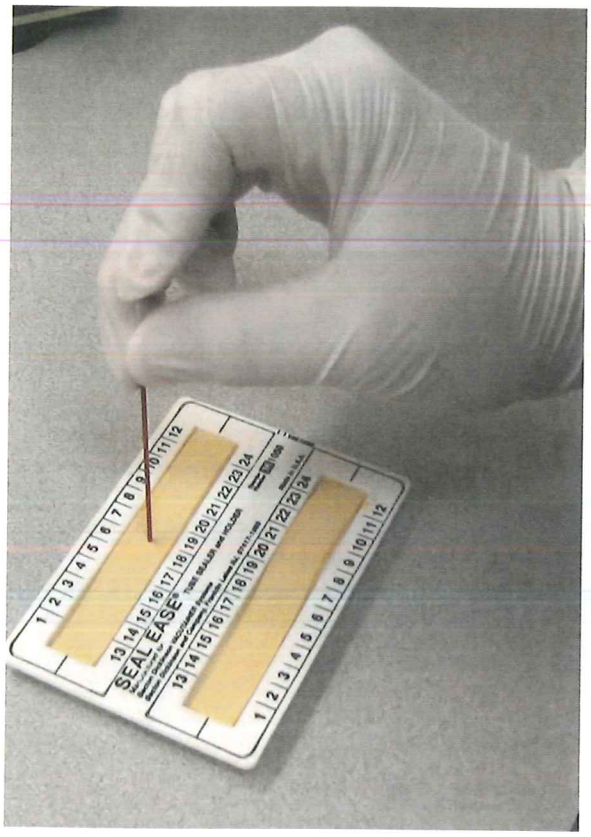


Figure 8-27 Sealing a capillary tube.
Total Care Programming, Inc.

Figure 8-28 Self-sealing capillary tubes.
Lillian Mundt

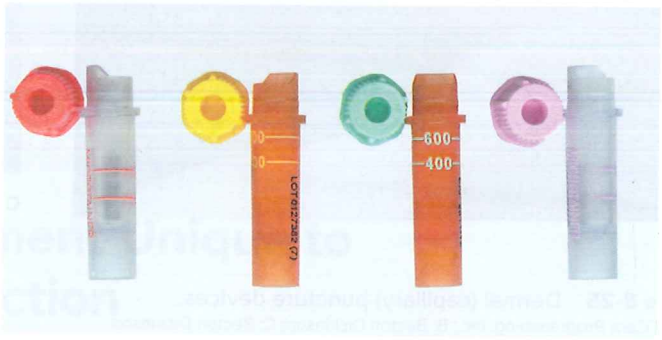


Figure 8-29 Microcollection containers.
Lillian Mundt

Microcollection containers or devices come with the same variety of anticoagulants as do evacuated tubes, including separator gels. The same color-coding system is used for microcollection containers as is used for commonly used evacuated tubes (Figure 8-29).

Life Span Considerations

Equipment Selection

The volume of blood normally drawn on pediatric and geriatric patients with fragile veins is less than the volume normally drawn on adult patients. Selecting the appropriate method of collection is crucial to the successful collection of a quality specimen. Microcollection techniques and equipment are most often used when collecting blood from infants and young children and during point-of-care testing. Routine venipuncture procedures and equipment are used for uncomplicated blood collection from older children and adults. Special equipment, such as the butterfly assembly and smaller draw tubes, may be required for venipuncture procedures on any patient with difficult veins.

The mixing process for microcollection devices is the same as for evacuated tubes, although the number of times the device is inverted may vary. Immediate and proper mixing is very important with the microcollection devices because the coagulation system is initiated during dermal (capillary) puncture. Without proper mixing of the anticoagulant and specimen for tests requiring whole blood, the specimen will clot, rendering it useless for laboratory testing.

1. What is the difference between a capillary tube and a microcollection tube?
2. What depth of lancet would be used to have high, medium, and low blood flow when performing a dermal (capillary) puncture?
3. List the types of capillary tubes available and explain their differences.

Checkpoint Questions 8.3

8.4 Additives and Color Coding

A variety of colors are used for the rubber stoppers and caps that function as closures for evacuated blood collection tubes. Each color indicates the presence of a specific additive contained in the tube. An additive is any substance in a blood collection tube that acts as an anticoagulant, a clot activator, or a preservative. A tube stopper color-coding system helps ensure that the correct additive is used during blood collection for specific laboratory tests. Although the colors used are fairly universal among manufacturers, the shades of these colors may vary. For the purposes of this color-code discussion, common Becton Dickinson brand colors are explained in Tables 8-3 and 8-4. Table 8-3 shows frequently used evacuated tube stoppers and additives. Table 8-4 shows evacuated tube stoppers and additives for special tubes. Phlebotomists should be familiar with the specific evacuated tube types and additives used at the facility where they are employed.

Evacuated tubes that draw a full volume have a solid-color top. Evacuated tubes with translucent Hemogard™ Tube Closure tops contain less vacuum and draw less volume. Volumes are indicated on the tube label with a line. The tubes that draw less volume are often used for pediatric blood collection. Older-style tubes for pediatric blood collection are physically smaller with a colored rubber stopper.

Because of the possibility of additive carryover from one tube to another, the Clinical and Laboratory Standards Institute (CLSI) has suggested a specific order of draw for collection of blood into tubes with various additives. The tube names and colors presented in this section appear in the order of draw, which is discussed later in this chapter. Phlebotomists must adhere to the policies and procedures for order of draw as outlined by their employers. Some laboratories may have determined an alternate order of draw for procedures specific to their needs.

Tubes with additives should *always* be inverted several times immediately after collection to ensure proper mixing of these additives with the sample. Best practice includes mixing all tubes, regardless of additive status, so that you don't forget to mix a tube containing an additive. Follow the manufacturer's instructions for the minimum number of tube inversions for proper mixing.

