Upon successful completion of this chapter, the reader should be able to:

1. Define the key terms and abbreviations listed at the beginning of this chapter.
2. List and describe the physiologic variables that influence laboratory test results and identify the tests most affected by each one.
3. List problem areas to avoid in site selection, identify causes for concern, and describe procedures to follow when encountering each.
4. Identify and describe various vascular access sites and devices and explain what to do when they are encountered.
5. Identify, describe, and explain how to handle patient complications associated with blood collection.
6. Identify, describe, and explain how to avoid or handle procedural error risks, specimen quality concerns, and reasons for failure to draw blood.
The preanalytical (before analysis) phase of the testing process begins when a test is ordered and ends when testing begins. Numerous factors associated with this phase of the testing process if not properly addressed can lead to errors that can affect specimen quality, jeopardize the health and safety of the patient, and ultimately increase the cost of medical care. Since each patient situation is unique, in addition to possessing the technical skills needed to perform a blood draw, a phlebotomist must have knowledge of the many patient variables, complications, and procedural errors associated with blood collection to avoid or reduce any negative impact.

**BASAL STATE**

Basal state refers to the resting metabolic state of the body early in the morning after fasting for a minimum of 12 hours. A basal state specimen is ideal for establishing reference ranges (normal laboratory test values for healthy individuals) on inpatients, because the effects of diet, exercise, and other controllable factors on test results are minimized or eliminated. Basal state is influenced by a number of physiologic patient variables such as age, gender, and conditions of the body that cannot be eliminated.

*fyi* Outpatient specimens are not basal state specimens and may have slightly different normal values.

**PHYSIOLOGIC VARIABLES**

**Age**

Values for some blood components vary considerably depending upon the age of the patient. For example, red blood cell (RBC) and white blood cell (WBC) values are normally higher in newborns than in adults. Some physiologic functions such as kidney function decrease with age. For example, creatinine clearance, a measure of kidney function, is directly related to the age of the patient, which must be factored in when calculating test results.

**Altitude**

Red blood cells carry oxygen. Decreased oxygen levels at higher altitudes cause the body to produce more red blood cells to meet the body’s oxygen requirements; the higher the altitude, the greater the increase. Thus red blood cell (RBC) counts and related determinations such as hemoglobin (Hgb) and hematocrit (Hct) have higher normal ranges at higher elevations.

**Dehydration**

Dehydration (decrease in total body fluid) that occurs for example, with persistent vomiting or diarrhea, causes hemoconcentration, a condition in which blood components that cannot easily leave the bloodstream become concentrated in the smaller plasma volume.
Blood components affected include RBCs, enzymes, iron (Fe), calcium (Ca), sodium (Na), and coagulation factors. Consequently, results on specimens from dehydrated patients may not accurately reflect the patient’s status. In addition, it is often difficult to obtain blood specimens from dehydrated patients.

**Diet**

Blood composition is significantly altered by ingestion of food. For example:

- Glucose (blood sugar) levels increase dramatically with the ingestion of carbohydrates or sugar-laden substances but return to normal within 2 hours if the patient has normal glucose metabolism.
- Ingestion of lipids (such as fats found in foods such as butter and cheese and in some IV feeding preparations) increases blood lipid content, a condition called *lipemia*. High levels of lipids cause the serum or plasma to appear milky (cloudy white) or turbid, and the specimen is described as being *lipemic* (Fig. 9-1).

**memory • jogger** To associate lipemic with fat, think “fat lip” or visualize a fat white cloud, because fat makes the specimen cloudy white.

![FIGURE 9-1](image)

*Left to right, Lipemic, icteric, and normal specimen.*
Lipemia can be present for up to 12 hours, which is why accurate testing of triglycerides (a type of lipid) requires a 12-hour fast. In addition, some chemistry tests cannot be performed on lipemic specimens because the cloudiness interferes with the testing procedure.

**Key Point** When a test requires a fasting specimen but the serum or plasma sample submitted is lipemic, it is a clue that the patient most likely was not fasting.

- Some test methods that detect occult (hidden) blood in stool specimens also detect similar substances in meat and certain vegetables. Consequently, a special diet that eliminates these foods must be followed for several days before the specimen is collected.
- Fluid intake can also affect blood composition. Excessive fluid intake can decrease Hgb levels, and alter electrolyte balance. Consumption of caffeine beverages can affect cortisol levels. Chronic consumption or recent ingestion of large amounts of alcohol can cause hypoglycemia, and increased triglycerides.

**Key Point** Requiring a patient to fast or follow a special diet eliminates most dietary influences on testing.

**Diurnal/Circadian Variations**

The levels of many blood components normally exhibit diurnal (happening daily) or circadian (having a 24-hour cycle) variations or fluctuations. Factors that play a role in diurnal variations include posture, activity, eating, daylight and darkness, and being awake or asleep. For example, maximum renin and TSH levels normally occur in the predawn hours of the morning during sleep, while peak cortisol levels normally occur later in the morning, around 8:00 AM. Other blood components that exhibit diurnal variation with highest levels occurring in the morning include bilirubin, hemoglobin, insulin, iron, potassium, testosterone, and red blood cells. Blood levels of eosinophils, creatinine, glucose, triglyceride, and phosphate are normally lowest in the morning. Diurnal variations can be large. For example the levels of cortisol, TSH, and iron can differ by 50% or more between morning and late afternoon.

**Key Point** Tests influenced by diurnal variation are often ordered as timed tests, and it is important to collect them as close to the time ordered as possible.

**Drug Therapy**

Some drugs alter physiologic functions, causing changes in the concentrations of certain blood analytes. The effect may be desired or an unwanted side effect or sensitivity.
Consequently, it is not uncommon for physicians to monitor levels of specific blood analytes while a patient is receiving drug therapy. The following are just a few examples of drugs that can alter physiologic function and the analytes they affect:

- Chemotherapy drugs can cause a decrease in blood cells, especially WBCs and platelets.
- Many drugs are toxic to the liver, evidenced by increased levels of liver enzymes such as aspartate aminotransaminase (AST), also called serum glutamic-oxaloacetic transaminase (SGOT), and alkaline phosphatase (ALP) and lactate dehydrogenase (LDH), and decreased production of clotting factors.
- Opiates such as morphine increase levels of liver and pancreatic enzymes.
- Steroids and diuretics can cause pancreatitis and an increase in amylase and lipase values.
- Thiazide diuretics can elevate calcium and glucose levels and decrease sodium and potassium levels.

Drugs can also interfere in the actual test procedure, causing false increases or decreases in test results. A drug may compete with the test reagents for the substance being tested, causing a falsely low or false-negative result, or the drug may enhance the reaction, causing a falsely high or false-positive result.

