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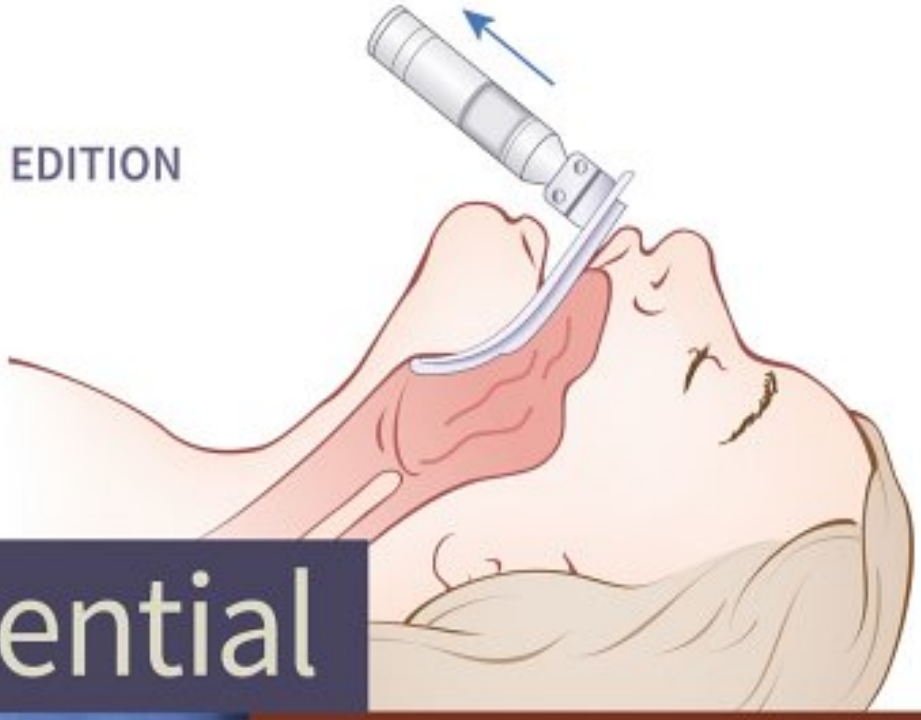
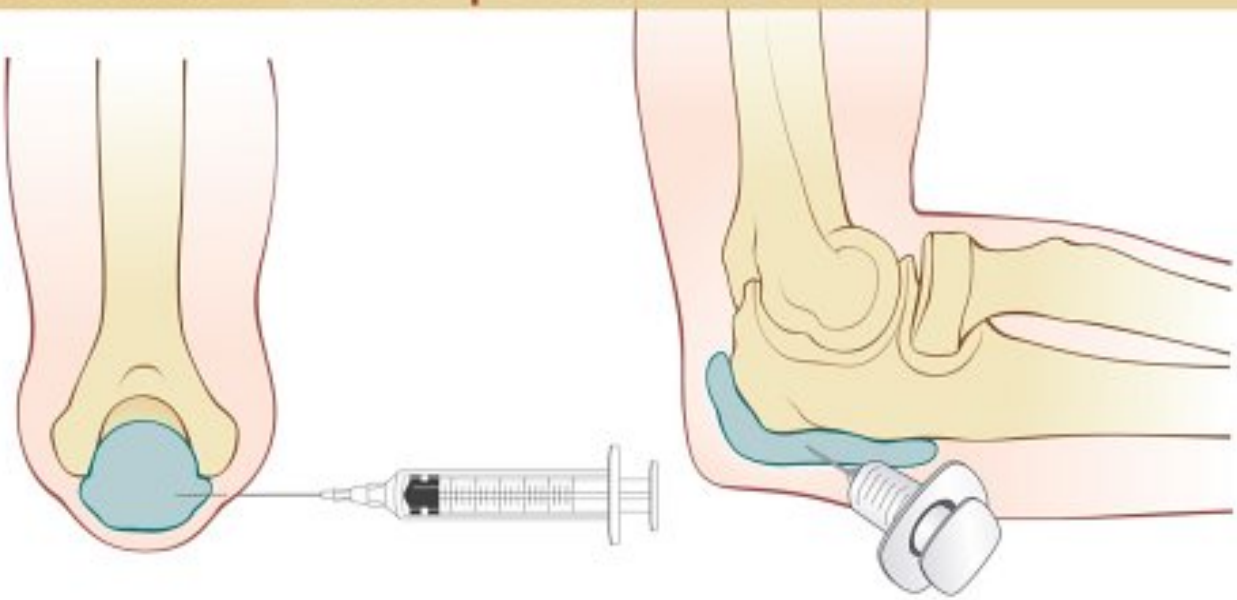


Essential CLINICAL PROCEDURES

RICHARD DEHN | DAVID ASPREY



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Essential Clinical Procedures

FOURTH EDITION

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Dedication

AS I APPROACH THE FINAL YEARS OF MY MORE THAN FOUR-DECADE CAREER AS A PHYSICIAN assistant and as a health professions educator, I would like to dedicate this edition to the physicians, PAs, NPs, and health professions students and graduates that I have had the priviledge of working with. Without the inspiration derived from their dedication to serving their current and future patients, it is unlikely this project would have been envisioned, let alone completed.

—RWD

AS AN EDITOR OF THIS TEXT, I AM INDEBTED TO THE MANY AUTHORS WHO HAVE WORKED diligently to prepare the content, thank you! Rick, this adventure we started many years ago as a fledgling idea has flourished into an amazing fourth-edition textbook. Thanks for partnering with me on this journey, you have been a great mentor, friend, and colleague. To the learners who utilize this book, I wish you every success as you prepare to practice the art and science of medicine. To my wife Jill and my children Laura, Nolan, and Caleb, thank you for supporting me in each of my endeavors.

—DPA

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Preface

IN WRITING THIS BOOK REGARDING COMMON CLINICAL PROCEDURES FOR MEDICAL PRACTITIONERS, WE HOPE TO FILL A UNIQUE NEED FOR AN AREA OF CLINICAL PRACTICE that is vital to clinical education and the practice of medicine. In attempting to accomplish this goal, we have turned to our colleagues who are involved in clinical education, as either core faculty or clinical preceptors, who are very knowledgable of the clinical procedure skills that clinical practice requires. Although we recognize that this textbook does not cover every procedure that clinicians may be asked to perform in practice, it does address a majority of the commonly occurring clinical procedures, and most were selected based on data that support the frequency with which physician assistants (PAs) and nurse practitioners (NPs) perform these procedures in primary care settings.

We are forever indebted to the hundreds of bright, caring, compassionate, and pioneering women and men who make up the PA and NP professions. Those who pioneered these professions ventured there with little assurance that they would have a job or a career, much less a dependable income. Yet they have made these professions into some of the most rewarding professions in existence today. Their vision, dedication, endurance, ingenuity, and concern for the best interest of their patients continue to be a motivating force for both of us as health professions educators.

We would also like to recognize the hundreds of colleagues with whom we share both the role and title of PA educator. These individuals often give up freely the opportunity for the greater income and greater control of their schedule that can often be found in clinical practice to help prepare the next generation of PAs. We

find the dedication and commitment of PA educators to their profession truly inspiring.

We also owe a great debt of gratitude to our students. Without their eager thirst for information and knowledge, we would find our responsibility to teach them clinical procedures to be simply another job. However, their passion and excitement about learning clinical procedures for the purpose of taking care of their future patients make this task a true pleasure.

Finally, we would like to acknowledge our publisher for its commitment to making educational materials such as this available to clinicians. Specifically, we would like to thank Shirley Kuhn for pursuing the idea of this book with us and encouraging us to take the leap of faith necessary to publish the first edition. We would also like to thank Rolla Couchman for his help in preparing the second edition. We would like to thank Julie Mirra and Joanie Milnes for help in preparing the third edition. And finally, we would like to thank Kim Benson and Lee Henderson for their support in preparing this fourth edition.

Videos

SEE THE VIDEOS CHAPTER IN THE *ESSENTIAL CLINICAL PROCEDURES* EBOOK AT WWW.EXPERTCONSULT.COM

We are pleased to provide a number of procedure videos alongside this book. These videos were not created by the authors, and consequently they might not demonstrate the exact same process outlined in the chapters; however, they can serve as a highly useful resource to help learners visualize the performance of select procedures.

Anoscopy
Arterial Blood Gas Sampling
General Splinting Techniques
Short-Arm Splint
Short-Leg Splint
Long-Arm Splint
Long-Leg Splint
Sugar Tong Splint
Thumb Spica Splint
Ulnar Gutter Splint
Cryosurgery
Wart Treatment
Excisional Biopsy (Dermatologic Procedures)
Punch Biopsy
Shave Biopsy
Endometrial Biopsy
Orotracheal Intubation
Epistaxis Management
Incision and Drainage of an Abscess
Intravenous Cannulation

Arthrocentesis: Knee (Joint and Bursal Aspiration)
Arthrocentesis: Elbow
Local Anesthesia
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Pap Smear
Urethral Catheterization Male
Urethral Catheterization Female
Phlebotomy (Venipuncture)
Laceration Repair: Simple Interrupted Sutures (Wound Closure)
Stapling Devices

CHAPTER 1

Anoscopy

Sue M. Nyberg

Ronda J. Hanneman

Abstract

Anoscopy is a common procedure performed in the outpatient setting to further evaluate patient complaint of rectal pain, bleeding, discharge, or pruritis. It may also be appropriate as a next step when a mass is detected during digital rectal examination.

Keywords

anorectal
anoscope
anus
bleeding
pain
rectum

Procedure Goals and Objectives

GOAL: To examine the anus and rectum thoroughly, with minimal discomfort to the patient, and obtain accurate information while maintaining patient modesty.
OBJECTIVES: The student will be able to:

- Describe the indications, contraindications, and rationale for performing anoscopy.
- Identify and describe potential complications associated with performing anoscopy.
- Describe the essential anatomy and physiology associated with the performance of anoscopy.
- Describe how to perform a digital rectal examination.
- Identify the materials necessary for performing anoscopy and their proper use.
- Properly perform an anoscopy.

Background and History

Anorectal disorders are a common source of discomfort for many patients, and adequate visualization of the anorectal canal is important for appropriate diagnosis and treatment of these conditions. Anoscopy is a relatively simple procedure to perform, but adequate patient education and clinical skill are required to reduce the patient's anxiety and embarrassment about the procedure. This procedure is performed in ambulatory, emergency, and inpatient settings.

Indications

Indications for performing anoscopy include, but are not limited to, the evaluation of the following:

- Rectal bleeding
- Anorectal pain
- Pruritus
- Anal discharge
- Mass detected in the rectal vault on digital examination
- Consider adding removal of foreign body and treatment of internal hemorrhoids

Therapeutic procedures may be performed along with routine anoscopy and include biopsy of suspicious lesions, removal of foreign bodies, and collection of a specimen for culture.

Contraindications

Relatively few contraindications to the procedure exist; however, in the following situations, further patient education or referral to a specialist may be necessary if the examination is indicated:

- Presence of severe rectal pain
- Anoscopic examination in patients with perirectal abscess, acutely thrombosed hemorrhoid, or acute anal fissure (possible severe discomfort); in the case of anal fissure, possible bleeding
- Patient unwilling to have the procedure performed
- Patient not able to cooperate appropriately so that an adequate examination can be performed
- Presence of imperforate anus or severe anal stricture
- Recent anorectal surgery

Potential Complications

Bleeding is rare but may occur with an anal tear or in the presence of internal hemorrhoids; usually responds to conservative measures unless a coagulation defect is present.

Essential Anatomy and Physiology

Understanding the anatomy of the anus and surrounding tissues facilitates accurate diagnosis and treatment of anorectal disorders. Careful visual inspection of the perianal region may reveal evidence of hemorrhoids, skin tags, fissures, dermatitis, abscesses, fistulous openings, or lesions. A thorough digital examination before anoscopy should be done to evaluate the competency of the external anal sphincter and assess for palpable lesions.

The rectum is the distal 10- to 12-cm portion of the alimentary tract continuous proximally with the sigmoid colon and distally with the anal canal (Fig. 1.1). The rectum ends anteroinferior to the tip of the coccyx by turning sharply posteroinferiorly (the anorectal flexure) as it perforates the pelvic diaphragm (levator ani) to become the anal canal. The most distal point of the anal canal is the anal verge. The anal verge, the dentate line, and the anorectal ring are the three main anatomic points of reference.

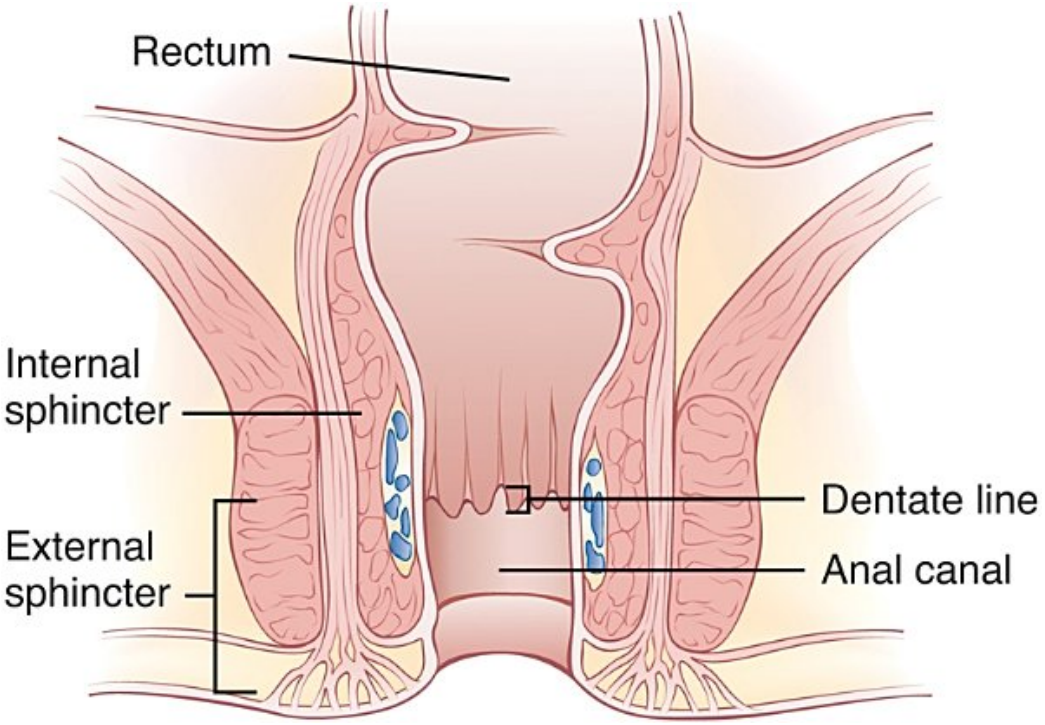

FIGURE 1.1 **Anatomy of the rectum.**

- The anal verge, the external boundary of the anal canal, is the junction between the anal and perianal skin.
- The dentate line, the cephalad border of the anatomic anal canal, is a true mucocutaneous junction. Squamous epithelium is located distal to the dentate line, and columnar epithelium is located proximal to the dentate line in the rectum. At this junction is a circular ring of glands that secrete mucus to lubricate the anal canal. The dentate line lies approximately 1 to 2 cm above the anal verge.
- The anorectal ring, 1 to 2 cm above the dentate line, is the upper border of the anal sphincteric complex and is easily palpable during digital examination.

The superior rectal artery, the continuation of the inferior mesenteric artery, supplies the proximal portion of the rectum. The two middle rectal arteries, usually arising from the inferior iliac arteries, supply the middle and inferior portions of the rectum. The inferior rectal arteries, arising from the internal pudendal arteries, supply the anorectal sphincter muscles and anal canal. It is important to remember that the internal hemorrhoidal plexus arises above the dentate line and that the external hemorrhoidal plexus arises below the dentate line.

Both sympathetic and parasympathetic nerves innervate the rectum. The external sphincter (a voluntary skeletal muscle) and the levator ani muscles are innervated by the inferior rectal branch of the internal pudendal nerve (S2, S3, S4), as well as by fibers from the fourth sacral nerve. The internal sphincter (an involuntary muscle approximately 2.5 cm in length) is innervated by both sympathetic and parasympathetic nerves. It is generally accepted that either an intact functional external sphincter or an anorectal ring (puborectalis muscle that encircles the very distal rectum) can provide nearly perfect anal continence. The internal sphincter plays little part in maintaining voluntary anal continence.

Standard Precautions

Every practitioner should use standard precautions at all times when interacting with patients, especially when performing procedures. Determining the level of precaution necessary requires the practitioner to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

Patient Preparation

The only patient preparation needed is adequate education about the purpose of the examination and the technique to be used. Many patients have a degree of anxiety about undergoing the examination and should be reassured that they will be appropriately draped. Although the procedure may be slightly uncomfortable and may cause an urge to defecate, it should not be painful (unless predisposing conditions are present). No bowel preparation is usually necessary.

Materials

- Anoscope: The anoscope is a cylindrical instrument with a removable obturator, made of clear polyethylene or reusable metal (Fig. 1.2). Some anoscopes have their own attached light source; if not, another external light source must be used.
- Water-soluble lubricant
- Disposable gloves
- Light source (directed or worn on the head)
- Appropriate culture swabs (when indicated)
- Ferric subsulfate 20% solution or silver nitrate stick for cautery
- Large-tipped cotton swabs

FIGURE 1.2 **A slotted anoscope (with obturator in place).**

Procedure

Anoscopy

Position

Place the patient in a lateral decubitus or dorsal lithotomy position with appropriate draping.

Inspection

1. Know the anatomy of the anus and surrounding tissues to facilitate accurate diagnosis and treatment of anorectal disorders.
2. Make a careful visual inspection of the perianal region to reveal any evidence of fissures, dermatitis, abscesses, fistulous openings, or lesions.
3. Ask the patient to bear down during inspection; this may reveal prolapsing hemorrhoids.

Digital Rectal Examination

A thorough digital examination should be performed before anoscopy.

4. With a gloved, lubricated finger, gently press on the anal verge and ask the patient to relax. This should allow the finger to enter the anal canal.
5. The examiner should then evaluate the competency of the external anal sphincter by asking the patient to simulate interrupting a bowel movement.
6. After the patient relaxes, the examiner should also assess the rectal canal for any palpable lesions or masses. Finally, the prostate gland should be assessed in the male patient. The examiner should rotate the finger a full 360 degrees to ensure that all rectal structures are fully evaluated.
7. Generally, internal hemorrhoids and the dentate line are not palpable.
8. Any stool present on the examining finger may be examined for occult blood; however, this single test alone should not be used as a screening test for colorectal neoplasia.[1]

Anoscopy

Anoscopy is an important next step after digital rectal examination to investigate rectal bleeding or other signs or symptoms of anorectal disease.

1. After lubricating the anoscope, gently spread the patient's buttocks and gently insert the **anoscope (with obturator in place)** into the anal canal. Slowly advance the anoscope until the flange at the base rests on the perianal skin.

2. Any fecal material encountered may be removed with a large swab.
3. Remove the obturator and inspect the mucosa of the perianal canal thoroughly for suspected pathology. Opaque devices should be rotated to the right and to the left (with obturator in place) for full visualization of the anal canal. A slotted anoscope should not be rotated (causes discomfort) and must be reinserted four times so that each quadrant can be fully examined.[2]
4. If a biopsy is necessary, one of a variety of long-handled biopsy instruments may be used.
5. Control any bleeding with direct pressure and if needed, a solution of ferric subsulfate 20% or silver nitrate.[2]
6. Slowly remove the anoscope with obturator in place.

> The obturator of the anoscope should always be in place when rotating the anoscope during the examination.

Follow-Up Care and Instructions

Examination findings should be discussed thoroughly with the patient. Complications are rare with this procedure, and follow-up care should be based on the treatment of any condition found during the examination. The patient should be instructed to notify the provider if significant, unexpected bleeding or pain occurs after the procedure.

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CHAPTER 2

Arterial Puncture

Claire O'Connell

Abstract

Arterial puncture is indicated whenever a sample of arterial blood is required. Unlike in venous blood, the level of dissolved gases in an arterial sample is constant throughout the arterial system. Arterial blood is preferred whenever an assessment of the level of dissolved gases is needed for diagnostic or therapeutic purposes.

Keywords

arterial access
arterial blood gas
ultrasound-guided vascular access

Procedure Goals and Objectives

GOAL: To obtain a high-quality sample of arterial blood while observing standard precautions and with a minimal degree of risk to the patient.
OBJECTIVES: The student will be able to:

- Describe the indications, contraindications, and rationale for performing an arterial puncture.
- Identify and describe common complications associated with arterial punctures.
- Describe how to perform an Allen test.
- Describe the essential anatomy and physiology associated with the performance of an arterial puncture.
- Identify the materials necessary for performing an arterial puncture and their proper use.
- Properly perform the actions necessary to collect an arterial sample of blood.
- Identify the important aspects of postprocedure care after an arterial puncture.

Background and History

Gaining intentional access to the circulatory system has been practiced for centuries. As discussed in Chapter 31, at approximately 400 BC, Hippocrates expressed the view that disease was a result of excess substances such as blood, phlegm, black bile, and yellow bile within the body. Resulting from this view was the belief that the removal of the excess could restore balance. Bloodletting, which involved cutting into a vein with a sharp instrument to release blood from the circulatory system, was commonplace.

Accessing the arterial system specifically is a relatively recent procedure. The first recorded arterial puncture was performed in 1912, and the first arterial sample used for blood gas analysis was obtained in 1919. However, routine blood gas analysis was not practiced until after 1953, with the introduction of technology designed to measure oxygen pressure.[1]

Indications

Arterial puncture is indicated whenever a sample of arterial blood is required. Unlike in venous blood, the level of dissolved gases in an arterial sample is constant throughout the arterial system. Therefore a sample obtained from any arterial site represents the true level of gases dissolved in the blood within the arterial system and provides a more accurate assessment of ventilation and oxygenation. Arterial blood is preferred whenever an assessment of the level of dissolved gases is needed for diagnostic or therapeutic purposes. The following conditions may necessitate arterial sampling:

- Diagnosis of an acute dysfunction in carbon dioxide/oxygen exchange or acid–base balance: Conditions include severe exacerbations in carbon dioxide/oxygen exchange of asthma, suspected pulmonary thromboembolism, coma of unknown cause, suspected drug overdose, shock states, and cardiac arrhythmias refractory to medical intervention.
- Monitoring the severity and progression of a documented disease process in patients with a chronic condition that affects carbon dioxide/oxygen exchange or acid–base balance: Progressive chronic obstructive pulmonary disease may be monitored through changes from baseline arterial blood gas values. Patients receiving long-term oxygen therapy should be monitored when changes in status occur and periodically to document status.
- Monitoring a return to baseline or the need for further intervention: After therapeutic hyperventilation therapy or cardiopulmonary resuscitation, arterial blood gas determinations assist with the need to quantify the patient's response to therapeutic interventions.

Procurement of an arterial sample may be preferred for a specific laboratory test that offers the most accurate assessment when performed on arterial blood. An arterial blood sample is preferable to a venous blood sample when assessing ammonia levels, carbon monoxide levels, and lactate levels. Other laboratory tests can be performed using an arterial sample when venous access cannot be

readily obtained, such as in emergency situations of severe hypovolemia.

Contraindications

The contraindications in arterial blood sampling are as follows:

- Arterial puncture for blood sampling is absolutely contraindicated when the arterial pulse is not palpable.
- For the radial artery, negative results of a modified Allen test (collateral circulation test) suggest an inadequate collateral blood supply to the hand, and an alternative arterial site should be selected. To perform the Allen test (Fig. 2.1), have the patient make a tight fist and elevate the hand; occlude both the radial and ulnar arteries using firm pressure for approximately 1 minute until the hand appears blanched. Lower the hand while maintaining pressure and instruct the patient to open the fist. Release only the ulnar compression while maintaining the radial artery pressure. Color should return to the entire hand within 15 seconds (positive test). Failure of color to return to normal indicates occlusion of the collateral circulation (negative test); radial artery puncture in this setting may result in ischemia and gangrene distal to the site and should not be attempted.
- Attempting an arterial puncture when surface landmarks are not visible is not recommended.
- Arterial puncture is inadvisable in the presence of arterial disease, including atherosclerosis, arterial inflammatory conditions, and known or suspected aneurysm.
- The higher pressure inherent in the arterial system makes arterial puncture a considerably higher risk in a patient with a coagulopathy, with severe thrombocytopenia, or undergoing anticoagulant therapy. A possible future need for such therapy also should be considered.
- Arterial puncture should be avoided in a patient undergoing therapy for end-stage renal disease who has an

arteriovenous shunt or may need placement in the near future.

- Sites exhibiting local skin irritations, including infections (e.g., cellulitis), chronic skin rashes, and burned areas, should be avoided. If these conditions are present in the site desired for arterial puncture, an alternative site should be selected.

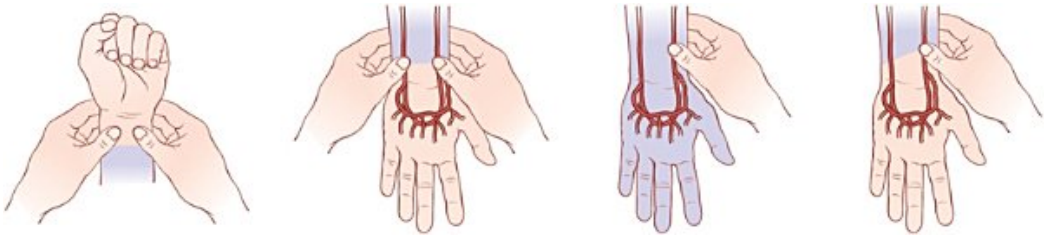

FIGURE 2.1 Modified Allen test. (Redrawn from Pfenninger JL, Fowler GC, eds. *Procedures for Primary Care Physicians.* St. Louis: Mosby–Year Book; 1994, p. 343.)

Potential Complications

Arterial puncture is an invasive procedure with the potential for significant complications and must be performed with priority given to the safety of the patient. Any break from the proper safety technique can cause injury to the patient, which may result in loss of form and function to the body distal to the arterial puncture site. The risk for complications is increased when repeated punctures are attempted at the same site.

- The most common complication is hemorrhage or **hematoma** formation at the puncture site. This occurs more often in brachial and femoral punctures than in radial punctures. Using the smallest-gauge needle acceptable for the task helps decrease the risk for hemorrhage or hematoma formation. Hematoma development can best be minimized by prompt pressure placed on the puncture site continuously for 10 minutes after the procedure is complete.

Hematoma formation can best be prevented by ensuring prompt pressure is applied to the site continuously for a minimum of 10 minutes.

- Thrombosis is more common at the radial artery than at the brachial or femoral artery. It is more likely if the arterial puncture is performed on a vessel with occlusive disease. Thrombosis may lead to ischemia and gangrene distal to the puncture. Thrombosis also may lead to distal embolization of a clot or plaque, with resultant arterial occlusion. The potential for loss of function of the hand or fingers is considerable if arterial embolism occurs and is not quickly recognized and treated. The likelihood of thrombosis can be reduced by varying the site of repeated puncture and using the smallest gauge needle possible. It is imperative to check for collateral circulation (Allen test) before a radial puncture.
- A transient arterial spasm may occur during or after arterial puncture. If this occurs, continue to monitor and assess the collateral circulation. If the circulation remains impaired, vascular consultation should be obtained. If the collateral circulation is compromised, immediate surgical intervention is warranted.
- Nerve damage may result from inadvertent direct needle insertion into the nerve bundle or by excessive nerve compression secondary to a large hematoma in the adjacent area. If the patient has a coagulopathy that delays clotting, the risk is increased.
- Infection is rare when proper technique is followed. Proper **sterile technique** and avoidance of broken or damaged skin when choosing the site for arterial puncture minimize this risk.

Ensure standard precautions are always observed when performing this procedure (see Chapter 35).

Standard precautions

Practitioners should use standard precautions at all times when interacting with patients. Determining the level of precaution necessary requires the practitioner to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

Essential Anatomy and Physiology

Radial Artery

The radial artery is the site most frequently used for arterial puncture. It is close to the skin surface and readily accessible. It also carries the lowest risk for complications. The radial artery runs along the lateral aspect of the anterior forearm and can be easily palpated between the styloid process of the radius and the flexor carpi radialis tendon. The point of maximal pulsation is just proximal (1 to 2 cm) to the transverse wrist crease.

Before attempting radial artery puncture, check for collateral circulation by performing the Allen test. The distal forearm and wrist should be slightly hyperextended and placed on a firm surface. A small, rolled towel placed under the wrist helps achieve hyperextension. The forearm, wrist, and towel can be secured to an arm board with tape for greater stability if necessary.

Brachial Artery

The brachial artery can be accessed if the radial artery has recently been punctured or is otherwise not available (Fig. 2.2). It carries a greater risk for complication, including trauma to the basilic vein or median nerve. If occlusive complications occur, there is greater potential for tissue loss distal to the artery because the collateral circulation is less extensive. The brachial artery courses along the medial surface of the antecubital fossa and should be accessed above the antecubital crease. The arm should be fully extended and secured to a firm surface, ulnar side up.

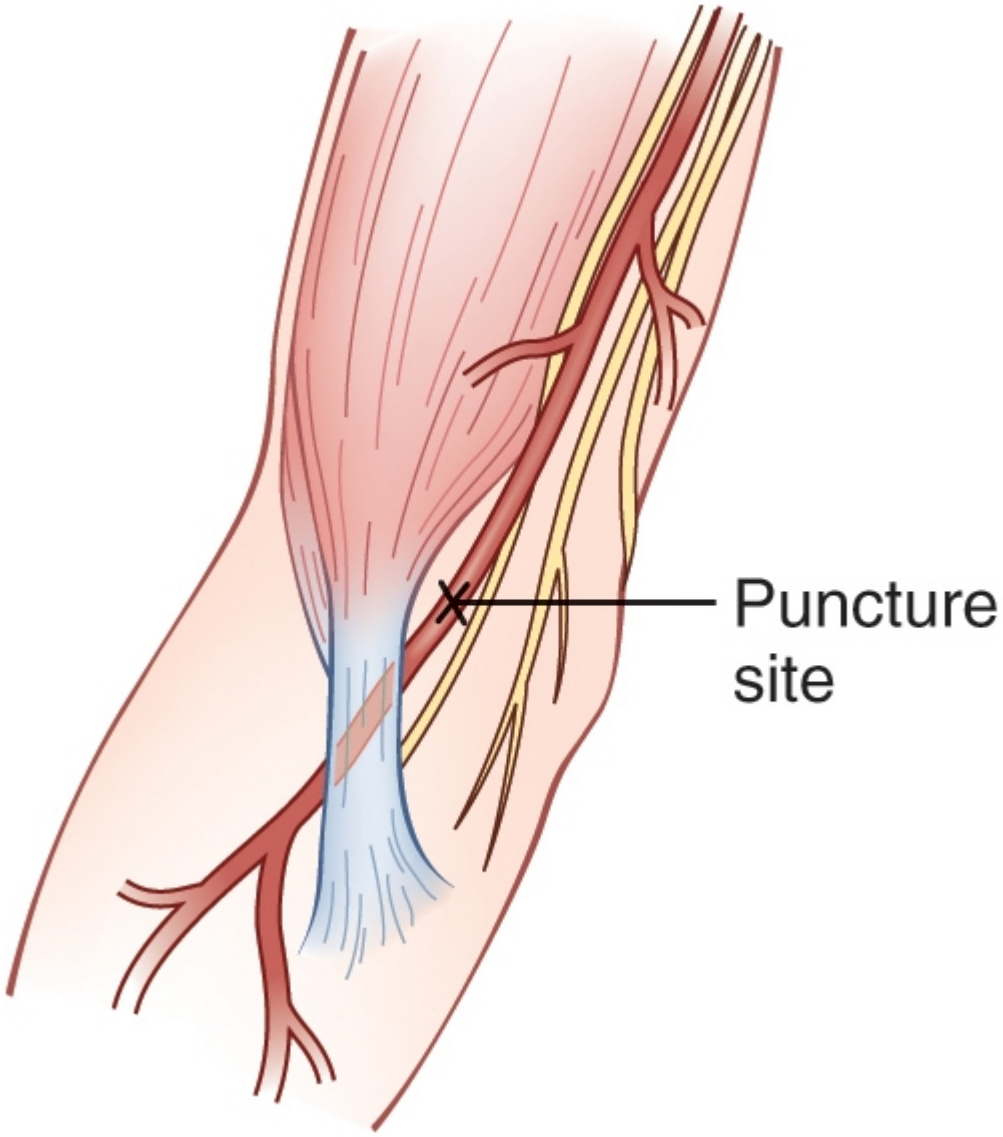

FIGURE 2.2 The right brachial artery, its branches, and the anatomic site for brachial artery puncture. (Redrawn from Pfenninger JL, Fowler GC, eds. *Procedures for Primary Care Physicians.* St. Louis: Mosby–Year Book, 1994, p. 345.)

Femoral Artery

The femoral artery should be punctured only if radial or brachial artery access is not possible or advisable (Fig. 2.3). If the patient is severely volume depleted or in shock, the femoral artery may be the only pulse with enough pressure to obtain arterial blood. The femoral artery can be located using the mnemonic NAVEL (***n***erve,

artery, ***v***ein, ***e***mpty space, ***l***ymphatics) from lateral to medial in the inguinal crease. The patient should be supine on a firm surface with the hip extended and rotated externally.

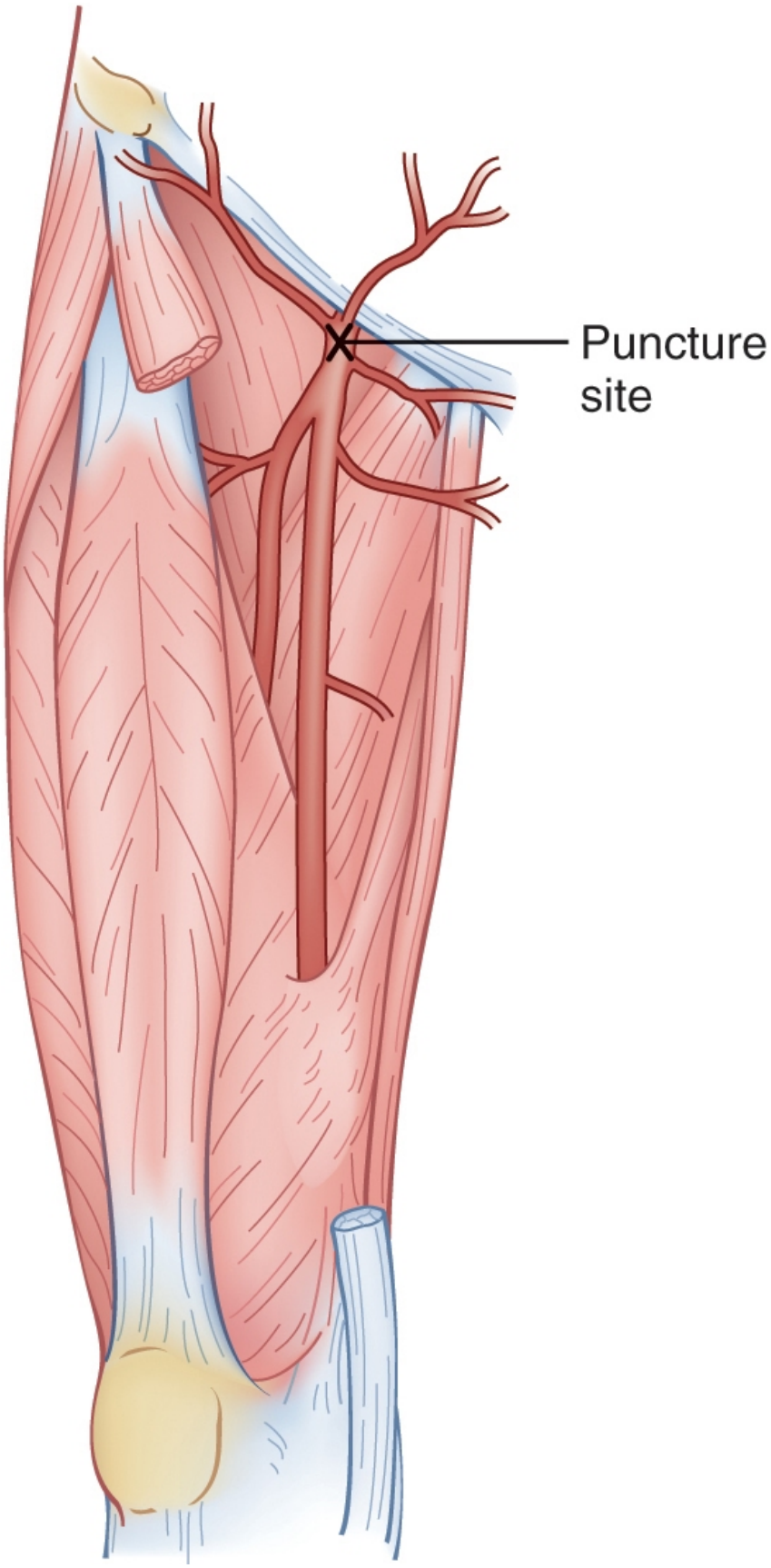
Puncture
site

FIGURE 2.3 The right femoral artery and branches. (Redrawn from Pfenninger JL, Fowler GC, eds. *Procedures for Primary Care Physicians.* St. Louis: Mosby–Year Book; 1994, p 345.)

The preferred site for arterial puncture is the radial artery unless circumstances require another site be used.

Patient Preparation

- The patient should be educated concerning the purpose of the test and advised of the potential level of discomfort and complications associated with performing the procedure.
- If consent forms are available, consent should be obtained.
- It is important that the patient remain as still as possible during the procedure; a supine position is recommended.
- If oxygen therapy is adjusted or suction has been performed, wait at least 15 minutes before sampling to allow gas levels to stabilize.

Materials

- 3- to 5-mL glass or special heparinized syringe made for arterial blood gas collection. **NOTE:** If not available, use plastic syringe and heparinize (see later).
- 21- to 25-gauge, ½- to ⅝-inch needle
- Bag or cup of ice for transport
- Iodine-containing skin preparation pads
- Cork board or rubber for needle safety
- Rubber stopper or plug for syringe
- Sterile gloves (two pairs)
- 2 × 2 inch or 4 × 4 inch sterile gauze

Procedure

Arterial Puncture

1. Secure and stabilize the site by placing the patient's supinated arm on the arm board and securing with tape. Prepare a sterile field and gather all equipment.
2. Put on sterile gloves.
3. Cleanse skin with an iodine solution (e.g., povidone-iodine [Betadine], iodophor).

NOTE: Some practitioners prefer to follow this with an alcohol cleansing. Allow the area to air dry.

4. Coat the syringe and needle with heparin; use a plain plastic syringe if a preheparinized syringe is not available. Heparinize by aspirating 0.5 mL heparin, 10,000 U/mL, and pulling the plunger to the end of the syringe while holding the syringe and needle vertically. Slowly push back on the plunger to evacuate the heparin. The syringe and needle are now adequately coated with heparin. Heparinization of the syringe is necessary to prevent coagulation of the sample.

Local Anesthesia

NOTE: Traditionally, arterial puncture has been performed without the use of local anesthesia. Several studies have proved that a significant decrease in pain occurs when local anesthesia is administered before arterial puncture. Concerns that local anesthesia inhibits proper placement by obliterating landmarks have been unfounded. The use of local anesthesia does make arterial puncture a "two-stick" procedure rather than a "one-stick" procedure. However, the intensity of the pain associated with arterial puncture may support the use of the less painful stick required with local anesthesia.

NOTE: Use a small amount (1 to 2 mL) of lidocaine without epinephrine to anesthetize the local area. Overzealous anesthesia may obscure landmarks or dull the pulse.

5. Anesthetize the area. Advance the needle to just above the periosteum on each side of the artery without entering or

making direct contact with the artery. Aspiration should be attempted before injecting the anesthetic to ensure that the anesthetic is injected into the surrounding tissues and not a blood vessel.

NOTE: Allow several minutes for the anesthetic to take effect before performing the arterial puncture. (For more information regarding local anesthesia techniques, refer to Chapter 16.)

6. Palpate the artery with the nondominant hand and locate the point of maximal pulsation. Alternatively, use ultrasound guidance to access the vessel (Box 2.1).

Box 2.1 Ultrasound-guided Vascular Access

Ultrasound-guided vascular access provides more precise placement into the correct vessel by relying on visual cues rather than palpation of anatomic landmarks. With proper training and experience, ultrasound-guided access leads to greater success in less time with reduced rates of complications including hematoma, pseudoaneurysm, and vascular dissection. The properly trained and experienced ultrasound operator must have good hand-eye coordination and manual dexterity as well as knowledge and skills regarding 3D ultrasound technique. Ultrasound imaging done using the transverse (or short) axis allows greater visualization of adjacent structures, but with only the tip of the needle; imaging done using the longitudinal (or long) axis provides visualization of the entire needle as well as better depth perception.

7. Face the patient. Hold the syringe like a dart or a pencil with the bevel facing proximally.
8. Insert the needle at a 40- to 60-degree angle (60- to 90-degree angle for femoral puncture) (Fig. 2.4).
9. Advance the needle until blood is seen entering the hub.
10. If no blood is seen, pull back until the needle is just below the skin and redirect the point 1 mm to either side. If the

patient complains of sharp pain radiating up the arm, withdraw slightly and reposition. Do not exit completely.
11. Once blood enters the hub of the needle, the arterial pressure should cause blood to fill the syringe spontaneously.
12. In severely hypotensive patients, slight aspiration may be required, but this is rarely necessary.
13. Collect 3 to 5 mL of blood and then remove the needle with a swift, smooth motion.
14. Immediately apply firm, continuous pressure to the area for a minimum of 10 minutes, longer if the patient is hypertensive or is receiving anticoagulant therapy. Pressure should be applied even if no sample is obtained (Fig. 2.5). Apply a pressure dressing and leave intact for the next several hours.

It is not advisable to have the patient apply the pressure; an assistant is recommended.

15. Hold the syringe and needle upright and allow any air bubbles to rise; tapping gently on the side of the syringe may help. Expel any air from the syringe.
16. Insert the needle into a cork or rubber piece for safety; remove the needle from the syringe, dispose of it properly, and close the syringe with a rubber stopper.
17. Gently roll the syringe between your palms to ensure uniform mixing of the sample with the heparin.
18. Label the syringe and place it on ice for immediate transport to the laboratory.
19. Check the arterial puncture site for hematoma formation and adequate distal perfusion.
20. Return to the patient for a repeat check in 5 minutes and again in 15 minutes. Monitor for any changes in color, temperature, vascular incompetency, or function. Inquire if the patient has experienced any numbness, increased pain, or coldness.
21. Record date and time of sampling, patient temperature, and whether the patient is on oxygen therapy at the time of

sampling.

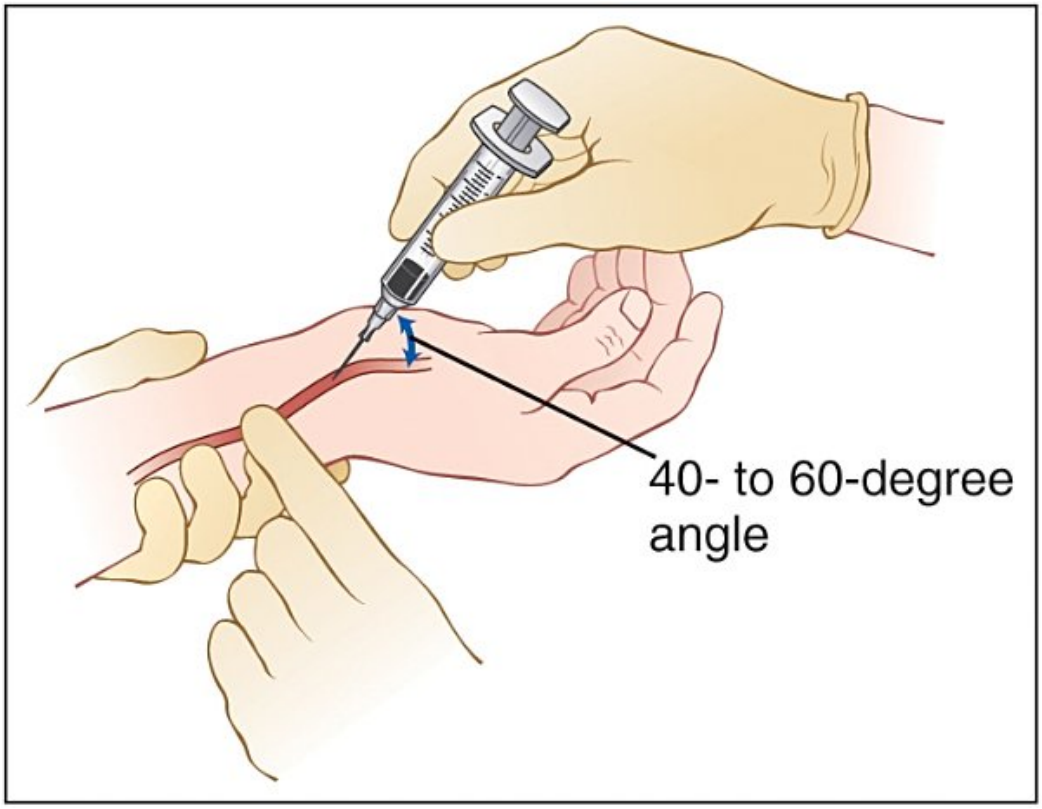

FIGURE 2.4 **Needle insertion.** (Redrawn from Pfenninger JL, Fowler GC, eds. *Procedures for Primary Care Physicians.* St. Louis: Mosby–Year Book; 1994, p. 345.)