Routinely Used Tubes

Discard Tubes

Red-topped tubes that *do not* contain a **clot activator** may be used as discard tubes if needed. More often, the plastic red-stoppered tube with a clear Hemogard™ cap is used for discard purposes. Another tube designed for discard draws is topped with a red and light gray conventional stopper. According to protocols at some facilities, a discard tube may precede tubes drawn for coagulation (light blue). In some facilities you may be required to save the discard tube in case another test is ordered. However according to the Clinical Laboratory Standards Institute (CLSI) Collection of Diagnostic Venous Blood

TABLE 8-3 Becton Dickinson Brand Evacuated Tube Identification: Commonly Used Tubes in Order of Draw

Stopper Image				
Conventional Stopper	Hemogard™ Tube Closure (Adult/ Pediatric)	Tube/Stopper/ Closure Color	Additive/Action	Laboratory Section
		Red/gray or clear/ red	None (plastic tube)	Coagulation (may be required to purge air from butterfly tubing)
		Light blue	Sodium citrate/ binds calcium	Coagulation
		Red	None (may use as discard) or clot activator	Chemistry Immunology
		Red/black or gold	Clot activator and separator gel	Chemistry
		Green	Heparin (sodium or lithium)/inhibits thrombin	Chemistry Hematology Flow cytometry
		Green/gray or light green	Heparin (as above) plus separator gel	Chemistry
		Lavender	EDTA spray (K2 or K3) chelates calcium	Hematology Chemistry
		Pink	EDTA spray (K2) chelates calcium; special labeling requirements	Blood bank
		Gray	Sodium fluoride/ glycolysis inhibitor and potassium oxalate/binds calcium	Chemistry

Becton Dickinson

Specimens, 7th ed (GP41) standards a discard tube is only required with using a winged collection set and the light blue is the first tube to be drawn. CLSI GP41 does not require a discard tube otherwise.

Light-Blue-Topped Tubes

Light-blue-topped tubes are used primarily in the coagulation section of the laboratory. The primary additive or anticoagulant in the light-blue-topped tube is sodium **citrate**. Sodium citrate binds calcium, which is needed for coagulation, thus preventing coagulation. In order to have accurate laboratory results, this tube must be filled to its draw capacity and all vacuum must be exhausted. In most cases, a line is found on the tube to designate the proper fill level. Anything less than full could change the results of the blood test ordered, possibly

TABLE 8-4 Becton Dickinson Brand Evacuated Tube Identification: Specialized Tubes (Inserted into Order of Draw Based upon Additives and Tests to Be Performed)

Stopper Image				
Conventional Stopper	**Hemogard™ Tube Closure**	**Tube Stopper/ Closure Color**	**Additive/Action**	**Laboratory Section**
		Yellow	Sodium polyanethol sulfonate/ neutralizes antibiotics	Microbiology/Blood cultures
		Yellow	Acid citrate dextrose/maintains cell viability	Blood bank HLA lab
		Royal blue	Specially formulated cap certified trace element free available as no additive or with EDTA	Chemistry/Trace elements
		Tan	EDTA specially formulated cap certified lead free	Chemistry/Lead levels
		Orange or Gray/ Yellow	Thrombin/ accelerates clotting	Chemistry/STAT tests
		White	EDTA with separator gel	Molecular diagnostics
		Red/Green (CPT™)	Na heparin, liquid density medium, inert gel barrier	mononuclear cell separation
		Light Blue/Black (CPT™)	Na citrate, liquid density medium, inert gel barrier	mononuclear cell separation
		Black	Na citrate	ESRs by Westergren method

Becton Dickinson

changing the patient's treatment. Light-blue-topped tubes have a relatively large amount of additive, a 9:1 ratio of blood to sodium citrate. This ratio of blood to additive is more important than in other tubes with additives. The tube should be inverted several times immediately after collection to prevent clotting. Commonly performed coagulation tests include prothrombin time (PT), activated partial thromboplastin time (APTT) or partial thromboplastin time (PTT), fibrinogen, and D-dimers. Collecting the light-blue-topped tube in the incorrect order of draw may alter the results of these tests.

Red-Topped Tubes

Red-topped tubes, which may be glass or plastic, are used primarily in the chemistry section of the laboratory. Glass red-topped tubes may be used for serum testing and do not contain any additives or gel. The glass tube allows for

access to the clot, should these cells be required for testing. Plastic red-topped tubes may contain a clot activator. The clot activator, which consists of very small silica particles (sandlike granules), speeds up the coagulation process, causing the sample to clot faster.

Serum Separator Tubes

Serum separator tubes (SSTs) are used in the laboratory's chemistry section. Conventional-stopper SSTs have a speckled look, with black mixed into the red portion of the top. Plastic Hemogard™ SSTs are gold-topped. SSTs contain a clot activator and a thixotropic separator gel. The gel separates the serum from the blood cells by settling between the clot and the serum during centrifugation. This separation process helps prevent chemical changes caused by cellular metabolism and fibrinolysis (dissolving of the clot). Even after leaving the body, cells continue to consume glucose and create waste products. The changes in these substances over time would invalidate test results if the gel were not present to keep the cells away from the serum or plasma. The gel separator makes it easier for laboratory personnel to obtain the serum for testing; with the gel in place, the cells will not mix with the serum, making it easier to **aliquot** the liquid for testing. Aliquoting is the process of removing small samples from the original specimen and placing them in another container. Tests commonly performed in chemistry that may require blood collection in an SST include those involving electrolytes, enzymes, glucose, hormones, lipids, and proteins.

Green-Topped Tubes

Green-topped tubes are used by several laboratory sections. They contain the anticoagulant sodium **heparin**, lithium heparin. Heparin stops the coagulation process mainly by inactivating thrombin, thereby preventing clot formation.

Plasma Separator Tubes

Light-green-topped tubes, or green-gray-stoppered tubes, have lithium heparin and a thixotropic gel. Similar to serum separator tubes (SST), plasma separator tubes (PST) are used to form a barrier between blood cells and plasma. Many facilities use light-green-topped tubes for STAT chemistry tests.