An acronym for substances that interfere in the testing process is CRUD, which stands for “compounds reacting unfortunately as the desired.”

Although it is ultimately up to the physician to prevent or recognize and eliminate drug interferences, this can be a complicated issue that requires cooperation between the physician, pharmacy, and laboratory to make certain that test results are not affected by medications. Phlebotomists can play a role in this effort by noting on the requisition when they observe medication being administered just prior to blood collection.

According to CAP guidelines, drugs that interfere with blood tests should be stopped or avoided 4 to 24 hours prior to obtaining the blood sample for testing. Drugs that interfere with urine tests should be avoided for 48 to 72 hours prior to the urine sample collection.

**Exercise**

Exercise affects a number of blood components, raising levels of some and lowering levels of others. Effects vary, depending on the patient’s physical condition and the duration and
Chapter 9: Preanalytical Considerations

intensity of the activity. Levels typically return to normal soon after the activity is stopped. The following are examples of how exercise affects blood components:

• Arterial pH and PCO₂ levels are reduced by exercise.
• Glucose, creatinine, insulin, lactic acid, and protein can be elevated by moderate muscular activity.
• Skeletal muscle enzyme levels are increased by exercise, with levels of creatine kinase (CK) and LDH remaining elevated for 24 hours or more.
• Vigorous exercise shortly before blood collection can increase cholesterol levels by 6%.

Athletes generally have higher resting levels of skeletal muscle enzymes, and exercise produces less of an increase.

Fever

Fever affects the levels of a number of hormones. Fever-induced hypoglycemia increases insulin levels followed by a rise in glucagon levels. Fever also increases cortisol and may disrupt its normal diurnal variation.

Gender

A patient’s gender affects the concentration of a number of blood components. Most differences are apparent only after sexual maturity and are reflected in separate normal values for males and females. For example, RBC, Hgb, and Hct normal values are higher for males than for females.

Jaundice

Jaundice, also called icterus, is a condition characterized by increased bilirubin (a product of the breakdown of red blood cells) in the blood, leading to deposits of yellow bile pigment in the skin, mucous membranes, and sclera (whites of the eyes), giving the patient a yellow appearance. The term icteric means relating to or marked by jaundice and is used to describe serum, plasma, or urine specimens that have an abnormal deep yellow to yellow-brown color due to high bilirubin levels (see Fig. 9-1). The abnormal color can interfere in chemistry tests based on color reactions, including reagent strip analyses on urine.

Jaundice in a patient may indicate liver inflammation caused by hepatitis B or C virus.
Position

Body position before and during blood collection can influence specimen composition. Going from supine (lying down on the back) to an upright sitting or standing position causes blood fluids to filter into the tissues, decreasing plasma volume in an adult up to 10%. Only protein-free fluids can pass through the capillaries, consequently the blood concentration of components that are protein in nature or bound to protein, such as aldosterone, bilirubin, blood cells, calcium, cholesterol, iron, protein, and renin, increases. In most cases the concentration of freely diffusible blood components is not affected by postural changes. Nevertheless, a significant increase in potassium (K⁺) levels occurs within 30 minutes of standing that has been attributed to the release of intracellular potassium from muscle. Other examples of the effects of posture changes include:

- A change in position from lying to standing can cause up to a 15% variation in total and high-density lipoprotein (HDL) cholesterol results.

**Key Point** The National Cholesterol Education Program recommends that lipid profiles be collected in a consistent manner after the patient has been either lying or sitting quietly for a minimum of 5 minutes.

- Plasma aldosterone and renin change more slowly but can double within an hour. Consequently, patients are required to be recumbent (lying down) for at least 30 minutes prior to aldosterone specimen collection, and plasma renin-activity levels require documentation of the patient’s position during collection.
- The RBC count on a patient who has been standing for approximately 15 minutes will be higher than a basal state RBC count on the patient.

**Key Point** Calling outpatients into the drawing area and having them sit in the drawing chair while paperwork related to the draw is readied can help minimize effects of postural changes on some analytes.

Pregnancy

Pregnancy causes physiologic changes in many body systems. Consequently, results of a number of laboratory tests must be compared to normal ranges established for pregnant populations. For example, body fluid increases, which are normal during pregnancy, have a diluting effect on the red blood cells, leading to lower red blood counts.

Smoking

A number of blood components are affected by smoking. The extent of effects depends upon the number of cigarettes smoked. Patients who smoke prior to specimen collection
may have increased cholesterol, cortisol, glucose, and triglyceride levels and white blood counts. Chronic smoking often leads to decreased pulmonary function and increased red blood cell counts and hemoglobin levels. Smoking can also affect the body’s immune response, typically lowering the concentrations of immunoglobulins IgA, IgG, and IgM, but increasing levels of IgE.

### Stress

Emotional stress such as anxiety, fear, or trauma can cause transient (short-lived) elevations in white blood cells (WBCs). For example, studies of crying infants demonstrated marked increases in WBC counts, which returned to normal within 1 hour after crying stopped. Consequently, CBC or WBC specimens on an infant are ideally obtained after the infant has been sleeping or resting quietly for at least 30 minutes. If they are collected while an infant is crying, it should be noted on the report.

**fyi** Studies in psychoneuroimmunology (PNI), a field that deals with the interactions between the brain, the endocrine system, and the immune system, have demonstrated that receptors on the cell membrane of WBCs can sense stress in a person and react by increasing cell numbers.

Stress also causes decreases in serum iron and increases in adrenal hormones such as cortisol. Other hormones that can be affected include aldosterone, and thyroid-stimulating hormone (TSH) and growth hormone (GH) in children.

### Temperature and Humidity

Environmental factors such as temperature and humidity can affect test values by influencing the composition of body fluids. Acute heat exposure causes interstitial fluid to move into the blood vessels, increasing plasma volume and influencing its composition. Extensive sweating without fluid replacement, on the other hand, can cause hemoconcentration. Environmental factors associated with geographic location are accounted for when reference values are established.

**fyi** Temperature and humidity in the laboratory are closely monitored to maintain specimen integrity and to ensure proper functioning of equipment.
PROBLEM SITES

Burns, Scars, and Tattoos

Avoid burned, scarred, or tattooed areas. Veins are difficult to palpate or penetrate in these areas. Healed burn sites and other areas with extensive scarring may have impaired circulation and yield erroneous test results. Newly burned areas are painful and also susceptible to infection. Tattooed areas can have impaired circulation, may be more susceptible to infection, and contain dyes that can interfere in testing.

**key point** If you have no choice but to draw in an area with a tattoo, try to insert the needle in a site that does not contain dye.