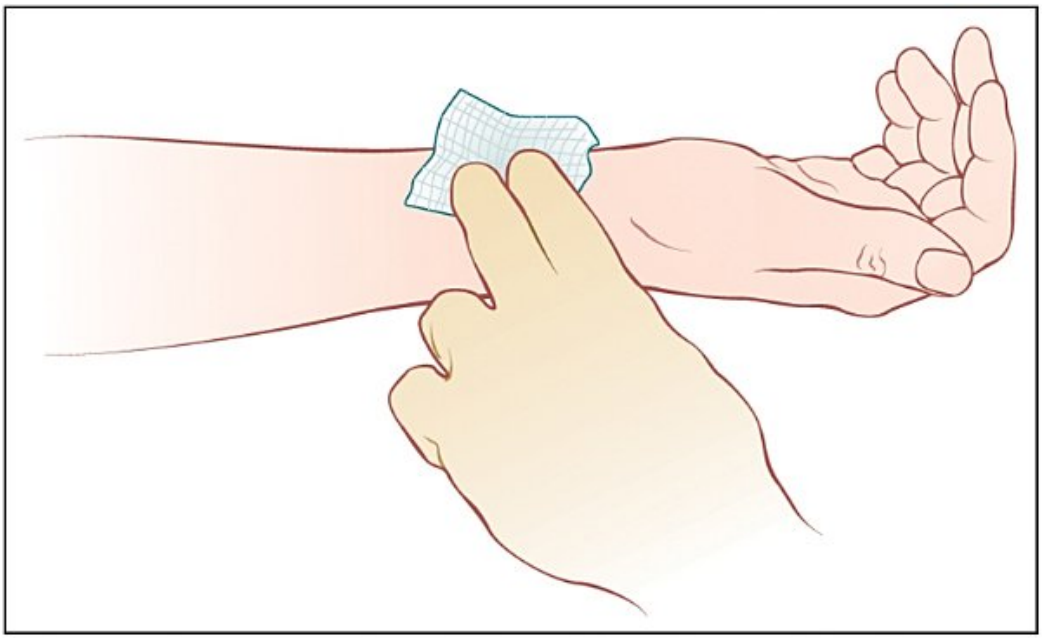

FIGURE 2.5 Application of pressure. (Redrawn from Potter PA, Perry AG. *Fundamentals of Nursing, ed 4.* St. Louis: Mosby–Year Book; 1997.)

- Arm board
- Tape (½ to 1 inch)
- Goggles
- 1:1000 lidocaine without epinephrine (1 to 2 mL)
- Syringe and needle for local anesthesia

Special Considerations

- Prompt analysis of the sample is imperative. Delay in analysis or improper chilling causes the blood to dissociate from the hemoglobin, thus affecting oxygen levels.
- If air is trapped in the syringe, an open system exists, which may cause oxygen to be dissolved into the sample, causing a relative decrease in PCO_2 and an increase in PO_2. The use of a Vacutainer system also allows oxygen to enter the sample. A plain plastic syringe may lose oxygen through diffusion.

- In the presence of leukocytosis (> 100,000/mm^3) or thrombocytosis (> 106/mm^3), consumption of oxygen may be great because of the breakdown of the excess cells. This is accompanied by a release of carbon dioxide, causing pseudoacidosis. A delay in analysis or improper chilling enhances this effect. The PCO_2 rises approximately 3 to 10 mm Hg/hour in an uniced specimen, but it is stable for approximately 1 to 2 hours in a properly iced specimen.
- Excess heparin in the syringe causes a decrease in pH. This is owing to the low pH of heparin and the dilutional effects on the bicarbonate present in the sample.

Follow-Up Care and Instructions

- Patients who have undergone this procedure must be monitored to ensure that hemostasis has been achieved.
- Advise the patient that a small amount of tenderness and ecchymosis may result from the procedure.
- Advise the patient to seek evaluation if increasing pain, redness, or coolness of the extremity distal to the arterial puncture site occurs.
- Patients should avoid rigorous activity for at least 24 hours.

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CHAPTER 3

Blood Pressure Measurement

Randy D. Danielsen

Abstract

This chapter provides a discussion of how to measure the systemic arterial blood pressure (BP) accurately in any patient and in any setting. The chapter describes the indications, contraindications, and rationale for performing arterial BP measurement. The essential anatomy and physiology associated with the performance of BP measurement are discussed. The chapter identifies the necessary materials and their proper use for performing BP measurement and describes the steps and techniques for obtaining BP measurement and orthostatic measurement.

Keywords

blood pressure
hypertension
orthostatic

Procedure Goals and Objectives

GOAL: To measure the systemic arterial blood pressure (BP) accurately in any patient in any setting utilizing a manual technique.
OBJECTIVES: The student will be able to:

- Describe the indications, contraindications, and rationale for performing arterial BP measurement.

- Describe the essential anatomy and physiology associated with the performance of BP measurement.
- Identify the necessary materials and their proper use for performing BP measurement.
- Perform the proper steps and techniques for obtaining BP measurement.
- Describe the indications for performing orthostatic BP assessment.
- Perform the proper steps and techniques for obtaining orthostatic BP measurement.

Introduction

This chapter outlines the process for taking accurate blood pressure (BP) measurements utilizing a manual measurement technique. In most clinical settings today, automated blood pressure measurement is also available. Many clinicians and organizations still consider the manual measurement of a patient's blood pressure to be the most reliable and accurate method when performed properly following national guidelines. Some studies have assessed manual versus automated blood pressures in various setting. Mirdamadi and Etebari[1] compared manual versus automated blood pressure measurement in intensive care unit, coronary care unit, and emergency room and concluded that manual measurement of BP often reveals a higher blood pressure, in particular for hospitalized patients, up to 15 mm Hg higher. Although this chapter does not address the technique for automated measurement of blood pressure, clinicians should be familiar with the advantages and disadvantages of utilizing automated blood pressure machines.

Background and History

Various theories about circulation and BP emerged about 400 BC. Hippocrates knew about arteries and veins, but he believed veins carried air. Six hundred years later, Galen demonstrated that both arteries and veins carried blood; however, he also thought that the heart was a warming machine for two separate types of blood. He was convinced that veins and arteries were not connected and that blood flowed both backward and forward from the heart. As antiquated as they seem today, Galen's teachings remained unchallenged for more than 1000 years.[2]

William Harvey (1616) disagreed with Galen by demonstrating one-way circulation of blood and theorized the existence of capillaries. Thirty years later, Marcello Malpighi was the first to view capillaries microscopically. The first

person to measure BP was Stephen Hales in 1733. An English physiologist, clergyman, and amateur scientist, Hales inserted a brass pipe into the carotid artery of a mare and then attached the pipe to a windpipe taken from a goose. The flexible goose windpipe was then attached to a 12-foot glass tube. Although the experiment had little practical application at the time, it did provide valuable information about BP.[3]

Although Ritter von Basch experimented with a device that could measure the BP of a human without breaking the skin, the prototype design of the sphygmomanometer was devised in 1896 by Scipione Riva-Rocci.[4] He introduced a method for indirect measurement of BP based on measuring the external pressure required to compress the brachial artery so that arterial pulsations could no longer be transmitted through the artery. The Riva-Rocci sphygmomanometer was described by Porter as "an inflatable band that was wrapped around the upper arm; the air was pumped in until the pulse disappeared; it then was released from the band until the pulse reappeared, and the reading was taken".[5]

In 1905, a Russian physician named Nicolai Sergeeivich Korotkoff first discovered the auscultatory sounds heard while measuring BP. While the artery is occluded during BP measurement, transmitted pulse waves can no longer be heard distal to the point of occlusion. As the pressure in the bladder is reduced by opening a valve on the inflation bulb, pulsatile blood flow reappears through the compressed artery, producing repetitive sounds generated by the pulsatile flow. The sounds, named after Korotkoff, change in quality and intensity. Around the turn of the twentieth century, BP became an accepted clinical measurement. As data increased, clinicians were able to establish normal BP ranges and identify abnormalities.

René Laënnec is credited with the invention of the stethoscope in 1816, which became a convenience for physicians who preferred not to place their ears directly on the chest wall of a patient. In 1905, Korotkoff tried using the stethoscope to monitor the pulse while the sphygmomanometer was inflated. He discovered a more accurate BP reading when the pulse disappeared as the cuff pressure decreased at a point in consonance with the expanding of the heart. Subsequently, the term *Korotkoff sounds* came to be used.[4]

Correct measurement and interpretation of indirect BP is one of the most frequently performed healthcare procedures and is essential in the diagnosis and management of hypertension. Because BP measurement is a simple procedure, it is taken for granted that graduates from health profession training programs can record **accurate, precise, and reliable BP readings**. However, research since the 1960s has shown this assumption to be false. Most health professionals do not measure BP in a manner known to be accurate and reliable. Grim and Grim[6] describe two factors that contribute to inaccurate BP measurement: (1) lack of depth in the instruction of necessary skills in

professional education; and (2) relying on nonmercury devices. Subsequently, every clinician who takes BP measurements should know and understand the principles and steps needed to obtain accurate indirect auscultatory BP measurement. O'Brien[7] suggests that failure to follow contemporary clinical guidelines may lead to potential errors in the diagnosis and management of hypertension. The measurement taken is an essential tool in screening and diagnosis, which is why arterial blood pressure is considered one of the patient's "vital signs."

Competent clinicians must be able to measure systemic arterial blood pressure accurately and reliably.

Indications

As one of the vital signs, peripheral BP measurement is an indirect method for determining cardiovascular function. Its use is indicated for the evaluation of both healthy and unhealthy patients to assess their cardiac status. BP measurement is a part of every physical or screening examination and is performed to screen for hypertension or hypotension.

Contraindications

There are no absolute contraindications to measuring BP. Relative contraindications include physical defects and therapeutic interventions, such as indwelling intravenous (IV) catheters and renal dialysis shunts.

Potential Complications

Complications from the measurement of BP occur as a result of improper training of the individual performing the assessment. Overinflation or prolonged time of inflation may lead to tissue or vascular damage at the measurement site. Lack of proper care of equipment or flawed equipment may give an inaccurate reading.

Essential Anatomy and Physiology

In most clinical settings BP is measured by the indirect technique of using a sphygmomanometer placed over the brachial artery of the upper arm. The **brachial artery** is a continuation of the axillary artery, which lies medial to the humerus proximally and gradually moves anterior to the humerus as it nears the antecubital crease (Fig. 3.1). Placement of the bladder and cuff of the sphygmomanometer circumferentially over the brachial artery allows inflation

of the cuff to create adequate pressure so that the artery is fully occluded when the pressure exceeds the systolic pressure within the brachial artery.

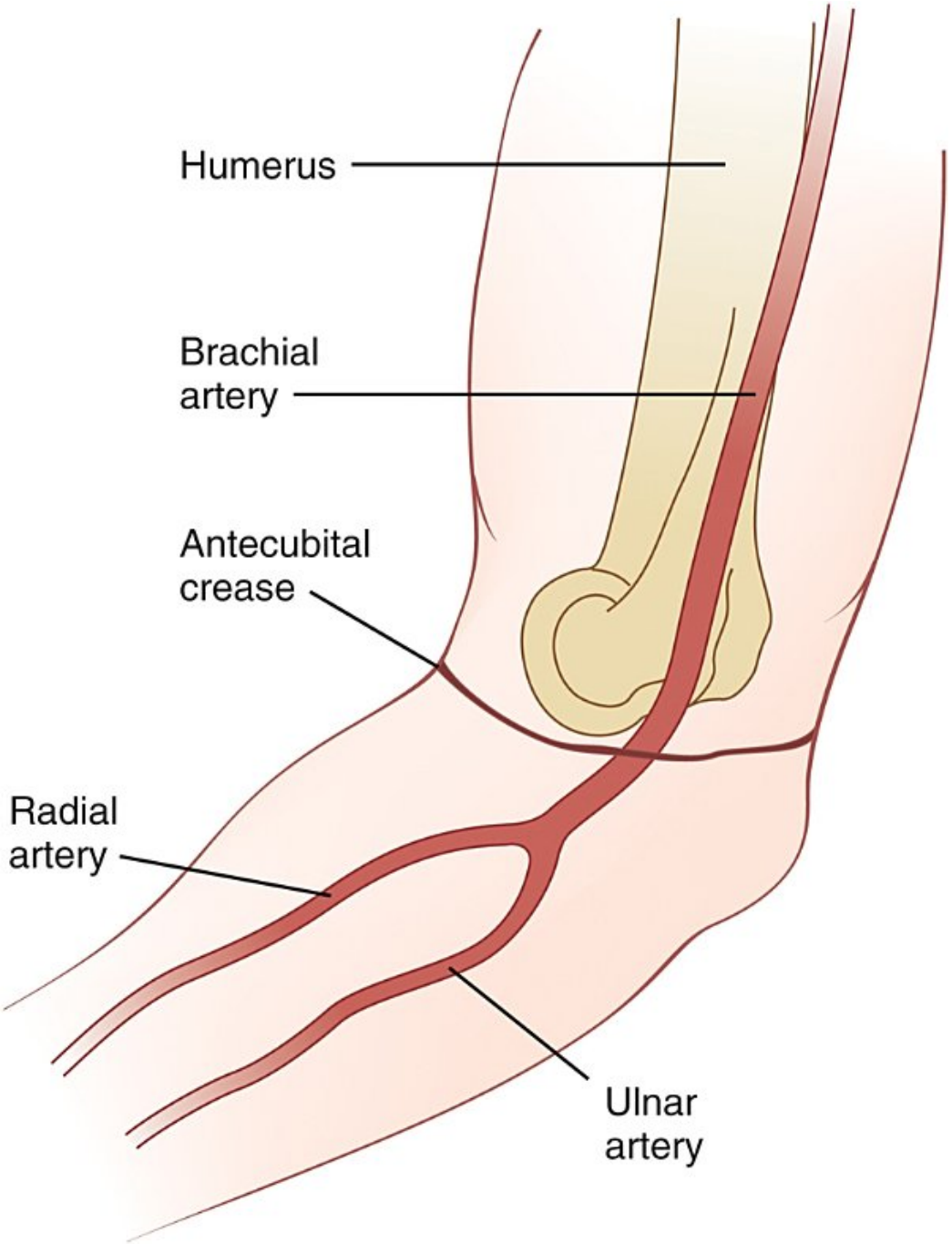

FIGURE 3.1 **Location of the brachial artery.**

Knowledge of the cardiovascular system's anatomy and physiology is important to diagnose blood pressure abnormalities.

Indirect measurement of the BP involves the auscultatory detection of the initial presence and disappearance of changes and the disappearance of Korotkoff sounds, which are audible with the aid of a stethoscope placed over the brachial artery distal to the BP cuff near the antecubital crease. Korotkoff sounds are low-pitched sounds (best heard with the stethoscope bell) that originate from the turbulence created by the partial occlusion of the artery with the inflated BP cuff.[8]

As long as the pressure within the cuff is so little that it does not produce even partial occlusion (or intermittent occlusion), no sound is produced when auscultating over the brachial artery distal to the cuff. When the cuff pressure becomes high enough to occlude the artery during at least some portion of the arterial pressure cycle, a sound becomes audible over the brachial artery distal to the cuff. This sound is audible with a stethoscope and correlates with each arterial pulsation.

The five phases of Korotkoff sounds are used in determining systolic and diastolic BP (Table 3.1). Phase I occurs as the occluding pressure of the cuff falls to a point equal to the peak systolic pressure within the brachial artery (Fig. 3.2). The tapping sound is clear and generally increases in intensity as the occluding pressure continues to decrease. Phase II occurs at a point approximately 10 to 15 mm Hg lower than at the onset of phase I, and the sounds become softer and longer, with the quality of intermittent murmur. Phase III occurs when the occluding pressure of the cuff falls to the point that allows large amounts of blood to cross the partially occluded brachial artery. The phase III sounds are again crisper and louder than phase II sounds. Phase IV occurs when abrupt muffling and a decrease in the intensity of the sound is heard. This occurs as the pressure is close to that of the diastolic pressure of the brachial artery. Phase V occurs when the pressure no longer occludes the blood vessel in the cuff. At this point, the tapping sound disappears completely.

Table 3.1

Korotkoff Sounds*

Phase	Sounds
I	The appearance of clear, repetitive, tapping sounds corresponding to the appearance of a palpable pulse.
II	Sounds become softer and longer.
III	Sounds again become crisper and louder
IV	Sounds are muffled and softer
V	Sounds disappear entirely and recorded as the last audible sound

* As the pressure is reduced during deflation of the occluding cuff, the Korotkoff sounds change in quality and intensity.

From Pickering TG, Hall JE, Appel LJ, et al. Recommendations for blood pressure measurement in humans and experimental animals. *Hypertension*. 2005;45:146.

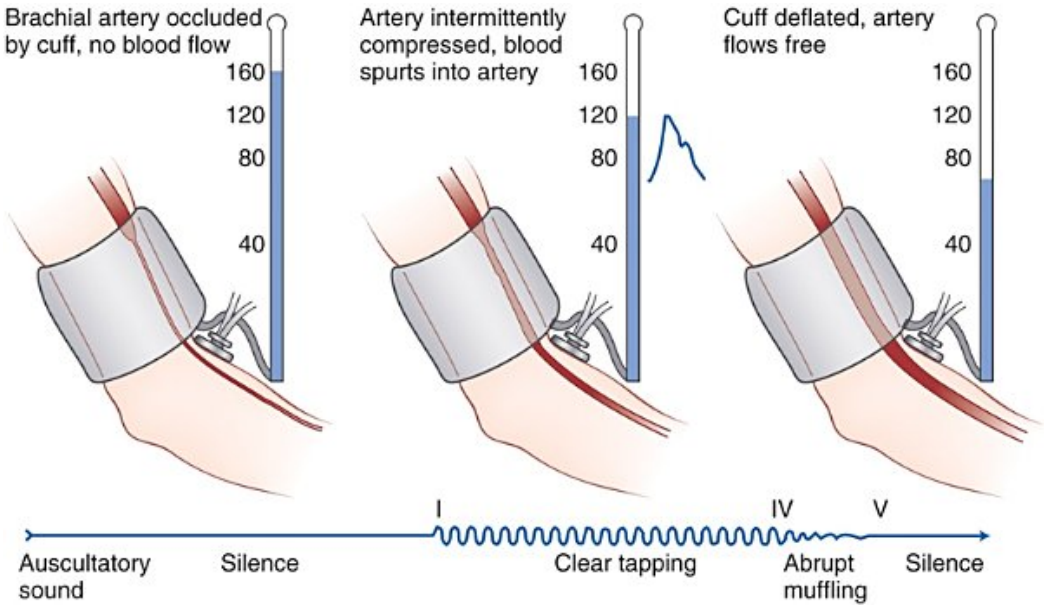

FIGURE 3.2 **Phase I of Korotkoff sounds.**

Patient Preparation

Ideally, the environment should be relaxed and peaceful. BP levels may be affected by emotions, physical activity, or the environment. Subsequently, the examiner should minimize all disturbances that may affect the reading. The procedure should be explained to the patient.

The patient is asked to be seated or to lie down with the back supported, making sure that the bare arm is supported horizontally at the level of the heart and having the patient avoid crossing the legs. A bare arm is preferred over taking the measurement over clothing. Although readings are usually similar with the cuff placed over the bare arm compared with a sleeved arm, taking the BP over thick clothing should be avoided.[8, 9, 10, 11]

According to Mourad and Carney,[12] choosing a dependent arm is a behavior likely to lead to the overdiagnosis of hypertension and inappropriate treatment of hypertension because the dependent arm falsely elevates both systolic and diastolic BP. These results should encourage national and international organizations to reaffirm the importance of the horizontal arm in the measurement of BP.

The clinician should avoid an arm that appears injured, has a fistula, or has an IV or arterial line. If the patient has undergone breast or axilla surgery, avoid the arm on the same side. It is important to note that rolling up the sleeves has the potential of compressing the brachial artery and may have an even more significant effect on the BP than if the shirt is left under the manometer's cuff.[13] According to Jamieson et al.,[14] the above situation may elevate supine systolic and diastolic measurements by 2 to 3 mm Hg.

Selecting Proper Cuff Size

For the accurate indirect measurement, it is recommended that the cuff size be based solely on the limb circumference. The bladder cuff should have a bladder length that is 80% and a width that is at least 40% of arm circumference (2:1 length-to-width ratio). For a child younger than 13 years of age, the bladder should encircle 100% of the child's upper arm. A cuff that is too narrow or too large for an arm may result in an incorrect BP reading.[6] Cuffs that are generally available have been classified by the width of the bladder rather than by its length and are labeled newborn, infant, child, small adult, adult, large adult, and thigh. Overestimation and underestimation of BP by using an inappropriate cuff size have been well documented in the literature.[7] Today, clinicians should have easy access to small, standard, and large cuffs.

Use of proper cuff size is paramount. The length of the cuff bladder should be 80% with the width at least 40% of the circumference of the arm.

Time of Measurement

Naturally, BP measurement should occur at the time of the clinical visit. For the diagnosis of hypertension, readings should be taken at various times and over multiple days. Hartley and associates[15] suggest that in the absence of end-organ damage, the diagnosis of mild hypertension should not be made until the BP has been remeasured on at least two visits over a period of 1 week or more. Various factors may influence obtaining an accurate BP value if they occur within 60 minutes of the measurement, including potential elevation of BP following smoking, ingestion of caffeine, eating, and strenuous exercise.

Training and Competencies

Health professionals are traditionally trained in blood pressure measurement through an introductory course on physical assessment followed by laboratory practice on fellow trainees. Before training begins, trainees should be assessed for physical and cognitive competencies required to perform the procedure, including:

- The trainee must be able to see the dial of the manometer or the mercury column at eye level without straining or stretching.
- The trainee must be able to hear the appearance and disappearance of the Kortotkoff sounds.
- The trainee must have good eye/hand/ear coordination, particularly if a mercury or aneroid device is used.[6]

Materials for Blood Pressure Measurement

- Stethoscope
- Calibrated sphygmomanometer (mercury, aneroid, or hybrid sphygmomanometer with a calibrated scale for measuring pressure; inflatable rubber bladders; tubes; and valves). Mercury sphygmomanometers still provide the most accurate measurement of indirect BP; however, environmental concern over the use of mercury sphygmomanometers continues because of the hazards of mercury spills and potential exposure. As a result, more automated devices are being used.[14] One of the factors affecting the accuracy of BP measurement is the equipment used. Defects or inaccuracy of aneroid sphygmomanometers may be a source of error in BP measurement. Automated oscillometric BP measurement is increasingly used in medical offices, emergency centers, and home monitoring. Although the readings may be lower than with the auscultatory technique, user error is minimal. Timing, positioning, and cuff size continue to be as important as in the traditional method.[15]

The mercury sphygmomanometer, once regarded as the gold standard, is rapidly disappearing from practice. Even with the simplistic design and good accuracy, the use of mercury may require a spill kit and a hazardous materials team if spilled.[6]

The aneroid sphygmomanometers uses a mechanical system of metal bellows that expands as the cuff pressure increases and a series of levers that register the cuff pressure on a circular scale.[6]

This hybrid device combines features of both electronic and ausculatory devices using an electronic pressure gage. This has become a replacement for the mercury sphygmomanometer.[6]

- Recording Instruments (Fig. 3.3)
- A cuff that has an antimicrobial agent to help prevent bacterial growth is recommended. It has been reported that BP cuffs can carry significant bacterial colonization and actually can be a source of transmission of infection.[16] Use of proper cuff size is paramount.[17]

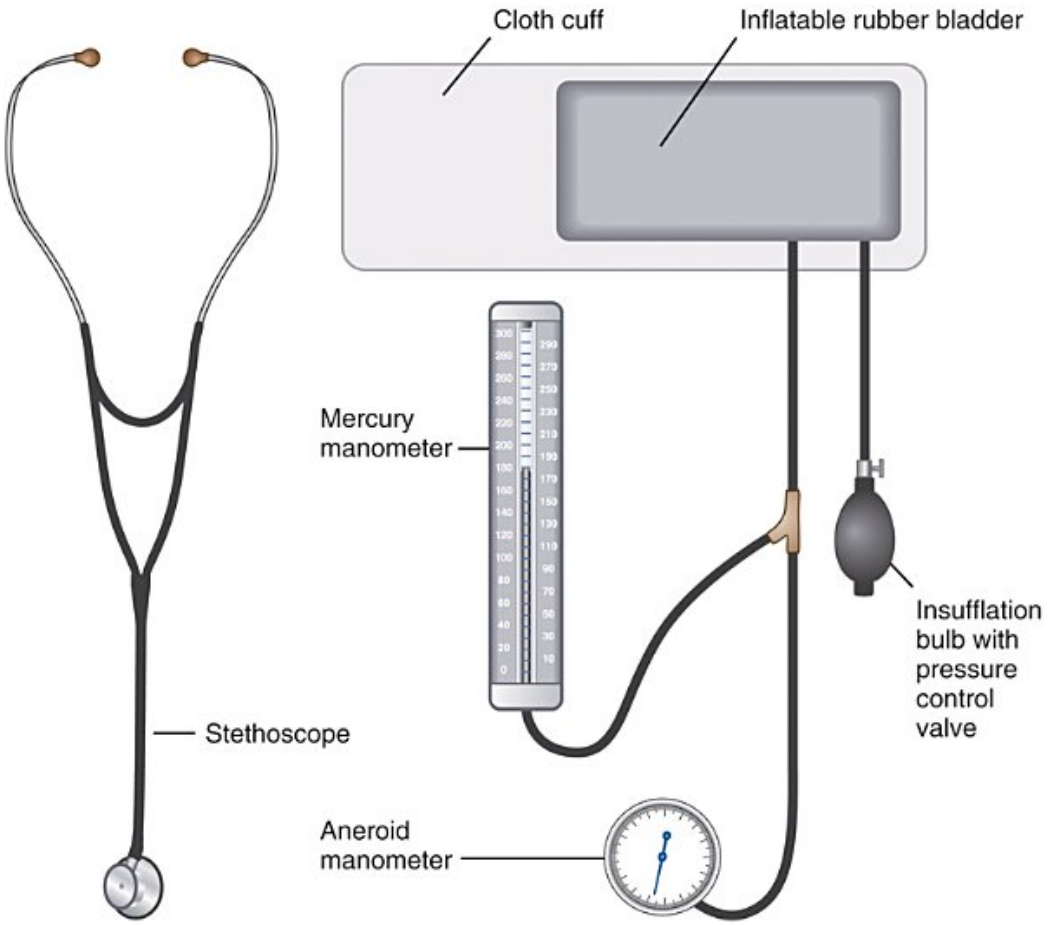

FIGURE 3.3 **Instruments used for recording blood pressure.**

Note: The standard location for blood pressure measurement is the upper arm. Devices that measure pressure at the wrist or finger, although popular, vary significantly in systolic and diastolic pressures and should be avoided for routine measurement of BP, particularly with a need for serial BP readings for discussion of treatment.[6]

Procedure

Indirect Blood Pressure Measurement

1. Check to see that the mercury level of the sphygmomanometer is at 0 or, if an aneroid or hybrid device is used, the needle rests within the calibration window.
2. Palpate the brachial artery and place the cuff so that the midline of the bladder is over the arterial pulsation. Take care that the cuff is placed at approximately the horizontal level of the heart.

3. Wrap and secure the cuff snugly around the patient's bare upper arm. The lower edge of the cuff should be 1 inch (≈2 cm) above the antecubital crease, the point at which the bell of the stethoscope is to be placed (Fig. 3.4). As noted earlier, avoid rolling up the sleeve in such a manner that it may form a restriction around the upper arm.
4. Place the manometer so that the center of the mercury column or aneroid dial is at eye level and visible to the examiner. Make sure that the tubing from the cuff is unobstructed.
5. Inflate the cuff rapidly to 70 mm Hg and increase by increments of 10 mm Hg while palpating the radial pulse. Note the level of pressure at which the pulse disappears and subsequently reappears during deflation. This procedure, the palpatory method, provides the necessary preliminary approximation of the systolic pressure to ensure an adequate level of inflation when the actual, auscultatory measurement is accomplished. The palpatory method is particularly useful to avoid underinflation of the cuff in patients with an auscultatory gap and overinflation in those with very low BP. The auscultatory gap occurs at a point between the highest systolic reading and the diastolic reading. The Korotkoff sounds may become absent between the peak systolic measurement and diastole, resulting in an underestimation of the peak systolic BP if the cuff is not initially inflated to a high enough pressure.
6. Place the earpieces of the stethoscope into your ear canals, angled forward to fit snugly.
7. Switch the stethoscope head to the low-frequency position (bell).
8. Place the bell of the stethoscope lightly over the brachial artery pulsation just above and medial to the antecubital crease but below the lower edge of the cuff (Fig. 3.5). Make sure the bell makes contact with the skin around the entire circumference. Excessive pressure will result in stretching the underlying skin, causing the bell to function as a diaphragm. This may result in the loss of low-frequency sounds.
9. Inflate the bladder rapidly and steadily to a pressure 20 to 30 mm Hg above the level previously determined by palpation. Partially unscrew the valve and deflate the bladder at 2 mm per second while listening for the appearance of Korotkoff sounds.
10. As the pressure in the bladder falls, note the level of the pressure on the manometer at the first appearance of repetitive sounds, the continuation of the sounds, and when the sounds disappear. During the period of the Korotkoff sounds (see Table 3.1), the rate of deflation should be less than 2 mm per beat, thereby compensating for both rapid and slow heart rates.
11. Record the systolic and diastolic pressure immediately, rounded off upward to the nearest 2 mm Hg. The name of the patient, the date and

time of measurement, the arm or site at which the measurement was taken, the cuff size, and the patient's position while taking the measurement should be noted.

12. Neither the patient nor the clinician should talk during the measurement.

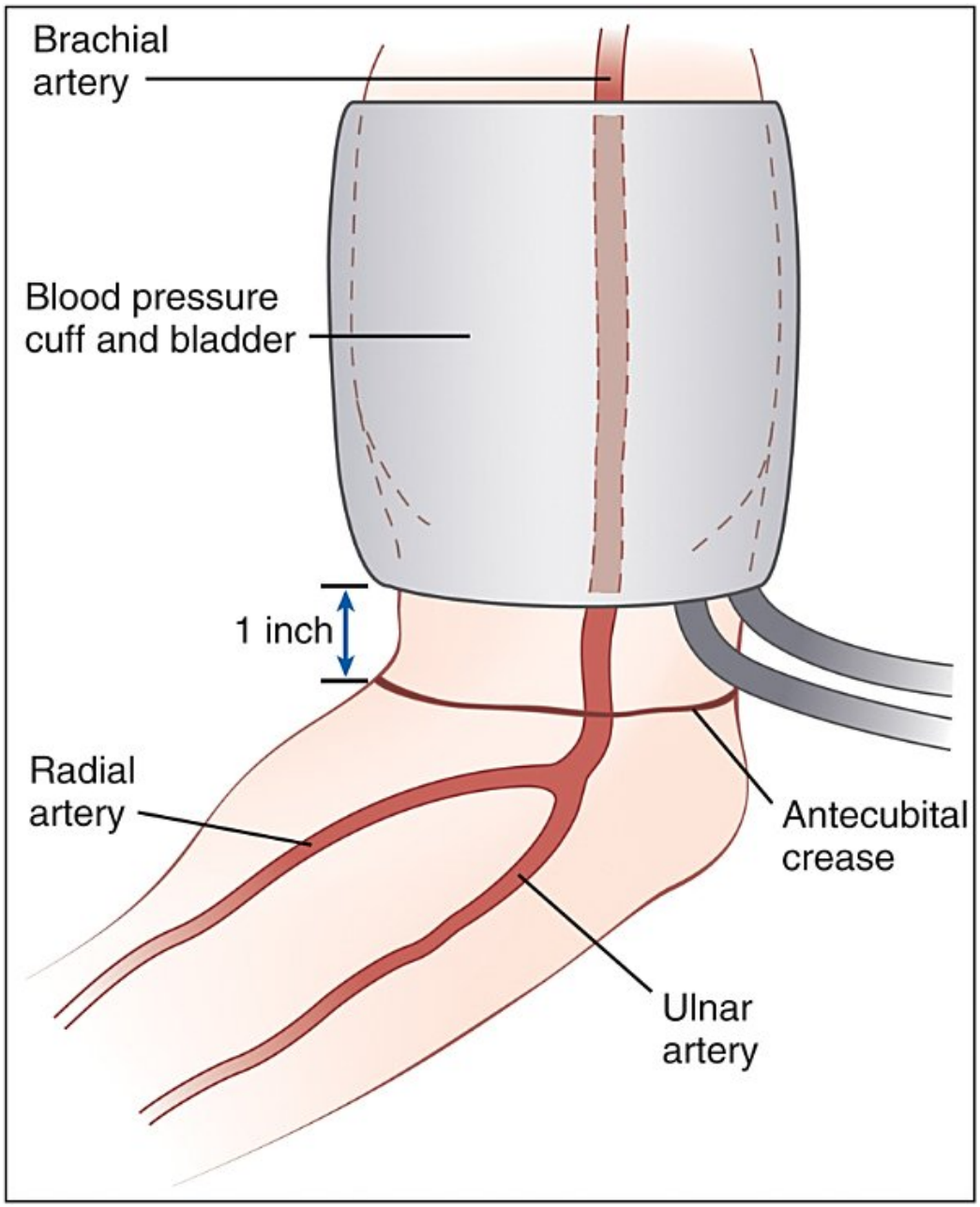

FIGURE 3.4 **Indirect Blood Pressure Measurement**

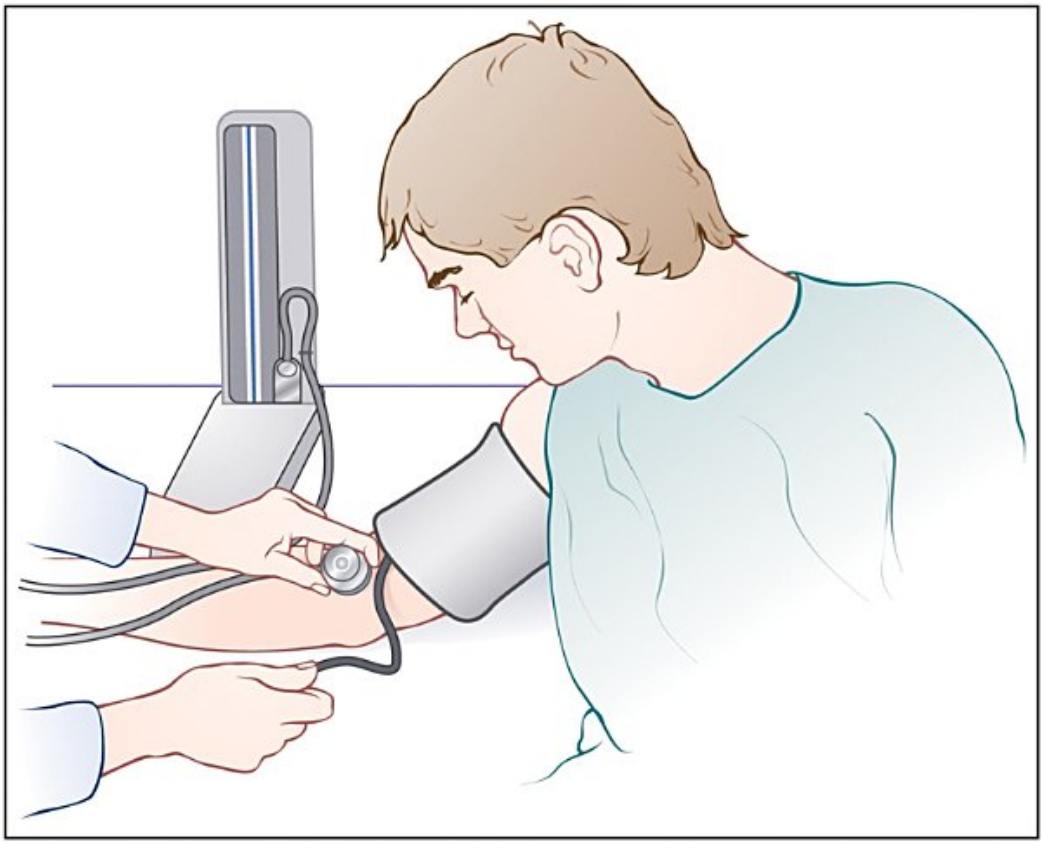

FIGURE 3.5 **Indirect Blood Pressure Procedure**

Special Considerations

The Apprehensive Patient or "White Coat" Hypertension

Patient anxiety when visiting a clinician may lead to a BP value substantially higher than during normal activities. White coat hypertension has been defined as clinical BP higher than 140 mm Hg systolic and 90 mm Hg diastolic.[18] Having the BP taken by someone other than the clinician may minimize the white coat effect. Ambulatory blood pressure measurement (ABPM) is increasingly being used in clinical practice. ABPMs correlate better than clinical measurements in patients with an end-organ injury.[19], [20], [21] ABPM is the most efficient means for assessing white coat hypertension, particularly in the absence of end-organ disease.

Ambulatory measurements also are valuable in assessing patients with apparent drug resistance and symptoms of low BP and those taking antihypertensive medications. ABPM is usually determined through a device worn by the patient that takes the BP measurements during a 24- to 48-hour period. The recorded BP is dated and determines the average day and night BP.

Pickering et al.[15] report that defining normal BP and hypertension using ABPM should be based on the following:

- Normal BP: 130/80 mm Hg; hypertension: 135/85 mm Hg or higher (24-hr average)
- **Awake (daytime) BP—normal** BP: 135/84 mm Hg or less; hypertension: 140/90 mm Hg or greater

Awake (daytime) normal BP is 135/84 mm Hg or less. Hypertension is defined as 140/90 mm Hg or greater.

- Asleep (nighttime) BP—normal BP: 120/70 mm Hg; hypertension: 125/75 mm Hg or greater.[22]

The Obese or Large Arm

It is well known that BP measurement using a standard cuff width of 12 to 13 inches (27 to 34 cm) is inappropriate for large or obese arms. If the arm circumference of the patient exceeds 13 inches (34 cm), use a thigh cuff 17 to 20 inches (18 cm) wide on the patient's upper arm. Table 3.2 gives acceptable bladder dimensions for adult arms of various sizes. In patients with massive arms, place the cuff on the patient's forearm and listen over the radial artery. Occasionally it may be necessary to determine the BP in the leg; this may be required to rule out coarctation of the aorta or if an upper extremity BP determination is contraindicated. To do this, use a wide, extended thigh cuff with a bladder size of 45 to 52 cm and apply it to the midthigh. Center the bladder over the posterior surface, wrap it securely, and listen over the popliteal artery. According to Pickering et al.,[23] "wrist monitors may be useful in very obese patients if the monitor is held at heart level. Finger monitors are not recommended." Block and Schulte[24] reviewed ankle BP measurements and found that a mean BP reading obtained at the arm or the ankle was statistically equivalent and concluded that ankle cuff placement provided a reliable alternative to the placement of the cuff on the arm.

Table 3.2

Acceptable Blood Pressure Cuff Sizes

Arm Circumference	Cuff Size
22–26 cm	12 × 22 cm (small adult)
27–34 cm	16 × 30 cm (adult)
35–44 cm	16 × 36 cm (large adult)
45–52 cm	16 × 42 cm (adult thigh)

Suggested blood pressure cuff should have a bladder length 80% and a width of at least 40% of arm circumference (length/width ratio of 2:1).

DePalma, Sondra M.; Himmelfarb, Cheryl Dennison; MacLaughlin, Eric J.; Taler, Sandra J. Journal of the American Academy of PAs. 31(6):16-22, June 2018.

Infants, Children, and Adolescents

Measuring BP in infants, children, and adolescents presents unique challenges to the clinician. The same measuring techniques are used as in adults. As mentioned earlier, pediatric cuff sizes are available to ensure that the bladder completely encircles the upper arm. Various techniques can enforce patient compliance, such as using relaxation techniques for the child, having the mother inflate the BP cuff, or demonstrating BP measurement on a stuffed animal. Adult hypertension may begin in childhood; consequently, appropriate measurement is recommended on a routine basis.

Elderly Patients

In elderly patients, who may have significant atherosclerosis, it is likely that the systolic pressure is overestimated by the indirect method of BP measurement. BP tends to be more labile in elderly patients, so it is essential to obtain several baseline measurements before making any diagnostic or therapeutic decisions.[25] ABPM is very useful in this age group. Supine and standing BP measurements should be taken in the elderly to look for postural hypotension.[24]

Assessment of Orthostatic Blood Pressure

The measurement of orthostatic BP is an essential clinical tool for the assessment and treatment of patients with many common medical disorders. The most common causes are volume depletion and autonomic dysfunction. According to Carlson,[26] **orthostatic hypotension**, which is a decline in BP when standing erect, is the "result of an impaired hemodynamic response to an upright posture or a depletion of intravascular volume. The measurement of orthostatic blood pressure can be done at the bedside and is therefore easily applied to several clinical disorders." Orthostatic hypotension is detected in 10% to 20% of community-dwelling older individuals.[26] This condition is frequently asymptomatic, but disabling symptoms of light-headedness, weakness, unsteadiness, blurred vision, and syncope may occur.

Orthostatic hypotension is defined as a "reduction of systolic blood pressure of at least 20 mm Hg or diastolic blood pressure of at least 10 mm Hg within 3 minutes of standing.

The consensus statement of the American Academy of Neurology[27] defines orthostatic hypotension as a "reduction of systolic blood pressure of at least 20 mm Hg or diastolic blood pressure of at least 10 mm Hg within 3 minutes of standing." Many clinicians use a combination of a decrease in BP combined with an increase in heart rate to determine the presence of orthostatic hypotension. Performing these orthostatic measurements requires adequate techniques in BP measurement, appropriate positioning of the patient, and proper timing of the measurements.

Materials for Measuring Orthostatic Blood Pressure

This technique requires the same equipment as previously mentioned for measuring BP.

Procedure

Measuring Orthostatic Blood Pressure

1. Ask the patient about his or her ability to stand.
2. Make sure the cuffed arm is positioned so that the brachial artery is held at the level of the heart.
3. After 5 to 10 minutes of supine rest, take a baseline BP and a pulse measurement.
4. Have the patient sit on the side of the bed with feet dangling for 2 to 3 minutes, then take BP and pulse measurements.

5. Repeat the measurements 1 and 3 minutes after continued standing. When recording the measurements, include the position when you took the readings and any signs or symptoms developed with postural changes.

Throughout the procedure assess the patient for dizziness, lightheadedness, pallor, sweating, or syncope. If any of these occur, return the patient to a supine position.

Follow-Up Care and Instructions

The results of the BP measurements dictate the follow-up actions and patient instructions. Long-term observations have been made on the contributions of high BP to illness and death. It is important to note that the classification of BP has changed over the years.[28] In 2017, the report of the American College of Cardiology/American Heart Association recommended the classification found in Table 3.3.[29]

Table 3.3

Classification of Blood Pressure for Adults 18 Years and Older

Classification	Systolic BP (mm Hg)		Diastolic BP (mm Hg)
Normal	< 120 mm Hg	and	< 80 mm Hg
Elevated	120–129 mm Hg	and	< 80 mm Hg
Stage 1 hypertension	130–139 mm Hg	or	80–89 mm Hg
Stage 2 hypertension	At least 140 mm Hg	or	At least 90 mm Hg
Hypertensive crisis	180 mm Hg	and/or	120 mm Hg

2017 Guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *J Am Coll Cardiol* 2017 Sep. 23976; DOI: 10.1016/j.jacc.2017.07.745. P. 4.

Clinicians should explain the meaning of BP readings to patients and advise them of the need for appropriate periodic follow-up care and remeasurement. Table 3.4 demonstrates a suggested follow-up form to be given to patients after their BP has been taken.

Table 3.4

Blood Pressure Record and Follow-up Recommendations

Date_____	**Name**_____	**Age**_____
BP Measurements	Right Arm	Left Arm
Sitting		
Lying		
Standing		
Recommendations	Medications	Home BP Readings
□ Return in _____ days		
□ Daily BP readings		
□ Salt restriction		

The measurement of orthostatic BP is a valuable and straightforward technique. Practical applications include detection of intravascular volume depletion and autonomic dysfunction and the treatment of hypertension, congestive heart failure, and other clinical disorders.

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CHAPTER 4

Casting and Splinting

Patrick T. Knott

Abstract

The goal of this chapter is to instruct the clinician on how to apply comfortable and well-fitting casts and splints that will effectively and appropriately immobilize injured extremities while minimizing potential complications.

Keywords

Casting
fracture care
splinting

Procedure Goals and Objectives

GOAL: To apply comfortable and well-fitting casts and splints that effectively and appropriately immobilize injured extremities and minimize potential complications to patients.
OBJECTIVES: The student will be able to:

- Compare and contrast the indications and contraindications of using plaster and fiberglass materials for casts and splints.
- Distinguish the various types of splints and casts used to immobilize upper and lower extremity injuries.
- Describe the proper procedure for selecting and applying a short-arm cast, short-leg cast, short-arm gutter splint, short-leg posterior mold, and lower-leg sugar tong splint.
- Identify and describe potential complications associated with casting and splinting extremities.
- Describe how to perform a proper assessment after cast or splint to determine if the device fits well, properly immobilizes the injured extremity, and is comfortable.
- Identify the important aspects of patient education and cast care after a casting and splinting application.
- Explain the proper use of an oscillating cast saw to remove a cast without causing injury to the patient.
- Recognize new technology that will likely replace plaster and fiberglass in the future.