Lavender-Topped Tubes

Lavender-topped tubes are used frequently in the hematology section of the laboratory. Most lavender-topped tubes contain K2 or K3 potassium **ethylenediaminetetraacetic acid (EDTA)**, which is sprayed on the interior of the tube. EDTA prevents blood from clotting by binding with calcium, which is essential for clot formation. EDTA is the anticoagulant of choice for hematology because it maintains the cells' shape and size better than other anticoagulants. Other anticoagulants may distort the size and shape of cells, causing them to mimic the appearance of a disease process. EDTA also inhibits platelet clumping and does not interfere with routine staining procedures in hematology. Commonly performed hematology tests performed are the CBC (complete blood cell count), a differential (percentage of each type of white cell), reticulocyte counts (percentage of immature red blood cells), and erythrocyte sedimentation rates (the distance in millimeters that red blood cells settle in 1 hour).

Pink-Topped Tubes

The pink EDTA tube is the preferred tube type for use in blood collection in the blood bank (immunohematology) section of the laboratory. Pink-topped tubes are evenly coated with a sprayed-on, powdered K2 EDTA. In addition,

the label on the pink-topped tube contains lines for additional information required by the American Association of Blood Banks (AABB). Tests commonly performed by the blood bank are blood typing, donor blood testing, cross-matching blood, and preparation of blood and blood products for transfusion.

Gray-Topped Tubes

Gray-topped tubes are most often used by the laboratory's chemistry section. These tubes contain potassium oxalate (an anticoagulant), which stops the coagulation process by binding with calcium. Gray-topped tubes also contain an **antiglycolytic** agent, or glucose preservative, such as sodium fluoride. An antiglycolytic, also known as a *glycolytic inhibitor,* prevents the red blood cells from using glucose and changing it to lactic acid. The gray-topped tube is preferred for glucose levels over red or gold because a blood sample drawn in a tube without a glycolytic inhibitor will produce a lower glucose result. In addition to glucose, gray-topped tubes are used for lactic acid analysis and may be used for blood alcohol levels, depending on the analysis method used by the laboratory.

Specialty Tubes

Yellow-Topped Tubes

Yellow-topped tubes are specialized tubes that are available with two different additives. Although the tubes look identical, one contains sodium polyanethol sulfonate (SPS) and is used for blood culture collections. The SPS acts as an anticoagulant and neutralizes the effect of bacterial growth inhibitors, such as antibiotics. The SPS yellow-topped tube is sterile and must be drawn first before any other tube is collected. When a blood culture is ordered along with coagulation tests, this tube replaces the discard tube in the order of draw. Many facilities no longer use SPS tubes. These facilities use specialized blood culture collection bottles, which are discussed in the chapter *Special Phlebotomy Procedures*.

The other yellow-topped tube available contains **acid citrate dextrose (ACD)**, which is an additive that maintains red cell viability or growth and is used for cellular studies in blood banks or human leukocyte antigen (HLA) typing. Care must be taken when selecting a yellow-topped tube to ensure that it contains the correct additive for the laboratory test ordered.

Royal-Blue-Topped Tubes

Royal-blue-topped tubes are specialized tubes that are available with different additives. These tubes display additive-specific color coding on the label: a red bar on the label indicates no additive is present, a lavender bar indicates sodium EDTA, and a blue bar indicates potassium EDTA. The royal blue stoppers are certified to have very low levels of trace elements, such as aluminum, lead, mercury, zinc, and other metals, making these tubes a requirement for trace element studies, toxicology, and nutritional chemistry tests. Care must be used when selecting a royal-blue-topped tube to ensure that the correct additive is present in the tube for the specific laboratory test ordered.

Tan-Topped Tubes

Tan-topped tubes are specialized tubes that contain EDTA. Tan-topped tubes are certified to have very low levels of lead, making these tubes a requirement when an accurate blood lead level is needed.

Orange-Topped Tubes

Orange-topped tubes are specialized tubes that contain *thrombin.* Thrombin is a powerful clotting factor that promotes quick clot formation. This tube is used

for specimen collections needing immediate testing (STAT) for tests where serum is required.

White-Topped Tubes

White-topped tubes are specialized plasma preparation tubes (PPT™) tubes that contain EDTA and a plasma separator gel. The white-topped tubes may be required by laboratories performing molecular diagnostic tests that involve DNA-based methods.

Red/Green-Topped Tubes

Tubes with a mottled red/green conventional stopper are cell preparation tubes (CPT™) containing sodium heparin, liquid density medium and an inert gel barrier. This tube is used when mononuclear blood cells need to be separated from heparinized whole blood.

Light Blue/Black-Topped Tubes

Tubes with a mottled light blue/black conventional stopper are cell preparation tubes (CPT™) containing sodium citrate, liquid density medium and an inert gel barrier. This tube is used when mononuclear blood cells need to be separated from citrated whole blood.

Black-Topped Tubes

Some laboratories use a method for erythrocyte sedimentation rate (ESR) that requires a specimen be collected in a special black-topped tube. This tube contains sodium citrate, but results in a different ratio of anticoagulant to blood than obtained in a light blue sodium citrate tube. This black-topped tube allows for eliminating manual dilutions of the blood prior to performing the ESR test.

Miscellaneous Tubes

Phlebotomists may need to use other tubes that are designed for inclusion with a specific test kit. One such test is for fibrin degradation products (FDP), also known as fibrin split products (FSP). FDPs are formed when blood clots break down. The tube that accompanies the FDP test kit may have either a light blue top (similar to the citrate tube), dark blue top, or a black top. The label on this tube identifies it as being specific for FDP. The FDP tube contains two additives: thrombin to quickly clot the specimen, and a fibrinolytic inhibitor, so that the clot does not break down. The FDP tube is usually kept refrigerated until needed.

Communicate & Connect

Tube Selection

Blood collection equipment color codes are fairly standard and most blood collection product manufacturers attempt to color-code additive tubes and needle gauges with similar colors. However, due to patent rights, different shades of standard colors will be used. Phlebotomists must become familiar with equipment and test requirements specific to their places of employment. Checking with procedure manuals, supervisors, and laboratory section staff will help ensure that the correct equipment is used in the collection of specimens.