Damaged Veins

Some patient’s veins feel hard and cordlike and lack resiliency because they are occluded or obstructed. These veins may be **sclerosed** (hardened) or **thrombosed** (clotted) from the effects of inflammation, disease, or chemotherapy drugs. Scarring caused by numerous venipunctures, as occurs in regular blood donors, persons with chronic illnesses, and illegal IV drug users, can also harden veins. Damaged veins are difficult to puncture; yield erroneous (invalid) test results because of impaired blood flow, and should be avoided.

**key point** Choose another site, if possible, otherwise draw below (distal to) damaged veins.

Edema

**Edema** is swelling caused by the abnormal accumulation of fluid in the tissues. It sometimes results when fluid from an IV infiltrates the surrounding tissues. Specimens collected from edematous areas may yield inaccurate test results due to contamination with tissue fluid or altered blood composition caused by the swelling. In addition, veins are harder to locate, the tissue is often fragile and easily injured by tourniquet and antiseptic application, and healing may be prolonged in these areas. Another site should be chosen, if possible.

**key point** Phlebotomists on early morning rounds in hospitals or nursing homes are often the first ones to notice edema from infiltrated IVs and should alert the appropriate personnel to the problem.
Mastectomy

Blood should never be drawn from an arm on the same side as a mastectomy (breast removal) without first consulting the patient’s physician. Lymph node removal, which is...

Hematoma

A hematoma (Fig. 9-2) is a swelling or mass of blood (often clotted) that can be caused by blood leaking from a blood vessel during or following venipuncture. A large bruise eventually spreads over the surrounding area. Venipuncture through an existing hematoma is painful and can result in collection of a specimen that is contaminated with hemolyzed blood from outside the vein and unsuitable for testing. Venipuncture in the area surrounding a hematoma may also be painful. In addition, obstruction of blood flow by the hematoma and the effects of the coagulation process may lead to inaccurate test results on the specimen.

**Caution** Never perform venipuncture through a hematoma. If there is no alternative site, perform the venipuncture distal to the hematoma to ensure the collection of free-flowing blood.

Mastectomy

Blood should never be drawn from an arm on the same side as a mastectomy (breast removal) without first consulting the patient’s physician. Lymph node removal, which is...
When a mastectomy has been performed on both sides, the patient’s physician should be consulted to determine a suitable site. Generally, the side of the most recent mastectomy is the one avoided.

**Key Point**

Obese patients often present a challenge to the phlebotomist. Veins on obese patients may be deep and difficult to find. Proper tourniquet selection and application is the first step to a successful venipuncture. Conventional latex tourniquets may be too short to fit around the arm without rolling and twisting. A long length of Penrose drain tubing or a long Velcro closure strap often works better than a latex or vinyl strap. A blood pressure cuff can also be used.

Check the antecubital area first. Obese patients often have a double crease in the antecubital area with an easily palpable median cubital vein between the two creases. If no vein is easily visible or palpable on tourniquet application, ask the patient what sites have been successful for past blood draws. Most patients who are “difficult draws” know what sites work best. If the patient has never been drawn before or does not remember, another site to try is the cephalic vein. To locate the cephalic vein, rotate the patient’s arm so that the hand is prone. In this position, the weight of excess tissue often pulls downward, making the cephalic vein easier to feel and penetrate with a needle.

**Vascular Access Devices (VADS) and Sites**

**Arterial Line**

An arterial line (A-line or Art-line) is a catheter that is placed in an artery. It is most commonly placed in a radial artery and is typically used to provide accurate and continuous measurement of a patient’s blood pressure. It may also be used to collect blood gas and other blood specimens and for the administration of drugs such as dopamine. Only specially trained personnel should access arterial lines. Never apply a tourniquet or perform venipuncture on an arm with an arterial line.

**Arteriovenous Shunt or Fistula**

An arteriovenous (AV) shunt, fistula, or graft (Fig. 9-3) is the permanent, surgical fusion of an artery and a vein that is typically created to provide access for dialysis. It is commonly located on the back of the arm above the wrist. The connection of the artery and vein
creates a loop close to the surface of the skin that can usually be easily seen and felt and is identified by a distinctive buzzing sensation called a “thrill” when palpated.

**Caution** Never apply a blood pressure cuff or tourniquet or perform venipuncture on an arm with a shunt.

### Heparin or Saline Lock

A **heparin** or **saline lock** (Fig. 9-4) is a catheter or cannula connected to a stopcock or a cap with a diaphragm (thin rubberlike cover) that provides access for administering medication or drawing blood. It is often placed in a vein in the lower arm above the wrist and can be left in place for up to 48 hours. To keep it from clotting, the device is flushed and filled with heparin or saline, respectively. A saline lock is sometimes flushed with heparin also. Heparin readily adheres to surfaces and to remove all traces is difficult. Consequently, a 5-mL discard tube should be drawn first when blood specimens are collected from either type of device. Drawing coagulation specimens from either type is not recommended because traces of heparin or dilution with saline can negatively affect test results. Only specially trained personnel should draw blood from heparin and saline locks.
Intravenous Sites

Intravenous (IV) means of, pertaining to, or within a vein. An intravenous line, referred to simply as an IV, is a catheter inserted in a vein to administer fluids. It is preferred that blood specimens not be drawn from an arm with an IV (Fig. 9-5) as they can be contaminated or diluted with the IV fluid, causing erroneous test results. This is especially true if the specimen is drawn above the IV. When a patient has an IV in one arm, blood specimens should be collected from the other arm. If a patient has IVs in both arms, or the other arm is also unavailable for some reason, it is preferred that the specimen be collected by capillary puncture. Many specimens (e.g., CBCs) can be easily collected this way. A specimen that cannot be collected by capillary puncture (e.g., a coagulation specimen) may be collected below the IV (never above) following the steps in Procedure 9-1.

Previously Active IV Sites

Previously active IV sites present a potential source of error in testing. Blood specimens should not be collected from a known previous IV site within 24 to 48 hours of the time the IV was discontinued. Follow facility protocol.

Central Vascular Access Devices (CVADs)

A central vascular access device (CVAD), also called an indwelling line, consists of tubing inserted into a main vein or artery. CVADs are used primarily for administering fluids and medications, monitoring pressures, and drawing blood. Having a CVAD is practical for
Only specially trained personnel should access CVADs to draw blood. However, the phlebotomist may assist by transferring the specimen to the appropriate tubes.

patients who need IV access for an extended time and is especially beneficial for patients who do not have easily accessible veins.

**Caution** Only specially trained personnel should access CVADs to draw blood. However, the phlebotomist may assist by transferring the specimen to the appropriate tubes.