Background and History

Immobilization of the extremities in casts and splints is a practice that dates back to nearly 3000 BC, when tree bark was used to splint injured forearms. In the 1920s, plaster of paris was commercially introduced to medicine as a powder that was impregnated into rolls of a gauze-like cloth. More recently, fiberglass and thermoplastic have been used to make casts or splints, but the principles of immobilization have remained remarkably constant.

Numerous types of casts and splints are used to treat an even greater number of specific fractures and soft-tissue injuries. Some devices immobilize only the distal half of an extremity ("short-arm" or "short-leg" casts or splints), whereas others immobilize the entire extremity ("long-arm" or "long-leg" casts or splints). Describing the many special types of immobilization is beyond the scope of this chapter, and the application of many of these specialized types of casts and splints may be inappropriate in the primary care setting. This chapter provides an explanation of the basic principles of casting and splinting and instructions for constructing several commonly used casts and splints.

A cast is an immobilization device that completely encases the circumference of an extremity. It consists of a rigid material (usually plaster or fiberglass) placed over several layers of padding and a cloth stockinette that together cover and protect the skin. Because a cast is circumferential and rigid, it typically is not used until the acute swelling phase of the injury has subsided. Casts are most commonly applied in orthopedists' offices by cast technicians, PAs/NPs, or orthopedic surgeons, but are also applied in some primary care settings. Two of the most common types of casts are discussed in this chapter, the short-arm cast (Fig. 4.1) and the short-leg cast (Fig. 4.2).

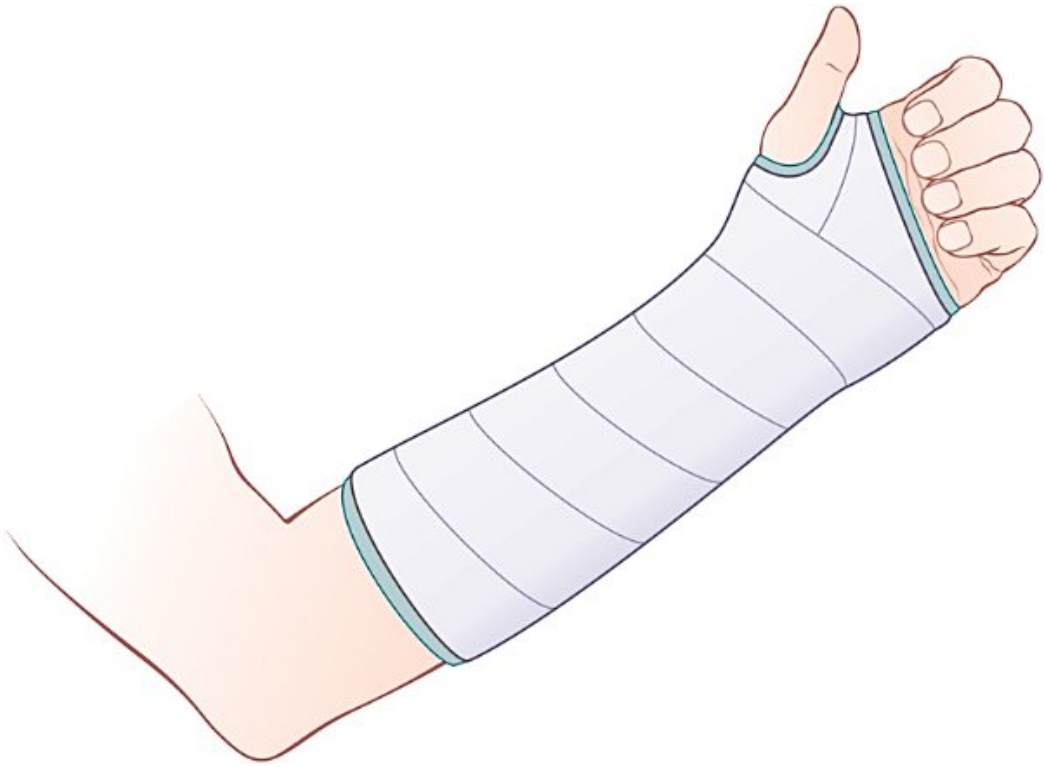

FIGURE 4.1 **Short-arm cast.**

FIGURE 4.2 **Short-leg cast.**

A **splint** is similar to a cast except that its rigid material encases only part of an extremity's circumference and must therefore be secured with an elastic wrap. Although a splint provides less mechanical support and protection than a circumferential cast, its main advantage is that it allows for soft-tissue swelling during the acute phase of an injury.

Although a noncircumferential splint provides less mechanical support and protection than a circumferential cast, its main advantage is that it allows for soft-tissue swelling during the acute phase of an injury.

For some soft-tissue injuries, a splint may be the primary immobilization therapy, but for fractures, a splint is usually replaced with a cast after the acute swelling subsides. For lower extremity fractures with which ambulation is allowed, a cast boot ("ski boot") device is sometimes used instead of a splint and cast. The stockinette is sometimes excluded from splint constructions because it is potentially constricting in the setting of acute swelling. A splint can be easily constructed from 6 to 8 strips of fiberglass or 8 to 12 strips of plaster that are either sandwiched between layers of cast padding or directly placed on a padded extremity. Prefabricated splints, however, are commercially available in a variety of precut sizes or as cut-to-size rolls, and typically consist of an outer reinforced paper sleeve that contains fiberglass with foam padding on one side. Splints are most commonly applied in emergency departments and other acute care settings. Three general types of splints are discussed in this chapter: the "gutter," the "posterior mold," and the "sugar tong." The gutter splint (Fig. 4.3) is appropriately named for its gutter-like shape in supporting the extremity. The forearm gutter splint is an example of this type. The posterior mold splint (Fig. 4.4) is so named because it is molded to the posterior aspect of the splinted extremity. Posterior mold splints of the short-leg, short-arm, or long-arm variety are commonly employed. The sugar tong splint (Figs. 4.5 and 4.6) forms a U-shaped strap around an extremity, resembling the kitchen accessory after which it is named. The sugar

tong splint can be used initially to immobilize the lower leg, lower arm, or upper arm.

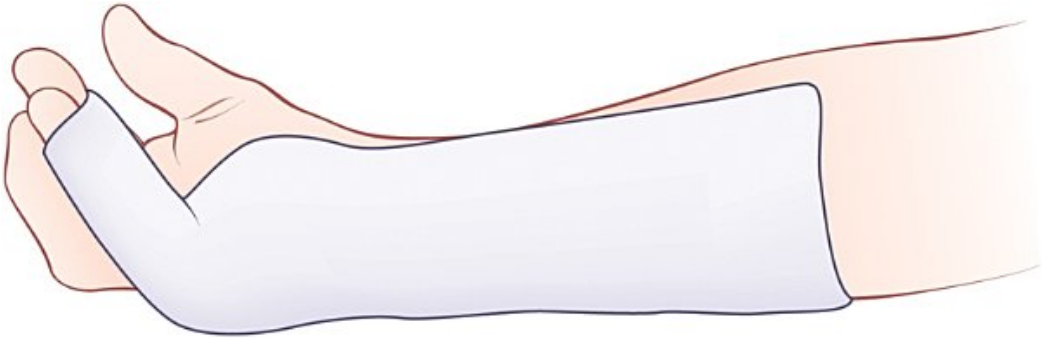

FIGURE 4.3 **Gutter splint.**

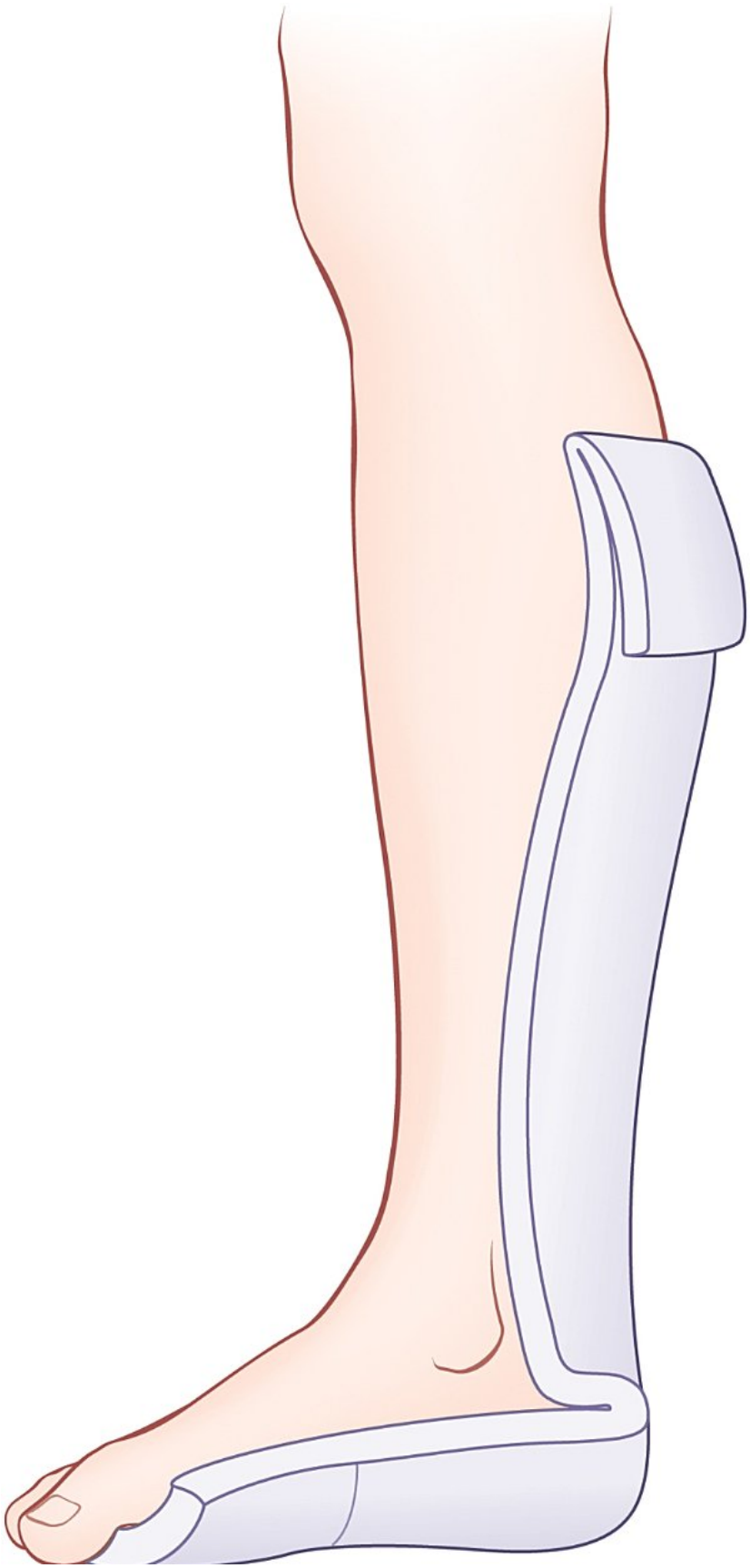

FIGURE 4.4 **Posterior mold splint.**

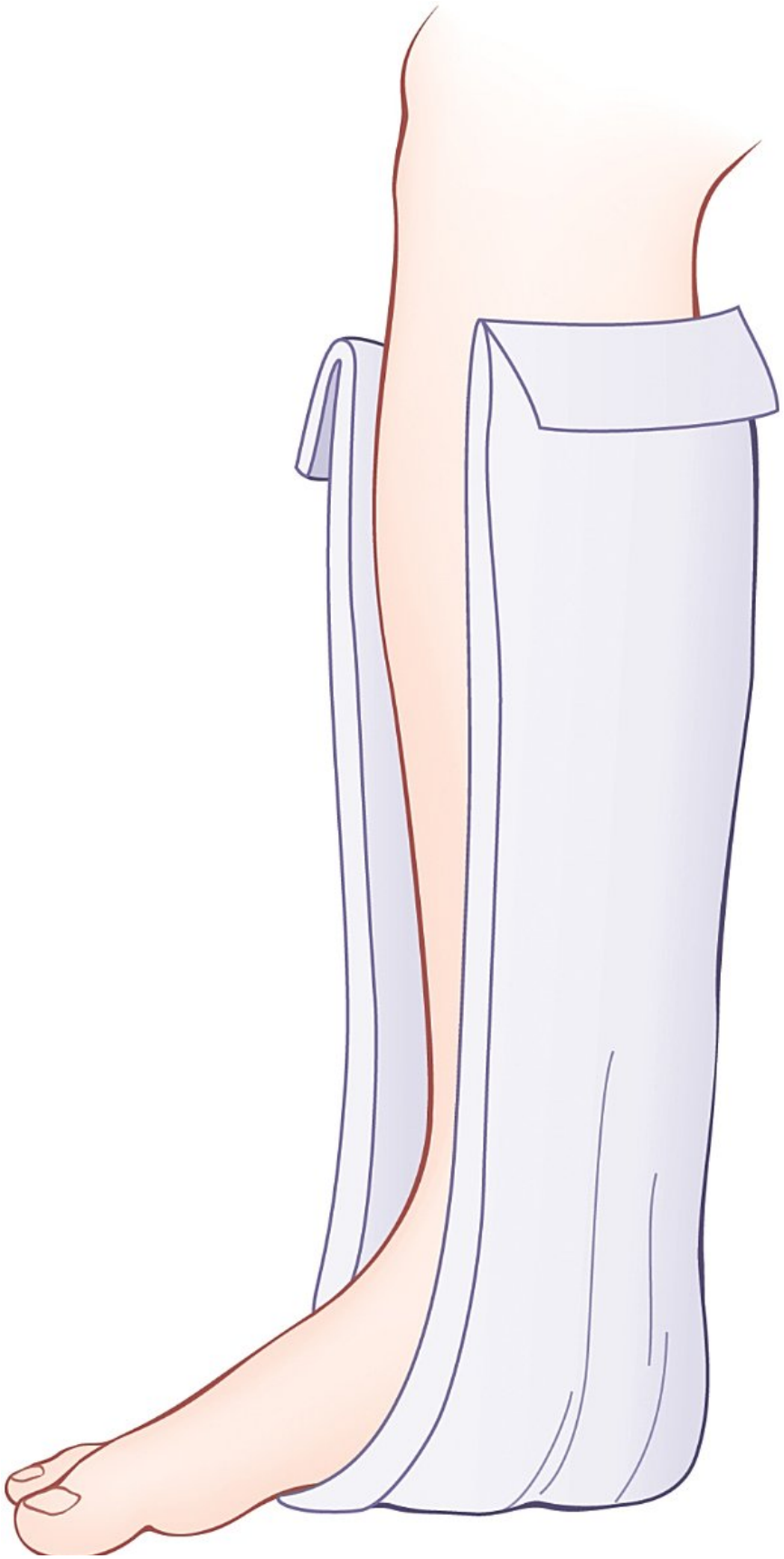

FIGURE 4.5 **Sugar tong splint for the lower leg.**

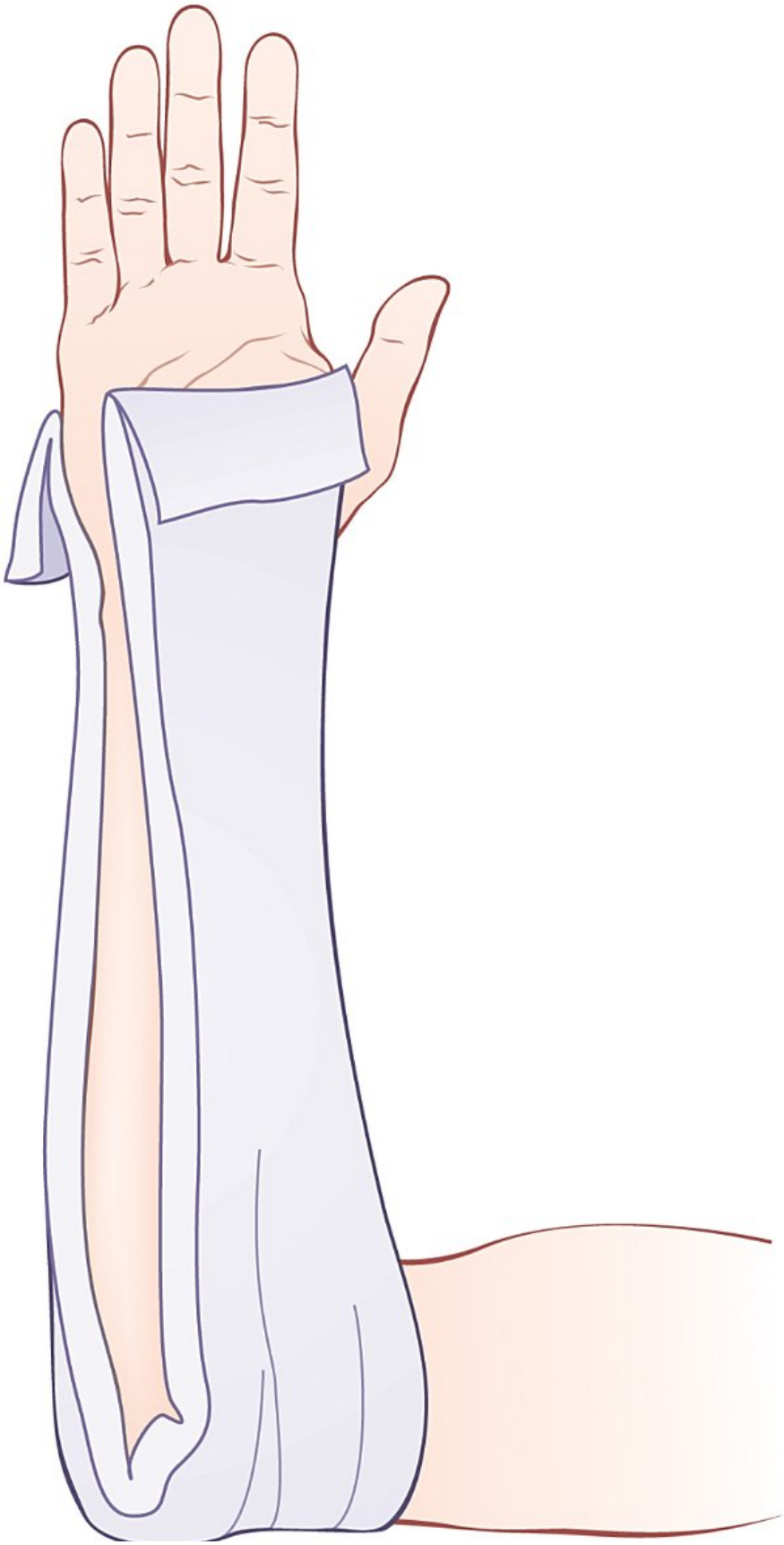

FIGURE 4.6 **Sugar tong splint for the lower arm.**

Plaster and fiberglass, the two primary materials used to make casts and splints today, are each applied after a brief immersion in water. Each material has inherent benefits and drawbacks that determine the best choice for the situation. Plaster is easier to mold to an extremity than is fiberglass, giving it an advantage when a snug and form-fitting cast is needed on an area with challenging contours, such as the chubby, cone-shaped arm or legs of a toddler. Plaster also absorbs ("wicks") underlying wound drainage, making it a desirable splinting material in trauma and postoperative settings. Although messy to apply, plaster is easily washed off with soap and water—making the wearing of gloves optional. Despite these advantages, plaster has some drawbacks. It is much heavier than fiberglass, yet not as durable. Once hardened, it will soften and break down if it gets wet, requiring cast reinforcement or replacement. Plaster begins to harden in 10 to 15 minutes, but takes 6 to 8 hours (or more) to fully dry and harden. Plaster also emits quite a bit of heat as it cures. Because of the **exothermic reaction** generated by plaster cast material, it poses a potential burn risk in patients with sensory deficits and in those who are unable to communicate their discomfort effectively because of immaturity or cognitive impairment. To reduce the amount of heat generated, cool water is used to wet the plaster, even though this increases the time to harden.

Because of the exothermic reaction generated by plaster cast material, it poses a potential burn risk in patients with sensory deficits and in those unable to communicate their discomfort effectively because of immaturity or cognitive impairment.

Fiberglass is an extremely popular cast material because of its strength and flexibility, light weight, ease of application, and excellent durability. Once hardened, it is fully water-resistant, although the underlying synthetic padding must still be kept dry. Fiberglass generates a much smaller exothermic reaction than

plaster. It begins to harden in 3 to 4 minutes and fully hardens in 1 to 2 hours. Because of its rapid curing time, it must be kept in its airtight foil package until immediately before application. If not, moisture in the air will prematurely initiate the curing process. This is not a concern with plaster cast material, which essentially has an unlimited shelf-life if kept dry. Fiberglass is available in a wide variety of colors, unlike plaster, which is uniformly chalky-white. For reasons cited, fiberglass is clearly the material of choice for the majority of cast and splint applications and especially for weight-bearing casts. A consideration when using fiberglass is that it is several times more expensive than plaster. Its higher initial cost can be justified because it lasts longer and requires fewer repairs and replacements during the period of immobilization. Gloves and an apron should be worn when applying fiberglass because of the sticky resin it contains. Fiberglass resin is nearly impossible to remove from clothing, and requires fingernail polish remover to remove it from skin.

Fiberglass is the material of choice for the majority of cast and splint applications, and especially for weight-bearing ("walking") casts.

Indications

Casts and splints are used in the primary care setting as follows:

- To treat simple, acute, nondisplaced fractures
- To immobilize a dislocation after it has been reduced
- To treat soft-tissue injuries, such as severe ligament sprains and muscle strains
- To treat some congenital deformities
- To help manage chronic foot and ankle ulcers

Immobilization is necessary for comfort and healing after a bone fracture, and it is also beneficial in the short-term follow-up of a soft-tissue injury. In orthopedic settings, serial casts are used gradually, over time, to manipulate a congenital deformity, such as a clubfoot

or hip dysplasia, into a more anatomically correct position. Casts also can be used to help manage chronic foot and ankle ulcers in patients with diabetes and those with neuropathic (Charcot) joints. Hard-shell casts and special cast boots can help off-load the weight overlying an ulcer, allowing it to heal. Soft cast compression dressings (Unna boots), composed of cotton gauze impregnated with zinc oxide paste, also can help heal chronic foot and ankle ulcers.

Contraindications

Cast (circumferential) immobilization should be avoided in the following situations:

- During the acute injury phase (usually 3 to 4 days), when acute swelling of the extremity is expected
- When the cast would cover or conceal a known skin or soft-tissue infection
- When the cast would cover or conceal an open wound, where infection may occur

In these situations, a splint is much safer than a cast because it allows the extremity to expand with swelling and provides access to the skin so it can be periodically checked for wound healing and signs of infection.

Potential Complications

A circumferential cast on an injured extremity can be a potentially dangerous form of treatment, and the primary care provider must be vigilant to signs and symptoms of **potential complications.** These include compartment syndrome, cast dermatitis, pressure sores, nerve injuries, and deep venous thrombosis.

Compartment Syndrome

The most serious complication after the application of a cast is the development of compartment syndrome. This refers to a buildup of pressure within the soft tissues that can impede or cut off the blood

supply to an injured extremity, causing permanent damage to muscles and nerves. Compartment syndrome typically follows an injury to a large bone in an area where there is a closed compartment formed by fascial layers (e.g., forearm, lower leg). It is also more likely after a crush injury or arterial laceration. However, compartment syndrome can occur without any of these predisposing factors. The classic example of compartment syndrome in an upper extremity is the Volkmann ischemic contracture, a complication that results in muscle necrosis and loss of function of the affected arm and hand. The most predictive symptom of compartment syndrome is pain that increases over time and is out of proportion to the severity of the injury. The pain is much worse with passive motion of the distal extremity and usually prevents active motion altogether. Less reliable signs and symptoms in the involved limb include paresthesias, decreased two-point discrimination, decreased capillary refill, pallor, and, ultimately, pulselessness. Normal soft-tissue compartment resting pressures are in the range of 5 to 10 mm Hg. As these pressures rise above 30 mm Hg and begin to approach diastolic pressures, irreversible damage to the soft tissues can result. If suspected, compartment syndrome should be investigated by directly measuring compartment pressure, rather than waiting for the later signs of decreased capillary refill or changes in the arterial pulse amplitude. Today, compartment pressure is most commonly measured with a special electronic hand held device, although it can also be measured using a needle, three-way stopcock, intravenous tubing, and a mercury manometer (Whiteside technique). Treatment for a suspected compartment syndrome requires immediate loosening of the cast by cutting and splitting it down both sides of the extremity and then separating the two halves to relieve pressure. This is known as “bivalving” a cast. Depending on which two sides are cut, a cast can be bivalved to create either anterior and posterior shells or medial and lateral shells. If the cast was designed to provide anterior and posterior fracture stabilization, the cast should be bivalved to produce medial and lateral shells. If the cast was designed to provide medial and lateral fracture stabilization, the cast should be bivalved to produce anterior and posterior shells. Adequate relief of pressure may not be achieved unless the

underlying padding and stockinette layers are cut all the way down to the skin. The two cut halves of the cast are then kept separated by about 2-4 mm using cotton padding, and secured with an elastic wrap. With this method, pressure is relieved but the fracture can still be maintained in proper alignment. If symptoms do not resolve within a few minutes of this bivalving procedure, compartment pressures should be measured and surgical decompression undertaken, if necessary.

Cast Dermatitis

Cast dermatitis is a complication that occurs when air circulation is insufficient to clear residual moisture and ongoing limb perspiration from inside the cast. Patients often try to relieve the associated pruritus by scratching with coat hangers, pencils, or other long objects they are able to insert into their cast. Such objects may cause skin abrasions or lacerations that become secondarily infected.

Pressure Sores

Cast- or splint-related **pressure sores** result from inadequate padding over bony prominences or from finger indentations that occur from improper handling of a cast or splint during application. To prevent the latter, plaster and fiberglass cast materials should be manipulated with the palms of the hands (not the fingertips) until sufficiently hardened. If not detected early, pressure sores may progress to pressure ulcers and may require surgical debridement and skin grafting.

Potential complications of casts include disuse atrophy, joint stiffness, compartment syndrome, cast dermatitis, pressure sores, compressive nerve injuries, and deep venous thrombosis.

Nerve Injuries

Pressure over superficial nerves, especially the ulnar nerve at the elbow and the common peroneal nerve at the fibular head, can cause

a temporary nerve palsy or permanent paralysis if left untreated. The causes are the same as for cast pressure sores.

Deep Venous Thrombosis

In addition to lack of ambulation, long periods of immobilization of the lower extremities can lead to formation of deep venous thrombi or pulmonary emboli.

Expected Outcomes

Expected outcomes after a successful immobilization period include decreased swelling and pain and satisfactory fracture alignment and healing. Depending on the age of the patient and the particular joints involved, joint stiffness and muscle atrophy expectedly begin to occur soon after immobilization in a cast or splint. The benefits of immobilization must therefore be weighed against these predictable side effects when deciding on the optimal duration of immobilization. In general, only as much of an extremity as is needed to accomplish the necessary degree of immobilization should be casted. Additionally, patients should be encouraged to move the unaffected joints that extend beyond the borders of the cast or splint frequently.

Essential Anatomy and Physiology

A rule of thumb when casting an injured extremity is that the immobilization should include the joints proximal and distal to the injured area. This rule is frequently broken, however, if the length of the limb proximal to the injury is sufficient to allow for proper immobilization and fixation of the fracture. For example, a cast for a wrist fracture may not have to include the elbow if the length of the cast along the forearm allows for adequate wrist joint immobilization. One should recognize that a short-arm cast never completely immobilizes the wrist joint because it does not prevent forearm pronation and supination. When uncertain about the length of cast required, an orthopedic specialist should be consulted.

Patient Preparation

The following should be considered in preparing the patient for casting or splinting:

- Inform the patient about the procedure and answer any questions.
- Place the extremity in the position of function, unless otherwise indicated.

Nondisplaced, nonangulated fractures are typically immobilized in the position of function, whereas fractures that have undergone closed reductions are immobilized in a position that maintains proper post-reduction alignment.

- *For a short-arm cast, short-arm ulnar gutter splint, or short-arm sugar tong splint:* The elbow is typically flexed to 90 degrees and the forearm maintained in neutral pronation-supination (with the thumb pointing upward). The wrist should be held in slight extension, with the fingers slightly curled as if holding a can of soda.
- *For a short-leg cast, short-leg posterior mold splint, or short-leg sugar tong splint:* The ankle must be strictly maintained at 90 degrees of flexion. Allowing an ankle to drift into plantar flexion (or "equinus") during cast application will result in a cast that hinders walking. If uncorrected, a plantar-flexed cast will result in contraction of the Achilles tendon and stiffening of the calf and hamstring musculature.

For cast or splint immobilization of the lower leg and ankle, the ankle must be strictly maintained at 90 degrees of flexion to avoid causing an equine gait that results from improper immobilization in a plantar-flexed position.

When this cast is removed, the patient will have a resultant equine (toe walking) gait with compensatory knee hyperextension that will

require corrective therapy.

It is easiest to maintain proper ankle position during casting or splinting by applying the cast with the patient lying prone with the knee flexed to 90 degrees. When applying the cast with the patient sitting, proper ankle position can be maintained by using a toe stand or by having an assistant hold the patient by the toes. Whether performed in the prone or sitting position, casting the leg with the knee flexed also helps avoid the mistake of casting too high into the knee area and restricting knee flexion.

Materials

- Stockinette

NOTE: Stockinette is a stretchable sock-like material that is available in several widths. It comes on a large roll that is cut to the desired length. The most appropriate width is selected based on the specific limb involved, the size of the patient, and the degree of limb swelling. Stockinette serves two purposes. First, it acts as a barrier between the skin and the itchy cast padding. Second, after the cast padding and layers of fiberglass are placed, the stockinette and cast padding are pulled over the rough edges of the cast to provide comfortable, padded cast borders.

- Cast padding

NOTE: Cast padding is available in multiple widths packaged in individual small rolls. Depending on the size of the injured extremity, usually 2- or 3-inch padding is used on the arm, 3- or 4-inch padding on the lower leg, and 4- or 5-inch padding on the upper leg. Padding primarily protects the skin and bony prominences from the overlying hard cast material, although it also provides some beneficial compression. Two types of padding are commonly available, cotton and synthetic. Cotton was the type of cast padding originally used when plaster was the only type of cast material available. Wet plaster gently adheres to cotton padding,

which is especially helpful during the application of plaster splints. Cotton padding also tears easily into small strips and adheres to itself (and to synthetic padding). This makes it ideal when additional padding is needed at cast edges and over bony prominences.

Cotton padding is typically used with plaster cast material and for additional padding over bony prominences; synthetic padding is used with fiberglass.

Unfortunately, cotton padding is somewhat difficult to roll onto an extremity without wrinkling and is very difficult to dry through a plaster cast if it gets wet. When fiberglass cast materials became available, synthetic cast padding was developed. Synthetic padding absorbs less water than cotton if it gets wet and is easily dried through a porous fiberglass cast using a hair dryer. Synthetic padding is also bulkier than cotton padding, making it easier to roll onto an extremity without wrinkling. For these reasons, cotton is typically used with plaster and for additional padding over bony prominences, and synthetic padding with fiberglass.

Newer, water-resistant padding made of Gor-Tex or other such materials can be used to pad fiberglass casts in select patients. Two layers of cotton or synthetic padding are usually sufficient, with additional padding added to cast edges and over bony prominences.

Generous padding of a splint is desirable because of the anticipated acute swelling of the injured extremity, but excessive padding of a cast may lead to a loose cast that provides inadequate fracture immobilization as the padding flattens over time.

- Cast material

NOTE: Cast material (i.e., plaster, fiberglass) is available in 2-, 3-, 4-, and 6-inch widths usually packaged in individual rolls. Smaller widths are used on the narrow, distal parts of the extremities (i.e., wrists, hands, ankles, feet), whereas larger widths are used on the

wider and longer areas. The width of cast material selected is usually similar to that of the cast padding.

- Large basin or bucket

NOTE: This is filled with cool or room-temperature water and used to fully immerse the cast material. Use of warmer water will increase the exothermic reaction of the cast materials, thereby increasing the possibility of a thermal injury.

- Apron and gloves

NOTE: These are used to protect the clinician's skin and clothing from the sticky and permanently staining resin contained in fiberglass cast material and from the messy splatter that occurs when using plaster cast material.

- Bandage scissors

NOTE: These are used to cut or trim the padding and cast materials, if needed.

- Cast saw and additional blades

NOTE: Specialized cast saws are used to remove or reshape casts after they harden. A cast saw has an oscillating blade that vibrates (instead of spinning like a conventional saw blade), thereby preventing the saw from inadvertently cutting the skin during cast removal.

Procedure

Applying Casts

1. Select the appropriate size of stockinette.

2. Cut the stockinette to an appropriate length so that there will be about 4 inches of excess stockinette on each end of the cast (Fig. 4.7). Try to smooth out all wrinkles from the stockinette. If necessary, use scissors to remove overlapping wrinkles at the top of the ankle or inside of the elbow.
3. Select the appropriate type and size of cast padding. Roll the padding on smoothly, overlapping each time by about 50% (Fig. 4.8). It is easier to apply cast padding by starting at the narrow end of an extremity and rolling toward the wider part. Properly orient the roll to the extremity (see Fig. 4.8). When rolling the padding, keep the roll in continuous contact with the extremity to avoid undesirable wrinkles that tend to occur when the roll is lifted during application. Two layers of foundation padding are usually sufficient. Extend the padding about 2 inches beyond the intended proximal and distal cast borders. Add an additional two layers of cast padding at the proximal and distal borders of the cast.
4. Using cotton padding, place additional padding over bony prominences, superficial nerves, and in areas of potential cast friction by tearing small sections of padding from the roll and placing them where needed.
5. Don a protective apron and gloves.
6. Immerse the cast material in a bucket of water. For plaster, immerse the roll in cool water until it is "sloppy wet." The excess cool water helps disperse the heat generated from the plaster's exothermic curing process. For fiberglass, immerse the roll in a bucket of water for about 10 seconds, and then squeeze it once gently to remove the bulk of the water.
7. Properly orient the roll of cast material to the extremity and roll it on smoothly, overlapping each time by about 50%. It is easier to apply cast material by starting at the narrow end of an extremity and rolling toward the wider part. Keep the roll in close contact with the extremity to avoid creating an uncomfortably constrictive cast that tends to occur when cast material is improperly lifted and stretched during application of the initial layers. Avoid bunching or

wrinkling by folding or tucking the roll when needed. Try to traverse the entire length of the planned cast with each roll. Start and finish each roll of cast material about 1 to 2 inches inside the border of the cast padding so there will be sufficient padding to roll over the edge of the cast (Fig. 4.9). The average non–weight-bearing cast may require 4 to 6 layers of plaster or 3 to 4 layers of fiberglass, with additional reinforcement at the foot for weight-bearing casts. Additional reinforcement at the foot is needed for a weight-bearing cast. Be sure to maintain the extremity in the position of function while rolling the cast material, and gently reposition it if needed.

8. Mold each layer to the contour of the extremity by gently, but firmly, rubbing the cast between the palms of your gloved hands. This is more easily accomplished after wetting your gloved hands. ***Proper molding*** is necessary to allow for a comfortable fit and appropriate immobilization of the extremity. With the proper amount of cast padding, molding can be accomplished with minimal discomfort to the patient.

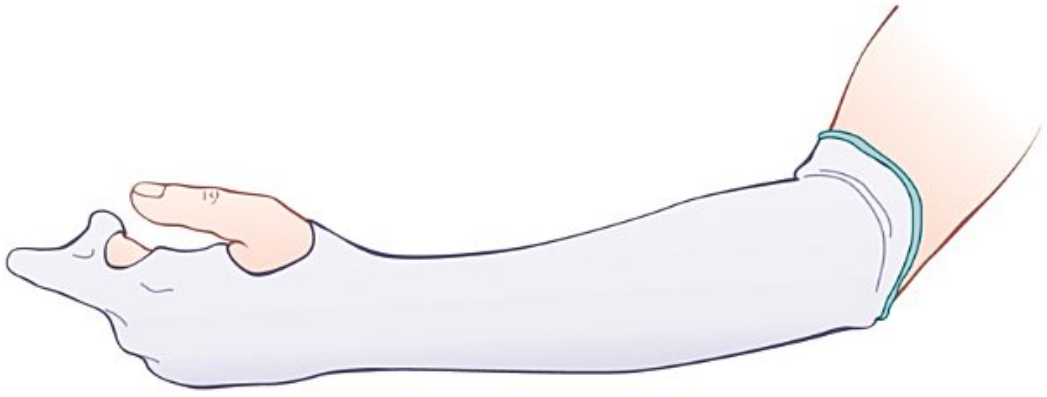

FIGURE 4.7 **Stockinette.**

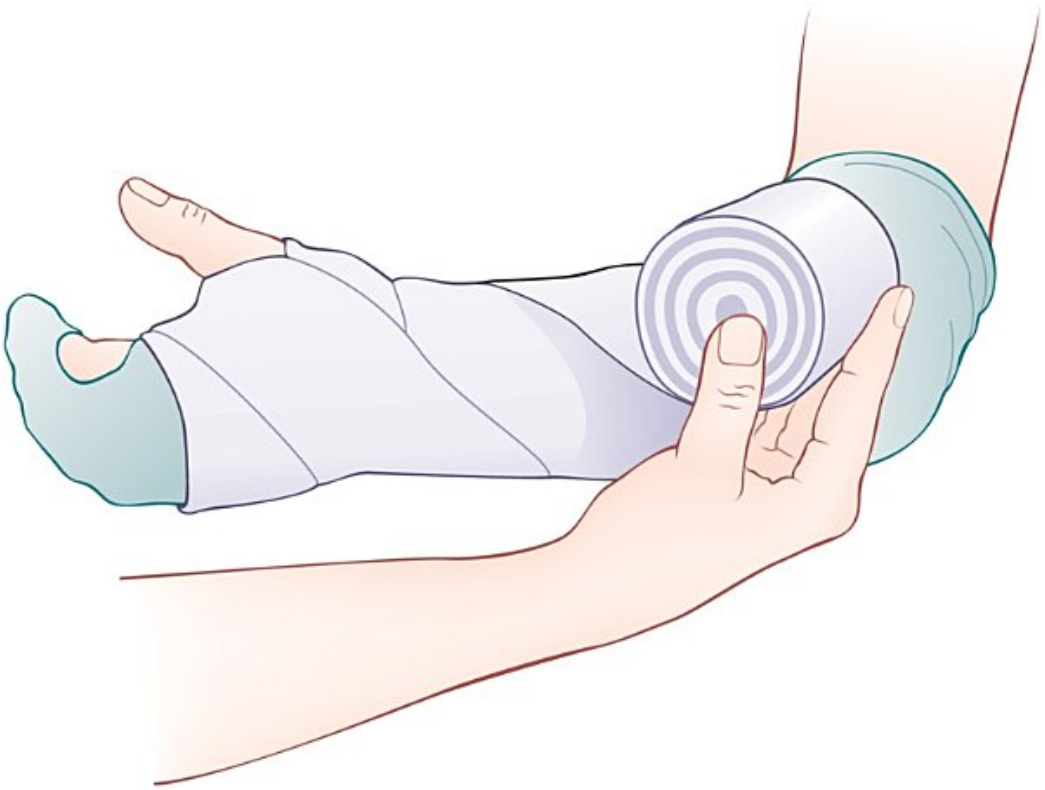

FIGURE 4.8 **Cast padding.**

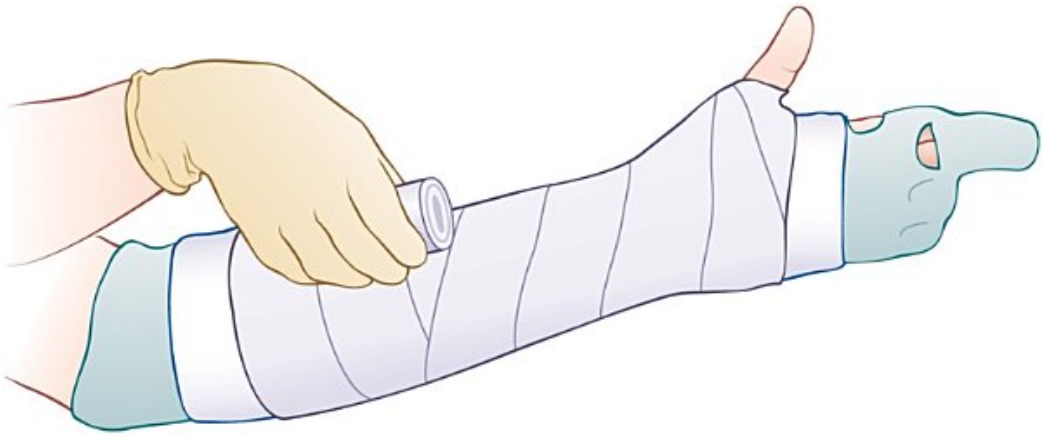

FIGURE 4.9 **Cast material.**

Materials Used for Applying a Short-Arm Cast

- 2-, 2.5-, or 3-inch stockinette (depending on arm size)
- One roll of 2- or 3-inch synthetic cast padding
- Two rolls of 2- or 3-inch fiberglass cast material

Procedure

Applying a Short-Arm Cast

A short-arm cast should extend from about two fingerbreadths distal to the olecranon fossa to just proximal to the metacarpophalangeal (MCP) joints of all fingers. If properly applied, it should immobilize the hand, wrist, and distal forearm, yet allow full flexion at the elbow, full range of motion of all the MCP joints (including the thumb), and an unobstructed thumb-index pinch. A short-arm cast is often used for hand, distal radius, and distal forearm fractures.

1. Place (and maintain) the extremity in the proper position of function, as previously described.
2. Apply stockinette, as previously described. Be sure to extend the stockinette about 4 inches beyond the anticipated cast borders. Cut an extra (distal) hole in the stockinette for the thumb when the stockinette is pulled down before the final layer of cast material is applied (see Fig. 4.7).
3. Apply cast padding, as previously described. Be sure to extend the cast padding about 2 inches beyond the anticipated cast borders so the excess stockinette and padding can later be folded over the rough cast edges to create rolled and padded cast borders. Also apply additional padding over the radial and ulnar styloid processes.
4. Roll on the fiberglass cast material, starting in the narrow wrist area, then do a couple of figure-eights around the hand before proceeding up the arm (Fig. 4.10). When rolling fiberglass through the narrow thumb-index web space, twist the fiberglass cast material 360-degrees (or cut it) so it forms a small bridge no wider than one finger width that allows for thumb-finger opposition (Fig. 4.11).

5. After each roll of fiberglass is applied, mold the cast to the arm (and hand) using your palms, as previously described (Fig. 4.12).
6. Before rolling the final layer of cast material, pull the stockinette and cast padding over each cast edge to create nicely padded and rolled-edge borders. Secure the border with the final layer of cast material.
7. Perform a postapplication assessment, evaluating each feature illustrated in Fig. 4.13.