Another type of black-topped tube is used with some test kits for erythrocyte sedimentation rate (ESR). These black-topped tubes contain a specific amount of citrate anticoagulant, which provides the correct ratio of additive to perform the ESR directly in this tube.

Microcollection Container Colors

Although the previously described colors and additives are the same for evacuated tubes and microcollection containers, the two types of containers are different in some respects. Microcollection containers are not evacuated tubes. Light blue (citrated) microcollection containers, which are used for coagulation tests, are uncommon because the coagulation system is activated during the dermal puncture. In addition, the gold-stoppered serum separator and light green plasma separator microcollection containers are available in an amber-colored plastic. The amber tube color protects the specimen from light and is used primarily for bilirubin testing.

Checkpoint Questions 8.4

1. What is the purpose of color coding the tops of blood collection tubes?
2. Explain why coagulation tests cannot be run on blood obtained by dermal (capillary) puncture.
3. What is the difference between a solid green-topped tube and a translucent green-topped tube?

8.5 Order of Draw

Routine Venipuncture

Routine venipuncture usually does not include a blood culture, for which special tubes are required to be drawn first. The CLSI recommends that uncomplicated blood draws use the following order:

1. Nonadditive (red or clear discard tube, if required by your facility)
2. Citrate (light blue)
3. Serum tube (clot activator tube: red, royal blue, or orange)
4. Serum separator (gold or red/black speckled)
5. Plasma separator (light green or green/black speckled)
6. Heparin (green)
7. EDTA (lavender, pink, royal, tan, or white)
8. Sodium fluoride (gray)

Sterile Venipuncture

When a blood culture is included with orders for other blood draws, the tubes for the blood culture must be drawn first. These tubes may be SPS yellow-topped tubes or blood culture bottles. The CLSI recommends the following order of draw when sterile procedures are included with routine blood draws:

1. Sterile tubes (SPS yellow or blood culture bottles)
2. Citrate (light blue)
3. Serum tube (clot activator tube: red, royal, or orange)
4. Serum separator (gold or red/black speckled)
5. Plasma separator (light green or green/black speckled)
6. Heparin (green)
7. EDTA (lavender, pink, royal, tan, or white)
8. Sodium fluoride (gray)

The common mnemonic used to help phlebotomists remember the order of draw for venipuncture includes the sterile tube and is outlined in Table 8-5. This mnemonic has evolved over the years as newer evacuated tubes are added or discoveries are made that alter the order of draw. Rarely used tubes are skipped, but the tubes that are collected should follow the same order.

Butterfly Venipuncture

When a winged infusion set is used to collect blood with evacuated blood collection tubes, the order of draw remains the same as for routine venipuncture or sterile blood draws. However, because the assembly tubing contains air, a discard tube must be drawn even for sterile blood draws. Using a discard tube for butterfly draws will ensure that the other tubes will fill with the proper amount of blood.

When using the butterfly assembly with a syringe, or using a syringe and hypodermic needle for blood collection, the blood must be transferred to the evacuated tubes. Using a syringe transfer device (Figure 8-30) lessens the chance of needlestick injury. The order of filling tubes in this manner is the same as for sterile blood draws. The CLSI has determined that using an alternate order of draw (filling of tubes) is not necessary for syringe draws.

TABLE 8-5 Order of Draw Mnemonic

Tube Cap	Acronym	Mnemonic Meaning
	STOP	Sterile specimens for blood culture
	LIGHT	Light-blue-topped citrate tubes
	RED	Red-topped clot activator tubes
	STAY	Serum separator tubes
	PUT	Plasma separator tubes
	GREEN	Green-topped heparin tubes
	LIGHT	Lavender-topped EDTA tubes
	PLEASE	Pink-topped EDTA tubes
	GO	Gray-topped potassium oxalate/sodium fluoride tubes

Lillian Mundt

Figure 8-30 Syringe transfer device.
©Lillian Mundt

Dermal (Capillary) Puncture

During dermal (capillary) puncture, the first drop of blood is *not* collected. Microcollection tubes are filled in the following order:

1. EDTA (lavender or pink)
2. Heparin (green, light green)
3. Sodium fluoride (gray)
4. Nonadditive (red) or serum separator (gold)

Avoiding Interfering Substances

An *interfering substance* is one that produces incorrect laboratory test results. These substances can enter the test system during the pre-examination phase (during specimen collection and handling). Improper patient preparation (discussed in the chapters *Patient and Specimen Requirements*, *Venipuncture*, and *Dermal [Capillary] Puncture*) may contribute to the presence of an interfering substance. However, interfering substances can also be introduced into the sample if the phlebotomist uses an incorrect draw order.

The order in which blood is collected using evacuated tubes and a winged blood collection set is critical to avoid introducing contaminants into the specimens. When the skin is punctured, it releases tissue thromboplastin, which may be present in the first tube collected. A citrate tube (light blue) should not be the first tube collected because the thromboplastin will activate the clotting system and render any results obtained invalid.

It is also possible to contaminate tubes with anticoagulants from other tubes. Anticoagulants or clot activators may adhere to the tube end of the double-ended needle and may be introduced into the next tube. Therefore, the light-blue-topped tube is best drawn before any other tube containing an additive because other additives may become interfering substances, altering coagulation test results.

Depending upon the equipment used, trace element blood test results can be affected. Contamination occurs because trace elements in blood collection equipment contribute to the specimen changing the results. Changes in specimen handling or the order of the draw may be needed. For example, using a

syringe for trace element collections of cobalt and chromium is not recommended. Check with the tube manufacturer and always follow the policies and procedures established by your facility.

Checkpoint Questions 8.5

1. What is the difference in the order of draw between routine blood collection and blood collection that includes a specimen for a blood culture?
2. Why is it important to use a discard tube when collecting blood with a winged infusion set directly into evacuated tubes?
3. A patient needs blood tests that require green-topped, gray-topped, light-blue-topped, and lavender-topped tubes. In what order would you draw the tubes?