Most CVADs are routinely flushed with heparin or saline to reduce risk of thrombosis. A small amount of blood must be drawn from the line and discarded before a blood specimen can be collected, to help ensure that it is not contaminated with the flush solution. The amount of blood discarded depends upon the dead space volume of the line. Two times the dead space volume is discarded for non-coagulation tests and six times (normally about 5
mL) is generally recommended for coagulation tests, although it is preferred that specimens for coagulation tests not be drawn from CVADs. Three main types of CVADs are described as follows:

- **Central venous catheter (CVC) or central venous line**: a line inserted into a large vein such as the subclavian and advanced into the superior vena cava, proximal to the right atrium. The exit end is surgically tunneled under the skin to a site several inches away in the chest. One or more short lengths of capped tubing protrude from the exit site, which is normally covered with a transparent dressing (see Fig. 9-6 for CVC placement). There are a number of different types of CVCs, including Broviac, Groshong, and Hickman (Fig. 9-7).

- **Implanted port** (Fig. 9-8): a small chamber attached to an indwelling line that is surgically implanted under the skin and most commonly located in the upper chest or arm. The device is located by palpating the skin, and accessed by inserting a special needle through the skin into the self-sealing septum (wall) of the chamber. The site is not normally covered with a bandage when not in use.

- **Peripherally inserted central catheter (PICC)** (Fig. 9-9): a line inserted into the peripheral venous system (veins of the extremities) and threaded into the central venous system (main veins leading to the heart). It does not require surgical insertion and is typically placed in an antecubital vein just above or below the antecubital fossa.
FIGURE 9-7

FIGURE 9-8
PATIENT COMPLICATIONS AND CONDITIONS

Allergies to Equipment and Supplies

Occasionally patients are encountered who are allergic to one or more of the supplies or equipment used in blood collection. Examples include the following.

ADHESIVE ALLERGY

Some patients are allergic to the glue used in adhesive bandages. Paper tape placed over a folded gauze square can be used instead, or the area can be wrapped with bandaging material such as Coban, which sticks to itself, eliminating the need for tape.

ANTISEPTIC ALLERGY

Occasionally, a patient is allergic to the antiseptic used in skin preparation prior to blood collection. (For example, increasing numbers of individuals are allergic to povidone-iodine.) Alternate antiseptics should be readily available for use in such cases.

LATEX ALLERGY

Increasing numbers of individuals are allergic to latex. Most latex allergies are seemingly minor and involve irritation or rashes from physical contact with latex products such as gloves. Others are so severe that being in the same room where latex materials are used can set off a life-threatening reaction. There should be a warning sign on the door to the room of any patient known to have a severe latex allergy, and it is vital that no items made of latex be brought into the room. This means the phlebotomist must wear nonlatex gloves, use a nonlatex tourniquet, and use nonlatex bandages when in the room, whether collecting blood from the patient or a roommate.
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**Excessive Bleeding**

Normally, a patient will stop bleeding from the venipuncture site within a few minutes. Some patients, particularly those on aspirin or anticoagulant therapy, may take longer to stop bleeding. Pressure must be maintained over the site until the bleeding stops. If the bleeding continues after 5 minutes, the appropriate personnel should be notified.

**Caution** Never apply a pressure bandage instead of maintaining pressure, and do not leave or dismiss a patient until bleeding has stopped or the appropriate personnel take charge of the situation.

**Fainting**

The medical term for fainting is *syncope* (sin’ko-pea), described as a loss of consciousness and postural tone that results from insufficient blood flow to the brain. It can last for as little as a few seconds or as long as half an hour.

**Memory Joggler** To remember that syncope means fainting, look for the word cope in syncope. If the body can’t cope, the patient faints.

Any patient has the potential to faint during or immediately following venipuncture. Some patients become faint at just the thought or sight of their blood being drawn, especially if they are ill or have been fasting for an extended period. Other contributing factors include anemia, dehydration, emotional problems, fatigue, hypoglycemia, medications, nausea, and poor ventilation. Sudden faintness or loss of consciousness due to a nervous system response to abrupt pain, stress, or trauma is called *vasovagal* (relating to vagus nerve action on blood vessels) *syncope*.

A patient who feels faint at the time or has a history of fainting should be asked to lie down for the procedure. Inpatients who typically are already lying down, rarely faint during blood draws. Outpatients are more likely to faint, because they are usually sitting up during venipuncture.

Blood collection personnel should routinely ask patients how they are doing during a draw, watch for signs of fainting, and be prepared to protect the patient from falling. Signs to watch for include pallor (paleness), perspiration, and hyperventilation, or an indication from the patient that he or she is experiencing vertigo (a sensation of spinning), dizziness, light-headedness, or nausea. See Procedure 9-2 for steps to follow if a patient complains of feeling faint or exhibits symptoms of fainting during venipuncture.

**Caution** The use of ammonia inhalants to revive patients can have unwanted side effects such as respiratory distress in asthmatic individuals and is not recommended (see CLSI H3-A5, 11.8.1).
PROCEDURE 9-2

Steps to Follow if a Patient Starts to Faint During Venipuncture

Purpose: To properly handle a patient who feels faint or shows symptoms of fainting during a blood draw

Equipment: NA

<table>
<thead>
<tr>
<th>Step</th>
<th>Explanation/Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Release the tourniquet and remove and discard the needle as quickly as possible</td>
<td>Discontinuing the draw and discarding the needle protects the phlebotomist and the patient from injury should the patient faint</td>
</tr>
<tr>
<td>2. Apply pressure to the site while having the patient lower the head and breathe deeply</td>
<td>Pressure must be applied to prevent bleeding and bruising. Lowering the head and breathing deeply helps get oxygenated blood to the brain</td>
</tr>
<tr>
<td>3. Talk to the patient</td>
<td>Diverts patient's attention, helps keep the patient alert, and aids in assessing the patient's responsiveness</td>
</tr>
<tr>
<td>4. Physically support the patient</td>
<td>Prevents injury in case of collapse</td>
</tr>
<tr>
<td>5. Ask permission and explain what you are doing if it is necessary to loosen a tight collar or tie</td>
<td>Avoids misinterpretation of actions that are standard protocol to hasten recovery</td>
</tr>
<tr>
<td>6. Apply a cold compress or washcloth to the forehead and back of the neck</td>
<td>Part of the standard of care</td>
</tr>
<tr>
<td>7. Have someone stay with the patient until recovery is complete</td>
<td>Prevents patient from getting up too soon and possibly causing self-injury</td>
</tr>
<tr>
<td>8. Call first aid personnel if the patient does not respond</td>
<td>Emergency medicine is not in the phlebotomist's scope of practice</td>
</tr>
<tr>
<td>9. Document the incident according to facility protocol</td>
<td>Legal issues could arise, and further documentation is essential at that time</td>
</tr>
</tbody>
</table>

When a patient who has fainted regains consciousness, he or she must remain in the area for at least 15 minutes. The patient should be instructed not to operate a vehicle for at least 30 minutes. It is important for the phlebotomist to document the incident (following institution policy) in case of future litigation.