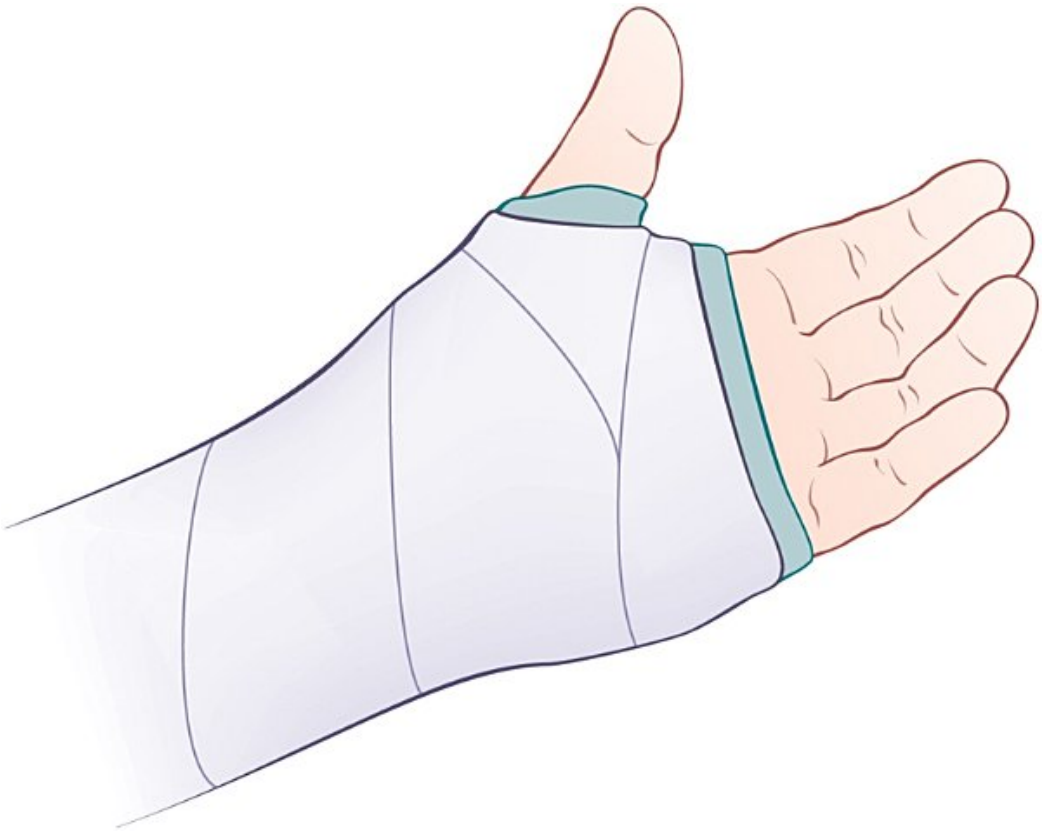

FIGURE 4.10 **Finished Cast Application**

FIGURE 4.11 **Allow Thumb/Index Opposition**

FIGURE 4.12 **Molding the cast.**

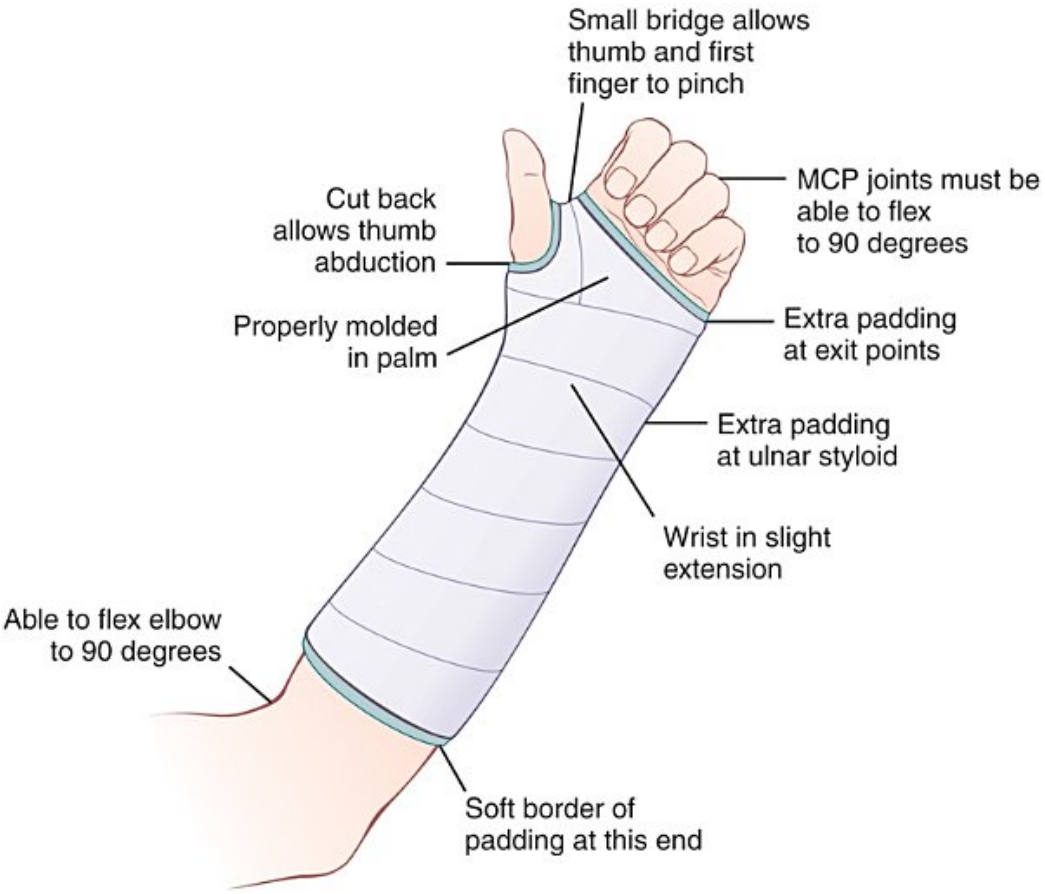

FIGURE 4.13 **Short-arm cast assessment.**

Materials Used for Applying a Short-Leg Cast

- 3- or 4-inch stockinette (depending on leg size)
- Two rolls of 3- or 4-inch synthetic padding
- Three rolls of 4-inch fiberglass cast material

Procedure

Applying a Short-Leg Cast

A short-leg cast should extend from the tibial tubercle (or two finger widths below the fibular head) to just proximal to the metatarsophalangeal (MTP) joints of all toes. If properly applied, it should immobilize the foot, ankle, and lower leg, yet allow full flexion at the knee and full range of motion of all the MTP joints,

including the little toe. It is most often used for ankle fractures or severe ankle sprains.

1. Place (and maintain) the extremity in the proper position of function, as previously described.
2. Apply stockinette, as previously described. Be sure to extend the stockinette about 4 inches beyond the anticipated cast borders.
3. Apply cast padding, as previously described. Be sure to extend the cast padding about 2 inches beyond the anticipated cast borders so that the excess stockinette and padding can later be folded over the rough cast edges to create padded cast borders. Apply additional padding over the tibial tubercle, anterior tibia, medial and lateral malleoli, metatarsal pad area, head of the fifth metatarsal, and especially over the heel.

CAUTION: Do not pad the heel by wrapping circumferentially around the foot because cast padding will bulk up at the dorsal ankle area. To apply heavy padding to the heel, tear strips of cotton cast padding and lay them over the heel.

4. Roll on the fiberglass cast material, beginning at the distal foot. Then make a few figure-eight passes around the heel and ankle before proceeding up the lower leg. To avoid heel area wrinkles in the cast material, include only about half the heel with each pass around the foot.
5. After each roll of fiberglass is applied, mold the cast to the leg (and foot) using your palms, as previously described.
6. Before rolling the final layer of cast material, pull the excess stockinette and cast padding over each cast edge to create padded and rolled cast borders and then secure them with the final layer of cast material.
7. If the cast is to be used for walking, apply extra layers of reinforcement to the bottom surface and heel area for increased strength and durability, and strap a cast shoe to the finished cast.

NOTE: Weight bearing must be restricted until the cast material has fully hardened (1 to 2 hours for fiberglass casts; 4 to 6 hours for plaster casts). Premature weight bearing will cause cracking or denting of the cast.

8. Perform a postapplication assessment, evaluating each feature illustrated in Fig. 4.14.

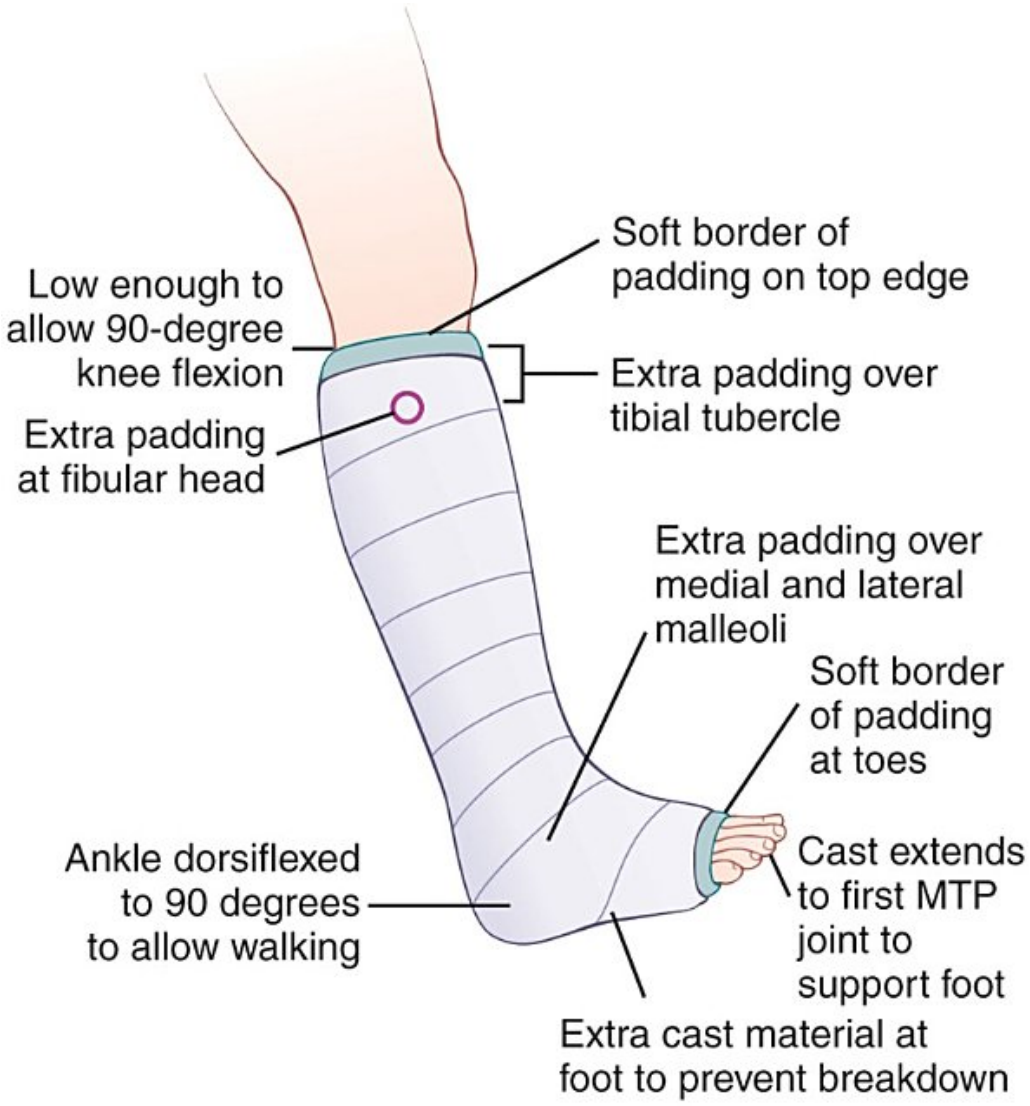

FIGURE 4.14 **Short-leg cast assessment.**

Materials Used for Applying a Short-Arm Ulnar Gutter Splint

- 3 × 12-inch prefabricated splint, with or without stockinette and additional padding
- Bucket of cool water
- Dry towel
- 2- or 3-inch ACE bandage or Coban wrap

Procedure

Applying a Short-Arm Ulnar Gutter Splint

A short-arm ulnar gutter splint resembles a rain gutter that runs along the ulnar border of the hand and forearm, extending from the tip of the little finger to just below the elbow. The forearm is placed in neutral position with the wrist at 20 degrees extension, the MCP joints flexed to 50 degrees, and the proximal interphalangeal (PIP) and distal interphalangeal (DIP) joints in slight flexion. If properly applied, it immobilizes the fourth and fifth digits, the ulnar border of the hand, the wrist, and the distal forearm. This splint is often used to treat fractures of the fourth and fifth phalanges and metacarpals.

1. Consider applying stockinette to the lower arm and hand unless there is strong concern it may become constrictive from acute limb swelling. Because prefabricated splints contain little padding, also consider placing additional padding over the hand, forearm, and styloid processes for improved comfort.
2. Immerse the splint in a bucket of cool water.
3. Remove excess water from the splint by rolling it up tightly or by rolling it like a jellyroll in a dry towel.
4. With the help of an assistant, maintain the patient's arm in the position of function while properly positioning the splint on the patient's arm. If the splint is too long, simply

fold it away from the arm at the proximal end. Carefully avoid making fingerprint indentations in the splint.

CAUTION: When using a prefabricated splint, remember to place the padded side of the splint toward the patient's skin.

5. Secure the splint using an elastic wrap, beginning distally and proceeding proximally.
6. Gently mold the splint around the ulnar aspect of the arm and hand.
7. After the splint sufficiently hardens, remove the wrap and neatly rewrap it. To permit mobility of the thumb, index, and middle fingers, exclude these three digits from the final elastic wrapping.
8. Perform a postapplication splint assessment.

Materials Used for Applying a Short-Leg Posterior Mold Splint

- 5 × 30-inch prefabricated splint, with or without stockinette and additional padding
- Bucket of cool water
- Dry towel
- 3- or 4-inch elastic wrap

Procedure

Applying a Short-Leg Posterior Mold Splint

A short-leg posterior mold splint extends along the posterior aspect of the lower leg, from two finger widths distal to the popliteal fossa to the distal ends of the toes. If properly applied, it should immobilize the foot and ankle yet allow full flexion at the knee. This type of splint is commonly used for initial

immobilization of severe ankle sprains and fractures of the distal leg, ankle, and foot.

1. Consider applying stockinette to the lower leg unless there is strong concern it may become constrictive from acute limb swelling. Because prefabricated splints contain little padding, also consider placing additional padding over the lower leg, medial and lateral malleoli, metatarsal pad area, head of the fifth metatarsal, and especially the heel.
2. Immerse the splint in a bucket of cool water.
3. Remove excess water from the splint by rolling it up tightly or by rolling it like a jellyroll in a dry towel. It is important to remove as much water from the splint as possible to prevent water from pooling at the heel of the splint and causing skin breakdown.
4. With the help of an assistant, maintain the patient's foot and ankle in the position of function. Properly position the splint on the patient's lower leg, starting at the foot and progressing to behind the knee. If the splint is too long, simply fold it back on itself, away from the body, at the proximal end. Carefully avoid making fingerprint indentations in the splint.

CAUTION: When using a prefabricated splint, remember to place the padded side of the splint against the patient's skin.

Secure the splint using an elastic wrap, beginning distally and proceeding proximally. To prevent pressure sores, ensure the folds in the splint at the medial and lateral ankle bend are directed outwardly so they do not press against the skin.

5. Gently mold the splint around the posterior aspect of the lower leg, ankle, and foot.
6. Perform a postapplication splint assessment.

NOTE: A long-leg posterior mold splint is constructed in a similar fashion, except that it includes the entire lower extremity with the knee in nearly full extension. It is constructed using

stockinette (optional), two to three rolls of 4-inch padding, a 5 × 45-inch splint, and additional padding over the medial and lateral malleoli, metatarsal pad area, head of the fifth metatarsal, and heel. It is often used for initial stabilization of tibia fractures.

NOTE: A long-arm posterior mold is constructed in a similar fashion, except the entire upper extremity is splinted in 90 degrees of elbow flexion and neutral forearm pronation or supination. It is constructed using stockinette (optional), three rolls of 3-inch padding, a 4 × 30-inch splint, and additional padding over olecranon, medial and lateral epicondyles, and ulnar styloid process. It is often used for initial stabilization of mid-forearm or proximal forearm fractures or fractures of the distal humerus.

Materials Used for Applying a Lower Leg Sugar Tong Splint

- 3 × 45-inch prefabricated splint, with or without stockinette and additional padding
- Bucket of cool water
- Dry towel
- 3- or 4-inch elastic wrap

Procedure

Applying a Lower Leg Sugar Tong Splint

A lower leg sugar tong splint is a U-shaped splint that starts at the medial aspect of the knee, passes under the heel and proximal foot, and extends to the lateral aspect of the knee. If properly applied, it provides great mediolateral support to the ankle, while allowing full range of motion of toes and knee. The sugar tong splint is an alternative to the posterior mold when splinting the lower leg.

1. Consider applying stockinette to the lower leg unless there is strong concern it may become constrictive from acute limb swelling. Because prefabricated splints contain little

padding, also consider placing additional padding over the lower leg and bony prominences, especially at the medial and lateral malleoli and heel.

2. Immerse the splint in a bucket of cool water.
3. Remove excess water from the splint by rolling it up tightly or by rolling it like a jellyroll in a dry towel.
4. With the help of an assistant, maintain the patient's foot and ankle in the position of function while properly positioning the splint. Start by positioning the splint just inferior to the knee on the medial side of the leg, pass it under the heel and proximal foot, and then up along the lateral side of the leg in a symmetrical fashion. If the splint is too long, simply fold it back on itself, away from the leg, at its lateral end. Carefully avoid making fingerprint indentations in the splint.

CAUTION: When using a prefabricated splint, remember to place the padded side of the splint against the patient's skin.

5. Secure the splint using an elastic wrap, beginning distally and proceeding proximally.
6. Gently mold the splint around the medial and lateral aspects of the lower leg, ankle, and foot.
7. Perform a postapplication splint assessment.

NOTE: An upper arm sugar tong splint is constructed in a similar manner, but it starts at the proximal medial upper arm, passes under the elbow, and extends to the distal lateral aspect of the upper arm. It requires stockinette (optional), a 3 × 30-inch splint, and additional padding over the medial and lateral epicondyles. If properly applied, it provides good stabilization (and some traction) of the upper arm while allowing for some pronation or supination and full range of motion of the wrist and hand. It is often used for initial stabilization of humeral fractures.

NOTE: A lower arm (forearm, short-arm) sugar tong splint is constructed in a similar manner, but it starts at the mid-palmar crease, passes along the volar forearm and around the elbow, and

extends to the MCP joints on the dorsum of the hand. It requires stockinette (optional), two or three rolls of 2- or 3-inch cast padding, a 3 × 30-inch splint, and additional padding over the bony prominences, especially at the medial and lateral epicondyles. If properly applied, it provides good stabilization of the forearm while allowing full range of motion of the fingers and shoulder. It is often used for initial stabilization of forearm fractures.

Follow-Up Care and Instructions

Evaluation after Casting

The following should be taken into consideration in evaluating the patient after cast application:

- Perform a careful assessment of the cast or splint before sending the patient out of the casting area.
- Make sure the cast or splint extends to the proper boundaries, yet does not interfere with the range of motion of necessary joints.
- Check for finger indentations and sharp edges. Using the cast saw or bandage scissors, trim back the cast and repad or recast if necessary.
- Be sure to ask the patient how the cast feels, allowing a few minutes so he or she can determine whether there are areas of increased pressure or sharp edges. If this step is neglected, an unhappy patient will return hours later for cast modification.

Cast Aftercare

The following should be taken into consideration for appropriate aftercare:

- For upper extremity casts and splints, a sling provides elevation (to reduce swelling) and support (for comfort).

When issued a sling, the patient should be instructed to remove it briefly three to four times each day to perform shoulder and elbow range-of-motion exercises to help prevent excessive stiffness and loss of function.

- An open- or closed-toe canvas cast shoe with fastener straps is usually applied to protect a short-leg cast. Most lower extremity casts initially are non–weight bearing until healing progresses over the following days or weeks.
- Provide the patient with crutches, a walker, or another assistive device, if needed, along with complete instructions.
- Advise the patient to avoid getting the cast wet. A wet cast may lead to cast breakdown and skin maceration. Before showering, a towel should be wrapped around the top of the cast, followed by a plastic bag that is tightly secured over the cast with tape. Inform the patient that a hairdryer may be used to dry a fiberglass cast and its padding, if needed. If minimally damaged, a plaster cast can be reinforced with additional cast material. More extensive damage may necessitate cast removal and reapplication.
- Instruct the patient not to insert any objects under the cast in an attempt to relieve itching.
- Instruct the patient to return for a cast or splint check in 3 to 7 days. A splint may be replaced with a cast at this time.
- Instruct the patient to notify you promptly of any numbness, tingling, weakness, skin lesions or discolorations, or, most importantly, increasing pain in the immobilized extremity.

Cast Removal

The following considerations are important in removal of a cast:

- Inform the patient that an oscillating cast saw (Fig. 4.15) is designed to cut rigid cast material, but not padding, stockinette, or underlying skin. The clinician may demonstrate to the patient that the saw does not cut skin by gently touching the oscillating saw to the fleshy part of his or her hand.

- Sawing over bony prominences, however, should be avoided because skin injuries can potentially occur in these locations. A long strip of rigid plastic is sometimes used to slip inside the cast to form a barrier between the saw blade and the patient's skin. This is especially useful when removing a cast from an overly anxious patient. If this device is not available, a wooden tongue depressor can be used to protect the skin at either end of the cast.
- When sawing, the saw blade should be firmly pressed against the cast at a 90-degree angle until it can be felt to pass completely through the cast shell. It should then be lifted out and moved to an adjacent spot and the process repeated. This vertical "in-and-out" sawing motion minimizes the heat generated by the cast saw and minimizes the potential for skin burns or abrasions that frequently occur when the saw is improperly angled and dragged or pulled along the cast.
- If the blade of the cast saw becomes too hot, turn it off until it sufficiently cools. Do not risk burning the patient.
- The cast should be cut down both sides. A special instrument known as a cast spreader is then used to widen the cut further until the two cast shells can easily be separated and removed. A bandage scissors is then used to carefully cut off the underlying cast padding and stockinette.

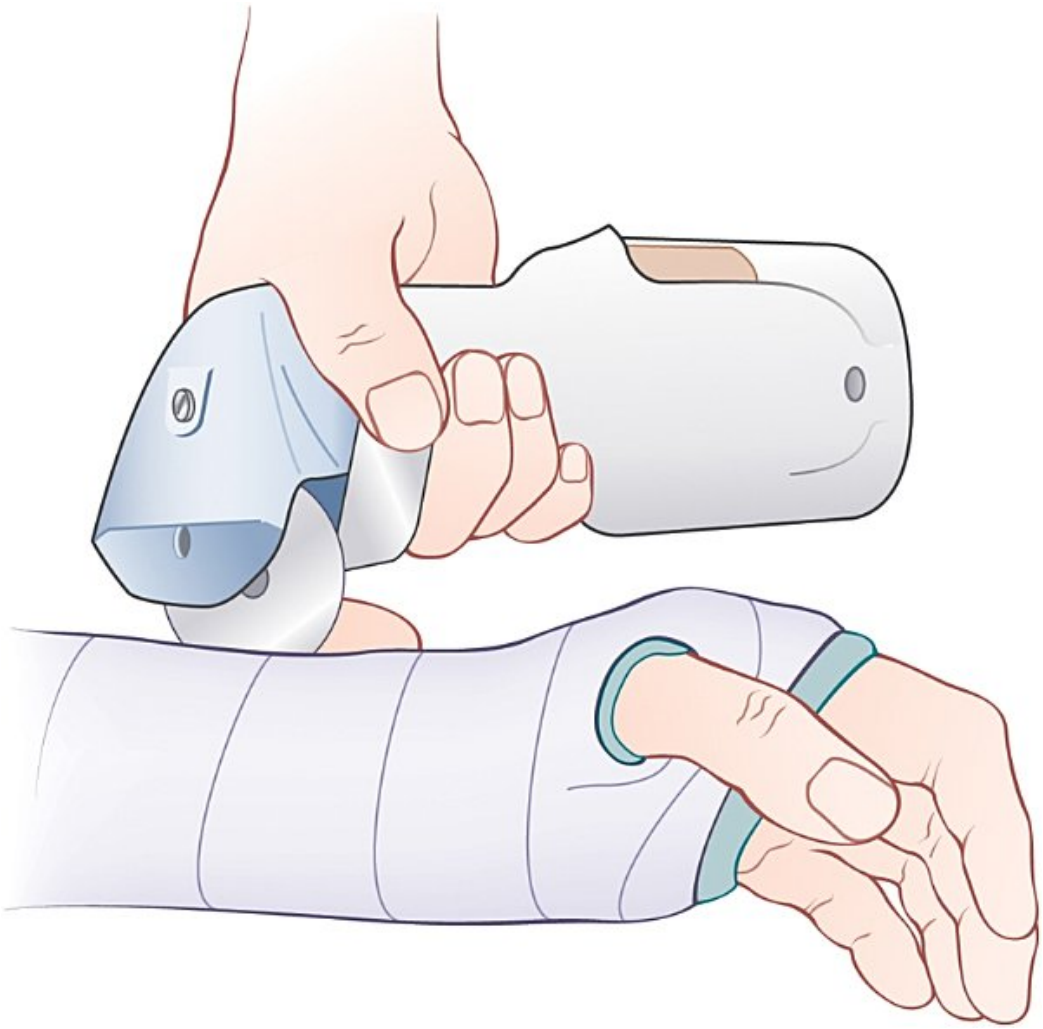

FIGURE 4.15 **Oscillating cast saw.**

When removing a cast with an oscillating cast saw, avoid sawing over bony prominences and use proper technique to prevent overheating of the saw blade.

Cast Window

Occasionally a window-like opening must be cut into an existing cast, or incorporated into a new cast, to provide access for wound care or removal of a foreign object. The cast window must be large enough to accomplish its purpose, yet not so large that it leads to window edema, compromises the structural integrity of the cast, or

compromises fracture immobilization. Generally, a cast window for wound care should be no more than ½ to 1 inch larger than the underlying wound.

Cast Wedging

If postcast radiographs reveal an unacceptable angular deformity of the fracture, two options are available. The first option is to remove the cast, perform another manual reduction, and recast the extremity. A second option is to make a saw cut in the original cast and attempt to bend it in a direction that corrects the underlying angular fracture deformity. This is known as *wedging* a cast. There are two types of cast-wedging procedures: a closing wedge and an opening wedge. With a closing wedge, a long and narrow triangular piece of hard cast shell is removed from one side of the cast, causing the cast to bend toward the cut-out piece. A closing wedge is placed on the side of the cast nearest the apex of the angular fracture deformity. With an opening wedge (more common), a long saw cut is made nearly circumferentially around the hard cast shell and a small plastic wedge is inserted into the slit on one side of the cast. Insertion of the plastic wedge pushes the two cast edges away from it, thereby bending the cast away from the wedge cut. An opening wedge is positioned on the side of the cast opposite to the apex of the angular fracture deformity. Once proper fracture alignment is radiographically confirmed, the wedged cast is reinforced with additional cast material.

Future Considerations

The invention of 3D printers is revolutionizing many industries, and casting/splinting may be one of them. Engineers are developing materials that can be printed into high-strength, low-weight structures that have the exact shape of the extremity to be immobilized. The extremity can be easily scanned with a hand held laser or stereographic scanner that will provide a 3D surface map of the skin to the computer. Then the computer can provide the 3D printer with the exact shape of the structure to fit the extremity. The printed splint can be designed to have many cut-outs that increase

air flow to the skin and reduce overall weight (Fig. 4.16). A hinge and closure device can be attached to allow the splint to be removed and replaced easily. Several recent research studies, including one by Chen and colleagues in China, have shown that 3D printing of casts for distal radius fractures is already practical, safe, and effective. Although the printed casts were more expensive than traditional ones, they were preferred by patients.

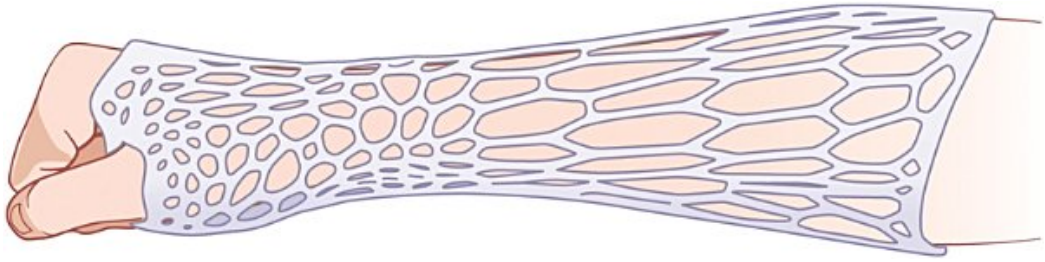

FIGURE 4.16 **3D Printed cast on a forearm.**

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CHAPTER 5

Cryosurgery

Emily D. Babcock

Abstract

Cryosurgery (cryotherapy) is a procedure performed intentionally by a clinician to cause selective tissue destruction. It has been used for decades to treat a variety of benign and malignant skin lesions. The most common cryogenic agent used is liquid nitrogen. It is often used with a cryogun owing to its portability and ease of use in dermatology and primary care offices. Lesions such as common warts, condyloma acuminatum, and actinic keratoses are frequently treated with this method. The depth of the freeze is approximately 1.5 times the lateral spread of the freeze (the halo produced), so it is important that the clinician be competent in this procedure. A blister typically develops after treatment, which can produce pain. However, it is expected to heal within 10 days.

Keywords

cryosurgery
cryotherapy
liquid nitrogen

Procedure Goals and Objectives

GOAL: To successfully perform cryosurgery on appropriate skin lesions using techniques that facilitate lesion resolution while minimizing the potential for complications.

OBJECTIVES: The student will be able to:

- Describe the mechanism of action of cryosurgery.
- Describe the indications and contraindications to cryosurgery.
- Describe potential complications and adverse effects of cryosurgery.
- Describe the pertinent anatomy and physiology of the skin as it relates to cryosurgery.
- Identify the materials, tools, and proper patient preparation needed before performing cryosurgery.
- Identify the benefits and limitations of cryosurgery.
- Describe proper postprocedure care after cryosurgery.
- Identify important elements of patient education after cryosurgery.

Background and History

Cryosurgery, sometimes referred to as *cryotherapy,* is a procedure performed by a clinician who uses a cryogen to cause selective tissue destruction. Cryosurgery has been used for decades for the treatment of various benign and malignant skin lesions and is commonly performed today by primary care clinicians or

dermatologists.[1] It continues to be a good therapeutic choice for many patients, in part because of its relative ease of use, tolerability, and effectiveness and in that it can be performed without anesthesia. Additionally, the materials needed to perform cryosurgery have become less expensive and more available, making it a practical choice for clinicians to perform in the office setting.

Cryosurgery is an affordable, practical choice for clinicians in an office setting.

Various cryogenic substances can be used, such as **liquid nitrogen**, nitrous oxide, and carbon dioxide, although the most commonly used and preferred agent is liquid nitrogen.[2,3] Although the use of liquid nitrogen in the office setting requires purchasing and refilling a storage tank, an agent such as nitrous oxide requires a pressure gauge, a regulator, and a delivery mechanism specific for its use. The use of nitrous oxide or carbon dioxide is more common in obstetrics and gynecology practices for treatment of lesions on the uterine cervix.[4] Use of these alternative cryogens may be seen in such clinical settings to treat skin lesions in addition to cervical lesions. However, nitrous oxide and carbon dioxide do not produce a freeze that is as cold as that produced by liquid nitrogen.[5]

Liquid nitrogen is the most commonly used and preferred cryogenic agent in cryosurgery.

Other cryogenic agents are available and are marketed to clinicians as easy-to-use portable canisters (therefore a storage tank is not needed) with disposable applicator tips. The cryogens in these systems include chemical refrigerants such as pentafluoroethane and dimethyl ether. However, these systems are indicated only for treatment of benign lesions, and the freeze produced is significantly warmer than that provided by liquid nitrogen.[6,7]

The clinician also should be aware of some agents sold over-the-counter that use cryogenic substances other than liquid nitrogen to

destroy lesions such as common warts. The cryogen used in one popular product, for example, is dimethyl ether.[9] These systems also generate a temperature that is much warmer than the freezing temperature provided by liquid nitrogen, but they may be effective for patients if used on a small treatable lesion.

Despite its name, many refer to cryosurgery as a "nonsurgical" approach to the treatment of various lesions, sometimes referring to it as ***cryotherapy*** instead, as mentioned previously. The clinician needs to be aware of the potential different uses of the word *cryotherapy* in the biomedical community. Although cryotherapy in this chapter refers to the delivery of a cryogen to cause tissue damage and lesion resolution, cryotherapy also can be used to indicate the use of agents such as cold packs, ice massage, or cold water immersion for therapeutic purposes.[8]

Cryosurgery in this context refers to treatment of a lesion with liquid nitrogen. However, some refer to it as cryotherapy.

The three main delivery methods for the application of liquid nitrogen in performing cryosurgery are by swab, spray, and cryoprobe. The cotton-tipped swab method uses liquid nitrogen poured into a disposable cup and applied to the skin with a cotton-tipped swab. The spray method uses a **cryogun,** a portable device for spraying liquid nitrogen onto a lesion. The cryoprobe method is similar to the spray method, with the additional use of any one of a variety of cryoprobes for direct application of liquid nitrogen to the skin (Fig. 5.1).

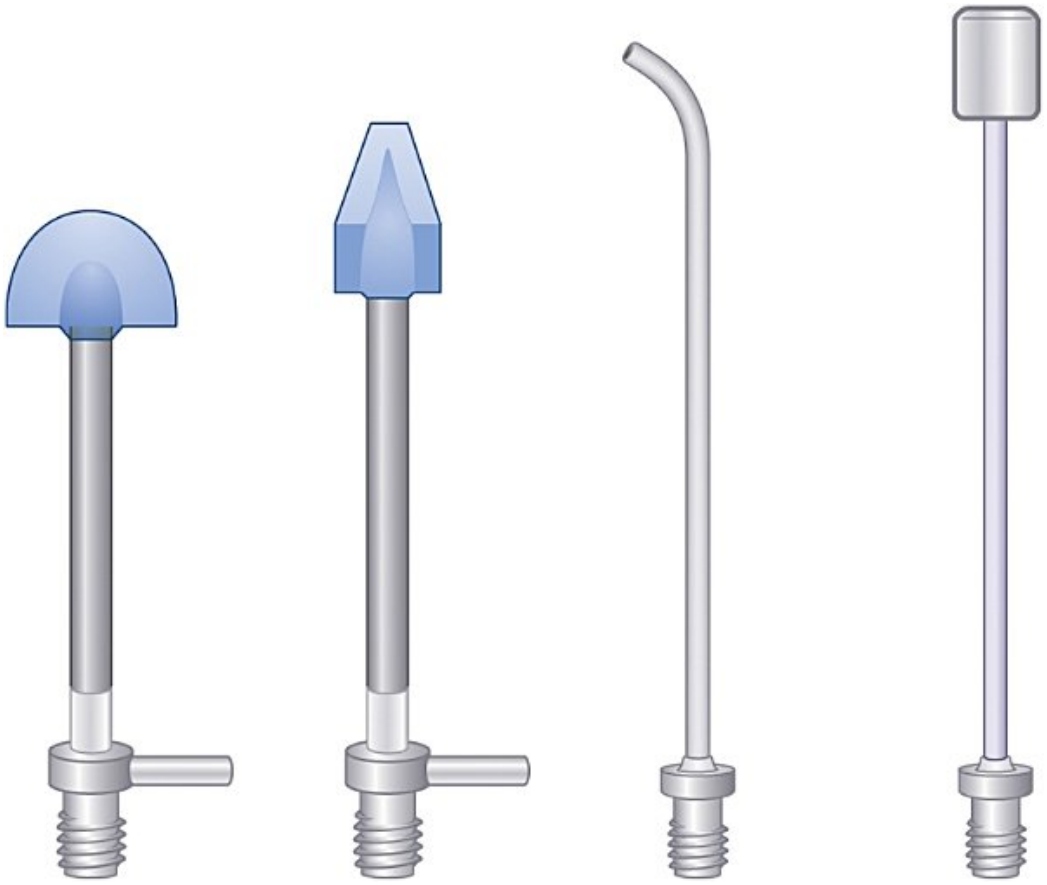

FIGURE 5.1 **Cryoprobe Options.**

A cryogun is the best choice for treatment with liquid nitrogen in a primary care clinic-based practice.

Any of these approaches may be used, but the spray method using a cryogun may be the preferred choice because it provides a continuous spray, enabling the clinician to achieve smaller, superficial freezes as well as larger, deeper freezes.[9] Additionally, it may be the safest choice. Cotton-tipped swabs and cryoprobes are capable of transmitting virus particles; thus using a cryogun is recommended. If a cryoprobe is used, care must be taken that the tips are properly autoclaved.[10]

Indications

Cryosurgery is indicated for the treatment of many benign and malignant skin lesions. It provides rapid freezing when in contact with living tissue. Although treatment of benign lesions can be done easily in the primary care clinic setting, **treatment of malignant lesions** with cryosurgery requires significant experience.[10]

Treatment of malignant lesions with cryosurgery requires significant experience.

Of utmost importance in choosing cryosurgery as a therapeutic modality is the certainty of the diagnostic identity of the lesion to be treated. Because cryosurgery causes tissue destruction, a **biopsy** should be performed on any lesion in which the diagnosis is not clear.

A biopsy should be performed on any lesion in which the diagnosis is not clear before treatment is initiated.

Cryosurgery is indicated for the treatment of lesions such as warts, seborrheic keratoses, and lentigines.[10] A more inclusive list of lesions appropriate for cryosurgery is found in Table 5.1.

Table 5.1

Lesions Appropriate for Cryosurgery

Benign Lesions	Precancerous Lesions	Malignant Lesions
Verrucae (common wart)	Actinic keratosis	Bowen's disease
Condyloma acuminatum (genital wart)		Squamous cell carcinoma in situ
Seborrheic keratosis		Basal cell carcinoma
Lentigo		Squamous cell carcinoma
Molluscum contagiosum		Lentigo maligna
Dermatofibroma		
Sebaceous hyperplasia		
Acrochordon (skin tag)		

One of the lesions most commonly treated with cryosurgery is the precancerous actinic or solar keratosis. The actinic keratosis is a precursor to squamous cell carcinoma in situ (SCCIS), and also to the invasive squamous cell carcinoma (SCC). Thus, when a lesion is properly identified as an actinic keratosis before it progresses, it can be easily treated in the primary care setting with cryosurgery before deeper invasion occurs.[9]

Contraindications

Cryosurgery has fewer absolute contraindications than relative contraindications. The absolute contraindications are as follows[5]:

- Any undiagnosed lesion in which malignancy is suspected
- Recurrent basal cell carcinoma
- Melanoma

- Morphea
- Sclerosing basal cell carcinoma
- Previous adverse patient reaction to cryosurgery

The relative contraindications are as follows:

- Body area with superficial nerves, such as the lateral aspects of the digits, angle of the jaw, and ulnar fossa of the elbow[10]
- Dark complexion
- An extremity with vascular compromise
- Cryoglobulinemia
- Autoimmune disorder
- Raynaud's disease[5]

Furthermore, cryosurgery performed on areas of the skin with hair can potentially destroy hair follicles, leaving a hairless area after the healing process is complete. This could be cosmetically significant in an area such as the eyebrow.

Potential Complications

Within minutes of cryosurgery, erythema and edema may occur, and vesicles or **bullae** may form within 24 to 48 hours.[10] Many clinicians feel that if a small bulla forms, it should be left intact because it provides an excellent biologic dressing for the underlying injured skin.[3]

If a bulla forms after cryosurgery, leaving it intact provides an excellent biologic dressing.

Whether the bulla is to be drained should be based on how much discomfort it causes the patient.

Other potential complications are as follows[2]:

- Hypopigmentation (more likely on a patient with a darker skin type) or hyperpigmentation

- Scarring
- Hair loss
- Infection

Further, because cryosurgery can leave hypopigmented areas or scars, these areas have the potential to conceal persistent lesions.[5] These lesions can remain or develop after treatment, yet be hard to see and identify. This becomes very important if that original lesion was precancerous or improperly identified before treatment. When lesions such as **nevi** are treated with cryosurgery, they are more difficult to interpret morphologically and histologically, should they recur.[5] In general, it is not recommended that nevi be treated with cryosurgery.

Nevi should not be treated with cryosurgery.

Many nevi have a dermal component that can regrow and pose a diagnostic dilemma for the clinician at a later date.

Essential Anatomy and Physiology

An appropriate understanding of the anatomy of the skin is essential for the proper use of cryosurgery and the understanding of its effects. The primary mechanism behind the effectiveness of cryosurgery is **tissue destruction**, enhanced by vascular stasis that occurs after the tissue thaws.[3]

Cryosurgery causes tissue destruction and vascular stasis.

Because cryosurgery causes tissue destruction below the surface of the skin, the clinician must estimate the depth of the freeze as it is occurring. The methods used to judge the degree of the freeze include the freezing time, the size of the halo (in millimeters) produced around the lesion, the thaw time of the halo, and the total thaw time.[5] Many clinicians find it most useful to estimate the tissue

destruction using the halo size. The larger the halo created on the skin, the deeper and colder the freeze.

A thaw time of 20 to 40 seconds after liquid nitrogen is applied is considered adequate to destroy epidermal lesions such as warts and actinic keratoses. Longer freeze–thaw times are able to destroy the dermis, so deeper freezes should be used with caution.[10] Because even a light freeze can cause separation of the dermoepidermal junction, a vesicle or bulla can readily form.

A primary consideration in performing cryosurgery on a skin lesion is the avoidance of unnecessary complications. Therefore, a clinician must understand that maximum tissue destruction occurs when the lesion is frozen rapidly but allowed to thaw slowly. It is the repetition of these freeze and thaw cycles that increases the cellular damage.[10] Although tissue destruction is the intended outcome of the treatment, caution must be used so the appropriate level of freeze is achieved.

Standard Precautions

Every practitioner should use standard precautions at all times when interacting with patients, especially when performing procedures. Determining the level of precaution necessary requires the practitioner to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

Patient Preparation

The following should be taken into consideration in preparing the patient for cryosurgery:

- Inform the patient that cryosurgery produces discomfort in many people. The discomfort from freezing of the tissue may last up to 20 minutes.[5] Lesions requiring longer freezing times are likely to cause more discomfort.
- Place the patient in a comfortable seated or supine position before the treatment, because cryosurgery can cause a

vasovagal reaction in some patients. These positions create a safer treatment environment for the patient and the clinician.

- **Topical anesthetics** such as lidocaine cream or gel may be used before treatment. However, the effects of such topical agents can take 15 to 60 minutes to manifest and necessitate that the patient remain in the office for much longer than it takes to perform the procedure without it.

Topical anesthetics can be used before treatment, but may take up to an hour to become effective.

- Discuss the pros and cons of the use of topical anesthetic with the patient (or parent of the patient), because often anticipating the procedure creates more patient anxiety and apprehension than the procedure itself.
- Inform the patient that it is common for the site treated with cryosurgery to develop a blister. Blisters typically occur within a few hours after the treatment and are expected to heal in approximately 10 days.
- Inform the patient that it is possible to have pain after treatment that may require medication, at the discretion of the clinician.
- Explain that treatment site erythema can last for several days or even weeks and should be expected.

Materials

- Disposable polystyrene cup (if using the cotton-tipped swab method)
- Cryogun (if using the spray method)
- Probes (if using the cryoprobe method)
- Liquid nitrogen
- Cotton-tipped swabs
- Gloves

Procedure

Cryosurgery

In general, a halo of 1 mm around the base of the lesion should be produced to cause effective destruction of many benign lesions (Table 5.2). The clinician should take note that some lesions respond better when the whitish discoloration of the skin does not extend beyond the margin of the lesion; therefore, the halo size in this situation is zero (see Table 5.2). This implies that the proper freeze for some lesions should not produce a halo, but should reach the border of the lesion instead. The **depth of the freeze** is estimated to be approximately 1.5 times the lateral spread of the freeze (the halo).[10]

Table 5.2

Recommended Halo Size for Specific Benign Lesions

Lesion	Recommended Halo Size (mm)
Verrucae (common wart)	1–2
Condyloma acuminatum (genital wart)	1–2
Seborrheic keratosis	1
Lentigo	0–1
Molluscum contagiosum	1
Dermatofibroma	0–1
Sebaceous hyperplasia	0–1
Acrochordon (skin tag)	1–2
Actinic keratosis	1–2

From Usatine RP, Tobinick, EL. In: Usatine RP, Moy RL, Tobinick EL, Siegel DM. *Skin Surgery: A Practical Guide*. St. Louis: Mosby–Year Book; 1998, pp. 137– 164.

Achieving the desired halo often can be accomplished with a freeze time of 5 to 15 seconds. For a lesion that is raised, such as a verruca on the hand, the lesion should be treated such that there is a continuous freeze, called an *ice ball,* that encompasses the lesion. To create an ice ball, a continuous freeze must be applied, beginning at the most distal portion of a raised lesion.[5]

Swab Method

1. Pour liquid nitrogen from the holding tank into the disposable cup.
2. Dip the cotton-tipped swab into the liquid nitrogen.

3. Apply the swab directly to the lesion (Fig. 5.2).
4. Continue to dip and apply repeatedly until the desired halo is achieved.

Spray Method

1. Ensure the cryogen contains enough liquid nitrogen.
2. Orient the spray tip perpendicular to the skin.[5]
3. Squeeze the mechanism to dispense the liquid nitrogen, keeping the tip of the cryogun approximately 1 cm from the skin (Fig. 5.3).
4. Continue to spray the lesion until the halo reaches the intended size.

Cryoprobe Method

1. Select the appropriate probe (see Fig. 5.1).
2. Squeeze the mechanism to apply liquid nitrogen to the lesion by direct contact.
3. Apply the liquid nitrogen with the probe until the desired halo is achieved.