8.6 Blood Collection Equipment Manufacturers

There are many blood collection equipment manufacturers. This section discusses three common ones: Becton Dickinson, Greiner Bio-One, and Sarstedt. As a phlebotomist, you should always be familiar with the equipment that you will be using.

Becton Dickinson

Becton Dickinson (BD) manufactures equipment for blood and urine collection, including the Vacutainer® and Microtainer® systems. These tubes are available with various anticoagulants and are color coded, as explained earlier in this chapter. BD Vacutainer® tubes, appropriate for venous blood collection from adults, have a solid cap, while those used for pediatric venous blood collection have a translucent cap. See Figure 8-31 for a comparison of adult and pediatric tube caps. Vacutainer® tubes containing a separator gel have a unique color to code them. For example, the cap on a Vacutainer® tube containing a clot activator is red, but the cap on a Vacutainer® tube containing a clot activator and separator gel is gold. Likewise, the cap on a Vacutainer® tube containing heparin is green, while the cap on a Vacutainer® tube containing heparin and a separator gel is light green. See Figure 8-32 for a comparison of these cap colors.

Greiner Bio-One

Greiner Bio-One manufactures equipment for blood and urine collection, including VACUETTE® tubes designed for venous collection (Figure 8-33) and MiniCollect® tubes designed for capillary collection (Figure 8-34). These tubes are available with various anticoagulants and are color coded with similar colors as the BD brand tubes. VACUETTE® tubes have solid-colored tops regardless of amount of vacuum. Tubes appropriate for adult blood collection have a black ring on the cap top. Tubes appropriate for pediatric blood collection have a white ring on the cap top (Figure 8-35). VACUETTE® tubes with a separator gel use the same additive color code as the tubes without a separator gel but have a yellow ring on the cap top (Figure 8-36).

Sarstedt

Sarstedt manufactures diagnostic specimen collection equipment including the S-Monovette®, Microvette®, and Multivette® collection systems.

Figure 8-31 Becton Dickinson uses (A and C) solid-colored caps to indicate use for adult venous blood collections and (B and D) translucent caps to indicate use for pediatric or difficult venous blood collections.
Lillian Mundt

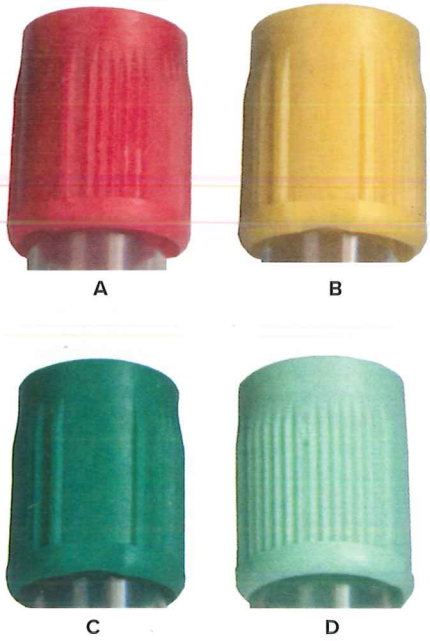


Figure 8-32 Becton Dickinson tube caps indicate the presence of (A) clot activator, (B) clot activator and separator gel, (C) heparin, and (D) heparin and separator gel.
Lillian Mundt

Figure 8-33 VACUETTE® tubes are part of the evacuated tube system that is manufactured by Greiner Bio-One.
greiner bio-one. Photo provided by greiner bio-one

Figure 8-34 MiniCollect® tubes are microcollection containers manufactured by Greiner Bio-One.
greiner bio-one. Photo provided by greiner bio-one

S-Monovette® is a closed blood collection system that allows the user to collect venous blood by either syringe aspiration or the vacuum principle (Figure 8-37). S-Monovette® devices can be used like a syringe to better control vacuum pull or used like an evacuated tube if the plunger is pulled back and removed before blood collection. The S-Monovette® is color coded to indicate the additive present. The color codes are similar to those on BD brand tubes. However, the cap on serum separator tubes is brown. The Microvette® enables blood sampling using either the capillary action principle or the gravity-flow

Figure 8-35 Greiner Bio-One uses (A) a black ring in tube caps to indicate use for adult venous blood collections and (B) a white ring in tube caps to indicate use for pediatric or difficult venous blood collections.
greiner bio-one. Photos by Photo Affairs, Inc./Steve Rouben

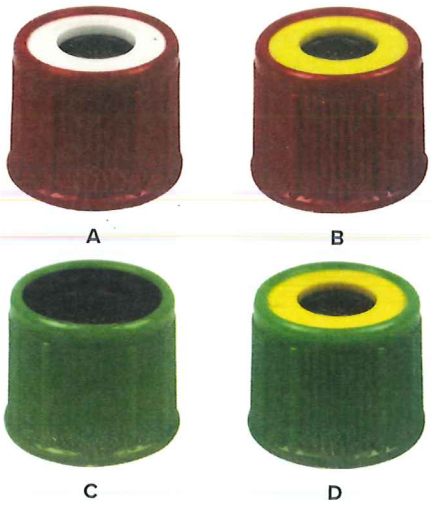


Figure 8-36 These Greiner Bio-One tube caps indicate the presence of (A) clot activator, (B) clot activator and separator gel, (C) heparin, and (D) heparin and separator gel.
greiner bio-one. Photos by Photo Affairs, Inc./Steve Rouben

Figure 8-37 Sarstedt S-Monovette® closed blood collection system.
Sarstedt, Inc.