Nausea and Vomiting

It is not unusual to have a patient experience nausea before, during, or after a blood draw. A blood draw should not be attempted until the experience subsides.

Key point: If the patient vomits during venipuncture the procedure must be terminated immediately.
The patient should be reassured and made as comfortable as possible. A feeling of nausea often precedes vomiting, so it is a good idea to give the patient an emesis basin or wastebasket to hold as a precaution. Ask the patient to breathe slowly and deeply. Apply a cold, damp washcloth or other cold compress to the patient's forehead. If the patient vomits, provide tissues or a washcloth to wipe the face and water to rinse the mouth unless the patient is NPO for surgery, other procedures, or otherwise not allowed to have water. Notify the patient's nurse, physician, or appropriate first aid personnel.

Pain
A small amount of pain is normally associated with routine venipuncture and capillary puncture. Putting patients at ease before blood collection helps them relax and can make the procedure less painful. Warning the patient prior to needle insertion helps avoid a startle reflex. A stinging sensation can be avoided by allowing the alcohol to dry completely prior to needle insertion.

Excessive, deep, blind, or lateral redirection of the needle is considered probing. It can be very painful to the patient; risks injury to arteries, nerves, and other tissues; and should never be attempted.

Marked or extreme pain, numbness of the arm, a burning or electric shock sensation, or pain that radiates up or down the arm during a venipuncture attempt indicates nerve involvement and requires immediate removal of the needle. If pain persists after needle removal, the patient’s physician or other appropriate personnel should be consulted, and the incident documented. Application of an ice pack to the site after needle removal can help prevent or reduce inflammation associated with nerve involvement. Follow your healthcare facility’s protocol.

If marked or extreme pain occurs, or the patient asks you to remove the needle for any reason, the venipuncture should be terminated immediately, even if there are no other signs of nerve injury.

Petechiae
Petechiae (Fig. 9-10) are tiny, nonraised red spots that appear on the patient’s skin when a tourniquet is applied. The spots are minute drops of blood that escape the capillaries and come to the surface of the skin below the tourniquet, most commonly as a result of capillary wall defects or platelet abnormalities. They are not an indication that the phlebotomist has used incorrect procedure. However, they are an indication that the venipuncture site may bleed excessively.

Seizures/Convulsion
In the rare event that a patient has a seizure or goes into convulsions during blood specimen collection, it is important to discontinue the draw immediately. Hold pressure over the
site without overly restricting the patient's movement. Do not attempt to put anything into
the patient's mouth. Try to prevent the patient from self-injury without completely re-
stricting movement of the extremities. Notify the appropriate first aid personnel.

**PROCEDURAL ERROR RISKS**

**Hematoma Formation**

Hematoma formation is the most common complication of venipuncture. It is caused by
blood leaking into the tissues during or following venipuncture and is identified by rapid
swelling at or near the venipuncture site. (See Box 9-1 for situations that can trigger
hematoma formation.) A hematoma is painful to the patient, often results in unsightly
bruising, and can cause compression injuries to nerves and lead to lawsuits. Continuing to
draw blood while a hematoma is forming risks injury to the patient and collection of a spec-
imen contaminated with hematoma blood that has mixed with tissue fluids from outside the
vein. Such a specimen has a high probability of being hemolyzed and rejected for testing.
Even if it is not hemolyzed, it can still produce inaccurate test results. Presence of a
hematoma makes the site unacceptable for subsequent venipunctures. (See Hematoma un-
der Problem Sites, page 334).
Chapter 9: Preanalytical Considerations

If a hematoma forms during blood collection, the phlebotomist should discontinue the draw immediately and hold pressure over the site for a minimum of 2 minutes. A small amount of blood under the skin is relatively harmless and generally resolves on its own. If the hematoma is large and causes swelling and discomfort, the patient should be offered a cold compress or ice pack to relieve pain and reduce swelling. Follow facility protocol.

**BOX • 9-1 Situations That Can Trigger Hematoma Formation**

- The vein is fragile or too small for the needle size.
- The needle penetrates all the way through the vein.
- The needle is only partly inserted into the vein.
- Excessive or blind probing is used to locate the vein.
- The needle is removed while the tourniquet is still on.
- Pressure is not adequately applied following venipuncture.

If a hematoma forms during blood collection, the phlebotomist should discontinue the draw immediately and hold pressure over the site for a minimum of 2 minutes. A small amount of blood under the skin is relatively harmless and generally resolves on its own. If the hematoma is large and causes swelling and discomfort, the patient should be offered a cold compress or ice pack to relieve pain and reduce swelling. Follow facility protocol.

**fyi** Acetaminophen or ibuprofen can help relieve discomfort from a hematoma. Ice applied in the first 24 hours helps manage the swelling and discomfort. After 24 hours, application of heat or warm moist compresses can help reabsorb accumulated blood.

**Iatrogenic Anemia**

Iatrogenic is an adjective used to describe an adverse condition brought on by the effects of treatment. Blood loss as a result of blood removed for testing is called iatrogenic blood loss. Removing blood on a regular basis or in large quantities can lead to iatrogenic anemia in some patients, especially infants.

**fyi** A primary reason for blood transfusion in neonatal ICU patients is to replace iatrogenic blood loss.

Blood loss to a point where life cannot be sustained is called exsanguination. Life is threatened if more than 10% of a patient’s blood volume is removed at one time or over a short period of time. Coordination with physicians to minimize the number of times a patient is drawn, following quality assurance procedures to minimize redraws, and collecting minimum required specimen volumes, especially from infants, help reduce iatrogenic blood loss.
Inadvertent Arterial Puncture

Inadvertent arterial puncture is rare when proper venipuncture procedures are followed. It is most often associated with deep or blind probing, especially in the area of the basilic vein, which is in close proximity to the brachial artery. (This is one reason why the basilic vein is the last choice for venipuncture.) If an inadvertent arterial puncture goes undetected, leakage and accumulation of blood in the area can result in compression injury to a nearby nerve. Such injuries are often permanent and can lead to lawsuits. Arterial blood can usually be recognized by its bright red color, if the patient’s pulmonary function is normal, or the fact that it spurts or pulses into the tube. If accidental arterial puncture is suspected, it is important for the phlebotomist to hold pressure over the site for a full 5 minutes after the needle is removed. Arterial puncture should not be used as a substitute for venipuncture, except in rare instances and with the approval of the patient’s physician.