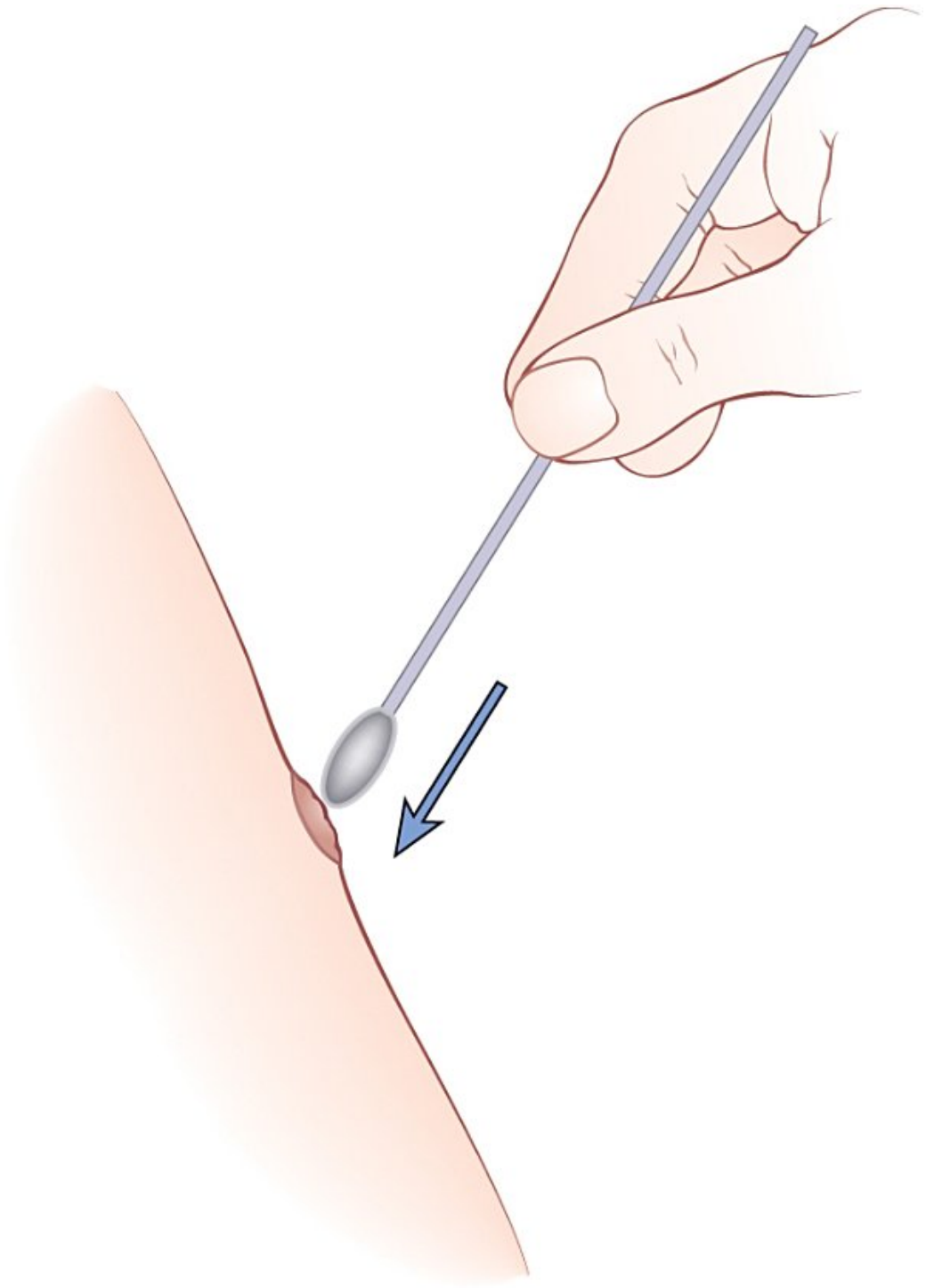

FIGURE 5.2 **Swab Method.**

FIGURE 5.3 **Spray Method.**

Special Considerations

Cryosurgery should be performed only as appropriate for a given lesion. **Overtreating** a lesion may result in unnecessarily destroying healthy tissue and creating scars and hypopigmentation.[10]

It is better to undertreat a lesion with cryosurgery than to overtreat it; overly aggressive treatment can cause excessive tissue damage.

Undertreated lesions can always be retreated at a later date, whereas scars and hypopigmentation can be permanent.

Although cryosurgery can be a quick and effective way to treat many skin lesions, it is imperative that the clinician remembers to be attentive to the skin reaction of every patient as cryosurgery is performed. As little as 10 seconds of freezing can cause depigmentation of normal skin. Finally, care must be taken to avoid treatment in commonly acknowledged "danger sites" such as the medial and lateral canthi, the nasolabial fold, and the postauricular

areas.[9] For treatment in these areas, consultation with a dermatologic surgeon is recommended.

Follow-Up Care and Instructions

After cryosurgery, the patient generally can resume normal activities as tolerated. Patient education must ensure the patient understands the normally expected results of the procedure. Patients must also understand reactions that may represent an important complication. Edema and erythema are to be expected, and pain may be uncomfortable enough to warrant a change in activities. For instance, walking or running may be painful for a few days if treatment was performed on the foot. As mentioned, the development of blisters, sometimes hemorrhagic, is possible; the blister should be left alone if the patient agrees. If the blister is more severe than the patient can tolerate, it can be drained with a sterile needle and treated with a topical antibiotic ointment such as polysporin. Most importantly, the patient should watch for signs of infection, including development of fever, chills, or increased pain in the treated area. In this case, the patient should contact the provider for assistance.

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CHAPTER 6

Dermatologic Procedures

Michelle DiBaise

Abstract

This chapter provides the reader with step-by-step instructions to perform biopsies, electrosurgery, and acne surgery successfully while observing standard precautions and with a minimal degree of risk to the patient. The chapter includes the indications, contraindications, and rationale for performing biopsies, electrosurgery, and acne surgery.in addition to identifying the common complications confronted during these procedures. A review of essential anatomy and physiology, the materials necessary to perform each procedure, and the postprocedure care are also be provided.

Keywords

acne surgery
electrosurgery
excisional biopsy
punch biopsy
shave biopsy

Procedure Goals and Objectives

GOAL: To perform biopsies, electrosurgery, and acne surgery successfully while observing standard precautions and with a minimal degree of risk to the patient.
OBJECTIVES: The student will be able to:

- Define the indications, contraindications, and rationale for performing biopsies, electrosurgery, and acne surgery.
- Identify and describe common complications associated with performing biopsies, electrosurgery, and acne surgery.
- Determine the essential anatomy and physiology associated with performing biopsies, electrosurgery, and acne surgery.
- List the materials necessary for performing biopsies, electrosurgery, and acne surgery and their proper use.
- Describe the steps in performing biopsies, electrosurgery, and acne surgery.
- Identify the important aspects of postprocedure care after biopsies, electrosurgery, and acne surgery.

Biopsy

Background and History

Skin biopsies are performed to determine the cause of a lesion, to remove a lesion, or both. The general categories of biopsies include shave, punch, and excision. A shave biopsy removes the epidermis and a portion of the upper dermis and is performed along the horizontal plane. Variations on the shave technique include

saucerization (deep shave or scoop excision), snip excisions, and curettage. A punch biopsy can be either incisional or excisional. An incisional biopsy removes only a portion of a lesion, whereas an excisional biopsy removes the entire lesion. Larger excisional biopsies can be completed using a no. 15 blade. Incisional and excisional biopsies extend to the subcutaneous fat. Determining the correct biopsy technique is based on the clinical diagnosis (Fig. 6.1) and the desired cosmetic outcome.[1-4]

Skin biopsy options are shave, punch, and excision.

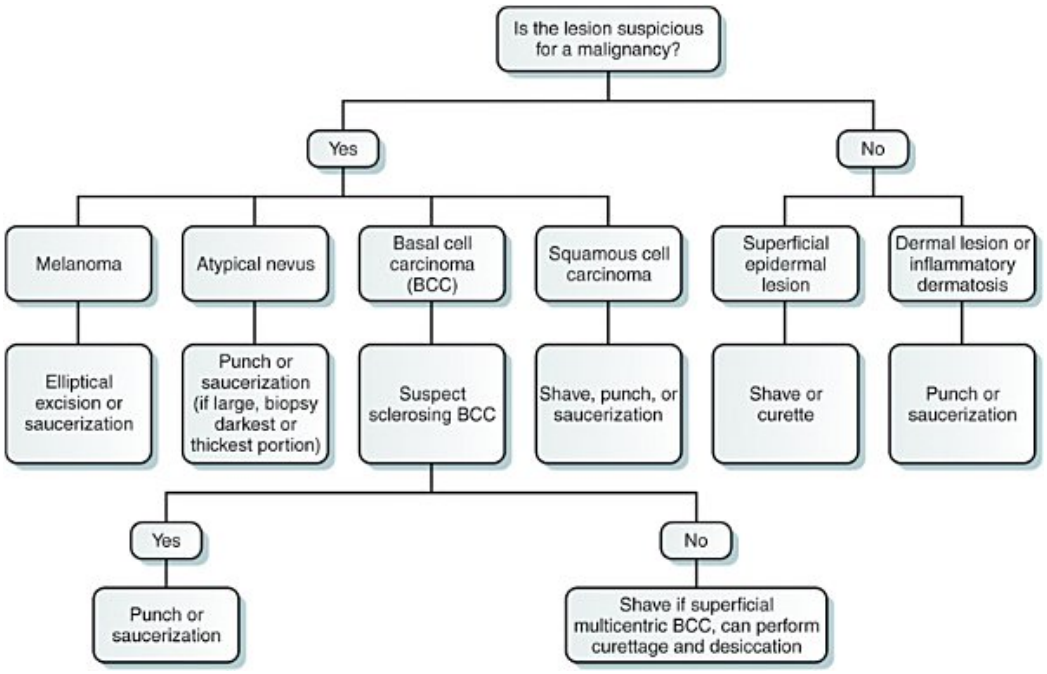

FIGURE 6.1 Algorithm for biopsy technique based on clinical assessment.

Indications

Biopsy is indicated in the following situations:

- Shave biopsy[1,2]
- Seborrheic keratoses

- Verrucous lesions
- Molluscum contagiosum
- Nonmelanoma cutaneous carcinomas

Occasionally, a shave biopsy may be performed on benign nevi, particularly on the face, when a good cosmetic result is essential.[1,2,4]

- Saucerization[2-4]
  - Wide pigmented lesions
  - Sites in which an elliptical excision would have poor cosmesis
  - Sites with a risk for hypertrophic or keloidal scarring (upper back, shoulders, anterior chest, upper arms, lower extremities, ears)
- Snip excisions[1,2]
  - Acrochordons (skin tags)
  - Pedunculated nevi

Care must be taken not to perform this technique on dermal nevi without anesthesia, because the patient will experience greater discomfort because of innervation of nevi.

- **Curettage**[1]
  - Molluscum contagiosum
  - Verruca vulgaris
  - Seborrheic keratoses, with or without cryotherapy
  - For superficial multicentric basal cell carcinomas and Bowen disease, curettage and desiccation are alternatives to excision[1,2]

Curettage should not be performed when tumor margins are necessary.

When curettage is used, histologic margins are impossible to determine. If tumor margins are necessary, an alternative biopsy technique should be used.

Contraindications

The contraindications for a shave biopsy are as follows[2-4]:

Contraindications for shave biopsy are suspected melanoma, atypical nevi, and large dermal lesions.

- Most pigmented lesions, except in the case of benign nevi, as stated earlier
- **Saucerization** is considered an excisional biopsy and can be used for atypical nevi; however, the American Academy of Dermatology issued a position statement that suspected melanomas should be removed by excisional biopsy with narrow margins (1-3mm).[4]

Saucerization can be used for atypical nevi because it is a deep excisional shave.

- Hairy nevi because of the concern of retained hair
- Infiltrative dermatoses
- Suspected sclerosing basal cell carcinoma
- Any lesion with a dermal component

Potential Complications

The most **common complications** seen with shave biopsy include the following[1,4,5]:

- Bleeding: Most bleeding is readily stopped with the use of 20% aluminum chloride (Drysol). If bleeding is more brisk, as occurs when patients are taking aspirin, clopidogrel, ticlodipine, or warfarin, or if the shave is deep into the dermis, handheld cautery may be used. Monsel solution (ferric subsulfate) and silver nitrate may be used, but tattooing can occur. It is not recommended that Monsel solution or silver nitrate be used on the face or highly visible

areas.[1,4] If a repeat biopsy is performed in an area in which Monsel solution was used, the pathologist should be informed because it can interfere with the histologic interpretation.[4]

- Infection: Wounds are dressed with white petrolatum ointment. Although the use of topical antibiotics may decrease the risk of infection slightly, the risk of allergic contact dermatitis and antibiotic resistance is greater than the potential benefits.[1,5] This has led providers to use white petrolatum under the dressing.
- Regrowth of the lesion: Lesions such as warts, incompletely removed nevi, or seborrheic keratosis can regrow.
- Scarring: Scarring, which usually has the appearance of an atrophic, lighter-than-normal area, may occur even when the procedure is performed correctly. It is more of a risk if the shave is deep into the dermis. High-risk areas for hypertrophic or keloid formation are the anterior chest, upper back, shoulders, and upper arms.[2–4]
- Pain: Some discomfort may be experienced with the injection of anesthetic.

Potential complications of a shave are bleeding, infection, regrowth of the lesion, scarring, and pain.

Essential Anatomy and Physiology

For simplicity, the skin structure consists of the epidermis or topmost layer of the skin, the dermal–epidermal junction, the dermis, and the subcutaneous fat. It is essential that the practitioner have knowledge of the vasculature and nerves of the biopsy site before performing any biopsy of the skin.

Be knowledgeable on the anatomic vasculature and nerves before performing a biopsy.

Standard precautions

Every practitioner should use standard precautions at all times when interacting with patients, especially when performing procedures. Determining the level of precaution necessary requires the practitioner to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

Patient Preparation

The following should be taken into consideration in preparing the patient for a biopsy:

- Explain the procedure to the patient, guardian, or both, and be prepared to answer any questions.
- The patient or patient's guardian must give informed consent before start of the procedure.
- A topical anesthetic can be applied 20 to 60 minutes before the procedure, depending on the topical agent used (see Chapter 16 for selection of topical anesthetics). If topical anesthesia is used, the occlusive tape, if any, is removed and cleaned with gauze.

Materials Used to Perform a Shave or Saucerization Biopsy

- Topical anesthetic, if used
- Sterile gloves
- Sterile towels
- Skin preparation: Alcohol pads; for saucerization, povidone-iodine or chlorhexidine
- No. 15 blade, DermaBlade, or razor blade
- Lidocaine with or without epinephrine, as indicated
- 3-mL syringe with 21-gauge needle to draw up anesthetic and 30-gauge needle for injection of local anesthesia
- 4 × 4-inch gauze
- Forceps

- Surgical marking pen
- Cotton-tipped applicator and 20% aluminum chloride for hemostasis (for more vascular lesions, handheld cautery may be needed)
- Specimen container
- Petrolatum ointment and an adhesive bandage

NOTE: Most biopsy specimens may be sent in formalin containers. The exceptions to this are specimens sent for culture or immunofluorescent studies and specimens in which formalin breaks down the tissue, such as in vesicular, bullous, or xanthomatous lesions.[1] In these instances, specimens should be sent fresh on sterile 4 × 4-inch gauze moistened with sterile water or normal saline in a sterile urine cup. All fresh specimens need to be transported immediately to the pathology department for examination.

Materials Used to Perform a Snip Biopsy

- Alcohol pads
- Forceps
- Tonometry scissors
- 4 × 4-inch gauze
- Cotton-tipped applicator and 20% aluminum chloride
- Petrolatum ointment and an adhesive bandage

Materials Used to Perform a Cure ttage

- Alcohol pads
- 4 × 4-inch gauze
- Cotton-tipped applicator and 20% aluminum chloride
- Petrolatum ointment and an adhesive bandage
- Handheld cautery and cryogun (optional)

Procedure

Performing a Shave, Saucerization, Snip, or Curettage Biopsy

Shave Biopsy

1. Place a sterile towel around the biopsy site.
2. Clean the skin with an alcohol pad unless cautery use is anticipated.

NOTE: Because alcohol is flammable, use nonflammable povidone-iodine or chlorhexidine to prepare the skin if cautery may be used.

3. For lesions that may blanch with an anesthetic injection, such as in basal cell carcinomas, mark the margins of the lesion with a sterile surgical marker before the anesthetic is injected.[4]
4. Inject the lesion with anesthetic so that a wheal is raised.
5. Hold the no. 15 blade flat and parallel with the skin surface.
6. If a razor blade is used, snap it in half lengthwise or use a Dermablade and bow the ends so that the middle of the blade is flat and parallel with the skin surface.
7. Smoothly draw the blade through the lesion (Fig. 6.2).
8. The lesion may be gently elevated with the use of forceps or by spearing the lesion with a needle.

NOTE: Care must be taken not to crush the lesion with the forceps, which will distort the histologic specimen (referred to as crush artifact).

9. Attempt to shave the base of the lesion completely by shaving into the uppermost portion of the dermis.

NOTE: If the specimen is too thin (just epidermis), a good histologic diagnosis may not be made.

10. To complete the shave, it is sometimes useful to stabilize the far end of the lesion with a cotton-tipped applicator to cut against.

11. Once the lesion is removed, most light bleeding can be stopped with direct pressure and 20% aluminum chloride on a cotton-tipped applicator.

NOTE: If bleeding is more brisk, handheld **cautery** should be used.

> With cautery, use nonflammable povidone-iodine or chlorhexidine to prepare the skin. Mark the margins of blanchable lesions before anesthetic injection. Take care not to crush the specimen with the forceps.

12. Place petrolatum ointment on an adhesive bandage to dress the wound.

Saucerization

1. Perform steps 1 through 4 as discussed for shave biopsy using povidone-iodine or chlorhexidine to prepare the skin.
2. Using the surgical marker, provide a 1- to 3-mm margin around the lesion.
3. Hold the razor or Dermablade at a 45-degree angle and remove the lesion within a disk of tissue and extending to the subcutaneous fat. (A demonstration video can be found at http://www.youtube.com/watch?v=R0yvX-ty9VM.)
4. Check the base of the lesion for residual pigmentation and remove if seen.
5. Use direct pressure, 20% aluminum chloride, or handheld cautery for hemostasis.
6. Place petrolatum ointment on an adhesive bandage to dress the wound.

Snip Excision

1. Clean the area lightly with an alcohol pad.

NOTE: There is usually no need to anesthetize the area. The exception is larger skin tags because they may actually be dermal nevi.

2. Pick up the skin tag with forceps and cut at the base with tonometry scissors.
3. If bleeding occurs, stop with 20% aluminum chloride on a cotton-tipped applicator.
4. Place petrolatum ointment on an adhesive bandage to dress the wound.

Curettage

For seborrheic keratoses, verrucous lesions, or molluscum contagiosum, cryotherapy (see Chapter 5) applied first and followed quickly by curettage requires no local injection because **liquid nitrogen** acts as a partial anesthetic.[1]

> Liquid nitrogen can be used to briefly anesthetize lesions before curettage.

1. If the patient is apprehensive, a topical anesthetic can be applied before the procedure.
2. If the use of cautery is anticipated, the lesion should be injected with anesthetic.
3. Hold the curette like a pencil with the sharp side down.
4. Stabilize the skin and use quick scraping motions.

NOTE: When the lesion has been removed, the skin feels different under the curette. Differentiating this change develops with the experience of the provider.

5. Once the lesion is completely removed, obtain hemostasis with 20% aluminum chloride on a cotton-tipped applicator or with handheld cautery.

NOTE: Curettage and desiccation for basal cell carcinomas and Bowen disease requires the following procedure: Curette the lesion until all visible signs of tumor are gone (generally 1 to 2 mm onto normal skin), desiccate the whole base of the lesion with handheld cautery, and then repeat both steps for three full cycles of curettage and desiccation.[1]

6. Place petrolatum ointment on an adhesive bandage to dress the wound.

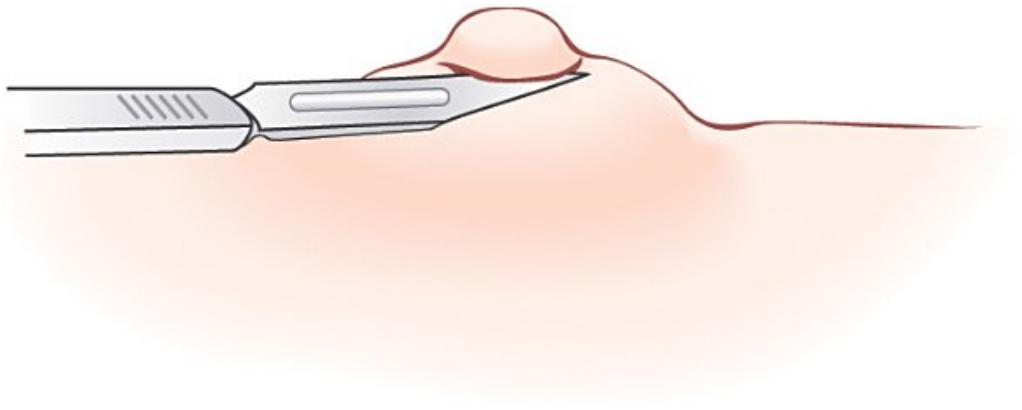

FIGURE 6.2 Shave biopsy. (Redrawn from Pfenninger JL, Fowler GC. *Procedures for Primary Care Physicians.* St. Louis: Mosby–Year Book; 1994, p. 22.)

Follow-Up Care and Instructions

The following should be considered in providing follow-up care:

- Send tissue to pathology, one specimen per container, appropriately labeled as to the site, patient name, identification number, and date, with the completed pathology form.
- Provide **written instructions** on wound care to the patient.
- Instruct the patient to keep the area clean and dry for 24 hours.[1]
- After that time, instruct the patient to remove the adhesive bandage and to clean the wound site with soap and water as usual.
- Instruct the patient that if an adhesive bandage is applied, more petrolatum ointment should be placed on the biopsy site. For most small shave biopsy sites, however, the adhesive bandage does not need to be reapplied after the first 24 hours. Saucerization sites should be washed daily with soap and water after 24 hours and a new dressing with petrolatum ointment applied for 5 to 7 days.
- Caution the patient that infection is a rare complication.
- Instruct the patient to call the office if the following signs appear: erythema, tenderness, or warm skin with purulent drainage. When this occurs, antibiotic treatment should be initiated. A broad-spectrum oral antibiotic that covers *Staphylococcus* and *Streptococcus* species should be used, such as cephalexin, dicloxacillin, or, if methicillin-resistant *Staphylococcus* is suspected, trimethoprim-sulfamethoxazole.[1,5]
- Barring infection, it is not necessary to schedule a **return appointment**, but the patient should be informed of the results of the pathologic examination.

Provide the patient with written wound care instructions.

Patients need not return for follow-up appointment after a shave biopsy, but must be called with results from the pathologic

examination.

Punch Biopsy

Indications

To confirm the diagnosis before starting treatment in a lesion or dermatosis that covers a large surface area, taking just a portion of the lesion is indicated.[2,4] It is important to take the most **representative area** of the lesion for the highest diagnostic yield.

Punch biopsy: Select most representative lesion.

- In the case of pruritic dermatoses, it is best to obtain a biopsy sample from a lesion that has not been **excoriated.**
- For vesicular lesions, an intact vesicle or bulla may provide the best diagnostic yield for general histologic examination. If an autoimmune bullous disorder is suspected, an additional punch biopsy should be obtained within 1 cm, but not on the vesicle or bulla. This fresh specimen should be sent to the pathology department for direct immunofluorescence staining.
- In suspected melanoma that is too large to excise at that time, the biopsy should be obtained from the darkest or thickest area of the lesion. Studies have demonstrated no difference in mortality between incisional and excisional biopsies for melanoma.[4]

Avoid excoriated lesions for biopsy.

Contraindications

Contraindications for an incisional biopsy are any lesion with highly suspected malignant potential, such as melanoma, that could be easily excised at the initial visit.[2,4] Any lesion 8 mm or smaller,

regardless of malignant potential, can easily be removed completely with a punch biopsy.

Potential Complications

The risks with a punch biopsy are similar to those of shave biopsies, as follows:

- Pain: Discomfort may be felt on injection of the anesthetic.
- Bleeding: The risk for bleeding is higher than in shave biopsies because the skin is incised to the subcutaneous fat, increasing the risk for severing small vessels. Direct pressure and handheld cautery is the method of choice to stop brisk bleeding. In any punch biopsy of 8 mm or larger, subcutaneous sutures also decrease the bleeding and improve wound healing.
- Infection: The infection rate is higher because the procedure is slightly more invasive. As with a shave biopsy, secondary infection can be easily treated with a 5- to 7-day course of an oral broad-spectrum antibiotic.
- Scarring: This will occur, but the extent depends on the patient's ability to heal versus the size of the end defect. In punch biopsies of 8 mm or larger, it is more cosmetically appealing to perform an excision with a no. 15 blade,[4] which avoids the potential problem of dog-eared closures. In addition, adequate knowledge of the lines of skin tension is required to determine the orientation of punch and excisional biopsies. Suture lines are less likely to develop into a widened scar if placed parallel to the lines of tension (Fig. 6.3).[2,4] In addition, placing suture lines parallel to wrinkles improves the cosmetic appearance of the end defect.

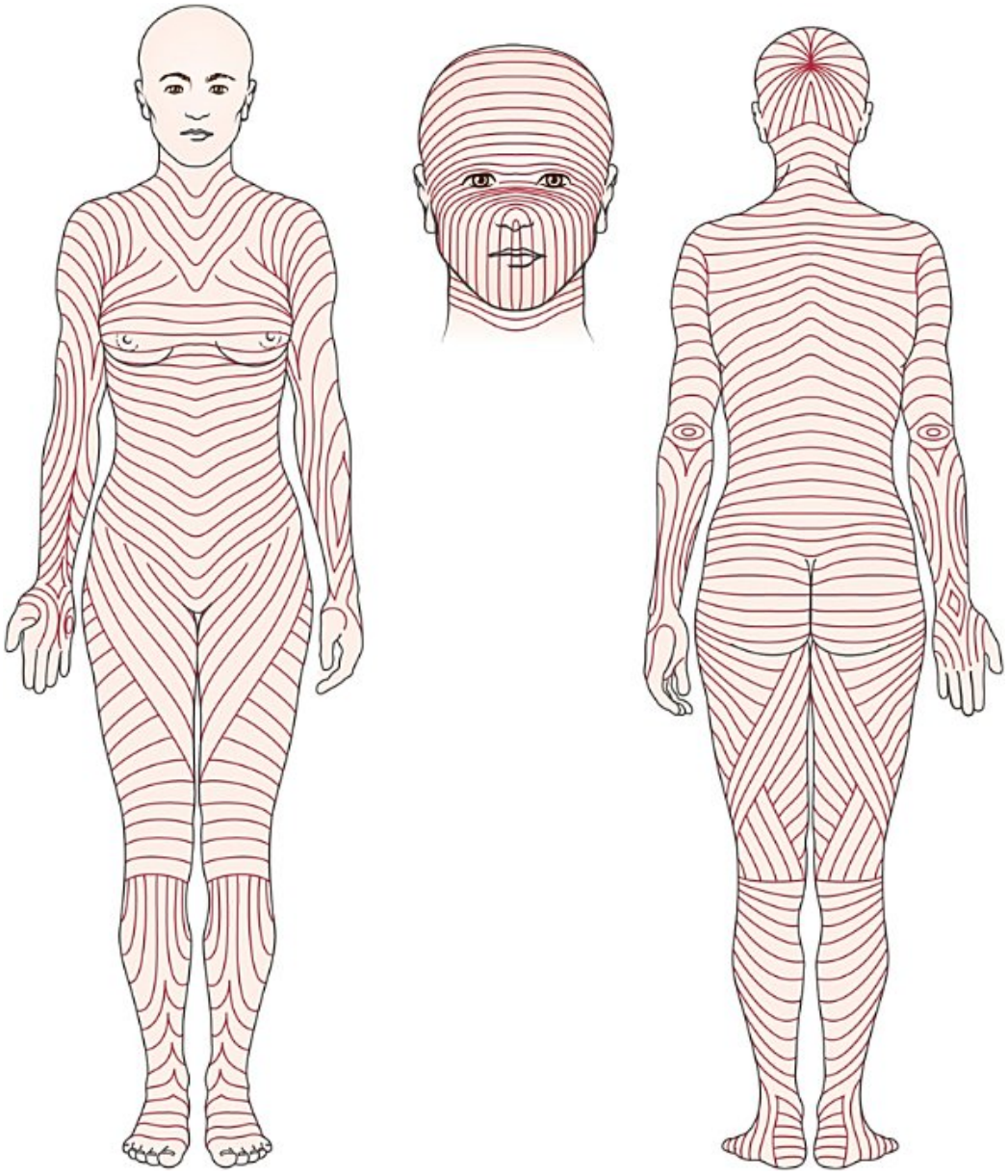

FIGURE 6.3 Skin tension lines of the body surface.
(Modified from Trott AT. *Wounds and Lacerations: Emergency Care and Closure,* ed 2. St. Louis: Mosby–Year Book; 1998, p, 17.)

Use standard precautions, as described in Chapter 35.

Patient Preparation

The following should be considered in preparing the patient for a punch biopsy:

- Explain the procedure to the patient, guardian, or both, and be prepared to answer any questions.
- The patient or guardian must give **informed consent** before the start of the procedure.
- A topical anesthetic can be applied 20 to 60 minutes before the procedure, depending on the topical agent used (see Chapter 16 for selection of topical anesthetics). If topical anesthesia is used, the occlusive tape, if any, is removed and cleaned with gauze.

Obtain informed consent for all patients.

Materials Used to Perform a Punch Biopsy

- Topical anesthetic, if used
- Metric ruler to determine the size of the lesion
- Sterile gloves
- Sterile towels
- Alcohol pads
- Lidocaine with or without epinephrine, as indicated
- 3-mL syringe with 21-gauge needle to draw up anesthetic and 30-gauge needle for injection of local anesthesia (for larger lesions use a 27-gauge, 1½-inch needle)
- 4 × 4-inch gauze
- Forceps
- Curved scissors
- Needle driver
- Appropriate suture to close skin (see Chapter 32)
- Specimen container
- Petrolatum ointment and an adhesive bandage
- Appropriately sized punch to excise the lesion completely with a minimal margin of normal skin

NOTE: Disposable punches are available in the following sizes: 2, 3, 4, 6, and 8 mm. In the case of incisional biopsies, a 3- or 4-mm punch should be sufficient to make the diagnosis. If tissue is needed

to send for both histologic examination and culture or immunofluorescent studies, two 3- or 4-mm biopsy specimens may be taken. Alternatively, one 6-mm specimen may be sent with a request to the pathology department to split the specimen with explicit directions on what is to be done with each half.

Select a punch that will excise the lesion with minimal normal borders.

Procedure

Performing a Punch Biopsy

1. Place a sterile towel around the biopsy site.
2. Use an alcohol pad to lightly clean the area.
3. Drape the area with sterile towels.
4. For lesions that may blanch with an anesthetic injection, such as in basal cell carcinomas, mark the margins of the lesion with a sterile surgical marker before injecting the anesthetic.
5. Inject the anesthetic to cover the area where the punch and sutures will be placed.

NOTE: It is also important to ensure that the full depth of where the punch will extend is **anesthetized.** Local anesthetic works rapidly, within a minute; however, in highly vascular areas such as the scalp, it is prudent to wait 10 minutes to allow the epinephrine to work.[4]

Make sure to anesthetize to the deep margin and wide enough to allow anesthesia of suture site.

6. After selecting the appropriate size punch, hold the skin taut perpendicular to the lines of tension, wrinkle, or skin fold.
7. Hold the punch perpendicular to the skin and place it so that the lesion is centered within the punch area (Fig. 6.4A).
8. Apply downward pressure while **rotating the punch.**

NOTE: It is useful to get into the habit of rotating the punch in one direction, as is necessary for the biopsy of vesicular or bullous lesions. Rotating back and forth in these cases distorts the plane of cleavage.[1]

Rotate the punch in just one direction for best pathology outcome.

9. The punch should extend to the subcutaneous fat.

NOTE: When performing a **punch biopsy over large vessels** or nerves and in areas of thin skin, it is sometimes helpful to pinch the skin upward to avoid damaging underlying structures.

Use caution when performing punch biopsy over large vessels.

10. Once complete, remove the punch, and the specimen will remain attached to the subcutaneous fat by a pedicle (see Fig. 6.4B).
11. Gently lift the specimen with a pair of forceps and cut at the base with a pair of scissors (Fig. 6.4C).

NOTE: Care must be taken not to crush the lesion with the forceps, which could distort the histologic specimen.

NOTE: If the punch is removed and the pedicle is missing, it may be found in one of two places. Most commonly it is inside the punch. Removal can be accomplished by spearing it with a needle and pulling it out. It may also be under the skin. Gently explore under the skin through the defect to look for the specimen.

12. Once the specimen is removed completely, place it in the specimen container.
13. Suture the wound, placing half as many sutures as the size of the punch (see Chapter 32). For instance, a 6-mm punch requires three evenly spaced sutures. Punch biopsy wounds of 4 mm or less can be allowed to heal by secondary intent.
14. Apply petrolatum ointment on an adhesive bandage to dress the wound.

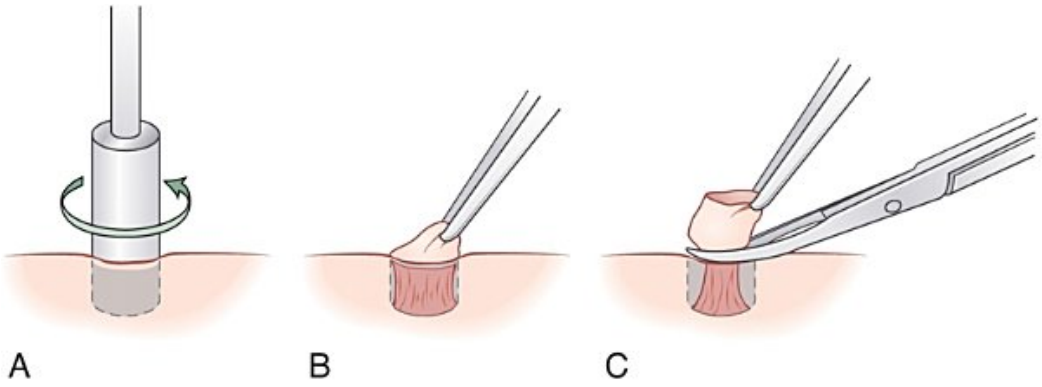

FIGURE 6.4 Punch biopsy. (Redrawn from Pfenninger JL, Fowler GC. *Procedures for Primary Care Physicians.* St. Louis: Mosby–Year Book; 1994, p. 23.)

Follow-Up Care and Instructions

The following should be considered in providing follow-up care after a punch biopsy:

- Send tissue to the pathology department, one specimen per container, appropriately labeled as to the site, patient name, identification number, and date with the completed pathology form.
- Provide written instructions on wound care to the patient.
- Instruct the patient to keep the area clean and dry for 24 hours. After that time, the adhesive bandage may be removed and the site cleaned with soap and water.
- If a new adhesive bandage is applied, instruct the patient to place more petrolatum ointment on the biopsy site. For most punch biopsy sites, however, the adhesive bandage does not need to be reapplied after the first 24 hours. The exception to this is in areas of friction or if drainage will get on the patient's clothing.
- Schedule a return appointment in 5 to 21 days, depending on the area biopsied. The head tends to heal faster, whereas areas of tension such as the anterior tibia require longer healing times. A basic time schedule for suture removal is as follows[2,6]:
  - Face: 3 to 5 days
  - Ears: 10 to 14 days
  - Neck: 7 days
  - Scalp: 7 to 10 days
  - Trunk and extremities: 10 to 14 days
  - Distal lower extremities: 10 to 21 days
- Advise the patient to not do any heavy lifting or exercising that might cause the sutures to break or lead to a widened scar.
- The patient should be informed of the results of the pathologic examination, either when the results are provided to the practitioner or when the patient returns for suture removal.

Excisional Biopsy

Indications

Any lesion that is 8 mm or smaller can be completely excised with a punch biopsy. Most **lesions larger than 8 mm** have a better cosmetic appearance if the excision is performed using a no. 15 blade. Lesions that are excised routinely are as follows:[1]

- Suspected melanomas
- Epidermal inclusion cysts
- Lipomas
- Dermal lesions larger than 8 mm

If a lesion is greater than 8 mm, use an excisional technique.

Mohs micrographic surgical procedures are beyond the scope of primary care providers because they require special training to perform. Mohs procedures are preferred in sclerosing and morpheaform basal cell carcinomas, recurrent tumors, and any malignant tumor around the eyes, nose, or lips and on the ears. They use a special technique of excising and color-coding the specimen before histologic examination. This method has a higher overall cure rate and lower recurrence rate than standard excisions.[1] Patients who meet the preceding criteria and in whom surgery is being considered should be referred to a dermatologist trained in the Mohs technique.

Potential Complications

The complications are similar to those of punch biopsies.

- Pain: Discomfort will be felt with the injection of anesthetic.
- Bleeding: The risk for bleeding is higher because a larger area of skin is incised to the subcutaneous fat, increasing the risk for severing small vessels. Handheld cautery is the method of choice to stop brisk bleeding in addition to subcutaneous sutures.
- Infection: The infection rate is also higher because the procedure is more invasive. Secondary infection can be

treated easily with a 5- to 7-day course of an oral broad-spectrum antibiotic covering *Staphylococcus* and *Streptococcus* species.
- Scarring: This will occur, but the extent depends on the patient's ability to heal versus the size and placement of the end defect.
- More than with any other biopsy technique, adequate knowledge of the **lines of skin tension** is required to determine orientation of excisional biopsies (see Fig. 6.3).

Understand the lines of tension and biopsy orientation placement.

Caution must be used when performing elliptic **excisions on the face**—particularly on the forehead or near the eyes or lips—so that distortion does not occur.[4] Large excisions in these areas may necessitate a graft or flap closure.

Use caution around facial features to avoid distortion.

Use Standard Precautions as described in Chapter 35.

Patient Preparation

The following should be considered in preparing the patient for excisional biopsy.

- Explain the procedure to the patient, the patient's guardian, or both, and be prepared to answer any questions.
- The patient or guardian must give informed consent before the start of the procedure.
- A topical anesthetic can be applied 20 to 60 minutes before the procedure, depending on the topical agent used (see Chapter 16 for selection of topical anesthetics). If topical anesthesia is used, the occlusive tape, if any, is removed and cleaned with gauze.

Materials Used to Perform an Excisional Biopsy

- Topical anesthesia, if used
- Chlorhexidine or povidone-iodine
- Sterile surgical marker
- Sterile gloves
- Sterile towels
- Alcohol pads
- Lidocaine with or without epinephrine, as indicated
- 3-mL syringe with 21-gauge needle to draw up anesthetic and 27-gauge, 1-inch needle for local anesthesia
- 4 × 4-inch gauze
- Forceps
- Curved scissors
- Needle driver
- Appropriate suture to close subcutaneous tissue and skin (see Chapter 32)
- Handheld cautery
- Specimen container
- Petrolatum ointment and a dressing of 4 × 4-inch gauze and paper tape or a large adhesive bandage
- Metric ruler to determine the size of the end defect

Procedure

Performing an Excisional Biopsy

Proper anesthetic technique is determined by the size of the area being excised and may warrant direct infiltration of the biopsy site, digital block, or a field block (see Chapter 16).

It is also important to ensure that anesthesia is adequate for the full depth and width of the excision and placement of sutures. Local anesthesia works rapidly, within a minute; however, in highly vascular areas, such as the scalp, it is prudent to wait 10 minutes to allow the epinephrine, when used, to work.

1. Scrub the area for 5 minutes with chlorhexidine or povidone-iodine.
2. Drape the area with sterile towels.
3. If the lesion has the potential to blanch with the injection of lidocaine with epinephrine, such as in basal cell carcinomas, the margins of the lesion should be marked with a sterile surgical marker before the anesthetic is injected.
4. Use a sterile surgical marker to mark the intended incision line, taking into account the lines of tension, wrinkles, or skin folds (see Fig. 6.3).
5. Hold the no. 15 blade like a pencil, perpendicular to the skin.
6. Use the tip of the blade to incise the corner of the ellipse, but use the belly for the rest of the incision.[5]
7. Continue the incision through the dermis to the subcutaneous fat (Fig. 6.5).
8. Use the forceps to lift the specimen gently, taking care not to crush it.
9. Use the no. 15 blade to cut the specimen at the base or subcutaneous fat.

NOTE: In the case of potentially malignant lesions, it is useful to place **a tag suture** on one corner of the specimen, indicating where the tag was placed on the form sent to pathology (e.g., tag is placed on medial corner).

In suspected malignant lesions, tag one corner of the specimen to determine orientation.

10. Once the specimen is completely removed, place it in the specimen container.
11. In larger excisions, push the skin edges of the defect together or pull them together with skin hooks to see how much tension will be placed on the sutures.

NOTE: If there is tension, **undermining** is needed. Undermining is performed by blunt dissection to mobilize adequate tissue for closure.

12. Stop any bleeding with handheld cautery.
13. Begin closure of the excision by placing subcutaneous vertical mattress sutures to approximate the wound edges, decrease wound tension, and reduce the risk for wound dehiscence. This is performed with an absorbable suture material.
14. Place nonabsorbable sutures to close the skin.

Perform undermining in areas of tension.

NOTE: This can be performed with running or simple interrupted sutures for most wounds. In areas of greater tension, mattress sutures may need to be placed for strength.

15. Leave the skin edges everted at the end closure for the best outcome.
16. Apply petrolatum ointment on a dressing over the wound.

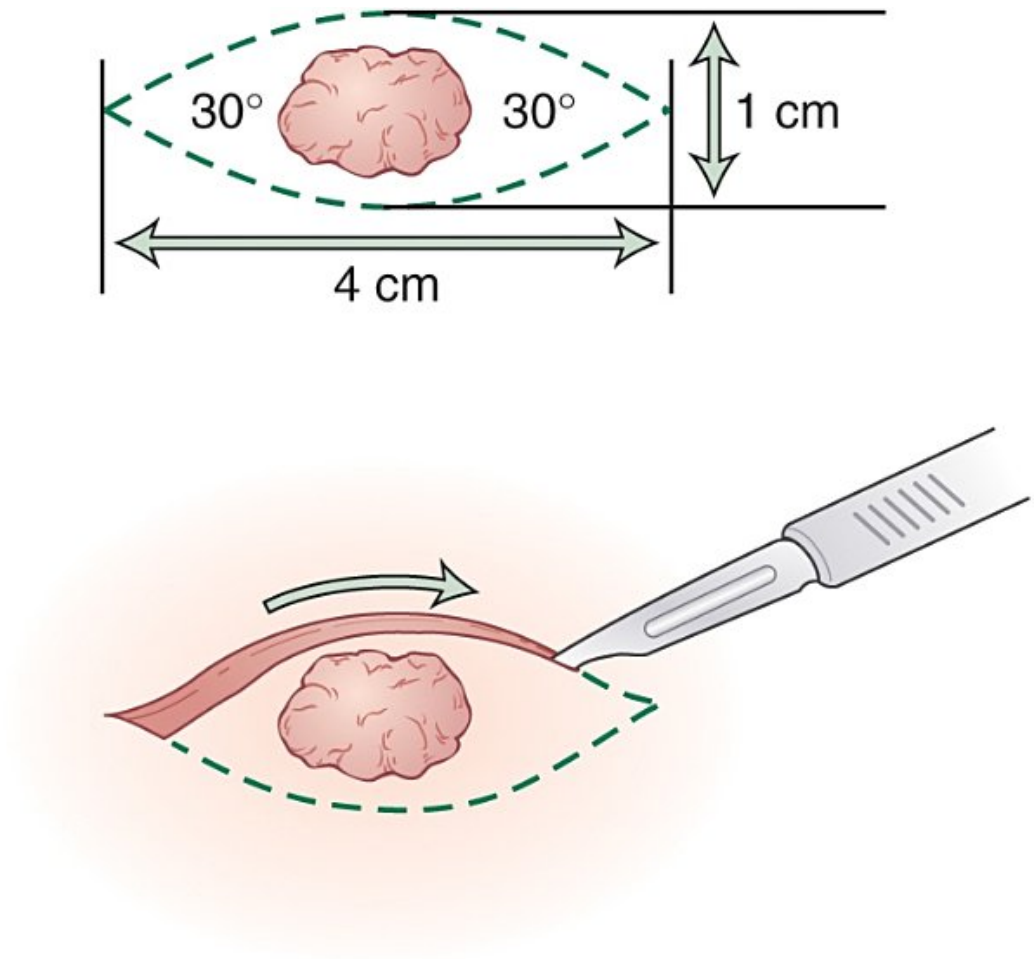

FIGURE 6.5 **Excisional biopsy.** (Redrawn from Pfenninger JL, Fowler GC. *Procedures for Primary Care Physicians.* St. Louis: Mosby–Year Book; 1994, p. 24.)

Special Considerations

With any invasive procedure, a good history and review of systems should be taken to determine if there are any contraindications to surgery. In addition, the patient's ability to heal, history of allergies, need for antibiotic prophylaxis, and use of anticoagulants should be assessed. **Antibiotic prophylaxis** is recommended for perforating dermatologic surgery that occurs on the lower extremities or groin, for wedge resections of the ear and lip, and for patients with extensive inflammatory skin disease. It is also recommended for patients with prosthetic joints at high risk for hematogenous spread

or high-risk cardiac conditions when biopsies are performed on infected tissue or the oral mucosa.[5,7] If possible, the patient should discontinue nonsteroidal antiinflammatory agents approximately 2 to 4 days before any invasive procedure and aspirin should be discontinued for approximately 10 days.[5,8] However, no significant difference in bleeding complications was found in patients undergoing minor dermatologic surgery who were taking aspirin, clopidogrel, ticlodipine, or warfarin in contrast to those who discontinued their medication.[8]

Understand the indications for antibiotic prophylaxis.

It is difficult to perform biopsies on small children, particularly those between the ages of 1 and 5. The provider needs to discuss the absolute need for biopsy with the parents or guardian before deciding to perform the procedure. Once it is determined that the biopsy is necessary, the child may need to be sedated. However, with the use of topical anesthetics, many children experience little discomfort.