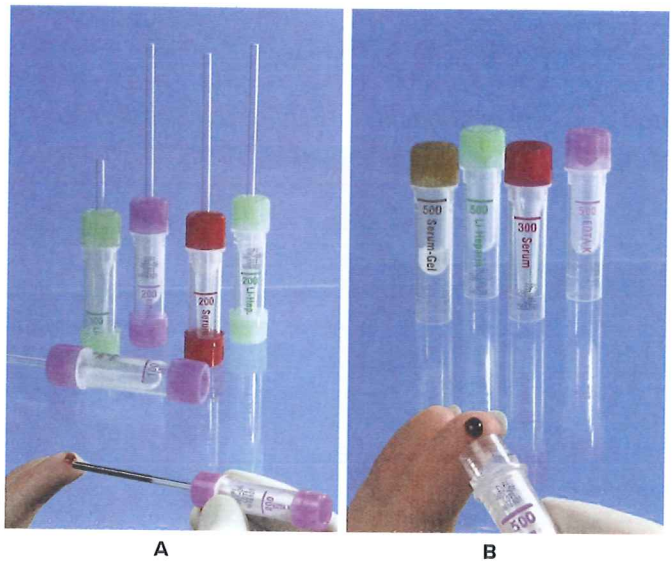


Figure 8-38 Sarstedt Microvette® tubes can be filled by (A) capillary action or (B) gravity fill.
Sarstedt, Inc.

principle, using the special rim (Figure 8-38). The Multivette® allows for the collection of both venous and capillary blood. For venous blood collection, a luer lock needle is connected to the capillary tube of the Multivette®, which automatically fills by normal venous pressure. Capillary blood is collected using the capillary tube (Figure 8-39).

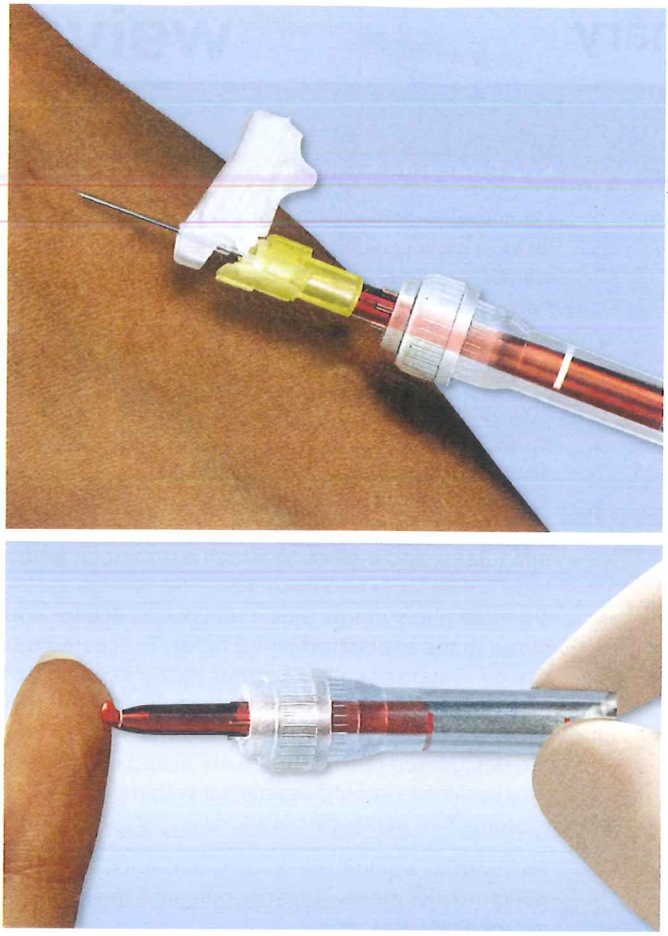


Figure 8-39 Sarstedt Multivette® can be used for small samples of venous blood or capillary blood.
Sarstedt, Inc.

Checkpoint Questions 8.6

1. How does Becton Dickinson indicate the difference between full-volume (adult) evacuated tubes and small-volume (pediatric) evacuated tubes? How is the presence of a separator gel in an evacuated tube indicated?
2. How does Greiner Bio-One indicate the difference between full-volume (adult) evacuated tubes and small-volume (pediatric) evacuated tubes? How is the presence of a separator gel in an evacuated tube indicated?
3. What is unique about the venous blood collection system manufactured by Sarstedt?