**key point**
Inadvertently collected arterial blood can usually be submitted for testing, rather than redrawing the patient. However, the specimen must be identified as arterial, since some test values are different for arterial specimens. Consult laboratory protocol.

Infection

Although a rare occurrence, infection at the site following venipuncture does happen. The risk of infection can be minimized by use of proper aseptic technique:

- Do not open adhesive tape or bandages ahead of time or temporarily tape them to lab coat cuffs or other contaminated items.
- Do not preload needles onto tube holders to have a supply for many draws ready ahead of time. The sterility of the needle is breached once the seal is broken.
- Do not touch the site with your finger, gauze, or any other nonsterile object after it has been cleaned, before or during needle insertion.
- Try to minimize the time between removing the needle cap and performing the venipuncture.
- Remind the patient to keep the bandage on for at least 15 minutes after specimen collection.

Nerve Injury

Poor site or improper vein selection, inserting the needle too deeply or quickly, movement by the patient as the needle is inserted, excessive or lateral redirection of the needle, or blind probing while attempting venipuncture can lead to injury of a main nerve (such as the median cutaneous), the risk of permanent damage, and the possibility of a lawsuit. Follow national guidelines for site selection, vein selection, and venipuncture technique to minimize the risk of problems. If initial needle insertion does not result in successful vein entry,
and slight forward or backward redirection of the needle does not result in blood flow, the needle should be removed, and venipuncture attempted at an alternate site, preferably on the opposite arm.

**Caution**

Extreme pain, a burning or electric shock sensation, numbness of the arm, and pain that radiates up or down the arm, are all signs of nerve involvement, and any one of them requires immediate removal of the needle. Application of an ice pack to the site after needle removal can help prevent or reduce inflammation associated with nerve involvement.

### Reflux of Anticoagulant

In rare instances, it is possible for blood to **reflux** (backflow) into the patient’s vein from the collection tube during the venipuncture procedure. Some patients have had adverse reactions to tube additives, particularly EDTA, attributed to reflux. Reflux can occur when the contents of the collection tube are in contact with the needle while the specimen is being drawn. To prevent reflux the patient’s arm must be kept in a downward position so that the collection tube remains below the venipuncture site and fills from the bottom up. This prevents the needle from contacting blood in the tube. Back-and-forth movement of blood in the tube should also be avoided until the tube is removed from the evacuated tube holder. An outpatient can be asked to lean forward and extend the arm downward over the arm of the drawing chair to achieve proper positioning. Raising the head of the bed, extending the patient’s arm over the side of the bed, or supporting the arm with a rolled towel can be used to help achieve proper positioning of a bedridden patient.

### Vein Damage

Properly performed, an occasional venipuncture will not impair the patency of a patient’s vein. Numerous venipunctures in the same area over an extended period of time, however, will eventually cause a buildup of scar tissue and increase the difficulty of performing subsequent venipunctures. Blind probing and improper technique when redirecting the needle can also damage veins and impair patency.

### SPECIMEN QUALITY CONCERNS

The quality of a blood specimen can be compromised by improper collection techniques. A poor-quality specimen will generally yield poor-quality results that can affect the patient’s care. Because it is not always apparent to the phlebotomist or testing personnel when the quality of a specimen has been compromised, it is very important for the phlebotomist to be aware of the following pitfalls of collection.
Hemoconcentration from Venous Stasis

Tourniquet application causes localized venous stasis, or stagnation of the normal venous blood flow. (A similar term for this is venostasis, the trapping of blood in an extremity by compression of veins.) In response, some of the plasma and filterable components of the blood pass through the capillary walls into the tissues. This results in hemoconcentration, a decrease in the fluid content of the blood with a subsequent increase in nonfilterable large molecule or protein-based blood components such as red blood cells. Other abnormally increased analytes include albumin, ammonia, calcium, cholesterol, coagulation factors, enzymes, iron, potassium, and total protein. Changes that occur within 1 minute of tourniquet application are slight; however, prolonged tourniquet application can lead to marked changes.

**key point**

Cholesterol levels can increase up to 5% after 2 minutes of tourniquet application, and up to 15% after 5 minutes.

Massaging or squeezing the site, probing for veins, long-term IV therapy, drawing blood from sclerosed or occluded veins, and vigorous hand pumping (making and releasing a fist), can also result in the collection of specimens affected by hemoconcentration.

**fyi**

Vigorous fist pumping can significantly increase blood potassium levels.

Test results on hemoconcentrated specimens may not accurately reflect the patient’s true status, and it is important that steps be taken to avoid them. A list of ways to prevent hemoconcentration during venipuncture is presented in Box 9-2.

**BOX • 9-2  Ways to Help Prevent Hemoconcentration During Venipuncture**

- Ask the patient to release the fist upon blood flow.
- Choose an appropriate patent vein.
- Do not allow the patient to pump the fist.
- Do not excessively massage the area when locating a vein.
- Do not probe or redirect the needle multiple times in search of a vein.
- Release the tourniquet within 1 minute.
Hemolysis

Hemolysis results when RBCs are damaged or destroyed and the hemoglobin they contain escapes into the fluid portion of the specimen. The red color of the hemoglobin makes the serum or plasma appear pink (slight hemolysis), dark pink to light red (moderate hemolysis), to red (gross hemolysis), and the specimen is described as being “hemolyzed” (Fig. 9-11). Hemolyzed specimens can be the result of patient conditions such as hemolytic anemia, liver disease, or a transfusion reaction, but they are more commonly the result of procedural errors in specimen collection or handling that damages the RBCs. Hemolysis can erroneously elevate levels of analytes such as enzymes, iron, magnesium, and potassium (K⁺) and decrease red blood cell counts. Consequently, a specimen that is hemolyzed as a result of procedural error will most likely need to be redrawn. Box 9-3 lists procedural errors that can cause hemolysis.