Follow-Up Care and Instructions

The following should be considered in follow-up care after excisional biopsy:

- Send tissue to pathology, one specimen per container, appropriately labeled as to the site, patient name, identification number, and date with the completed pathology form.
- Provide written instructions on wound care to the patient.
- Instruct the patient to keep the area clean and dry for 24 hours.
- After that time, the dressing may be removed and the site cleaned with soap and water.
- If a new dressing is applied, instruct the patient to place more petrolatum ointment on the biopsy site. For most

biopsy sites, however, the dressing does not need to be reapplied after the first 24 hours. The exception to this is in areas of friction or if drainage will get on the patient's clothing.

- Schedule a return appointment in 5 to 21 days, depending on the area biopsied. (Refer to the time schedule for suture removal given in the discussion of follow-up care and instructions under Punch Biopsy.)
- Inform the patient that care should be taken not to do any heavy lifting or exercising that might cause the sutures to break or lead to a widened scar.
- Inform the patient of the results of the pathologic examination either when the results are provided to the practitioner or when the patient returns for **suture removal.**

Schedule a return visit based on healing time of the body part sutured.

Electrosurgery

Background and History

Electrosurgery encompasses electrodesiccation, electrocoagulation, electrofulguration, electrosection, and electrolysis. This section focuses on electrodesiccation. The three methods of electrodessication are heat electrocautery, which does not use electric current; monopolar electrosurgery, which delivers an electric current through one electrode with or without a grounding pad; and bipolar electrosurgery, which uses a two-electrode instrument without a grounding pad.[9] In patients with **implantable electronic devices (IEDs)** (cardiac and gastric pacemakers, cochlear implants; deep brain, sacral, vagal, and phrenic nerve stimulators; and spinal cord and bone stimulators), it is recommended that hemostasis be accomplished with heat electrocautery or bipolar electrosurgery because there is little to no risk to the patient of interference with the IED. Monopolar devices should be avoided in patients with IEDs. Cardiac pacemaker-dependent patients should be monitored during

electrosurgery with emergency pacing and defibrillation equipment immediately available.[9] In addition, electrosurgery should not occur within 6 inches of an IED, should use less than 1-second intermittent bursts, and the device functionality should be monitored after the procedure is complete.[9]

Use only heat electrocautery or bipolar electrosurgery in patients with implantable electronic devices.

Indications

Lesions commonly treated with electrodesiccation include the following:

- Acrochordons
- Pyogenic granulomas and other vascular lesions
- Verruca vulgaris
- Condyloma acuminata
- Actinic keratoses
- Superficial multicentric basal cell carcinomas, in combination with curettage

Contraindications

- Caution should be used on patients with IEDs, as noted earlier.
- It also should not be performed if flammable material or gases are present in the immediate surgical field.

Potential Complications

Common complications of electrodesiccation include the following:

- Pain
- Scarring: This may occur and can be hypertrophic, atrophic, or a keloid on rare occasions.

- Delayed bleeding
- Risk for burns: The use of alcohol to prepare the skin could lead to fire during electrosurgery. A nonflammable alternative preparation such as povidone-iodine is preferred. Care must also be taken when electrosurgery is performed in the perianal area. Bowel gas, which is composed of methane and hydrogen gas, can ignite. This can be prevented with adequate bowel preparation before the procedure or the placement of cotton in the rectum.[9]
- Pigment alterations: A crust will form within 24 hours. Within 5 to 7 days, the crust sloughs off. Once this occurs, a hypopigmented area may remain, which is generally temporary. Occasionally, an area of hyperpigmentation may develop that could require further treatment with keratolytic (e.g., topical retinoids) or bleaching agents (e.g., 4% hydroquinone) to lighten the skin.[9]
- Viral particles can be aerosolized in cautery and laser smoke, particularly human papillomavirus (HPV) and human immunodeficiency virus (HIV). No cases of HIV transmission through cautery and laser smoke have been reported. However, reports of laryngeal papillomatosis in health care providers from cautery and laser ablation of warts have been published.[10]

Use Standard Precautions as described in Chapter 35.

Complications of electrosurgery include pain, scarring, delayed bleeding, risk for burns, pigment alterations, and aerosolized viral particles.

Patient Preparation

The following should be considered in preparing the patient for electrosurgery:

- Explain the procedure to the patient, the patient's guardian, or both, and be prepared to answer any questions.
- The patient or guardian must give informed consent before start of the procedure.
- A **topical anesthetic** can be applied 20 to 60 minutes before the procedure, depending on the topical agent used (see Chapter 16 for selection of topical anesthetics). If topical anesthesia is used, the occlusive tape, if any, is removed and cleaned with gauze.
- Electrodesiccation does not induce partial anesthesia; therefore, the procedure is better tolerated if a topical anesthetic is applied before starting the procedure or local anesthesia infiltration is used. After the procedure, patients rarely need any analgesia.

Anesthesia is necessary before electrosurgery.

Materials Used to Perform Electrosurgery

- Topical anesthetic, if used
- Hyfrecator and desiccation electrode needle or heat electrocautery unit
- Laser or high-filtration face mask (for protection from smoke generated during the procedure)
- 4 × 4-inch gauze
- Petrolatum ointment and an adhesive bandage
- 5- or 7-mm curette, if curettage of a lesion will follow the electrosurgery

Procedure

Performing Electrosurgery

1. Clean the area with povidone-iodine and water only for electrodesiccation.

2. For electrodesiccation, remove the occlusive tape from the topical anesthetic.
3. Use the hyfrecator with desiccation electrode needle.

NOTE: Set the hyfrecator to a low setting to begin and turn it up as needed. Lightly touch the lesion to determine if the power setting is adequate.

4. Once the correct power setting is found, ablate the lesion.

NOTE: Small lesions usually are ablated immediately, whereas larger lesions require gentle passes with the electrode.

5. Gently wipe the charred lesion with 4 × 4-inch gauze or curette. No bleeding should occur.
6. Apply petrolatum ointment and an adhesive bandage.

Follow-Up Care and Instructions

The following should be considered in providing follow-up care for electrosurgery:

- Provide written instructions on wound care to the patient.
- Instruct the patient to keep the area of electrodesiccation clean and dry for 24 hours.
- After that time, the dressing may be removed and the site cleaned with soap and water as usual.
- If a new dressing is applied, instruct the patient to place more petrolatum ointment on the biopsy site. For most biopsy sites, however, the dressing does not need to be reapplied after the first 24 hours. The exception to this is in areas of friction or if drainage will get on the patient's clothing.
- No return appointment is necessary.

Acne Surgery

Background and History

Acne surgery is performed on comedones and, occasionally, pustules. Open comedones, or "blackheads," are removed purely for cosmetic purposes. Removal does not shorten the resolution of the acne lesions. Removal of closed comedones, or "whiteheads," does shorten the resolution time because acne surgery prevents them from rupturing and becoming larger papules or pustules.[1]

Acne surgery on closed comedones (whiteheads) will shorten resolution time, but will not do so with open comedones or (blackheads).

Indications

Acne surgery may be performed on most patients with comedonal or pustular acne. **Pretreatment** with a topical retinoid by the patient for approximately 1 month greatly improves the removal of comedones.[1]

Pretreatment with a topical retinoid 1 month before acne surgery improves comedone removal.

Contraindications

Care should be taken with patients who may develop **postinflammatory hyperpigmentation** or those who may bruise easily. They should be informed of the possible risks for bruising and hyperpigmentation.

Use caution in patients who are at risk for postinflammatory hyperpigmentation or bruising.

Potential Complications

The following complications may occur with acne surgery[1]:

- Discomfort from the procedure
- Immediate swelling and pinpoint bleeding
- Small amounts of bruising
- Postinflammatory hyperpigmentation
- Rupture of the comedo if improper technique is used

Use Standard Precautions as described in Chapter 35.

Patient Preparation

The following should be taken into consideration in preparing the patient for acne surgery:

- Explain the procedure to the patient, the patient's guardian, or both, and be prepared to answer any questions.
- The patient or guardian must give informed consent before start of the procedure.

Materials Used to Perform Acne Surgery

- Alcohol pads
- No. 11 blade or a 25-gauge needle
- Unna-type comedo extractor
- 4 × 4-inch gauze

Procedure

Performing Acne Surgery

1. Clean the area with an alcohol pad.
2. Use a no. 11 blade or 25-gauge needle to open the pore of the comedo or pustule gently.
3. Place the Unna-type comedone extractor flat against the skin.

4. Apply pressure downward while gently sliding toward the comedo or pustule (Fig. 6.6).

NOTE: The extractor may need to be moved in all four quadrants to ensure all the comedonal contents are removed.

5. Stop any bleeding with direct pressure with 4 × 4-inch gauze.

NOTE: The patient may want to wash his or her face before leaving the office.

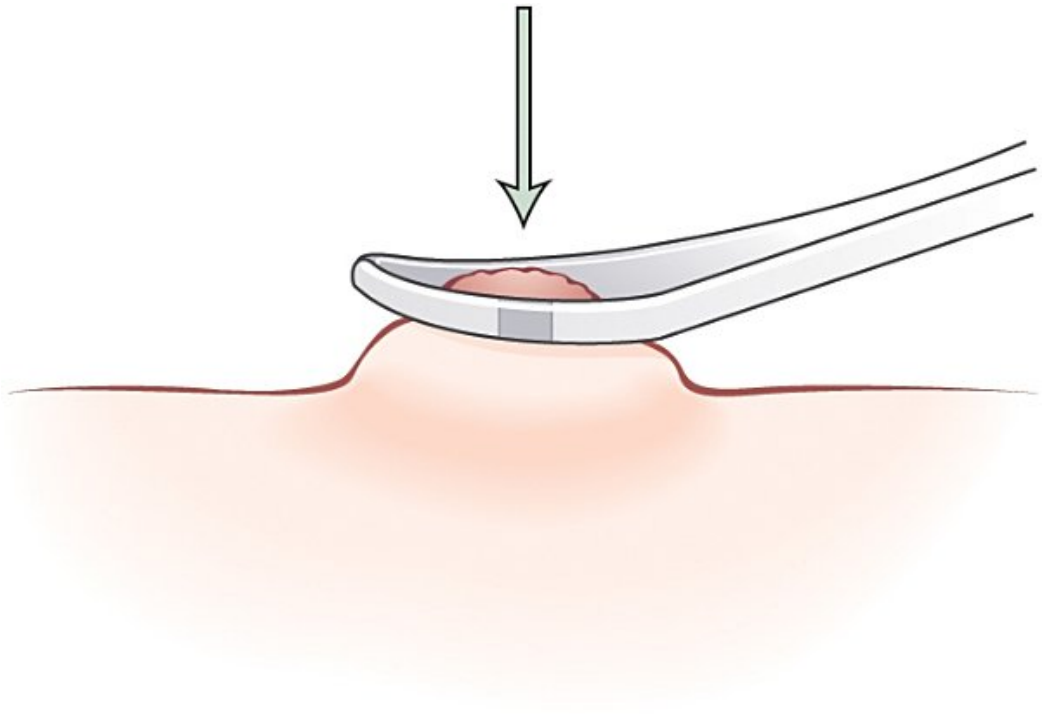

FIGURE 6.6 Acne surgery. (Redrawn from Pfenninger JL, Fowler GC. *Procedures for Primary Care Physicians.* St. Louis: Mosby–Year Book; 1994, p. 55.)

Follow-Up Care and Instructions

The following should be considered in providing follow-up care after acne surgery:

- Instruct the patient to wash the area with soap and water as usual.
- Advise the patient that **topical retinoids and alpha-hydroxy** acids may need to be avoided for 24 hours to prevent irritation of the open areas.
- No return appointment is necessary.

Avoid alpha-hydroxy acids and topical retinoids for 24 hours after acne surgery.

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CHAPTER 7

Draining/Evacuation of Subungual Hematomas

Cody Sasek

Abstract

This chapter addresses the procedure for the treatment of subungual hematomas by nail trephination. The indications, contraindications, and rationale for draining a subungual hematoma are addressed. The essential anatomy and physiology associated with draining a subungual hematoma is also covered. This background will allow the reader to select the materials and follow the procedure necessary for successful and safe subungual hematoma drainage and appropriately care for the patient postprocedure.

Keywords

distal phalanx fracture
nail bed trauma
nail plate
nail removal
nail trephination
subungual hematoma

Procedure Goals and Objectives

GOAL: To manage a subungual hematoma successfully by nail trephination with a minimal degree of risk and discomfort to the patient.
OBJECTIVES: The student will be able to:

- Describe the indications, contraindications, and rationale for draining a subungual hematoma.
- Describe the essential anatomy and physiology associated with injury leading to subungual hematomas and their management by draining.
- Select the materials commonly necessary for nail trephination and describe their proper use.
- Identify the important aspects of postprocedure care after nail trephination.
- Identify and describe common complications associated with draining a subungual hematoma.

KEY POINTS

- Subungual hematomas, which are typically caused by simple direct trauma to the affected area, result in bleeding into the space between the nail bed and fingernail.
- The primary goal of treatment is to relieve the pressure caused by the hematoma.
- Drainage of the hematoma by nail trephination quickly provides dramatic pain relief for the patient.
- Local anesthesia may be used, but is generally not necessary.
- Cautery or needle bore methods are preferred.
- Additional injuries, including fracture and more significant nail bed injuries, need to be evaluated

and treated appropriately.

Background and History

Injury to the finger and toe nail beds leading to subungual hematomas is commonly seen. The vast majority are caused by simple direct trauma to this area, which can result in bleeding into the space between the nail bed and fingernail. Subungual hematomas may also occur as a result of repetitive, indirect trauma to the distal end of the nail plate, such as those caused by wearing tight-fitting shoes and those occurring in runners. Subungual hematomas can be a challenge to treat because of the inability to observe the extent of possible nail bed laceration and comorbid injury, such as fracture, nail breakage, and disruption of nail edges. These must be evaluated in addition to the hematoma; one study found 32% of patients with a subungual hematoma also had a distal phalangeal fracture.[1]

Patients often presents with intense pain secondary to the pressure produced by the hematoma. The primary goal of treatment is to relieve the pressure caused by the hematoma. **Drainage** of the hematoma by nail trephination provides dramatic pain relief for the patient and decreases the secondary pressure effects to the digit. If the pressure is not relieved, damage and scarring to the nail matrix and the germinal layer may occur, causing delayed regrowth or dystrophy of the nail plate.[2] The procedure itself is simple and can generally be performed safely and effectively in the office.

Evacuation of a subungual hematoma is fairly simple and can generally be performed in the office.

Indications

Nail trephination is indicated for relief from the acute pain and pressure associated with visible, painful subungual hematomas.

Contraindications

All patients presenting with **nail trauma** must be carefully assessed by history, physical examination, and, when indicated, radiography. Based on the clinical impression from an appropriate evaluation, the provider should ensure the nail bed injury is not more severe, such as a fracture, which will require an alternative management strategy.

Ensure the nail bed injury is not more severe, such as a fracture, which will require alternative management.

Potential contraindications include:

- Crushed or fractured nails
- Fracture of the distal phalanx, which can be converted to an open fracture when draining the hematoma
- Suspected subungual melanoma
- Cautery or a heat-method should be avoided when the patient has artificial acrylic nails, because these may be flammable.[2]
- Nail removal and primary repair of a nail bed laceration are recommended if there is disruption of the nail matrix (nail fold) or digital (fingertip or toe tip) avulsion.[3] If nail removal is indicated to explore for complex nail bed lacerations, subungual hematoma drainage is not indicated. Traditionally, consideration for referral to a hand specialist for nail removal was recommended for hematomas involving more than 50% of the nail bed.[1,4,5] Studies have also shown no difference in outcome whether nail removal or trephination is performed.[6,7] Most simple nail bed lacerations that do not involve the nail folds do not require nail removal and laceration repair.

Avoid using a heat method if the patient has artificial acrylic nails, which may be flammable.

The size of the subungual hematoma is not directly related to the possibility of a fracture. Observe for nail breakage and disrupted nail edges.

Potential Complications

Significant complications associated with this procedure are rare. Patients should be informed of the potential for nail bed deformities to persist even after healing of the injury has occurred.

- The most likely complication resulting from a subungual hematoma is permanent nail deformity, especially if a nail bed injury is involved.
- Infection of any remaining hematoma is uncommon, but can occur. Using sterile technique and covering the site with a dressing after the procedure help to minimize the risk for infection.
- Use of a cautery may result in an inadvertent burn to the nail bed after penetrating the nail, causing permanent damage.
- Functional deficits (numbness) may rarely occur.

Essential Anatomy and Physiology

Relevant nail anatomy is shown in Fig. 7.1. The nail plate is produced by the underlying matrix or nail bed. The nail plate and underlying nail bed are supported by the distal phalanx. The nail plate is not directly innervated; however, the nail bed is richly innervated. The nail bed consists of the tissues directly beneath the nail, which function in nail generation and migration. The arterial blood supply to the nail bed comes from two terminal branches of the volar digital artery.[4]

Standard precautions

Every practitioner should use standard precautions at all times when interacting with patients, especially when performing procedures. Determining the level of precaution necessary requires the practitioner to exercise clinical judgment based on the

patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

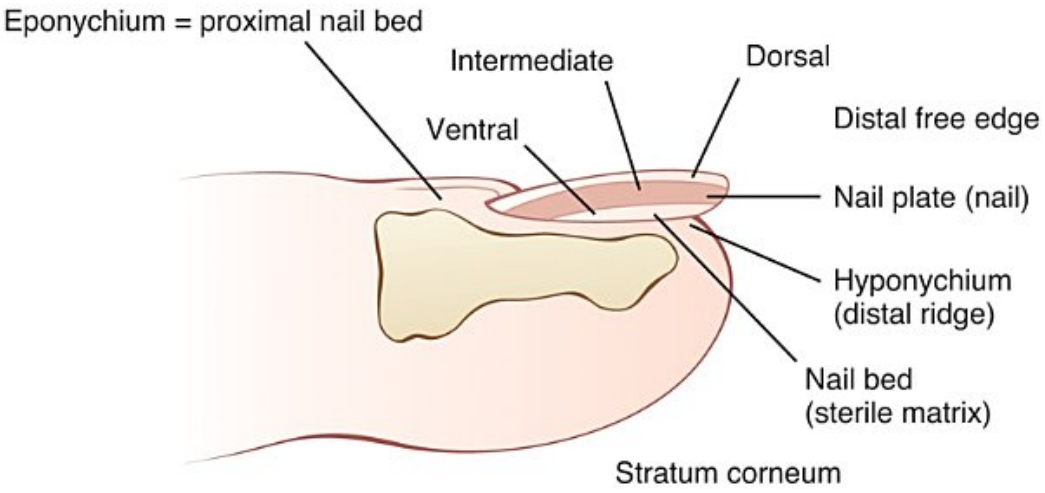

FIGURE 7.1 Anatomy of the nail and nail bed. (Redrawn from Pfenninger JF, Fowler GC. *Procedures for Primary Care Physicians.* St. Louis: Mosby; 2010, p. 200.)

Patient Preparation

To prepare for nail trephination:

- Describe the procedure to the patient and reassure the patient that pain with the procedure is rarely greater than what is already being experienced.
- Anesthesia is typically not needed and is often more painful than the procedure itself.
- If procedural pain is a concern, a digital block can be used (see Chapter 16). However, this is rarely required.
- Inform the patient that, depending on the selected technique, an irritating odor may occur.
- Ask the patient if she has artificial acrylic nails to avoid using a heat technique on these patients.
- The patient should be instructed to hold the digit very still during the procedure.

Materials

- Nonlatex gloves
- Face shield
- Chlorhexidine gluconate, povidone-iodine (Betadine), or other antiseptic–germicidal solution
- 70% isopropyl alcohol wipes
- Cautery (battery-operated microcautery unit) or single bevel 18-gauge needle
  - It is not recommended that the clinician use a heated paper clip because it requires an open flame to heat the material. In addition, many paper clips are now made of metals that are difficult to heat sufficiently to penetrate the nail successfully.[8]
- Sterile gauze
- Antibiotic ointment
- Bandage

Procedure

1. Place the patient in a sitting or supine position that allows him or her to rest comfortably during the procedure without risk for further injury should lightheadedness occur.
2. Examine the injured digit to determine the extent of injury, documenting the size of the hematoma, examining tendon function, and assessing for fractures of the digit, especially the distal phalanx.
3. Radiographs should be obtained whenever there is concern for fracture. If a nondisplaced fracture is suspected, consider the appropriateness of drainage, with splinting in an anatomic position until swelling is reduced.
4. Prepare with aseptic technique, soaking the affected digit in an antiseptic solution such as chlorhexidine or povidone-iodine.

CAUTION: Alcohol is highly flammable. It should be washed off with sterile water or allowed to dry before placing hot cautery or flame near the nail.

5. Perform nail trephination using selected technique. Care should be taken to control depth of trephination to avoid contact with the nail bed. After the blood has drained, the associated pain should be relieved. If pain does not subside significantly, underlying fractures should be reconsidered.
    a. Cautery: Burn a small hole in the nail using a conventional handheld microcautery unit (Fig. 7.2).
        i. Make a 1- to 2-mm hole, which is large enough to allow for long-term drainage.
    b. Needle puncture: Alternatively, with an 18-gauge or insulin needle, use a rotary motion to bore a hole through the nail to the hematoma. Consider using a digital block for this method if the patient is unable to tolerate pressure on the nail (see Chapter 16).
6. Clean the area with alcohol wipes.
7. Apply antibiotic ointment and a light dressing to the nail. The use of prophylactic antibiotics does not appear to improve outcomes in patients with subungual hematomas and intact nail folds.[7]

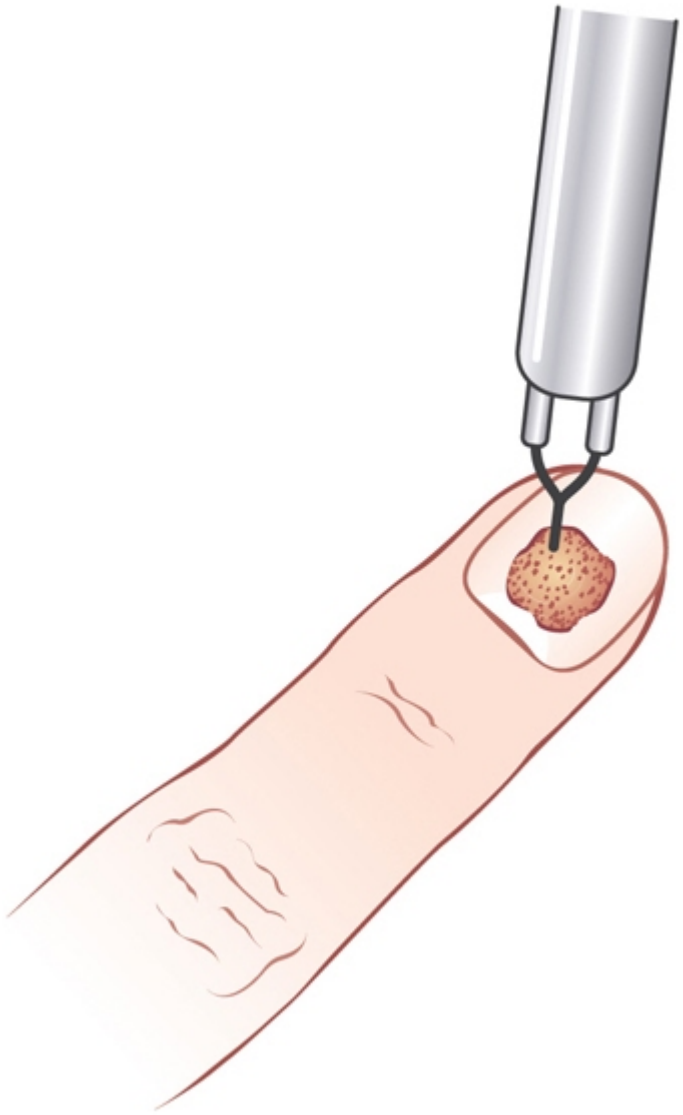

FIGURE 7.2 Nail trephination. (Redrawn from Pfenninger JF, Fowler GC. *Procedures for Primary Care Physicians.* St. Louis: Mosby; 2010, p. 240.)

Special Considerations

For young children, secure immobilization may be helpful when performing this procedure.

The clinician should consult a hand surgeon if there is concern for permanent deformity or loss of function, including patients with:

- Displaced fractures

- Intraarticular fractures
- Extensive nail bed injury
- Infected wounds

Follow-Up Care and Instructions

Follow-up care after subungual hematoma drainage should include the following:

Place a small amount of antibiotic ointment on the nail twice daily for the first few days after evacuation.

- Leave the initial dressing in place for 24 hours, placing a small dab of antibiotic ointment and light dressing on the nail twice daily until the evacuation site closes completely.
- The affected digit should be soaked in warm, soapy water two or three times a day until the evacuation site closes.
- **Inform patient** that the nail and discomfort should improve progressively over the following few days. The patient should notify the practitioner if pain persists, there is a change in sensation; there is purulent or foul-smelling drainage, fever, or erythema of the skin surrounding the area; or if the injury is not improving as expected.

Inform the patient the nail may still spontaneously fall off as a result of the original injury.

Disposal of Materials

All supplies, tools, and items used that may have come into contact with bodily fluids should be disposed of in a biohazard container. Additionally, any sharps should be disposed of in a sharps container.

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CHAPTER 8

Endometrial Biopsy

Melinda Blazar

Abstract

Endometrial biopsy is a common office-based procedure that can be used quickly and safely to evaluate for underlying causes of abnormal uterine bleeding at a minimal cost compared with imaging or other diagnostic hospital-based procedures, such as dilation and curettage. Endometrial biopsies are most frequently used to evaluate postmenopausal women for evidence of endometrial hyperplasia or endometrial cancer. The only absolute contraindication to performing an endometrial biopsy is pregnancy, although caution should be used in women with active pelvic infections, clotting disorders, and cervical pathology. The procedure is generally well-tolerated, but common complications include uterine cramping, a vasovagal response, and postprocedural bleeding or infection. A very rare but serious complication is uterine perforation. Endometrial biopsy is done using sterile technique with a suction device that is placed through the cervical canal to obtain the endometrial sample. Soon after the procedure, the patient can return to regular daily activities, but should maintain pelvic rest and avoid tampon use for 14 days. This chapter will review the approach to obtaining a high-quality endometrial sample while minimizing risk and discomfort to the patient.

Keywords

abnormal uterine bleeding

endometrial biopsy
endometrial cancer
endometrial hyperplasia

Procedure Goals and Objectives

GOAL: To obtain a high-quality sample of endometrial tissue for histologic examination while observing standard precautions and minimizing risk and discomfort for the patient.
OBJECTIVES: The student will be able to:

- Describe the background and history of the endometrial biopsy procedure.
- Identify the indications and contraindications for performing an endometrial biopsy.
- Identify common complications associated with the performance of the procedure.
- Describe the essential anatomy and physiology associated with endometrial biopsy.
- Describe the process of general and individualized patient preparation.
- Identify necessary materials for performing endometrial biopsy and their proper use.
- Demonstrate the correct and safe technique for obtaining an adequate sample of endometrial tissue.
- Describe the special considerations for an endometrial biopsy.
- Describe postprocedure care and patient education and counseling after endometrial

biopsy.

Background and History

Endometrial cancer is the most common invasive gynecologic cancer in women in the United States, with abnormal uterine bleeding being the primary presenting symptom.[1,2] The mean age at diagnosis is 63 years, with greater than 90% of cases effecting women over the age of 50, making it essentially a postmenopausal condition.[1] Of significant concern is that mortality related to endometrial cancer has increased over 100% over the past two decades.[1] In reproductive-age women, up to 14% will experience abnormal uterine bleeding, which may require endometrial evaluation if clear etiology cannot be identified.[3] This is particularly important in women over the age of 40 who may experience abnormal uterine bleeding as a result of normal menopausal transition, but must have endometrial hyperplasia and cancer ruled out as a potential cause of the bleeding.[4] The endometrial biopsy is a common office-based procedure that can quickly and safely assist in diagnosing the causes of abnormal uterine bleeding.

The **endometrial biopsy** procedure provides a quality histologic sample using a less invasive, more cost-efficient, and better-tolerated procedure than the dilation and curettage (D&C).[5] Suction, as opposed to curettage or scraping, reduces the incidence of certain complications, such as Asherman syndrome, or scarring of the endometrium. Although endometrial biopsies are done blindly, many studies have verified that adequate sampling can be obtained in most women, particularly in patients with a thickened endometrium.[1,6] Sensitivity of endometrial biopsy is as high as 99% in detecting endometrial cancer in postmenopausal women, and 91% in women who are premenopausal.[2] Diagnostic accuracy is improved when endometrial pathology is global, compared with focal.[6]

Indications

The indications for biopsy of the endometrium are noted in Box 8.1. Indications include the evaluation of abnormal uterine bleeding in women younger than 35 years with prolonged unopposed estrogen stimulation, as well as those women over the age of 35 with anovulatory bleeding.[3] Other indications may include the evaluation of atypical glandular cells identified on a Pap test, follow-up for endometrial hyperplasia, and as part of the evaluation and treatment of infertility.[7] The American Cancer Society also recommends use of endometrial biopsy annually to screen for endometrial cancer in women over the age of 35 at very high risk for endometrial cancer, such as women with Lynch syndrome (hereditary nonpolyposis colon cancer).[2,8]

Box 8.1 Indications for Endometrial Biopsy[7]

Abnormal uterine bleeding
Postmenopausal bleeding
Amenorrhea for 1 year (nonmenopausal)
Endometrial dating of menstrual cycle
Infertility
Response to hormonal therapy
Atypical glandular cells on Pap test
Evaluation of abnormal endometrial findings on imaging
Prior diagnosis of endometrial hyperplasia
Family or personal history or known genetic mutations for hereditary nonpolyposis colorectal cancer (HNPCC, Lynch syndrome): Yearly biopsy beginning at age 35.

Contraindications

The only **absolute contraindication** for sampling of the endometrium is a viable, desired pregnancy. Various relative contraindications are listed in Box 8.2. Endometrial biopsy can be performed successfully with an intrauterine device (IUD) in place; however, studies have not been done to evaluate whether the

presence of an IUD during endometrial sampling decreases the diagnostic performance.[6]

Box 8.2 Contraindications[6,7]

Absolute

- Pregnancy

Relative

- Acute pelvic inflammatory disease
- Clotting disorders
- Acute cervical infection
- Cervical cancer
- Severe cervical stenosis

Potential Complications

The following **potential complications** are possible in endometrial biopsy:

Most complications are mild and can be managed in the office setting. A rare but serious complication is uterine perforation.

- Cramping: The most common side effect of the endometrial biopsy is cramping during or after the procedure, particularly with the high-pressure suction devices.[6] Recommending a nonsteroidal antiinflammatory drug (NSAID) an hour before the procedure will reduce discomfort.[5] Application of a topical cervical anesthetic such as 20% benzocaine can also reduce pain and cramping during the procedure.[5,7]

- Vasovagal: A transient vasovagal reaction may also be a common response during endometrial biopsy.[6] Encourage the patient to eat and drink in advance of the procedure, which may minimize the effect.[5] Allow the patient to remain supine for 10 to 15 minutes after the procedure to diminish this effect, confirm the patient is not experiencing lightheadedness or dizziness, and ensure that someone is present when the woman sits up, stands, and dresses after the endometrial biopsy.[7]
- Uterine perforation: Reports of uterine perforation during endometrial biopsy procedures in the office are very rare (0.1% to 1.3%), and may be difficult to identify.[6] Tell the patient to contact the office with worsening pain.[6]
- Stenotic os: In a patient with a severely stenotic os, the use of an osmotic laminaria dilator placed by the patient several hours before the procedure will generally permit the introduction of the suction catheter.[5,7]
- Infection: Postprocedure infection may include pelvic infection or bacteremia, both of which are rare if the procedure is performed properly and there is no preexisting infection.[5] Patients should notify the office immediately if fever or pain develops. Research does not support the use of prophylactic antibiotics to prevent endocarditis secondary to bacteremia in the majority of women, but some providers may prescribe tetracycline (500 mg twice daily for 4 days) after the procedure in women deemed high risk for endocarditis.[5]

Essential Anatomy

Figure 8.1 illustrates the anatomy of the uterus and its surrounding structures.

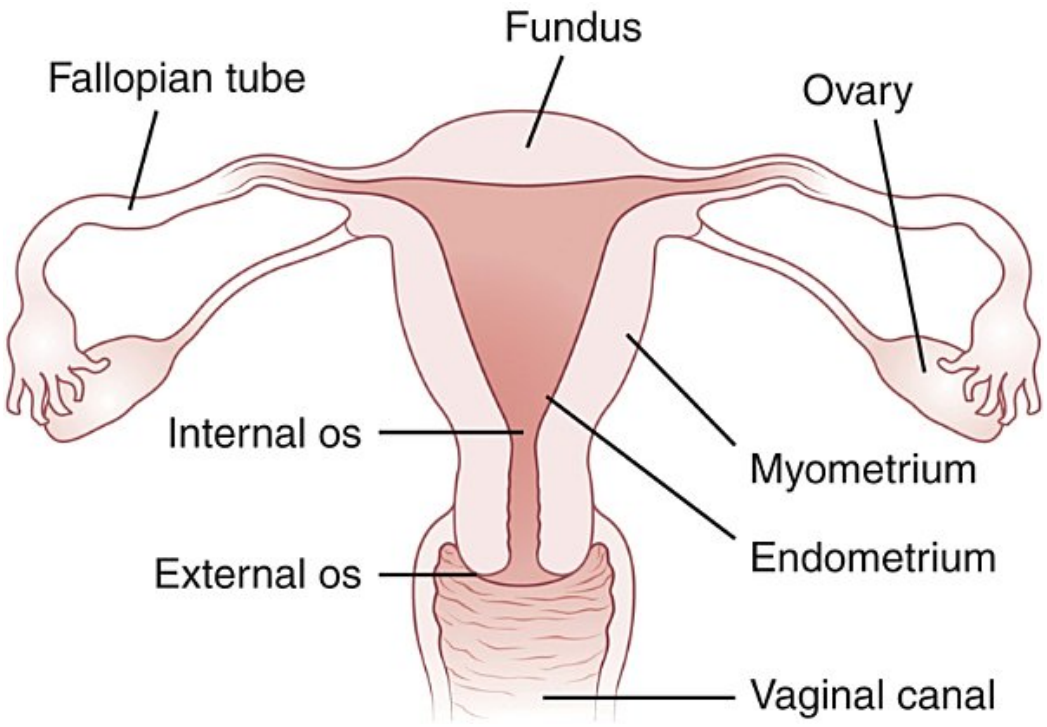

FIGURE 8.1 **Anatomy of the uterus and surrounding structures.**

Anatomy, Physiology and Pathophysiology

The endometrium consists of two layers, the stratum basale and the stratum functionale. The stratum functionale cells proliferate under the influence of estrogen and desquamate at the time of menses. The thickness of the endometrium varies throughout the menstrual cycle from 1 to 2 mm at the time of menses to 4 mm in the early proliferative (follicular) phase, to about 12 mm at ovulation, and maintaining 12 mm during an appropriate secretory (luteal) phase. Hyperplasia is defined as the abnormal proliferation of endometrial cells usually caused by estrogen unopposed by the action of progesterone. Endometrial hyperplasia is described as mild, moderate, or complex, and in histologic terms such as cystic, adenomatous, or glandular. The major findings on endometrial biopsy sample are as follows[8]:

- Proliferative (estrogen effect), secretory (progesterone effect), or atrophic endometrium [benign pathology])
- Simple (adenomatous) hyperplasia without atypia—low risk of progression to cancer, < 5%
- Simple or complex (adenomatous) hyperplasia with atypia—premalignant lesion, 30% to 45% progress to cancer
- Endometrial carcinoma

Standard Precautions

Every practitioner should use standard precautions at all times when interacting with patients, especially when performing procedures. Determining the level of precaution necessary requires the practitioner to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

Patient Preparation

The endometrial biopsy is **a safe and quick procedure**. The following should be done in preparation of the patient for endometrial biopsy:

The patient is not sedated for the procedure and will be able to drive and resume normal activities quickly.

- Clarify the procedure completely to the patient and discuss possible alternative techniques.
- Endometrial evaluation can be achieved by a variety of methods, so it is important that the patient understands the choices and reasons for the chosen procedure.
- Obtain informed consent.
- Explain to the woman that she may experience slight cramping during and after the biopsy.
- Advise the patient to premedicate with NSAIDs 30 to 60 minutes prior to the procedure.[6]

- The patient should remain semirecumbent for several minutes following the procedure to ensure there is no evidence of heavy bleeding or a vasovagal response.[6,7] After this, she may safely drive herself and resume normal daily activities.[6,7]

Materials

The **choice of equipment** depends on the reason for the biopsy and the clinician's preference. Smaller suction devices are more comfortable for the patient during the procedure, but obtain less tissue.[6] Conversely, higher-pressure suction devices acquire more tissue sample, but they produce more discomfort for the patient.[6] As a result, higher-pressure suction devices tend to be used less frequently by providers.[6] An endometrial brush may also be used to obtain an endometrial sample.

For endometrial sampling, the choices include the following (see examples in Figs. 8.2 and 8.3):

- Low-pressure devices (includes Pipelle, Endocell): Disposable devices made of flexible polypropylene sheath, 23 cm in length with a small opening in the distal end, through which the endometrial sample is obtained. Suction is created by an internal piston system. These devices are most commonly used for endometrial biopsy procedures.[6]
- Higher-pressure devices (includes Vabra, Karman): Vabra is disposable; Karman is a reusable syringe with disposable cannula. Suction occurs via an external vacuum pump. These devices provide higher-volume specimens, but are more uncomfortable for the patient and often require use of a tenaculum, cervical dilation, and a paracervical block.[6]
- Other, less common types of endometrial sampling devices: Novak curette, Tao Brush, and a Tis-U-Trap.

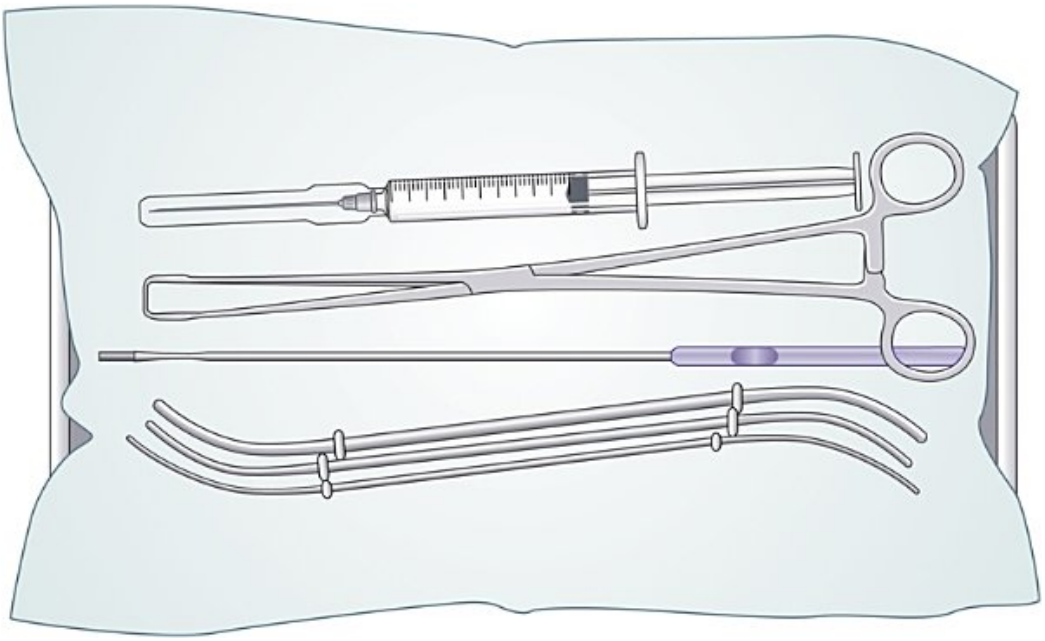

FIGURE 8.2 Endometrial BIOPSY SETUP (*from top*): Anesthetic, tenaculum, Novak curette, and cervical dilators.

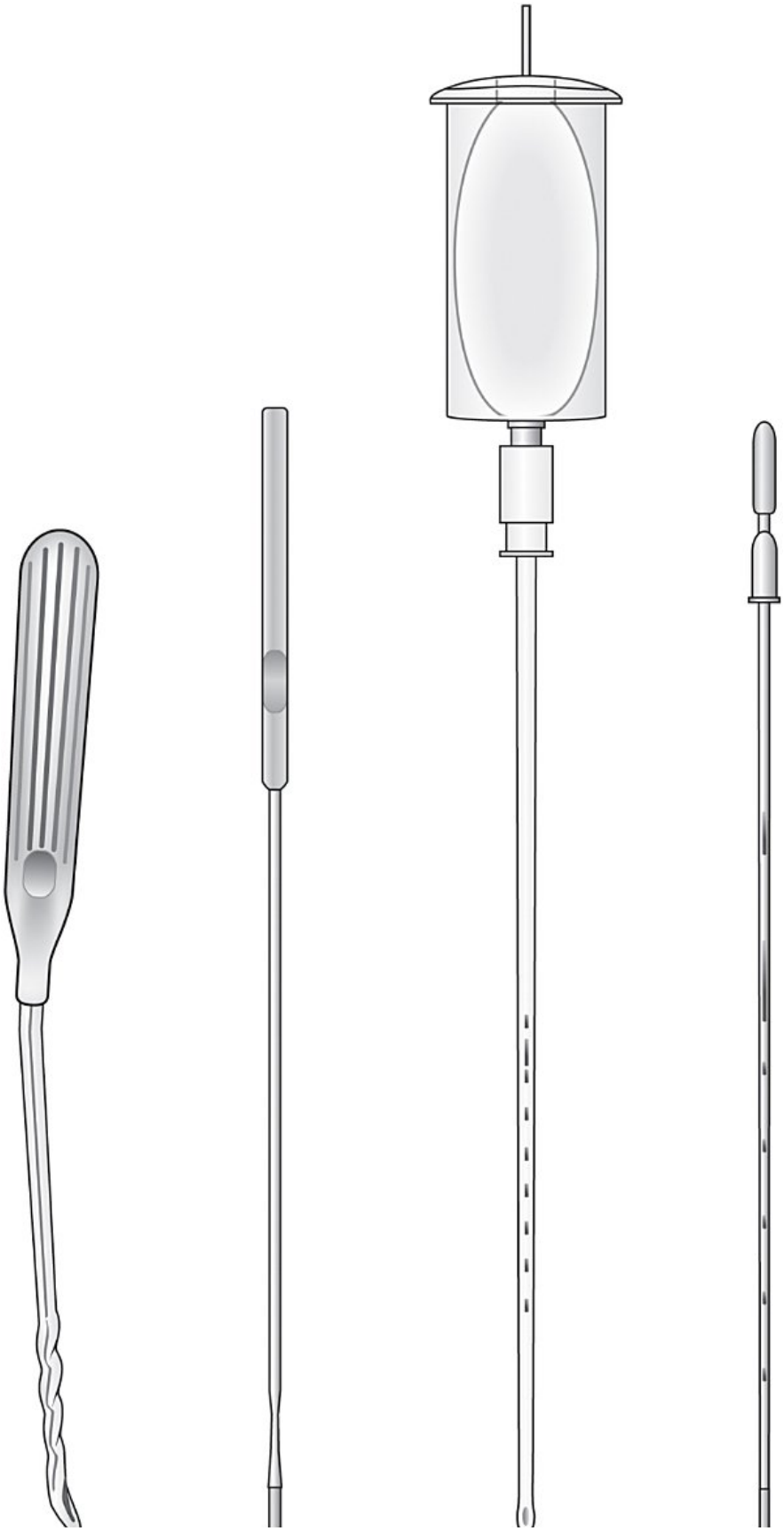

FIGURE 8.3 Instruments
(*left to right*): Uterine sound, Novak curette, Tis-U-Trap, and Pipelle.