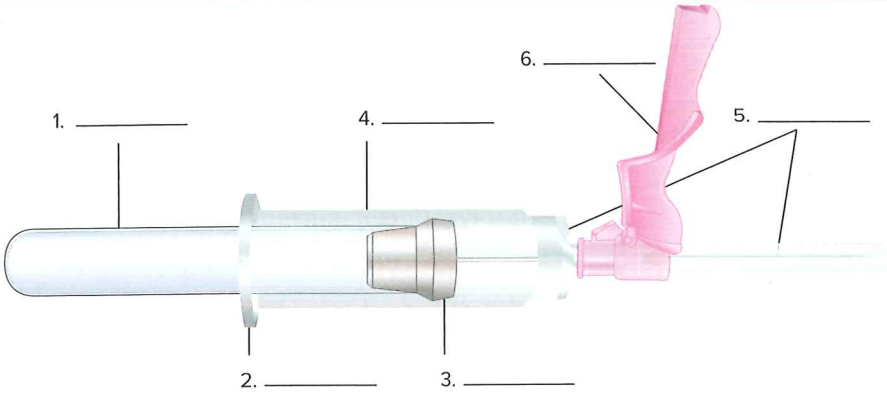
Chapter Summary

Learning Outcome	Key Concepts/Examples	Related NAACLS Competency
8.1 Identify equipment used for both venipuncture and dermal (capillary) puncture.	Common equipment and supplies needed for phlebotomy include gloves; alcohol prep pads; gauze pads; tissue warmers; adhesive bandages or tape; sharps container; permanent marker, pen, or computer labels; specimen transport bags; and evacuated tubes. Equipment is stored and transported on a tray or cart.	5.1, 5.6, 5.7
8.2 Identify equipment specific for venipuncture procedures.	Phlebotomy equipment specific to venipuncture procedures includes tourniquets, needles or butterfly assemblies, evacuated tube holders or syringes, and evacuated tubes. The winged infusion set (butterfly assembly) includes a needle that has butterfly wings; short, thin tubing; and a place to attach a syringe or an evacuated tube holder for blood collection. The syringe set includes a needle and syringe, plus a transfer device for adding blood to the evacuated blood tubes. Evacuated tubes are a closed system of collection that allows for multiple tubes to be collected with one venipuncture. Evacuated tubes come with tops of different colors and with different additives and are designated for different tests based on their additives. Phlebotomists should be familiar with the tube color-coding system used at their facility.	5.6, 5.7
8.3 Identify equipment specific for dermal (capillary) puncture procedures.	Phlebotomy equipment specific to dermal (capillary) puncture includes a lancet or puncture device and special microcollection tubes.	5.6
8.4 Identify the various types of additives and color coding used in blood collection and explain the reasons for their use.	Additives used in blood collection containers are indicated by the color used in the tube closure. Commonly used additives and colors are nonadditive (white or clear with red center, depending on brand), citrate (blue), clot activator and gel (gold or red with yellow ring, depending on brand), heparin (green), EDTA (lavender), and potassium oxalate with fluoride (gray).	5.1, 5.2, 5.3, 9.11
8.5 Implement the correct order of draw for venipuncture and dermal (capillary) puncture procedures.	The order of the draw using the routine venipuncture procedure depends on the facility's policies. An accepted order of draw may include a nonadditive discard tube being collected first, followed by citrate tube, SST serum separator tube, heparin and heparinized plasma separator tubes, EDTA tube, and last, sodium fluoride/potassium oxalate tube. Specimens requiring sterile blood collection procedures (blood cultures) must be drawn first, regardless of order of draw. Sterile tubes replace the discard tube in the order of draw using the evacuated tube system. The order in which blood is collected using evacuated tube systems is critical for avoiding contamination with interfering substances.	5.4, 5.5, 5.7
8.6 Compare blood collection equipment from various manufacturers.	Several companies manufacture blood collection equipment. The coding used to indicate additives and draw volumes vary among manufacturers. Phlebotomists must become familiar with the equipment used at their facilities.	5.3

Chapter Review

A: Labeling

Label the parts of the following evacuated tube assembly.



1. [LO 8.2] _____

2. [LO 8.2] _____

3. [LO 8.2] _____

4. [LO 8.2] _____

5. [LO 8.2] _____

6. [LO 8.2] _____

B: Matching

Match each term with its definition.

7. [LO 8.2] anticoagulant

8. [LO 8.2] gauge

9. [LO 8.2] winged infusion set

10. [LO 8.2] evacuated tube

11. [LO 8.2] evacuated tube holder

12. [LO 8.2] safe needle device

a. covers the needle after specimen collection

b. plastic holder for both the needle and the blood collection tube

c. closed collection tube containing a premeasured vacuum

d. agent that prevents blood from clotting

e. also known as a butterfly needle

f. needle diameter or bore

C: Fill in the Blank

Next to each additive listed on the left, write the colors of the tubes containing that additive on the right.

13. [LO 8.4] none _____

14. [LO 8.4] EDTA _____

15. [LO 8.4] sodium citrate _____

16. [LO 8.4] sodium fluoride/potassium oxalate _____

17. [LO 8.4] heparin (either sodium, lithium, or ammonium) _____

18. [LO 8.4] clot activator _____

19. [LO 8.4] thixotropic gel _____

D: Sequencing

Place the following types of tubes in the correct order of draw (from 1 to 7).

20. [LO 8.5] _____ light blue (coagulation)

21. [LO 8.5] _____ sterile specimens (blood cultures or yellow SPS tube)

22. [LO 8.5] _____ pink or lavender (EDTA)

23. [LO 8.5] _____ gold or red/black (SST)

24. [LO 8.5] _____ red plastic or glass (serum)

25. [LO 8.5] _____ green (heparin)

26. [LO 8.5] _____ gray (fluoride)

E: Case Studies/Critical Thinking

27. [LO 8.4] Your supervisor asks you to collect an EDTA sample on a patient waiting in the outpatient drawing room. Which tubes contain EDTA? How will you determine which tube to collect?

28. [LO 8.3] You are going to collect blood from an elderly person with fragile veins. What are your options for blood collection equipment in this case? What other things do you need to consider for your selection of equipment?

29. [LO 8.2, 8.3] A young child needs blood drawn for coagulation studies prior to going to surgery. What are your options for blood collection equipment? What are the concerns for order of draw?

30. [LO 8.4] While you are drawing blood on a patient, he asks why there are so many different colors of tubes. How would you respond to this question?

F: Exam Prep

Choose the best answer for each question.

31. [LO 8.1] The term *evacuated tube* refers to a venipuncture collection tube that

a. does not contain a vacuum.
b. contains a vacuum.
c. does not contain an anticoagulant.
d. contains an anticoagulant.

32. [LO 8.4] The purpose of an anticoagulant in a blood collection container is to

a. decrease the chance of hemolysis.
b. preserve the life span of red blood cells.
c. prevent blood from clotting.
d. produce serum for testing.

33. [LO 8.1] Needles used with evacuated tube systems have a *(Choose all that apply.)*

a. single point.
b. double end.
c. blunt end.
d. rubber sleeve.

34. [LO 8.2] Syringes are used with which type of needle? *(Choose all that apply.)*

a. Butterfly
b. Double-ended
c. Hypodermic
d. Surgical

35. [LO 8.2] When performing a venipuncture on a patient with small veins, the best size of needle to use is

a. 19 gauge.
b. 20 gauge.
c. 21 gauge.
d. 22 gauge.

36. [LO 8.1] Gloves are *not* required while

a. transporting specimens to the lab.
b. performing a venipuncture.
c. performing a dermal (capillary) puncture.
d. cleaning the venipuncture site.

37. [LO 8.3] The depth of a dermal (capillary) puncture device is controlled during capillary collection in order to

a. puncture an artery.
b. control excessive clotting.
c. avoid puncturing a bone.
d. avoid bacterial contamination.