Partially Filled Tubes

ETS tubes should be filled until the normal amount of vacuum is exhausted. Failing to do so results in a partially filled tube (Fig. 9-12) referred to as a short draw. Short draw serum tubes such as red tops and SSTs are generally acceptable for testing as long as the specimen is not hemolyzed and there is sufficient specimen to perform the test. Underfilled anticoagulant tubes and most other additive tubes, however, may not contain the proper blood-to-additive ratio for which the tube was designed.
BOX • 9-3 Procedural Errors That Can Cause Specimen Hemolysis

- Drawing blood from a vein that has a hematoma
- Failure to wipe away the first drop of blood (that may contain alcohol residue) during capillary puncture
- Forcing the blood from a syringe into an evacuated tube
- Frothing of the blood caused by improper fit of the needle on a syringe
- Mixing additive tubes too vigorously such as shaking them or inverting them too quickly or forcefully
- Partially filling a normal draw sodium fluoride tube
- Pulling back the plunger on a syringe too quickly
- Rough handling during transport, or horizontal transportation that allows back-and-forth movement of tube contents
- Squeezing the site during capillary specimen collection
- Using a needle with a too-small diameter for venipuncture
- Using a too-large tube with a small-diameter butterfly needle

FIGURE 9-12
Two examples of under-filled light-blue-top tubes.
Although in some cases underfilled additive tubes may be accepted for testing, the specimens can be compromised. For example:

- Excess EDTA in underfilled lavender-top tubes can shrink red blood cells and cause erroneously low blood cell counts and hematocrits.
- Excess heparin in plasma from underfilled green-top tubes may interfere with testing of some chemistry analytes.
- Excess sodium fluoride in underfilled gray-top tubes can result in hemolysis of the specimen.
- Underfilled coagulation tubes do not have the correct blood-to-additive ratio and will produce erroneous results.

Inadvertent (unintentional) short draws are usually the result of difficult draw situations in which blood flow stops or vacuum is lost during needle manipulation. Phlebotomists sometimes underfill tubes on purpose when it is inadvisable to obtain larger quantities of blood, such as when drawing from infants, children, or severely anemic individuals.

Partial vacuum tubes the same size as standard fill tubes but designed to contain a smaller volume of blood are available and should be used in situations where it is difficult or inadvisable to obtain larger amounts. These tubes are sometimes referred to as “short draw” tubes (Fig. 9-13), but they are designed to contain the proper blood-to-additive ratio even though they contain less blood. A line on the tube is typically used to indicate the fill level.

**FIGURE 9-13**
“Short draw” tube designed for partial filling. Line on tube indicates proper fill level.
Specimen Contamination

Specimen contamination is typically inadvertent and generally the result of improper technique or carelessness such as:

- Allowing alcohol residue, fingerprints, glove powder, baby powder, or urine from wet diapers to contaminate newborn screening samples, leading to specimen rejection.
- Getting glove powder on blood films (slides) or in capillary specimens, resulting in misinterpretation of results. Calcium-containing powders can affect calcium results.
- Unwittingly dripping perspiration into capillary specimens during collection or any specimen during processing or testing. The salt in sweat, for example, can affect sodium and chloride levels.
- Using the correct antiseptic but not following proper procedure. For example, improperly cleaning blood culture bottle tops or the collection site, touching the site after it has been prepped (cleaned), or inserting the needle before the antiseptic on the arm or bottle tops is dry. (Traces of the antiseptic in the culture media can inhibit growth of bacteria and cause false-negative results.) Performing capillary puncture before the alcohol is dry causing hemolysis of the specimen and leading to inaccurate results or rejection of the specimen by the lab.
- Using the wrong antiseptic to clean the site prior to specimen collection. For example, using alcohol to clean the site can contaminate an ethanol (blood alcohol) specimen. Using povidone-iodine (e.g., Betadine) to clean a skin puncture site can contaminate the specimen and cause erroneously high levels of uric acid, phosphate, and potassium.

TROUBLESHOOTING FAILED VENIPUNCTURE

Failure to initially draw blood can be caused by a number of procedural errors. Being aware of these errors and knowing how to correct them may determine whether you obtain blood on the first try or have to repeat the procedure. If you fail to obtain blood, remain calm so that you can clearly analyze the situation and check the following:

Tube Position

Tube position is important. Check the tube to see that it is properly seated and the needle in the tube holder has penetrated the tube stopper. Reseat the tube to make certain the needle sleeve is not pushing the tube off the needle.

Tube Vacuum

Loss of tube vacuum can occur during venipuncture procedures if the needle bevel is not completely under the skin or the bevel backs out of the skin slightly. When this happens a short hissing sound is often heard, and there may be a spurt of blood into the tube before the blood flow stops. Tubes can also lose vacuum during shipping and handling, when they bump one another in trays, if they are dropped, or if they are pushed too far onto the needle prior to venipuncture. If you suspect that a tube has lost its vacuum, try a new one.
Needle Position

Improper needle position is a common cause of failure to obtain blood. A seasoned phlebotomist uses visual cues to help determine if the needle is correctly positioned in the vein (Fig. 9-14A). Try first to visually determine if any of the following common

**Figure 9-14**

Proper and improper needle positioning. **A.** Correct needle insertion technique; blood flows freely into tube. **B.** Bevel on vein upper wall prevents blood flow. **C.** Bevel on vein lower wall prevents blood flow. **D.** Needle inserted too far penetrates through the vein. **E.** Partially inserted needle causes blood leakage into tissue. **F.** Needle slipped beside the vein, not into it; caused when a vein rolls to the side. **G.** Collapsed vein prevents blood flow.
problems with needle position or insertion have occurred. Some are harder to discern than others. Eliminate the ones that you can and try the remedy for the others to see if one works.

**BEVEL AGAINST THE VEIN WALL**

Blood flow can be impaired if the needle bevel is up against the upper or lower wall of the vein (Fig. 9-14B and C). This can happen if the needle angle is wrong. For example, an angle that is too shallow can cause the needle to contact the upper wall; an angle that is too steep can cause the needle to embed in the lower wall. This can also happen if the needle is inserted near a bend in the vein or at a point where the vein goes deeper into the skin. All of these situations are very hard to detect. Remove the tube from the holder needle to release vacuum pull on the vein, and pull the needle back slightly. (Rotating the bevel slightly may also help.) Advance the tube back onto the needle. If blood flow is established, the problem most likely was an issue with the bevel and the vein wall.

**C A U T I O N**

Tube vacuum may hold the vein wall against the needle bevel. Do not rotate the bevel of the needle without first removing the tube and pulling the needle back slightly or the vein may be injured.

**NEEDLE TOO DEEP**

The needle may have gone in too deeply and penetrated all the way through the vein (Fig. 9-14D). This can happen on needle insertion, especially if the needle angle is too steep, or as a tube is pushed onto the needle if the tube holder is not held steady. If this is the case, withdrawing the needle slightly should establish blood flow. If the needle position is not corrected quickly, blood will leak into the tissues and form a hematoma.

**C A U T I O N**

Continuing the draw while a hematoma is forming increases the risk of injury to the patient and collection of blood from outside the vein that is contaminated with tissue fluids and very likely to be hemolyzed.