General equipment includes the following:

- Absorbent pad for the examination table
- Antiseptic solution of choice for cleansing the cervix (e.g., chlorhexidine-gluconate or povidone-iodine)
- Topical or injectable lidocaine or 20% benzocaine spray or gel for the cervix
- Labeled tissue containers with appropriate preservative (not needed if sampling device has container attached, such as the Tis-U-Trap)
- Lubricating gel
- Fox swabs (large cotton swabs)
- Sanitary napkins for postprocedure hygiene
- Fluid-proof gown and protective eyewear
- Nonsterile examination gloves

Sterile equipment includes the following:

- Sterile examination gloves
- Speculum
- Uterine sound (depending on type of biopsy instrument used)
- Endocervical curette (if endocervical curettage is to be performed)
- 4 × 4-inch gauze pads, soaked in antiseptic solution
- Ring forceps
- Tenaculum
- Cervical dilators (two types are available):
  - Mechanical (unopened but available if needed)—sterile rigid metal or plastic curved rods in graduated thicknesses
  - Medical (particularly useful for the postmenopausal cervix)

- Laminaria (sizes 2 mm through 10 mm): A natural osmotic cervical dilator made from seaweed and packaged as a narrow tampon, which is inserted into the cervix 2 to 12 hours before the procedure to soften and open the cervix
- Synthetic laminaria (Dilateria, Lamicel, Dilapan): An absorbent polyvinyl acetal sponge, impregnated with less than 500 mg of magnesium sulfate (Epsom salt) and compressed and inserted into the cervix 2 to 12 hours before the procedure to absorb fluid and gently open the cervix
- Misoprostol 200 to 400 μg by oral or vaginal route administered the night before the procedure
- Anesthetic (optional)—one of the following:
  - 2% lidocaine with epinephrine, 5 mL injected into the cervix before the procedure
  - 0.5% to 1% lidocaine without epinephrine
  - 20% benzocaine spray or gel applied to the cervix

Procedure

Endometrial Biopsy

1. Place the patient in the dorsal lithotomy position appropriately draped.
2. Thoroughly wash your hands, and using nonsterile gloves perform a bimanual examination to determine the position, shape, and size of the uterus. Palpate the adnexa to rule out tenderness that may indicate infection.
3. Review the specific directions for equipment and the sampling device being used and be certain all parts are in working order before beginning the procedure.
4. Using a vaginal speculum, inspect the cervix for discharge, stenosis, or other abnormalities. Perform ***Pap test, culture, or endocervical curettage***, if indicated, before performing endometrial biopsy (see later section, Supplementary and Alternative Procedures).
5. Apply or inject anesthetic 5 to 10 minutes before starting the procedure, especially if a tenaculum will be used. The

options are as follows:
   - Apply benzocaine spray or gel to cervix, *or*
   - Inject lidocaine at the 4 o'clock and 8 o'clock positions of the cervix
   - Then, with an 18-gauge catheter sheath insert 5 mL of 2% lidocaine into the uterine cavity, leaving the catheter in place for several minutes to penetrate.
6. Rewash your hands, put on a gown and protective eyewear, and don sterile gloves.
7. Using ring forceps holding cotton or gauze, wipe the cervical os with water-based antiseptic.
8. Using moderate pressure, insert the sound through the os until gentle resistance is encountered, usually at a depth of 6 to 8 cm. Note the measurement of the uterine cavity and remove the sound.

NOTE: This step is optional if the biopsy device is marked for measurement.

9. If you are unable to pass the sound through the os, use the tenaculum to straighten the uterocervical angle. Grasp the anterior lip of the cervix with the tenaculum in a horizontal position and lock it in place. To avoid lacerating the cervix, grasp enough tissue.
10. Apply gentle traction on the tenaculum.
11. If the need to dilate the cervix is anticipated prior to the procedure, a luminaria may be applied in advance of the appointment. During the procedure, if you are unable to pass the biopsy instrument through the internal os, you will need to dilate the cervix mechanically. Start with the smallest dilator, progressing to the next size until the os is opened enough for the sound to pass.
12. Collect the endometrial sample, as described below (Figs. 8.4 and 8.5).
13. Insert the sampling cannula through the os, being careful to avoid touching vulvar or vaginal tissue, which would cause contamination.

14. Rotate the sampling cannula device between the thumb and forefinger as it passes through the os. Apply gentle pressure until it reaches the fundus, as indicated by previous measurement or by resistance, then withdraw very slightly.
15. Stabilize the sampling cannula with one hand while activating suction with the other.
16. If using a syringe sampling device, steadily withdraw the plunger in one smooth motion, being sure not to advance the cannula or to let the plunger slide forward.
17. If using external suction, activate suction according to the manufacturer's instructions.
18. Gently pull the cannula toward the internal os and then push it back into the uterine cavity at least four times, being careful not to withdraw past the internal os, which will cause loss of negative pressure. Rotate the cannula consistently in a clockwise direction several times, and then counterclockwise, while performing the movement in all four quadrants of the endometrial cavity in a systematic fashion in a vacuuming type of pattern.
19. Release suction pressure and remove the device when the entire uterine cavity has been sampled and the device is visibly filled with tissue.
20. Expel the specimen into the appropriately labeled formalin-filled specimen container by pushing the piston into the sheath, thereby discharging the specimen. With the Pipelle, use sterile scissors to cut off the tip to expel the sample.

NOTE: This step is not necessary with the Tis-U-Trap.

21. If there appears to be insufficient tissue for diagnosis, the same catheter may be used to perform a second pass, provided it has not touched the formalin. Deposit the sample into a labeled tissue container with the appropriate preservative.
22. If used, remove the tenaculum.
23. Cleanse the vagina and cervix gently with gauze.

24. Ensure hemostasis. Most bleeding can be controlled with pressure via cotton swabs or a sponge stick. For persistent bleeding, Monsel solution or silver nitrate sticks can be used.
25. Remove the speculum.
26. Dispose of equipment according to standard biohazard precautions.[5–7]

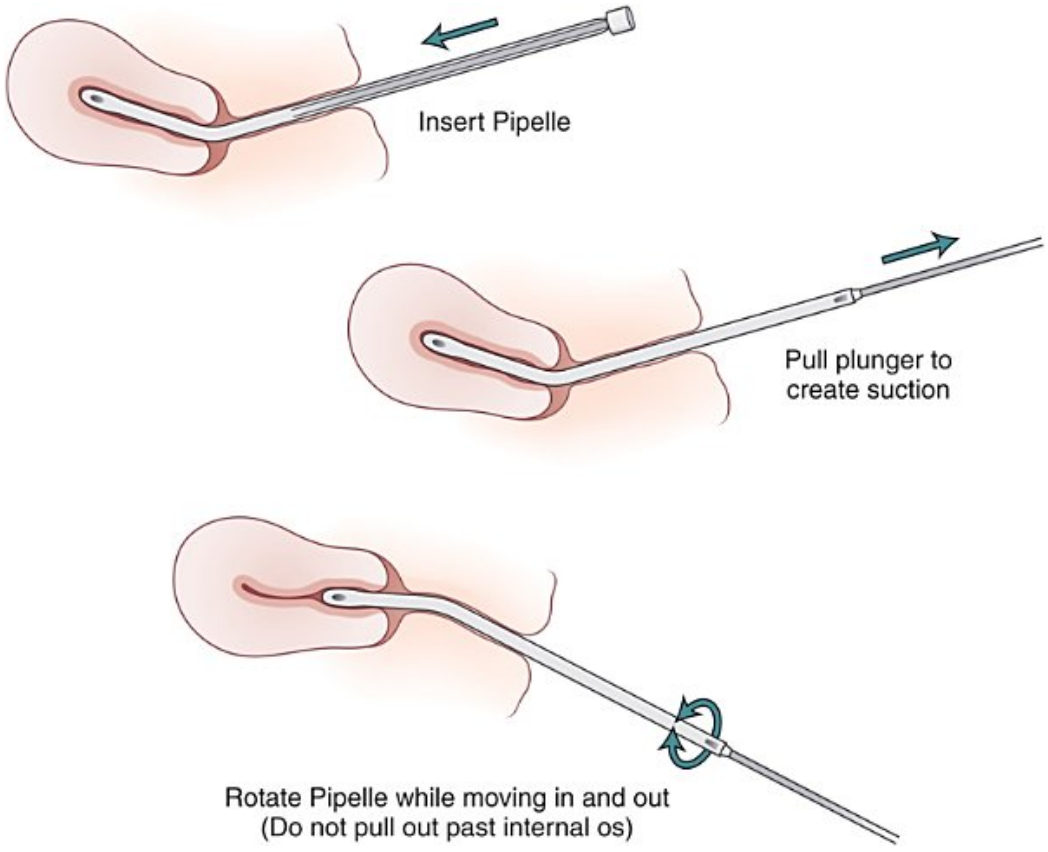

FIGURE 8.4 **Endometrial biopsy using Pipelle.**

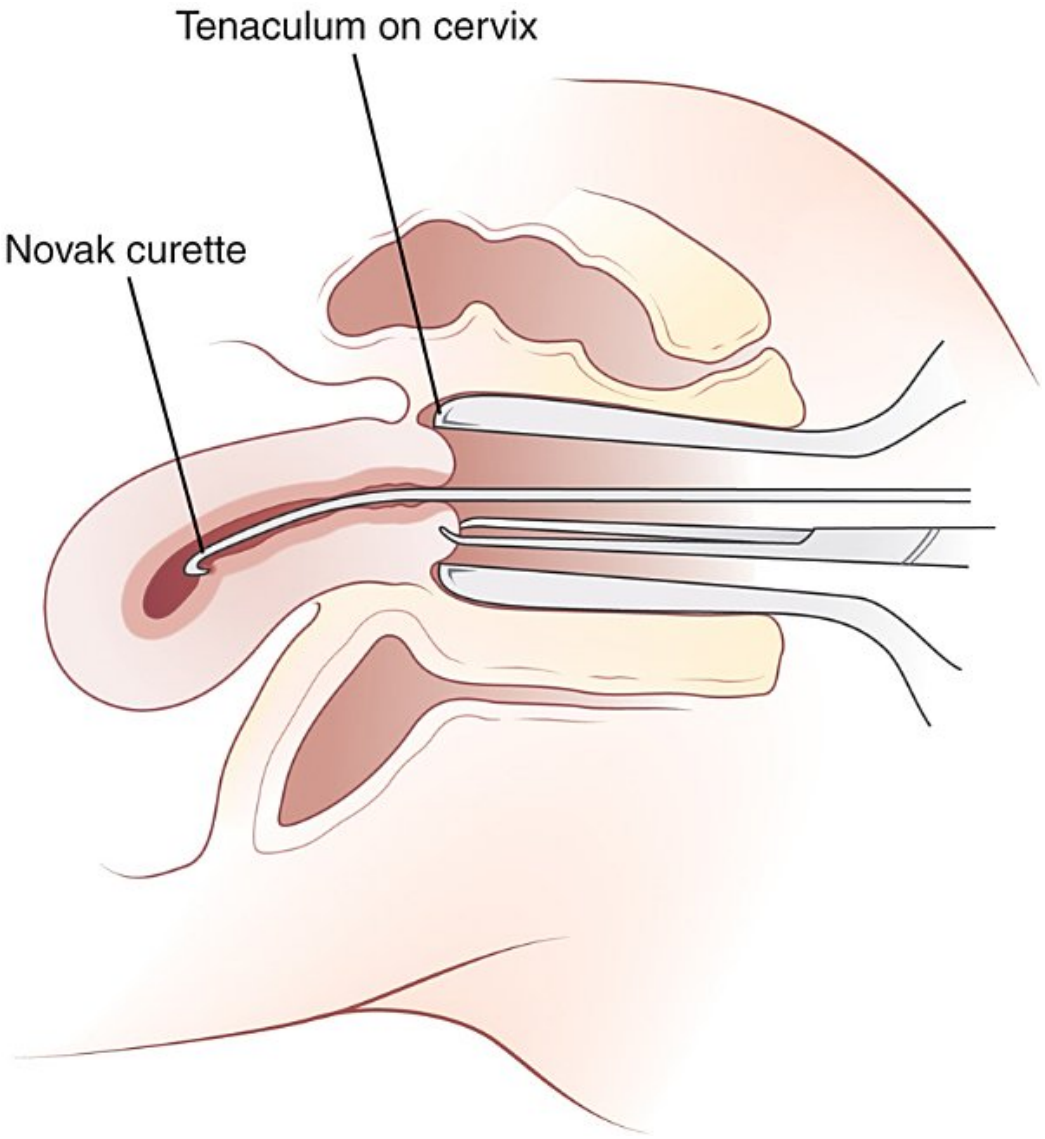

FIGURE 8.5 **Endometrial biopsy using Novak curette.**

Follow-Up Care and Instructions

The following should be taken into consideration in **follow-up care**:

- The patient should remain lying down in the examination room for 5 to 15 minutes to reduce the risk of a vasovagal reaction.[7] A vasovagal reaction typically occurs within the first 10 minutes after the procedure, if at all.

- Inform the patient that slight spotting and cramping are considered normal.
- The patient may drive after release from the office.
- Persistent discomfort after the procedure is unusual. Patients should be advised they may take NSAIDs as needed, which may also provide the additional benefit of antiprostaglandin activity.[6,74] Acetaminophen is an acceptable option for discomfort.
- Instruct the patient to place nothing into the vagina for 14 days following the procedure. This includes tampons and engaging in sexual activity.[7]
- The patient should notify the office of any development of fever, cramping greater than 48 hours, worsening pain, foul-smelling vaginal discharge, or bleeding heavier than a typical menses.[6,7]

Supplementary and Alternative Procedures

The following supplementary and alternative procedures may be considered:

Be sure the patient is educated on the risks and benefits of all methods of assessing the endometrium.

- Hysteroscopy can be used with or without concurrent biopsy to evaluate abnormal uterine bleeding. This has the benefit of direct visualization of the endometrial cavity.[1]
- Transvaginal sonography may be used to assess endometrial thickness, with an endometrial stripe of 4 mm or less having 96% sensitivity in ruling out endometrial cancer.[1]
- Saline infusion sonohysterography involves filling the uterine cavity with saline before ultrasound and allows for improved visualization of endometrial thickness, polyps, and other focal uterine irregularies.[1]

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CHAPTER 9

Endotracheal Intubation

Shepard B. Stone

Abstract

Few would argue that a patent airway is not a priority (if not THE priority) in survival. Clinical circumstances arise in which patients need assistance in obtaining and maintaining a clear air passageway. Often lesser maneuvers suffice, but intubation of the trachea via natural orifices is often viewed as a gold standard in this regard. Indications and contraindications are discussed as well as the particulars of patient preparation and the implementation of intubation itself. Guidance in postintubation care is offered.

Keywords

airway management techniques
airway obstruction
artificial airways
emergency airways
endotracheal intubation
intubation
tracheal intubation
tracheal tube placement

Procedure Goals and Objectives

GOAL: To successfully insert an endotracheal tube while observing standard precautions and with a minimal degree of risk to the patient.
OBJECTIVES: The student will be able to:

- Discuss the indications, contraindications, and rationale for performing endotracheal intubation.
- Identify and describe common complications associated with endotracheal intubation.
- Describe the essential anatomy and physiology associated with the performance of endotracheal intubation.
- Identify the materials necessary for performing endotracheal intubation and their proper use.
- Identify the important aspects of patient care after endotracheal intubation.

Background and History

Endotracheal intubation is the process by which a tube is inserted into the trachea. This may be accomplished through the larynx or through the skin of the neck. *Cricothyroidotomy* and *tracheostomy* are the terms for the latter approach. This chapter limits discussion to the former approach and refers to the translaryngeal intubation of the trachea simply as intubation.

Intubation is a procedure performed daily in many locations around the world—electively in the operating room and urgently in emergency rooms, in clinics, and in the field. Practitioners should be familiar with this lifesaving skill. Proficiency at intubation is a requirement for practitioners whose practices put them in an environment in which advanced cardiac life support, pediatric and neonatal advanced life support, and advanced trauma life support

skills are used on a regular basis and in which advanced backup (i.e., an anesthesia care provider) is not rapidly accessible.

The technique has been performed since the eighteenth century[3]; however, its use as we know it today became more common in the 1940s. The value of intubation is well established. The ability to place an unobstructed conduit into a patient's airway to assist with ventilation and to protect the airway is potentially a lifesaving skill. Conversely, if performed improperly, endotracheal intubation can be life threatening. Providing the necessary knowledge and skills to master this technique successfully is the goal of this chapter.

Indications

Intubation, which provides a secure means of maintaining a patent air passage, should be used for the following situations:

- For a patient who has lost the ability to maintain a patent airway if other methods are ineffective or unreliable
- If a patient is at risk for losing the ability to ventilate adequately (e.g., airway edema, decreasing of consciousness, respiratory failure)
- For bypassing anatomic obstructions to clear airflow and provide a means to suction the lower airways of secretions and foreign materials; positive-pressure ventilation with a self-inflating reservoir bag (e.g., Ambu) is facilitated, as is the use of mechanical ventilators.

Contraindications

The only **contraindication** to translaryngeal intubation is laryngeal disruption itself. Airway compromise must never be tolerated, but intubation through the traumatized larynx may not succeed, may waste precious time, and may exacerbate the injury. In this situation, creation of a surgical airway (e.g., cricothyroidotomy) may be the more prudent choice.

The only contraindication to translaryngeal intubation is laryngeal disruption itself. Airway compromise must never be tolerated, but intubation through the traumatized larynx may not succeed, may waste precious time, and may exacerbate the injury. In this situation, creation of a surgical airway (e.g., cricothyroidotomy) may be the more prudent choice.

Potential Complications

Complications of intubation may be anatomic, physiologic, or psychological. Anatomic complications, which may result from the intubation itself or from the presence of the tracheal tube, are as follows:

- Nasal intubation may traumatize the nasal turbinates, the nasal mucosa, or the adenoids or may dissect into the retropharyngeal tissues.
- Oral intubation may cause damage to the lips, teeth, tongue, tonsillar pillars, tonsils, or a combination of these structures. All intubations may damage the epiglottis, the laryngeal cartilages and mucosa, and the vocal cords.
- Esophageal and tracheal perforations have occurred during intubation attempts.
- Cervical spine injuries and ocular injuries have also been reported.
- As in any instrumentation, bleeding may occur.
- Late complications of intubation include vocal cord paralysis and a subsequent increased risk for aspiration and dysphonia, tracheal stenosis, and tracheomalacia.
- The anatomic problems of tracheal tube malposition or kinking can occur.

Physiologic complications of intubation include the following:

- Hypoxia
- Hypercarbia
- Cardiac dysrhythmias (including cardiac arrest)

- Hypertension
- Hypotension
- Intraocular hypertension
- Intracranial hypertension
- Vomiting and aspiration
- Bronchospasm
- Laryngospasm

Late complications include the following:

- Pain
- Sore throat
- Speech problems
- Difficulty swallowing and breathing
- Sinusitis (with nasal intubation)
- Pneumonia
- Posttraumatic stress disorder that may result from intubation of patients who have not been adequately prepared psychologically for the intubation procedure or have not been sufficiently anesthetized or sedated during or after the intubation, or both.

Prevention of all complications in all patients is not possible. However, proper preparations (i.e., physical, psychological, and pharmacologic) and gentle manipulations result in both the highest success and the lowest complication rates.

Essential Anatomy and Physiology

The successful performance of any procedure is enhanced by adequate knowledge of the relevant anatomy. A review of the structures of the oropharynx, nasopharynx, and larynx is essential (Fig. 9.1).

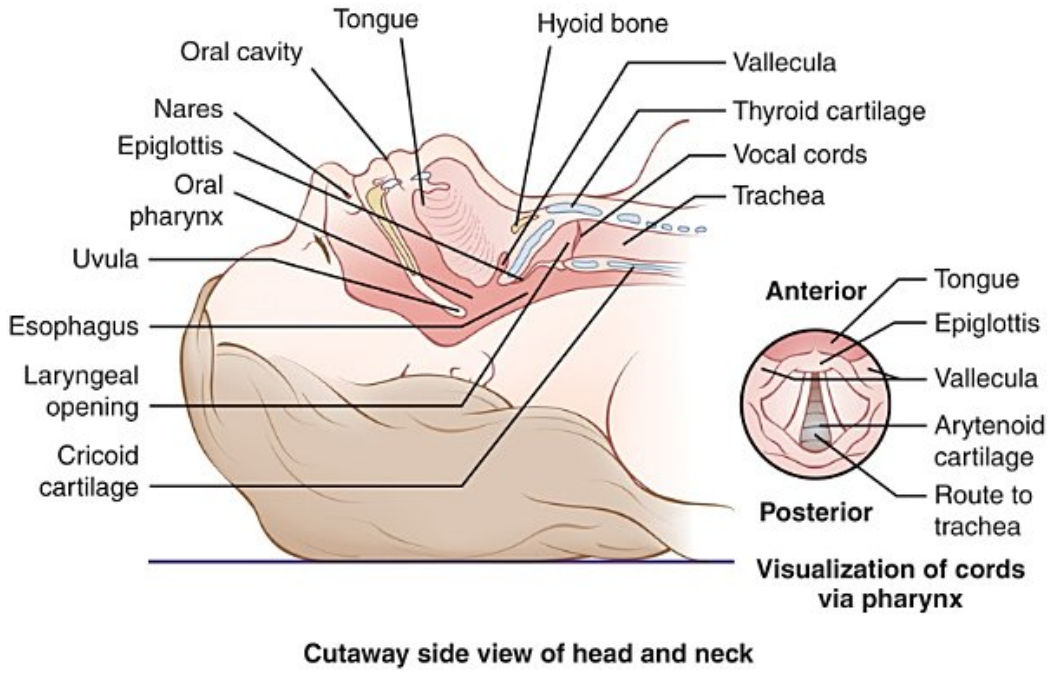

FIGURE 9.1 Anatomy of the oropharynx, nasopharynx, and larynx. (Redrawn from Pfenninger JL, Fowler GC. *Procedures for Primary Care Physicians*. St. Louis, MO: Mosby–Year Book; 1994:456.)

The nasotracheal tube traverses a nostril, passing between the nasal septum and the nasal turbinates and following the course of the posterior nasopharynx to arrive in the hypopharynx. The nasal mucosa is both friable and sensitive. Efforts must be made to reduce the likelihood of epistaxis before tube insertion.

Orotracheal intubation involves manipulation of the tongue to elevate the epiglottis, exposing the larynx. The lips and teeth are structures to avoid when manipulating the laryngoscope, as are all other tissues. Epiglottic manipulation is carried out either directly with the laryngoscope blade or indirectly by placing the laryngoscope blade in the vallecula. The vallecula is the point at which the epiglottis attaches to the tongue. Elevation of the tongue at this point causes the epiglottis to rotate anteriorly and expose the larynx.

When the epiglottis is elevated, the larynx is visualized. Note that in pediatric patients (younger than 3 years of age) the epiglottis is relatively long and floppy and it must be manipulated directly for laryngeal exposure. The key landmark is the glottis, the opening into

the larynx itself. The glottis is bordered laterally by the vocal cords, which are whitish structures originating at the 12 o'clock position and attaching at 5 and 7 o'clock (when the patient is supine). The arytenoid cartilages are the paired posterior laryngeal landmarks from the 3 to 9 o'clock positions. The vocal cords are located in the narrowest portion of the adult larynx. Deep to the larynx (which is formed anteriorly by the thyroid cartilage) is the cricoid cartilage. This is a complete cartilaginous ring attached to the thyroid cartilage via the cricothyroid membrane. This is important to remember when it is desirable to manipulate the larynx during intubation attempts or to occlude the esophagus. Also, the cricoid cartilage is the narrowest part of the pediatric airway. Distal to the cricoid is the trachea itself. The tracheal bifurcation results in the left mainstem bronchus taking a more acute deviation to the left than the right mainstem bronchus takes to the right. Overly enthusiastic tracheal tube insertion usually results in a right mainstem bronchial intubation. The esophagus lies posterior to the airway structures.

The nasopharynx, oropharynx, and larynx are richly innervated by the sphenopalatine ganglion, anterior ethmoidal nerve, glossopharyngeal nerve, superior laryngeal nerve, and recurrent laryngeal nerve.[4] This must be considered when intubating a patient who is conscious. The placement of a tracheal tube or a laryngoscope, or both, in this circumstance will result in discomfort and autonomic nervous system stimulation. This is the cause of many of the physiologic complications mentioned earlier.

Certain features assessable on physical examination may predict difficulties in intubation. Narrow nostrils make nasal intubation difficult, as do narrow nasal passages. This can be ascertained by occluding one nostril and having the patient breathe in rapidly and deeply through the nonoccluded nostril. If there is occlusion, this is readily noted by the patient. Limited mouth opening may make laryngoscopy difficult. Limited intraoral visualization (often caused by a large tongue) is a risk factor for difficult traditional laryngoscopy. Limited neck movement, especially extension, may be a predictor of intubation difficulty. A significant overbite or micrognathia may make intubation challenging. Another predictor

of possible difficulty is if the distance from the chin to the larynx is less than three fingerbreadths (patient's), or 6 cm.

Certain features are assessable on physical examination that may predict difficulties in intubation. Narrow nostrils and narrow nasal passages, limited mouth opening, limited intraoral visualization, limited neck movement (especially extension), significant overbite or micrognathia, and if the distance from the chin to the larynx is less than three fingerbreadths (patient's), or 6 cm.

None of these physical examination findings is completely reliable for accurately predicting difficult intubation. Their presence should not be ignored, however, and the presence of multiple risk factors must be considered as an increasing likelihood of difficult intubation.[2]

Standard Precautions

Practitioners should use standard precautions at all times when interacting with patients. Determining the level of precaution necessary requires the practitioner to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens(for further discussion, see Chapter 35).

Patient Preparation

Having a cooperative patient markedly facilitates intubation, and the following points should be taken into consideration in preparing the patient:

- In the patient who is capable of responding to the environment but requires intubation, it is important to explain why he or she needs to be intubated and what the procedure will entail, both during and after the procedure.
- As always, it is important to consider historical information, including the patient's past medical history.

- If possible, query the patient or the patient's family about any prior difficulties with intubation.
- If time permits and previous medical records are available, look for an anesthesia record.
- If it is found that general anesthesia was administered, intubation may have taken place. If intubation was difficult, the anesthesia care provider should have noted it.

Pharmacology

Pharmacologic support can be useful. If intubation with the patient awake is desired, the process can be facilitated with the use of topical anesthetics; in fact, intubation may be performed using topical anesthetics alone. Intubation also can be performed without any pharmacologic support; if time is critical, this may be the only option. Providing adequate topical anesthesia requires approximately 10 to 20 minutes of preparation. The anesthetization itself takes no more than 10 minutes, but the drying of the airways that enhances absorption of the local anesthetics takes about 10 minutes after intravenous administration or 20 minutes after intramuscular administration. Glycopyrrolate 0.2 mg intravenously in adults is an adequate dose. The advantage of glycopyrrolate over atropine is that it does not cross the blood–brain barrier, decreasing the potential for causing confusion, which can be a major problem when patient cooperation is desired.

Local Anesthetics

Commonly used topical anesthetics include cocaine, benzocaine, tetracaine, lidocaine, or combinations thereof. These drugs are applied to the surfaces that are to be in contact with the laryngoscope and endotracheal tube, but they are not necessary for airway anesthesia. One nerve that must not be blocked is the recurrent laryngeal nerve, because sensory blockade anesthetizes the larynx and part of the epiglottis, and motor blockade results in vocal cord paralysis. A unilateral block causes hoarseness, dysphonia, and possible aspiration; a bilateral block causes complete airway obstruction. To produce sensory blockade only, topical application

of local anesthetics to the larynx and trachea may be performed (this may be carried out from above the larynx or by injecting through the cricothyroid membrane). If the patient is at risk for pulmonary aspiration of oral or gastric secretions, anesthesia should not be provided, some argue, so that the patient can sense the presence of aspirated material and be able to clear it by coughing.

Cocaine

Cocaine offers the unique advantage of also providing topical vasoconstriction. This is useful for reducing epistaxis when performing intubations via the nasal route. If used, no more than 3 mg/kg of body weight of a 4% or 10% solution should be used to avoid toxicity. It should also be avoided when tachycardia and hypertension are a concern. If vasoconstriction is desired, phenylephrine (Neo-Synephrine) or oxymetazoline (Afrin) may be used in conjunction with other local anesthetics. Because cocaine is a controlled substance, its use has diminished.

Benzocaine

Benzocaine has a rapid onset and brief duration of action. The dose limit of 4 mg/kg is readily exceeded because it comes in high concentrations of 10%, 15%, and 20%. Overdosage can result in methemoglobinemia.

Tetracaine

Tetracaine has a longer duration of action than benzocaine. Its dose limit is 0.5 mg/kg. It is available in dilute concentrations of 0.5%, 1%, and 2%.

Cetacaine

Cetacaine is a commercially available aerosolized mixture of 14% benzocaine and 2% tetracaine that has a rapid onset and reasonable duration. Be aware that the toxic effects of local anesthetics are additive; thus, it is recommended to limit administration to no more

than two 1-second sprays. Cocaine, benzocaine, and tetracaine are all members of the aminoester group of local anesthetics. This group has a higher associated incidence of allergic reactions than amino-amino local anesthetics.

Lidocaine

Lidocaine is the most readily available local anesthetic. It is of the amino amide group, and allergic reactions to lidocaine itself are rare. The dose limit is 5 mg/kg. It is available in 0.5%, 1%, 2%, and 4% solutions; 2% viscous solution; 2% jelly; 2.5% and 5% ointments; and a 10% aerosol spray.

Sedatives

The intubation of the patient who is not obtunded (by pathologic or iatrogenic processes) is made easier by sedation. Drugs that have a rapid onset and brief duration of action are best for this purpose. Surprisingly small amounts are necessary in the presence of a well-anesthetized airway; in fact, the anesthetization itself may be facilitated with judicious sedation. The most commonly used drugs are fentanyl and midazolam. These drugs also have the advantage of having an antagonist available—naloxone (Narcan) and flumazenil (Romazicon), respectively. Dexmedetomidine, alfentanil, and remifentanil are also used. Titrated to effect, they are not likely to produce adverse hemodynamics. Be aware that synergism may result from polypharmacy, and undesired responses, such as airway obstruction and respiratory depression, may result. Any drug can be used as long as the desired effects are achieved, that is, a patient who breathes and is calm and cooperative. The advantage of intubation performed in a conscious patient is that the patient maintains airway patency, spontaneous ventilation, the ability to protect the airway and the ability to verify neurologic function during and after intubation. This is particularly important with cervical spine injuries.[4] It should always be considered in patients who are known to be difficult to intubate, are anticipated to be difficult to intubate, have airway or neck trauma, or are hemodynamically unstable.[4]

Other Methods of Anesthesia

If performing intubation while the patient is awake is not required, performing intubation while the patient is unconscious is usually faster and easier for both the patient and the practitioner. Psychological stress is reduced, and the intubating conditions may be improved by general anesthesia. The risk of anesthetized intubation is that it removes the patient's ability to maintain the airway and ventilate spontaneously.

It is possible that the intubation will not succeed. If the patient cannot be ventilated by face mask or other device and cannot be intubated and the anesthetizing drugs' effects cannot be terminated, the only recourse to save the patient's life is to create a **surgical airway, which is not without risk**. In the process of performing intubation, it is important to remember to "do no harm."

The risk of anesthetized intubation is that it removes the patient's ability to maintain the airway and ventilate spontaneously.

The practitioner can use the sedatives mentioned previously in larger doses to obtain unconsciousness, or other drugs can be used. The intravenous agents that are used most commonly to induce rapid unconsciousness are propofol, etomidate, and ketamine. All work within seconds. Propofol may cause hypotension. Propofol and etomidate cause local pain on injection and sometimes cause myoclonic movements. Etomidate has a high incidence of nausea associated with its use. Ketamine is associated with auditory and visual hallucinations during the recovery phase that may be attenuated by benzodiazepines. It also causes bronchodilation, making it especially useful as an induction agent in status asthmaticus. Both etomidate and ketamine tend to maintain blood pressure and are the preferred induction agents in hemodynamically unstable patients in whom anesthetized intubation is desired. It should be noted that ketamine might cause hypotension in patients who are catecholamine-depleted (associated with long-term physiologic stress). Note that ketamine and etomidate may cause increases in cerebral metabolic rate and are not the agents of choice if

cerebral ischemia is of greater concern than the ability to intubate the anesthetized patient. Usual induction doses are thiopental 3 to 5 mg/kg, propofol 2 to 2.5 mg/kg, etomidate 0.3 to 0.5 mg/kg, and ketamine 1 to 2 mg/kg. Doses should be decreased in elderly, hypovolemic, and hemodynamically unstable patients. No reversal agents exist for these drugs.

Neuromuscular Blocking Drugs

Rendering the patient unconscious may be helpful; providing neuromuscular blockade or paralysis may be helpful or may result in death. By causing all the skeletal muscles to relax, the patient cannot cough or offer any physical resistance to intubation. The jaw muscles are lax, enabling easier mouth opening and facilitating laryngoscopy. The lack of coughing prevents spontaneous movement of an unstable cervical spine. Lack of coughing also prevents increases in intrathoracic pressure that can increase central venous pressure, which can result in increased intracranial pressure. The life-threatening complication of neuromuscular blockade is cessation of any spontaneous ventilatory efforts. If the patient cannot be intubated or ventilated and surgical access to the airway is not attained rapidly, the patient may die.

The other consideration when using neuromuscular blocking drugs is that they paralyze skeletal muscles only. They do nothing to suppress consciousness, pain, or the reception and interpretation of any sensory stimulus. When neuromuscular blockade agents are administered alone, the patient remains as awake as you are, with the ability to feel, hear, smell, taste, and see (if you open the patient's eyelids). The only way that the patient can protest is automatically. This may be manifested by hypertension, arrhythmias, bronchospasm or elevations in intracranial pressure. Subtle clues are pupillary dilation, tearing, and diaphoresis. Administering sufficient amounts of sedating and anesthetizing drugs can prevent these undesirable effects. If this cannot be carried out because of hemodynamic status, the patient should be informed. Let the patient know that he or she will feel and hear everything that will be happening.

Two desirable characteristics of neuromuscular blockade agents to facilitate intubation include rapidity of onset and brevity of duration; if intubation fails, breathing may return sooner. The absence of unwanted hemodynamic and other side effects is also desirable. The neuromuscular blockade agents are of two classes: depolarizers and nondepolarizers. The one depolarizer, succinylcholine, causes muscular depolarization at the neuromuscular junction. This is just like the effect of acetylcholine. Unlike acetylcholine, however, it takes minutes rather than seconds to be cleared from the muscle receptor. The depolarizers (all other neuromuscular blocking agents) are competitive inhibitors of acetylcholine, preventing depolarization by occupying the muscle receptor site where acetylcholine normally triggers the depolarization. Termination of effect takes minutes to hours, depending on the drug and the dose; a greater dose results in a longer duration of action. Anticholinesterases (traditionally neostigmine, pyridostigmine, and edrophonium) can be used to reverse nondepolarizing neuromuscular blockade, when indicated. Note that this reversal may be neither rapid nor complete depending on the intensity of the neuromuscular block. Sugammadex is a new reversal agent that rapidly reverses neuromuscular blockade via a different mechanism that does not involve anticholinesterase inhibition. Consequently, it does not require concurrent administration of anticholinergics (i.e., atropine, glycopyrrolate) to offset the cholinergic side effects of neuromuscular blockade reversal. Sugammadex is effective only for reversal of the amino-steroid neuromuscular blocking drugs: aminosteroids pancuronium, rocuronium, and vecuronium.

Succinylcholine

Succinylcholine is effective at a dose of 1 mg/kg (in children 1 to 2 mg/kg). Its intravenous onset is within 60 seconds, and the duration of action is about 5 to 10 minutes. Increasing the dose increases the duration of action. Its mode of action, skeletal muscle membrane depolarization, results in a transient hyperkalemia of about 0.5 to 1 mEq/L. Patients who are paretic, have been burned, have sustained

crush injuries or myopathies, or are hyperkalemic for any reason may sustain a hyperkalemic increase of 5 to 10 mEq/L, resulting in cardiac arrest. Succinylcholine may trigger malignant hyperthermia. It also may cause transient increases in intraocular and intracranial pressures, so it should be used with caution if the patient has an open globe injury or a closed head injury unless the risk for a failed intubation is greater than the risk for increased intracranial pressure. Succinylcholine may cause bradycardia; therefore, its use in pediatric patients should be preceded by anticholinergic administration. Myalgias sometimes follow succinylcholine use; administering a small dose of a nondepolarizing agent before the succinylcholine may reduce the incidence of myalgias. If a nondepolarizing neuromuscular blockade agent is used to mitigate myalgias, the dose of succinylcholine should be increased to 1.5 mg/kg.

Nondepolarizing Neuromuscular Blockade Agents

The nondepolarizing neuromuscular blockade class includes curare, metocurine, pancuronium, vecuronium, atracurium, cisatracurium, doxacurium, pipecuronium, mivacurium, and rocuronium. Rocuronium offers the fastest onset (within 1 minute and maximal effect within 3 minutes, with a duration of 30 minutes) at a dose of 1.2 mg/kg. The others have a slower onset. Increasing the dose enhances the onset of all of these drugs and increases their duration of action. Increasing the dose also increases the likelihood of unwanted side effects. Some of the drugs listed release histamine when given rapidly or in a large dose, which may cause flushing, hypotension, and bronchospasm.

Physical Preparation

Patient positioning is critical.

- Intubation is easiest if the patient is supine with the head as close to the practitioner as possible and at the level of the practitioner's xiphoid cartilage.

- The patient's head should be in the "sniffing" position: cervical flexion with C1-C2 extension.
- If **cervical spine injury is a possibility**, the patient should either be maintained in an appropriate cervical immobilization system or should have axial stabilization maintained by an individual who has no other duties during the intubation sequence.
- In normal adults, the sniffing position is readily attained by placing a support under the head while displacing the occiput toward the patient's feet.
- In children and the obese, a more optimal position may be attained by placing support under the shoulders and neck.

Caution: The importance of this maneuver cannot be overstressed. The sniffing position aligns the axes of the oropharynx (mouth), hypopharynx (throat), and larynx, making the shortest distance from the "outside world" to the trachea (Fig. 9.2).

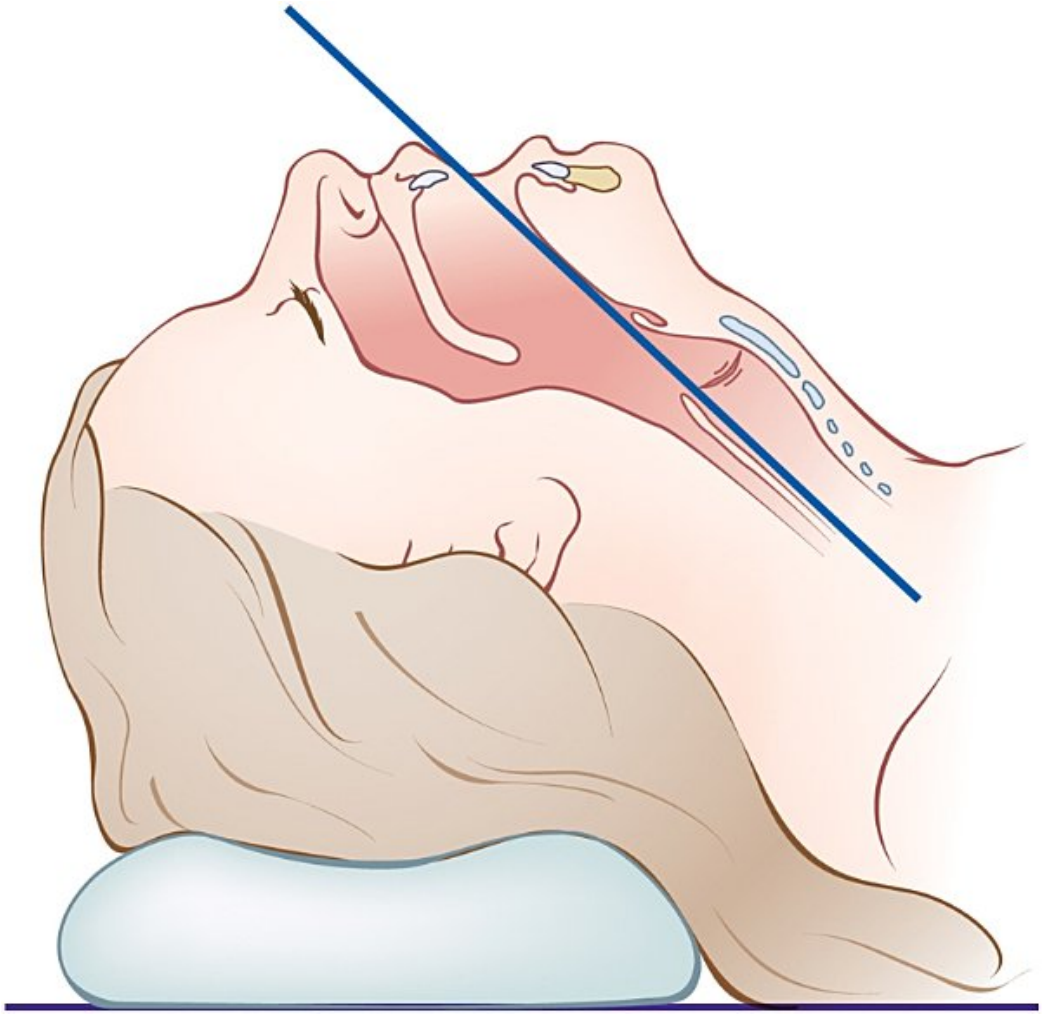

FIGURE 9.2 Axes in line with "sniffing" position. (Redrawn from Pfenninger JL, Fowler GC. *Procedures for Primary Care Physicians*. St. Louis, MO: Mosby–Year Book; 1994:456.)

If cervical spine injury is a possibility, the patient should either be maintained in an appropriate cervical immobilization system or should have axial stabilization maintained by an individual who has no other duties during the intubation sequence.

Adjuncts

- Emergency support equipment (Fig. 9.3) (More frequently than not, tracheal intubation is an urgent, if not an emergent,

procedure.)
    - An adequate source of suction to reduce the likelihood of pulmonary aspiration and to enhance laryngeal visualization
    - Airway adjuncts, such as oropharyngeal, nasopharyngeal, and supraglottic (e.g., laryngeal mask airways) airways
    - An appropriately sized face mask, self-inflating reservoir bag, and oxygen source
    - For patients in whom mask ventilation and intubation are unsuccessful, a supraglottic airway or Combitube, which may be a lifesaving aid
    - Intravenous access and resuscitative medications, as well as specific adjunctive medications (see later)
- Monitors for pulse oximetry, electrocardiography, and blood pressure. Use of capnography is encouraged.

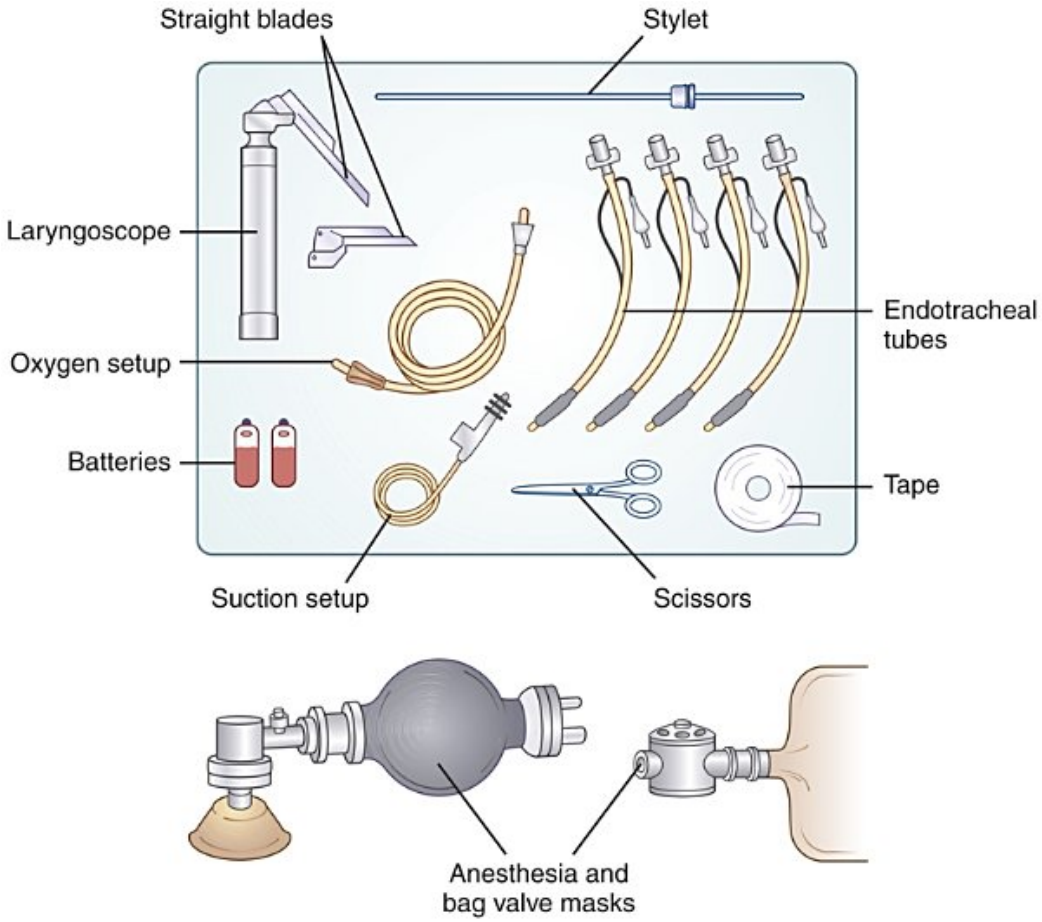

FIGURE 9.3 Endotracheal intubation equipment. (Redrawn from Pfenninger JL, Fowler GC. *Procedures for Primary Care Physicians*. St. Louis, MO: Mosby–Year Book; 1994:454.)

If neuromuscular blocking drugs are to be used, a peripheral nerve stimulator to monitor the onset and duration of action of those drugs can be most useful.

Laryngoscopes

- The laryngoscope is a lighted tongue elevator (rather than depressor) and is a necessity for most oral intubations and some nasal intubations.

NOTE: The intubator should confirm that the laryngoscope is functioning. If the batteries are exhausted or the bulb is burned out,

the intubation process will be significantly impeded. Other common causes of malfunction are loose bulbs and impurities between the contacts of the blade and the handle. Fiberoptic laryngoscopes are more reliable and often brighter than conventional devices.