38. [LO 8.1] An alcohol prep pad is

a. not an appropriate antiseptic to use in blood collection.
b. a bacteriostatic preventing contamination of the puncture site.
c. saturated with a 70% iodine solution.
d. used after the venipuncture to stop bleeding at the site.

39. [LO 8.4] A plastic red-topped tube contains

a. an anticoagulant.
b. an antiglycolytic agent.
c. a clot activator.
d. no additives.

40. [LO 8.4] A gray-topped tube contains

a. an antiglycolytic agent.
b. a clot activator.
c. no additives.
d. separator gel.

41. [LO 8.4] Blood specimens for coagulation testing are collected in _____tubes.

a. citrate
b. EDTA
c. fluoride
d. heparin

42. [LO 8.4] EDTA is the anticoagulant found in _____-topped tubes. *(Choose all that apply.)*

a. lavender
b. pink
c. tan
d. white

43. [LO 8.4] Gel separation barriers are included in which tubes? *(Choose all that apply.)*

a. Gold
b. Light blue
c. Light green
d. Tan

44. [LO 8.4] Tubes with a gel separation barrier may also contain *(Choose all that apply.)*

a. heparin.
b. EDTA.
c. clot activator.
d. citrate.

45. [LO 8.5] When collecting blood using a butterfly assembly, which tubes must have a discard tube drawn prior to their filling? *(Choose all that apply.)*

a. Gray
b. Lavender
c. Royal blue
d. Light blue

46. [LO 8.5] If gray, green, and lavender tubes are needed, the correct order of draw is

a. green, lavender, gray.
b. gray, lavender, green.
c. lavender, gray, green.
d. gray, green, lavender.

47. [LO 8.5] An erroneous coagulation test result was obtained on a specimen. What may have happened in the pre-examination phase of testing to cause this?

a. The blue-topped tube was filled to capacity.
b. A nonadditive tube was drawn before the blue-topped tube.
c. The blue-topped tube was underfilled.
d. The blue-topped tube was drawn before the lavender-topped tube.

48. [LO 8.5] To avoid contamination of sterile specimens,

a. sterile tubes should be collected first.

b. sterile tubes should be collected last.

c. discard tubes should be collected before sterile tubes.

d. blue-topped tubes should be collected before sterile tubes.

49. [LO 8.5] Interfering substances that may contaminate specimens for coagulation testing may be introduced into specimens *except* when

a. nonadditive tubes are collected first.

b. fluoride tubes are collected first.

c. heparin tubes are collected first.

d. clot activator tubes are collected first.

50. [LO 8.6] Which tube would you use to collect a pediatric coagulation study?

a. Translucent, lavender-topped tube

b. Solid, light-green-topped tube

c. Solid, blue-topped tube

d. Translucent, blue-topped tube

51. [LO 8.6] You have to complete a difficult microcollection draw. Which of the following tubes would you most likely use?

a. Greiner Bio-One black ring tube cap

b. Becton Dickinson solid, blue-topped tube

c. Greiner Bio-One white ring tube cap

d. Sarstedt closed blood collection system

52. [LO 8.5] Which tube is drawn first in a sterile venipuncture?

a. SPS yellow-topped tube

b. Light-blue-topped tube

c. Gray-topped tube

d. Red-topped tube

53. [LO 8.5] If red, yellow, and light blue tubes are needed, which is the correct order of draw?

a. Yellow, red, light blue

b. Red, yellow, light blue

c. Yellow, light blue, red

d. Light blue, yellow, red

54. [LO 8.4] Which anticoagulant may be present in a dark green-topped tube? (*Choose all that apply.*)

a. Ammonium heparin

b. Lithium heparin

c. Potassium heparin

d. Sodium heparin

55. [LO 8.4] Which tube should be used when a specimen for lead level needs to be collected in EDTA?

a. Lavender

b. Pink

c. Royal

d. Tan

56. [LO 8.4] Which tube should be used when a specimen for trace elements needs to be collected in potassium EDTA?

a. Royal with red bar

b. Royal with lavender bar

c. Royal with blue bar

d. any of these

57. [LO 8.4] Which tube is used for specialized cell separation? (*Choose all that apply.*)

a. red/black

b. green/black

c. blue/black

d. red/green

NAME: _____ DATE: _____

COMPETENCY CHECKLIST: ORDER OF DRAW FOR VENIPUNCTURE

Procedure Steps	Practice 1	2	3	Performed Yes	No	Master
Procedure						
1. Determines whether routine or sterile venipuncture is required.						
2. If sterile venipuncture is required, collects sterile SPS yellow or blood culture bottles first.						
3. If sterile venipuncture is not required, and if the facility requires a discard tube, fills a red-topped or clear discard tube.						
4. Collects light-blue-topped tube(s), if blood with citrate additive is required.						
5. Collects red, royal blue, or orange clot activator serum tube(s), as required.						
6. Collects gold or red/black speckled serum separator tube(s), as required.						
7. Collects light green or green/black speckled plasma separator tube(s), as required.						
8. Collects green heparinized tube(s), as required.						
9. Collects lavender, pink, royal blue, tan, or white EDTA tube(s), as required.						
10. Collects gray sodium fluoride tube(s), as required.						

COMMENTS: _____

_____

SIGNED

EVALUATOR: _____

STUDENT: _____

NAME: _____ DATE: _____

COMPETENCY CHECKLIST: ORDER OF DRAW FOR DERMAL (CAPILLARY) PUNCTURE

Procedure Steps	Practice 1	Practice 2	Practice 3	Performed Yes	Performed No	Performed Master
Procedure						
1. Collects lavender or pink EDTA microcollection tube(s), as required.						
2. Collects green or light green heparin microcollection tube(s), as required.						
3. Collects gray sodium fluoride microcollection tube(s), as required.						
4. Collects nonadditive (red) or serum separator (gold microcollection tube[s]), as required.						

COMMENTS: _____

_____

SIGNED

EVALUATOR: _____

STUDENT: _____