**NEEDLE NOT DEEP ENOUGH**

If the needle is only partly through the vein wall (Fig. 9-14E), blood may fill the tube very slowly. Correct blood flow should be established by gently pushing the needle forward into the vein. Partial needle insertion can also cause blood to leak into the tissue and form a hematoma. If this occurs, discontinue the draw immediately and hold pressure over the site.
Needle Beside the Vein

Veins are fairly tough and if a vein is not anchored well with the thumb, it may roll (move away) slightly and the needle may slip to the side of the vein instead of into it (Fig. 9-14F). Often the needle ends up beside the vein and slightly under it as well. (This is often the case with the basilic vein, which is not well anchored in the tissue to begin with.) If this happens, slip the tube off the needle to preserve the vacuum, withdraw the needle slightly until just the bevel is under the skin, anchor the vein securely, and redirect the needle into the vein. If redirection is unsuccessful, discontinue the draw and choose a new site. Do not search or probe for the vein or move the needle in a lateral (sideways) direction to find it.

When phlebotomists “miss” veins, they often tell patients that they have “veins that roll.” This leads patients to mistakenly believe that there is a problem with their veins, when more than likely the problem is the phlebotomist’s technique.

Undetermined Needle Position

If you cannot determine the position of the needle and the above solutions do not help, you may have to use your finger to relocate the vein. Remove the tube from the holder needle and withdraw the needle until the bevel is just under the skin. Clean your gloved finger with alcohol and palpate the arm above the point of needle insertion to try to determine needle position and vein location. Be careful not to feel too close to the needle, as this is painful to the patient. Once you have relocated the vein, pull the skin taut, and redirect the needle into it. If you cannot relocate the vein, (or if access to it would require lateral redirection of the needle) discontinue the draw and select a new site.

Caution: Do not blindly probe the arm in an attempt to locate a vein. Probing is painful to the patient and can damage nerves or lead to inadvertent puncture of an artery.

Collapsed Vein

Sometimes the vacuum draw of a tube or the pressure created by pulling on a syringe plunger can be too much for a vein, causing it to collapse temporarily (Fig. 9-14G) and blood flow to cease. A vein may also collapse if the tourniquet is tied too tightly or too close to the venipuncture site. In this case, blood cannot be replaced as quickly as it is withdrawn and the vein collapses. In addition, veins sometimes collapse when the tourniquet is removed during the blood draw. This is often the case in elderly patients whose veins are fragile and collapse more easily.
A clue that a normally visible vein has collapsed is that it disappears as soon as the vacuum tube is engaged or when the tourniquet is removed. To reintroduce tourniquet pressure, grasp the ends of the loose tourniquet with one hand and twist them together. That may be enough to reestablish blood flow. If the tourniquet cannot be retightened, use your finger to apply pressure to the vein several inches above the needle. Remove the tube from the needle and wait a few seconds for the blood flow to reestablish before reengaging it. Try using a smaller-volume tube or pull more slowly on the plunger if using a syringe. If the blood flow does not reestablish, remove the needle and attempt a second venipuncture at another site.

Stoppage of blood flow upon tourniquet removal does not necessarily mean that the vein has collapsed. It may be that the needle is no longer positioned properly and a slight adjustment is needed to reestablish blood flow.
1. Peak levels of this analyte typically occur at about 0800.
   a. Bilirubin  c. Eosinophil
   b. Cortisol  d. Glucose

2. Which of these tests are most affected if the patient is not fasting?
   a. CBC and protime  c. RA and cardiac enzymes
   b. Glucose and triglycerides  d. Blood culture and thyroid profile

3. Veins that feel hard and cordlike when palpated may be
   a. Collapsed  c. Thrombosed
   b. Fistulas  d. Venules

4. Tiny red spots that appear on a patient’s arm when the tourniquet is applied are a sign that the
   a. Patient is allergic to latex  c. Site may bleed excessively
   b. Patient is anemic  d. Tourniquet is too tight

5. When the arm of the patient is swollen with excess fluids, the condition is called
   a. Edema  c. Icterus
   b. Hemoconcentration  d. Syncope

6. A patient has several short lengths of IV style tubing protruding from his chest. This is most likely a/an
   a. A-line  c. Implanted port
   b. CVC  d. PICC

7. Which of the following is most likely to cause reflux during venipuncture?
   a. Allowing the tube to fill from c. Releasing the tourniquet as soon as
      the stopper end first  blood flows freely into the tube
   b. Lateral redirection of the needle  d. Using the wrong order of draw

8. A patient complains of extreme pain when you insert the needle during a
   venipuncture attempt. The pain does not subside, but the patient does not feel any numbness or burning sensation. You know the needle is in the vein because the blood is flowing into the tube. You only have two tubes to fill, and the first one is almost full. What should you do?
   a. Ask the patient if he or she wants you to continue the draw
   b. Discontinue the draw and attempt collection at another site
   c. Distract the patient with small talk and continue the draw
   d. Tell the patient to hang in there as you only have one tube left
9. Which of the following situations can result in hemoconcentration?
   a. Leaving the tourniquet on longer than a minute
   b. Mixing the specimen too vigorously
   c. Partially filling a normal draw tube
   d. Using a needle that is too small for size of the tube

10. You are in the process of collecting a specimen by venipuncture. You hear a hissing sound, there is a spurt of blood into the tube, and blood flow stops. What has most likely happened?
   a. Reflux has occurred
   b. The needle has gone through the back of the vein
   c. The tube has lost its vacuum
   d. The vein has collapsed

CASE STUDY 9-1

Physiological Variables, Problem Sites, and Patient Complications

Charles is a phlebotomist who works in a physician’s office laboratory. One morning shortly after the drawing station opens he is asked to collect blood specimens for a CBC and a glucose test from a very heavyset woman who appears quite ill. The patient tells Charles that she vomited all night and was unable to eat or drink anything. She also mentions that she has had a mastectomy on the left side and the last time she had blood collected she was stuck numerous times before the phlebotomist was able to successfully collect the specimen.

QUESTIONS:
1. What physiologic variables may be associated with the collection of this specimen and how should they be dealt with?
2. What complications might Charles expect and how should he prepare for them?
3. How should Charles go about selecting the blood collection site?
4. What options does Charles have if he is unable to select a proper venipuncture site?
A phlebotomist named Sara is in the process of collecting a protime and CBC from a patient. The needle is in the patient’s vein. As Sara pushes the first tube onto the needle in the tube holder there is a spurt of blood into the tube and she hears a hissing sound. Then the blood stops flowing. She repositions the needle but is not able to establish blood flow.

**QUESTIONS:**
1. Why did blood spurt into the tube and then stop?
2. What clues are there to determine what the problem is?
3. What can Sara do to correct the problem?