- Appropriately sized blades for the patient: For adults, Macintosh no. 3 and no. 4 (curved blades) and Miller no. 2 and no. 3 (straight blades) (Fig. 9.4); for pediatric patients, straight blades to manipulate the relatively large and floppy epiglottis directly. Blade size must be appropriate for patient size.
- Available backup equipment, such as additional handles, batteries, and blades
- Use of video laryngoscopes should be considered. Numerous types are available, and their use should be considered when they are available. Their characteristics may facilitate what would otherwise be a difficult laryngoscopy or intubation, *especially* when the individual performing the intubation does not have currency or proficiency with traditional laryngoscope (i.e., Macintosh or Miller blades) (Fig. 9.5).

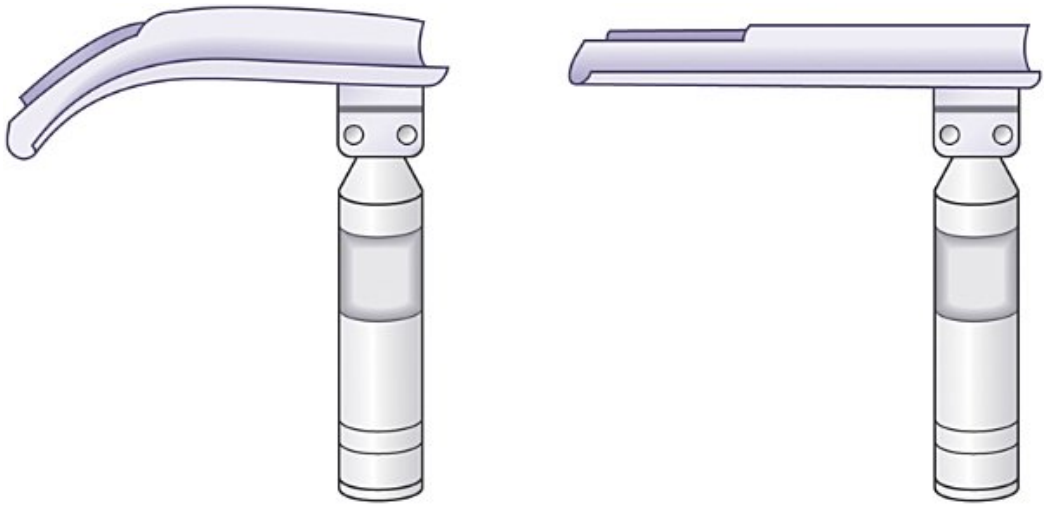

FIGURE 9.4 **Curved and straight laryngoscope blades.**

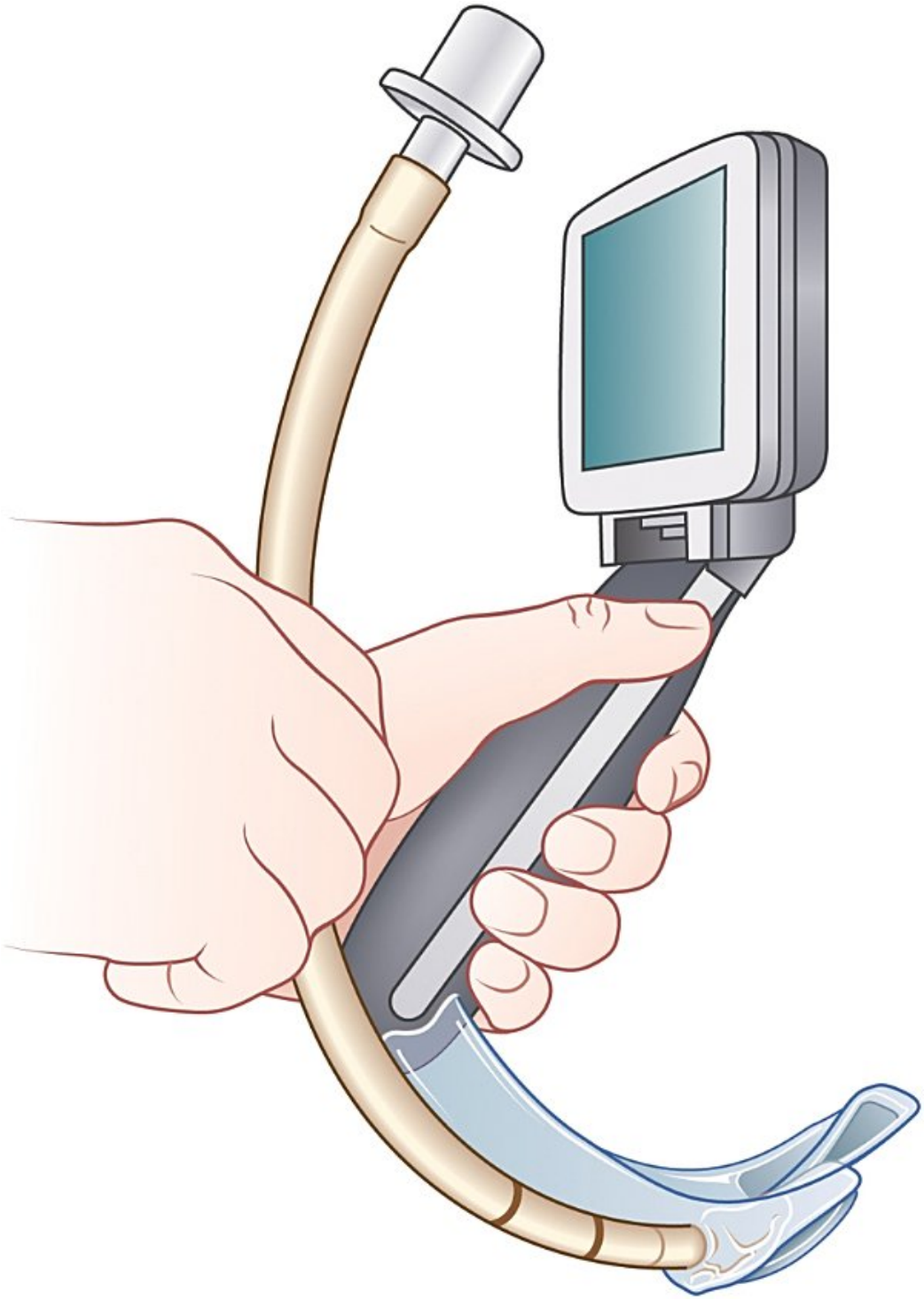

FIGURE 9.5 **Video laryngoscope.**

Tracheal Tubes

Tracheal tubes (or endotracheal tubes), constructed of a plastic that has been implant tested to prove it is not harmful to biologic tissues, are needed. They are for single-patient use. The tubes are described by their size, which is determined from the internal diameter in millimeters. Common sizes are from 2.5 to 10 mm. Sizes frequently used for orotracheal intubation in adults are 7 to 8 mm in women and 7.5 to 8.5 mm in men (Fig. 9.6). When in doubt about size, use a smaller tube. Tube size for nasotracheal intubation is limited by the size of the nasal passages; small nares or enlarged nasal turbinates may markedly limit the size of the tracheal tube that can pass.

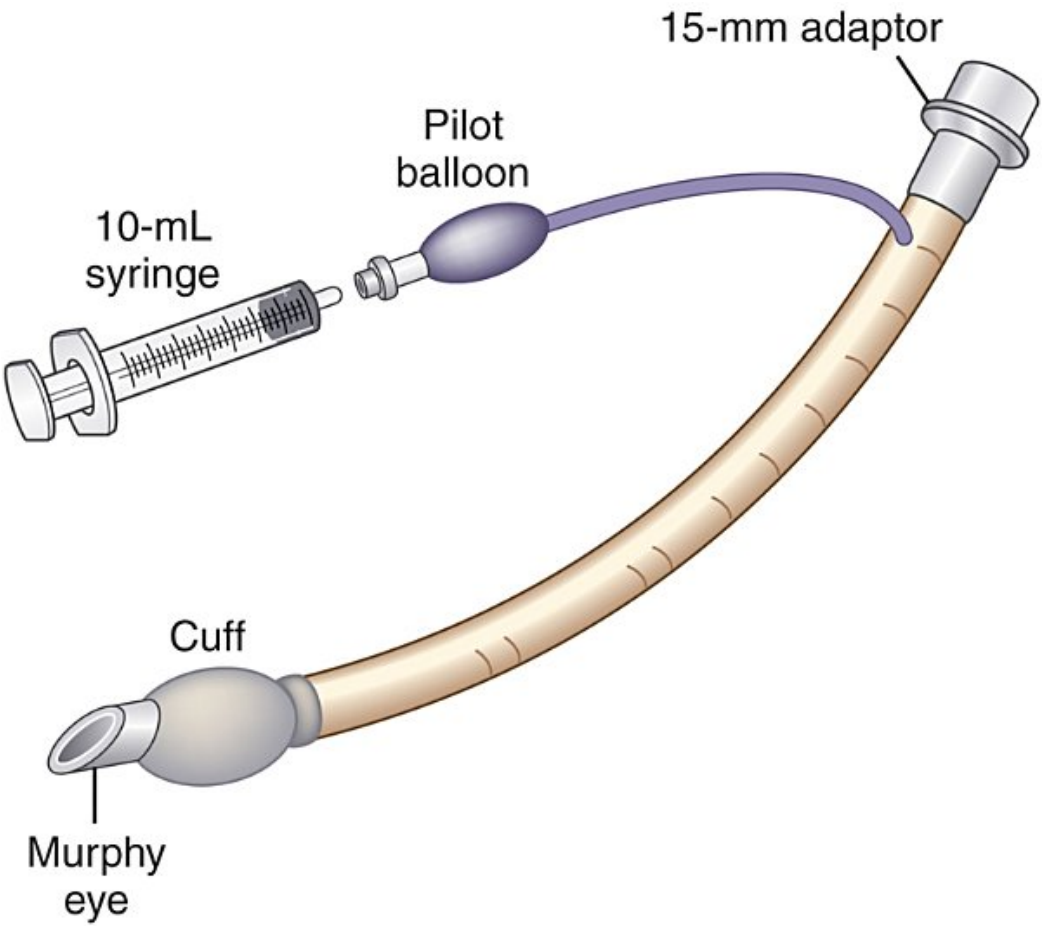

FIGURE 9.6 **An endotracheal tube.**

NOTE: An often-used formula for calculating tube size in children is 18 plus age in years divided by 4; this is a rule of thumb, and

adjustments are made as required (see later discussion). Tracheal tubes of the expected size, as well as those a size larger and a size smaller, should be immediately available. The tubes have centimeter markings along the distal length.

NOTE: Tracheal tubes should be kept in the sterile wrapper until ready for insertion. Preparation of the tube includes confirming that the 15-mm external diameter adapter is securely in place—it is usually loosely in place in the unopened package. If the adapter is lost, conventional ventilation equipment will not be able to "mate" with the tracheal tube, and only "mouth-to-tube" ventilation or spontaneous ventilation will be possible.

NOTE: Other preparation includes confirming that the tube's inflatable cuff and its inflation valve are functional. First injecting a volume of air sufficient to distend the cuff into the inflation valve and then detaching the inflation syringe from the inflation valve accomplishes this. The cuff should be observed to maintain its inflated state. If it does, both the cuff and inflation valve are functional. If the syringe is not removed, the competence of the inflation valve has not been confirmed. It is more common to have a defective inflation valve than a defective cuff on a new tracheal tube.

NOTE: Tracheal tubes for children younger than 3 months of age are usually not cuffed (cuffed tubes are manufactured but are not commonly used). This is because of concerns of postextubation airway narrowing. The inflammation after intubation of the narrow pediatric airway can result in obstruction to airflow. Adult airways also develop inflammation, but because they are of much greater diameter, the effect of the inflammation usually is not clinically significant.

Tracheal tubes for children younger than 3 months of age usually are not cuffed. This is because of concerns of postextubation airway narrowing.

- Lubrication for tracheal tubes

NOTE: This is rarely needed but may be helpful in the presence of dry oral mucosa (oral intubation). Lubrication is essential for nasal intubation to reduce nasal trauma, bleeding, and pain. Water-soluble lubricants (sterile) or local anesthetics (e.g., lidocaine, 2% jelly) are useful. Surprisingly, the use of tubes lubricated with local anesthetics has been associated with an increased incidence of sore throat. The cause is unknown.

Stylets

The final step in tube preparation is preparing a lubricated stylet for the tracheal tube.

- Stylets are made of a malleable metal, often coated with polymeric silicone (Silastic). They provide a means of modifying the tube's innate mild curve to the shape desired by the intubator.
- Stylets should be lubricated before insertion into the tracheal tube. The lubricant must not be harmful if inhaled into the lungs. A sterile, water-soluble jelly is used most often. Care should be taken to avoid getting the lubricant on the outside of the 15-mm adapter, because it can interfere with mating to self-inflating bag-valve units, ventilator tubing, or anesthesia circuits.
- A stylet should be placed for all oral intubations. During intubation, removing an unneeded stylet is easier than placing a needed one.

Magill's Forceps

- Magill's forceps are used to help pass nasotracheal tubes when laryngoscopes are used to facilitate nasal intubation.

Confirming Tube Placement

- Tools for confirming correct placement of tracheal tubes are immediately available
- A stethoscope to confirm breath sounds and a carbon dioxide detector (a capnograph is ideal; colorimetric is acceptable) to confirm placement in an airway that is in continuity with perfused and ventilated lungs in a perfused, ventilated airway

NOTE: Other devices are advocated but are not yet in common use.

Medications

See discussion of patient preparation.

Other Equipment

The equipment described is sufficient for most intubations. If it is insufficient, specialized assistance should be sought. If this assistance is unavailable, transcricothyroid jet ventilation or cricothyroidotomy should be considered. Tracheostomy specifically is not recommended.

A failed intubation is likely owing to anatomic abnormalities such as a short, thick neck; airway edema and bleeding; and cervical immobilization. Emergently "cutting down" into this anatomy to search for the trachea while striving to avoid the carotid arteries, the jugular veins, and the thyroid gland while the patient is becoming increasingly distressed is not recommended. Many patients have died in such a circumstance. The specialist consultant may have more experience, expertise, and special equipment. Examples of this equipment include, but are not limited to, (gum-elastic) bougies, Frova intubating introducers, airway exchange catheters, fiberoptic laryngoscopes, fiberoptic bronchoscopes, specialized laryngoscope blades, antegrade and retrograde intubating stylets, and intubating laryngeal mask airways.

Procedure

Oral Endotracheal Intubation

1. Reliable intravascular access (intravenous or intraosseous) should be in place before beginning the procedure. Cardiac and respiratory monitors should be applied (i.e., electrocardiogram, pulse oximetry, and blood pressure, at a minimum). The patient must be breathing 100% oxygen, and suction and intubating equipment must be immediately available in close proximity.

NOTE: If the patient has been rendered (or is) unconscious, application of cricoid pressure should be considered to reduce the risk for regurgitation and aspiration. This pressure may need to be modulated to facilitate laryngeal visualization.

2. On completion of the preceding preparations, open the patient's mouth as wide as possible, with the right thumb displacing the mandible toward the patient's feet and the right index finger pushing against the patient's maxillary teeth (thumb being anterior to index finger).

NOTE: This is best accomplished at the level of the molar teeth, which are flat and will not injure the fingers as incisors might. Additionally, molars are closer to the temporomandibular joint, so displacement there will yield greater mouth opening, and by having a hand off to the patient's right, there will be ample room to place the laryngoscope in the mouth.

NOTE: If video laryngoscopy is used, mouth opening is less critical.

3. Hold the laryngoscope in the left hand and place it in the right side of the open mouth. Slide along the tongue, displacing the tongue anteriorly and to the left.

Video laryngoscopy: Lateral displacement of the tongue is not usually helpful. Keep the blade in the midline.

4. Keep the tongue from falling over the right side of the blade, which will obscure visualization. *This is not a factor in video laryngoscopy.*
5. Keep an eye on the tip of the blade as it is being manipulated. *This is less a factor in video laryngoscopy, but is recommended to minimize pharyngeal trauma.*

NOTE: As the blade is advanced, the epiglottis comes into view.

6. When a fair amount of the epiglottis is visualized (curved blade; Fig. 9.7), apply force along the axis of the laryngoscope's handle. This lifts the tongue and rotates the epiglottis, exposing the larynx (Fig. 9.8).

NOTE: When using a straight blade (Fig. 9.9), the epiglottis is directly elevated with the tip of the blade, again exposing the larynx.

NOTE: A common mistake is inserting the blade too far. This can be disorienting, because the ensuing esophageal visualization is unanticipated. Another common error is not applying the force vector along the laryngoscope handle's axis but "levering" the laryngoscope. This tends to cause it to pivot on the patient's upper incisor teeth, sometimes breaking them. More importantly (in a lifesaving situation), it makes laryngeal visualization more difficult because it tends to lift the larynx anteriorly out of the view of the intubator. The goal is to raise the structures above the larynx, leaving the larynx in the field of vision. Assistance may be obtained by displacing the cricoid cartilage posteriorly; this displaces the larynx for a better view. A cephalad and rightward displacement also may be helpful—backward, upward, rightward, posteriorly (BURP) describes this combination maneuver.[1]

Video laryngoscopy: The blade is advanced along the curve of the tongue while the screen/eye piece is monitored. The laryngoscope is manipulated so that the glottis is visualized.

7. Take the tracheal tube in the right hand, held as one would hold a writing instrument, and pass it from the right side of the mouth into the laryngeal inlet, medial to the vocal cords and anteromedially to the arytenoid cartilages.

Video laryngoscopy: The tracheal tube is held as above but is passed along the video laryngoscope's blade until passage between the vocal cords is visualized. Please note that some devices have specialized requirements for tracheal tube preparation and passage.

8. If the patient is breathing spontaneously, the vocal cords will be moving. Time the tube insertion to correspond to the end of inspiration. This is when the vocal cords are farthest apart.

NOTE: Be aware that at the moment of tube insertion, the view into the larynx is lost. If the tube is not properly aligned with the larynx, it is possible for it to be deflected into the esophagus. The key to this potential problem is to keep one's eye on the larynx during and after the tube insertion. If the tube is visualized between the vocal cords and anterior to the arytenoids after tube insertion, the tube is in the correct position. If it is visualized posteriorly in the esophagus, it is not in the correct position and should be removed and placed properly.

Video laryngoscopy: In video laryngoscopy laryngeal visualization is generally not lost during tube insertion.

9. Pass the tube so that the cuff just passes the vocal cords; more is neither necessary nor better.

NOTE: A great tendency occurs among practitioners who intubate infrequently to advance the tube much too far. In most adults, the depth of insertion is in the range of 18 to 24 cm at the level of the upper incisor teeth; the depth is less in shorter patients

and more in taller patients. As long as the cuff is just beyond the vocal cords, tube placement is adequate.

10. Pass the uncuffed pediatric tube so that the heavy black marker line just passes the vocal cords. The cuffed tube should be passed as above.
11. At this point, remove the laryngoscope from the patient's mouth, holding the tube securely while the stylet is removed.
12. Inflate the cuff at this time with just enough air to cause a seal within the trachea.

NOTE: The volume of air depends on the size of the tube relative to the size of the trachea— large tube, small trachea, small volume; small tube, large trachea, large volume. It is usually in the range of 5 to 10 mL. More is not better, because excessive pressure is exerted on the tracheal mucosa. This causes ischemia that may predispose to tracheal scarring, stenosis, or tracheomalacia. Just enough air should be administered so that during positive-pressure ventilation air is not heard leaking around the tube out of the patient's mouth.

NOTE: In children, especially when using an uncuffed tube, a leak should be heard at 20 cm of water pressure. If there is no leak at this level of positive pressure, replace the tube with a smaller one. If, conversely, the leak is so large that one cannot effectively ventilate the child, replace the tube with a larger one.

NOTE: A recommended technique to change the tube is to repeat the laryngoscopy and, under direct vision, withdraw the wrong-sized tube and replace it with another. If necessary, an endotracheal tube exchange catheter may sometimes facilitate the exchange.

13. Confirm tube placement by auscultating breath sounds bilaterally at the lung apices (either in the axillae or supraclavicularly)—first the right, then the left. If tube placement is in question, radiographic confirmation may be helpful.

NOTE: Auscultating the left side first confirms placement in the airway; if there are sounds, there is either a tracheal or right mainstem bronchial intubation. No sounds indicate esophageal intubation. Sounds on the right confirms tracheal intubation. This sequence verifies correct placement. Another approach is to disprove incorrect placement. One auscultates over the stomach first, then the right hemithorax, and finally the left hemithorax.

14. Assess the expiratory gas for carbon dioxide while simultaneously auscultating.

NOTE: It is highly desirable that a capnographic waveform be available for analysis. This enables ruling out a false–positive determination, as is seen when a patient has recently consumed carbonated beverages. False–negative determinations occur when there is a total absence of blood flow to the lungs, as happens during either cardiac arrest or massive pulmonary embolus. Additionally, success of resuscitation may be monitored by the presence and amount of end-tidal carbon dioxide.

15. Inspect for symmetrical chest expansion, fogging of the tube with airway moisture, and absence of gastric distention. If the tube is seen in the larynx after tube placement, it is in place (unless it gets displaced afterward). The tube must now be secured.
16. Degrease the patient's skin and prepare the skin with tincture of benzoin or other skin adherent and protector. Use of some commercially available tube holders makes this step unnecessary.

NOTE: The tube can be secured by circumferentially wrapping the tape around the patient's neck and then the tracheal tube. If performed properly, it is almost impossible for the tube to "fall out." The tube can also be secured circumferentially with cloth umbilical tapes or commercial tube holders.

17. Placement of a bite block is recommended after orotracheal intubation to protect the tracheal tube from occlusion if the patient is inadequately sedated or is uncooperative.

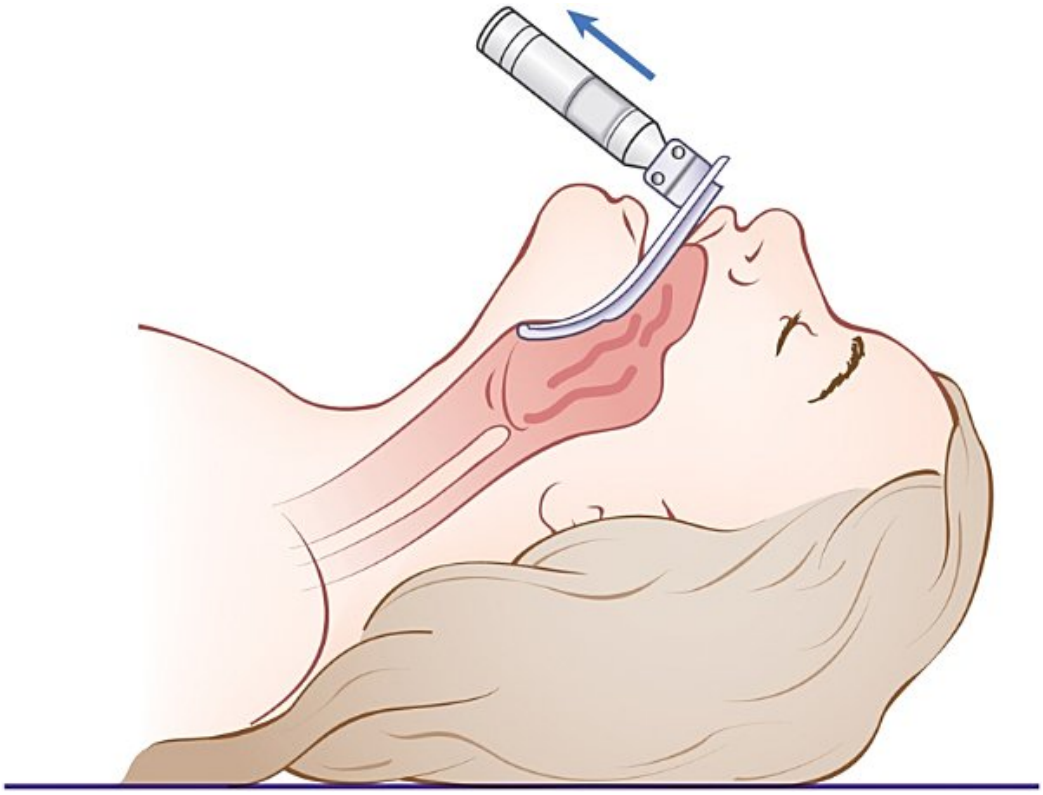

FIGURE 9.7 **Use of curved laryngoscope blade**

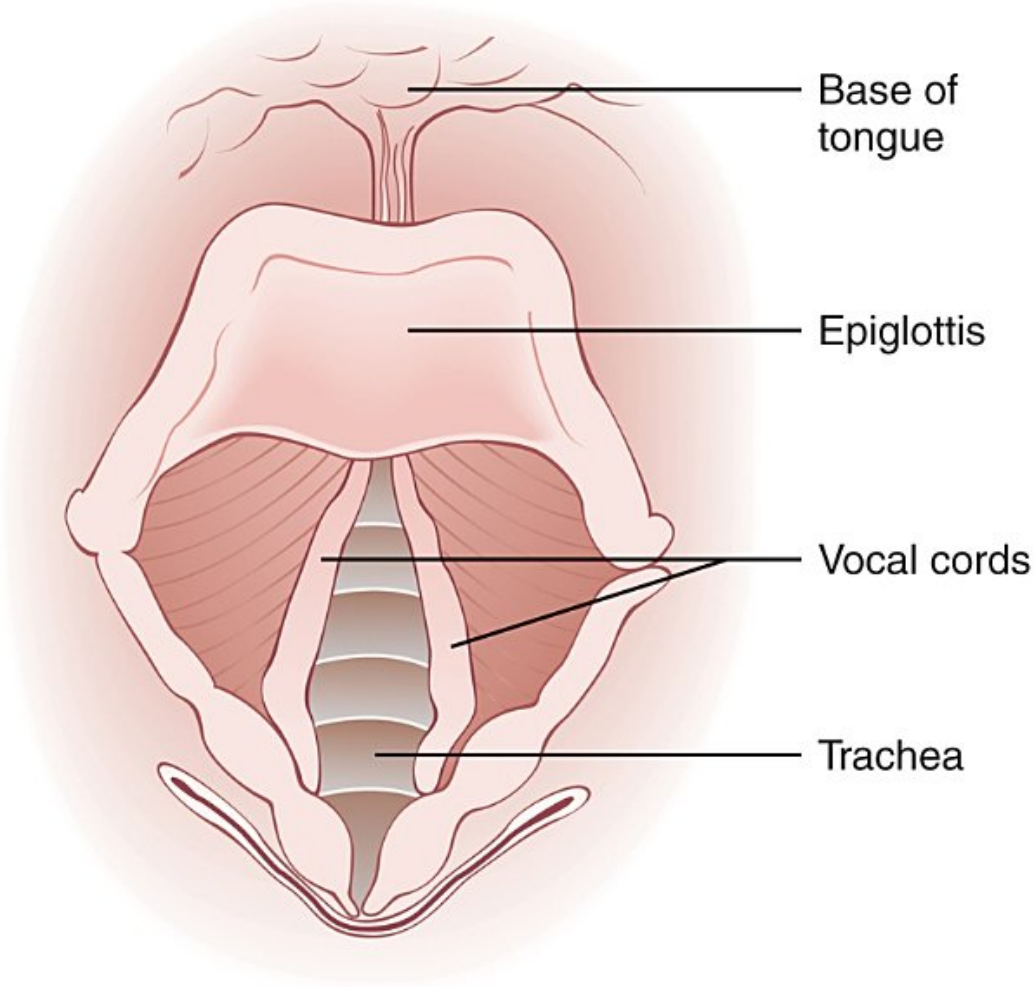

FIGURE 9.8 **Structures of note during laryngoscopy**

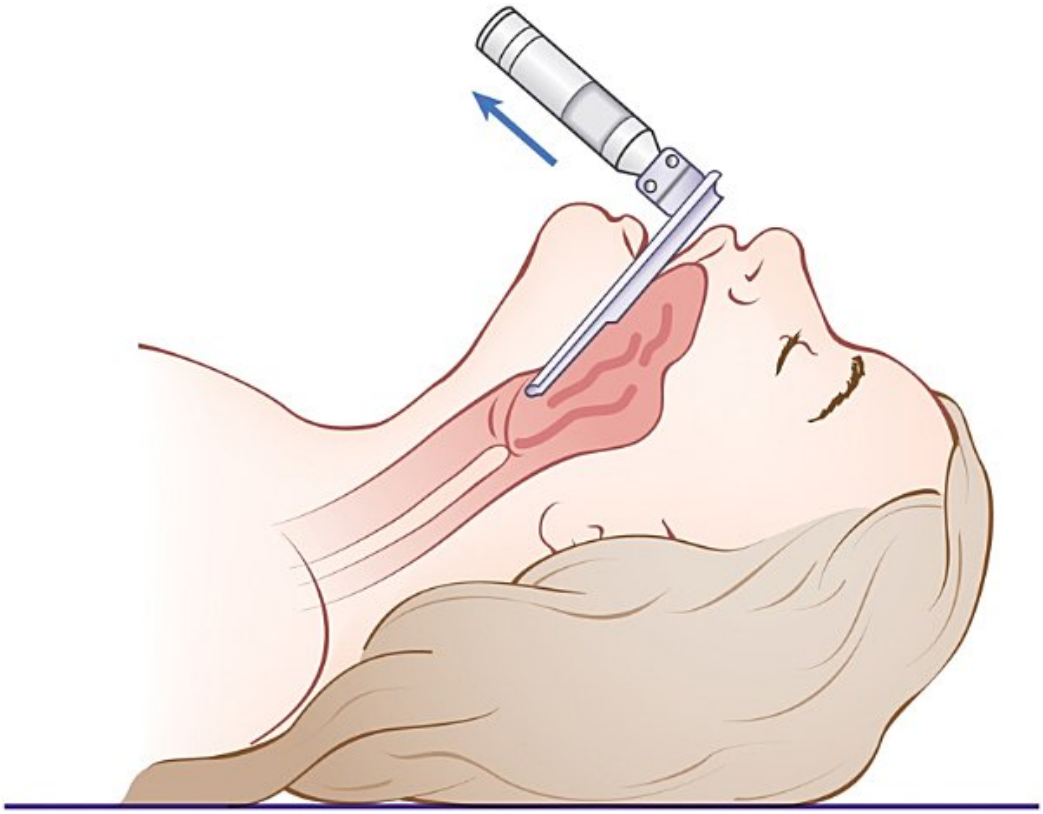

FIGURE 9.9 **Use of straight laryngoscope blade**

Procedure

Nasal Endotracheal Intubation

Nasal intubation is most easily performed in the spontaneously breathing patient who is placed in a sitting position. Topical vasoconstrictors are essential to reduce the chance of epistaxis. If both nostrils are equally patent, the right nostril is preferred, because the bevel of the tube is less likely to "scoop" the nasal turbinates as it passes them.

1. Lubricate the tube; an easy way is to place water-soluble jelly or anesthetic jelly in the nostril, and the tube will "pick up" the jelly as it is inserted.
2. Exert firm, steady pressure along the axis of the nasopharyngeal floor (just as in the insertion of a nasogastric tube).

3. As the tube reaches the posterior nasopharynx, some resistance is felt; continue the steady pressure, and the resistance decreases as the tube "turns the corner."
4. As the tube is advanced further, breath sounds are audible. It may be helpful to occlude the other nostril and the patient's mouth so that all ventilation is via the tube.
5. Advance the tube during inspiration.

NOTE: If the tube is aligned with the larynx, it will pass into the trachea. This is often marked with a cough and, if the patient is conscious, the loss of the ability to phonate.

6. If alignment is off in the midline, flex the patient's neck and advance the tube. This may attain success.
7. If the tube is misaligned laterally (the tube causes a bulge laterally), rotate it to remedy the situation.

NOTE: Because of the resistance of the tube in the nose, a much greater rotation is necessary than would be expected. It might be necessary to rotate the tube 180 degrees to get 30 degrees of rotation at the tube's tip.

8. If these maneuvers are ineffective, place the patient supine as for oral intubation and perform direct or indirect laryngoscopy and advance the tube under direct vision.

NOTE: The Magill forceps is often helpful at manipulating the tube into the larynx.

CAUTION: Do not grab the tube's cuff with the forceps, because it may tear. An assistant should advance the tube as the intubator guides it.

9. Once in place, confirmation should be obtained and the tube secured.

Follow-Up Care and Instructions

After successful intubation has been completed, the patient must be protected both physically and psychologically.

Physical Protection

- Provide an adequate amount of humidified oxygen.
- Prevent the tube from kinking or becoming dislodged.

Psychological Protection

- Administer sedation and analgesia. If drugs are used to facilitate intubation, the patient will experience pain and anxiety after their effects have dissipated. It is both cruel and dangerous not to treat these symptoms. It is dangerous because self-extubation is likely, and hypertension, tachycardia, arrhythmias, and increased intracranial pressure may occur. Neuromuscular blockade agents are an inappropriate means of keeping the tube in place in the absence of sedatives and analgesics.
- In infrequent circumstances a patient's hemodynamic status is so precarious that administration of sedatives and analgesics is inadvisable, and the patient must be pharmacologically paralyzed to prevent self-harm or harm to others, to facilitate evaluation and treatment, or to allow mechanical ventilation at safe airway pressures.
- When these circumstances exist, all personnel must remember that the patient is awake and sensate and must be treated appropriately. Speech must be appropriate, and comfort and explanations must be offered to the patient. It is my opinion that neuromuscular blockade agents are overused both inside and outside the operating room.

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CHAPTER 10

Epistaxis and Nasal Foreign Body Removal

Shalon R. Buchs

Abstract

This chapter explores the procedural process for epistaxis control and nasal foreign body removal. Indications and contraindications for both procedures are included. Anatomy of the nose and etiology of both conditions (nosebleeds and foreign body) are reviewed. The appropriate examination technique and required materials are discussed for nose bleeds and foreign bodies in the nose. Placement of nasal packing is described in detail with considerations for complications.

Keywords

epistaxis
nasal foreign body
nasal packing
nose
nosebleed

Procedure Goals and Objectives

GOAL: To control epistaxis and remove nasal foreign body, when indicated, with minimal risk and discomfort to the patient.

OBJECTIVES: The student will be able to:

- Describe the essential anatomy and physiology of the nose and nasal cavities.
- Describe the indications, contraindications, and rationale for treating epistaxis and for removal of a foreign body from the nasal passages.
- Identify the materials necessary for evaluation and management of epistaxis and a nasal foreign body.
- Discuss the important aspects of postprocedure care.

Epistaxis

Background and History

More than 60% of the general population will experience at least one nosebleed in their lifetime. Approximately 6% of patients that present for epistaxis will require medical or surgical intervention and less than 0.2% will require hospitalization.[1] Emergency department visits for epistaxis in the United States is approximately 0.5%.[2] Visits for epistaxis are also common in primary care and urgent care clinics.

A bimodal age distribution is noted for epistaxis, with an initial peak in patients younger than 10 years of age; the second peak occurs in patients older than 50 years.[3] Epistaxis episodes in the younger population are more likely to be secondary to injury or

foreign body. Older adult cases are often atraumatic and occur in the winter months.[2] Older persons are more likely to have more severe episodes than younger patients.[4]

An estimated 65% of epistaxis episodes seen in medical settings could be treated at home with pressure and oxymetazoline (Afrin) nasal spray.[5] More than half of visits to emergency departments for epistaxis resolve without the use of any medications or procedural intervention. The opportunity for patient education, prevention, and health care cost savings is therefore great.[2]

Several products are available to assist in epistaxis control, which range from topical vasoconstrictors and chemical cautery to sophisticated commercial balloon products. Newer commercial systems often combine mesh that will affect platelet aggregation with the double-balloon systems found in earlier products. The Rapid Rhino 900 is an example of a double balloon system (Figs. 10.1 and 10.2). Some advantages to this system include a softer balloon with lower pressure and decreased discomfort for the patient as well as ease of insertion for the clinician.

FIGURE 10.1 The Rapid Rhino 900 dry, with two external ports for anterior and posterior balloons. (With permission from Smith + Nephew, Inc.)

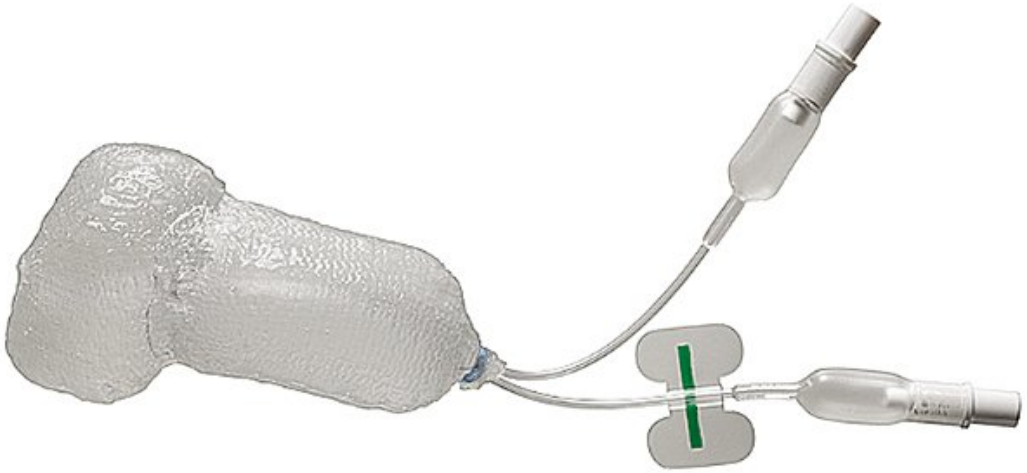


FIGURE 10.2 The Rapid Rhino 900 wet with visible anterior and posterior balloons. (With permission from Smith + Nephew, Inc.)

Indications

The indications for nasal packing include:

- Epistaxis that is not controlled by more conservative measures (pressure, chemical cautery, and so forth)

Contraindications

The **contraindications** for nasal packing include:

- Shock and altered mental status are contraindication because they can prevent autonomous airway protection.
- **Nasal bone and cribriform plate fractures**, specifically for posterior nasal packing.

Shock and altered mental status are contraindications because they can prevent autonomous airway protection. Nasal bone and cribriform plate fractures are also contraindications, specifically for posterior nasal packing.

Patients with any contraindications require otolaryngology or maxillofacial surgical consultation and are generally treated in the operative setting.

Potential Complications

The potential complications of nasal packing include:

- Infection (sinus and systemic) and toxic shock syndrome are the most worrisome potential complications. Many clinicians are selecting **antibiotics** that cover *Staphylococcus aureus* in an attempt to prevent toxic shock syndrome.[4]

Clinicians are using topical antibiotic agents to coat packing to facilitate placement, in addition to the antimicrobial coverage, and adding an oral agent at discharge.

- Mechanical complications include sinus perforation and tissue necrosis.[4]
- Hematoma, while not common, may also occur.[3,5]
- **Airway compromise is a concern** with both anterior and posterior packing. Because the risk is higher with posterior packing, many patients with a unilateral posterior pack in place and most patients with bilateral posterior packs will require hospitalization in a monitored bed.[3,5] In one study, 3.7% of patients required intubation.[6]

In both anterior and posterior packing, the airway is vulnerable to compromise. Most patients with posterior packs should be hospitalized in a monitored bed.

The balloons in tamponade devices can become dislodged or leak; recurrent bleeding, soft-tissue necrosis, extreme discomfort, and severe anxiety can occur, and hypoxia is always a concern. Although the efficacy of oral antibiotics used prophylactically has not been proven and is not universally accepted, it is likely the majority of

clinicians use antibiotics after nasal packing because of the possibility of these complications.[4,7]

Essential Anatomy and Physiology

Approximately 90% of all nosebleeds are anterior. The most commonly involved anatomic area is Kiesselbach's plexus (Fig. 10.3). Fewer than 10% of episodes are posterior; these posterior nosebleeds more commonly occur in older persons or persons with systemic comorbid conditions.[2] The most common site of posterior epistaxis is the sphenopalatine artery as it emerges posterior to the middle turbinate.[3]

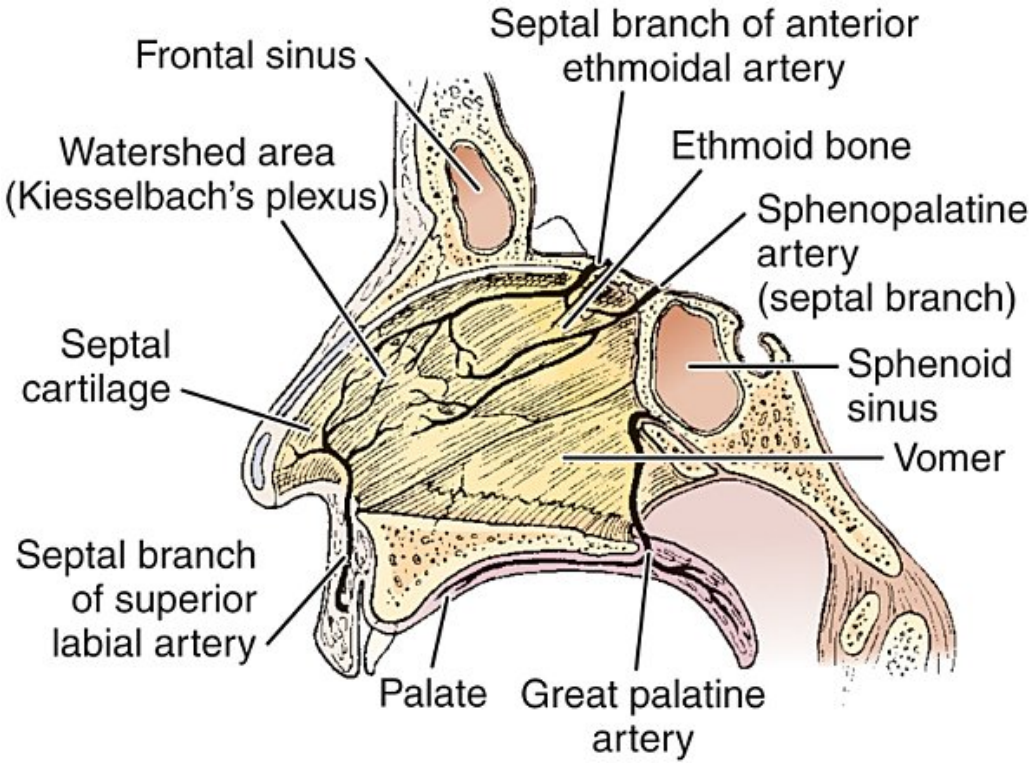


FIGURE 10.3 Vascular supply to the septum.
The most common site of anterior epistaxis is within the area labeled Kiesselbach's plexus. (From Maceri DR. Epistaxis and nasal trauma. In: Cummings CW, ed. *Otolaryngology: Head and Neck Surgery,* ed 2. St. Louis: Mosby–Year Book; 1993, p. 728.)

Cause of Nasal Bleeding and Pathophysiology

Causes can be mechanical (local) or systemic. The most common mechanical causes include digital manipulation, foreign body insertion, and trauma. Digital trauma is the most common cause of epistaxis in the pediatric population.[5] Other local causes include irritation from nasal exposure to irritants (i.e., prescription or nonprescription nasal sprays or voluntary nasal inhalation of illicit substances), exposure to dry indoor air in winter, exposure to inadvertently inhaled substances (e.g., smoke, dirt from sandstorms), and other miscellaneous exposures. Benign structures, such as nasal polyps, also contribute. Rarely, solid-tissue nasal and sinus malignancies can cause acute, severe epistaxis by eroding through contiguous major vessels. Viral and bacterial upper respiratory tract infections contribute to local tissue friability. Hereditary hemorrhagic telangiectasia (Osler-Weber-Rendu disease) often initially presents with epistaxis. It can cause severe local bleeding that may be refractory to traditional treatment and may be life-threatening.[5,6]

Comorbid conditions that include coagulopathies, such as hemophilia, thrombocytopenia, leukemia, von Willebrand disease, and others, have been implicated[3,4] and, if present, may lead to difficulty in controlling bleeding. Anything that causes disruption of coagulation or hemostasis, including anticoagulant or antiplatelet medications, nonprescription herbal medications, and subacute hepatic and renal disease, falls within this category. Specific drugs that should be considered include aspirin, nonsteroidal antiinflammatory drugs (NSAIDs), warfarin, and other chronic anticoagulants. Additionally, herbals such as garlic, gingko, and ginseng can cause coagulopathy.[5,6] Finally, cocaine and any other illicit substances that may be taken through the nasal passage must be considered when evaluating a patient with a nosebleed.[3,4]

Hypertension

No firm evidence indicates hypertensive emergencies or urgencies are the cause of, or significant contributors to, discrete episodes of

epistaxis.[4] It has been noted that many patients with epistaxis have **elevated blood pressure**.[1] However, a direct connection between the two conditions has not been definitively made.[1,4] Additionally, the peak incidence of adults with epistaxis is in persons older than 50 years; these patients have higher blood pressures physiologically than younger adults.[5,6] If hypertension persists after treatment of the acute bleed or is emergently problematic in and of itself, appropriate treatment, referral, or monitoring should be arranged.[5]

It is generally agreed that the emergent or urgent treatment of hypertension need not be part of the acute intervention for epistaxis to achieve hemostasis.

Standard precautions

Every practitioner should use standard precautions always when interacting with patients, especially when performing procedures. Determining the level of precaution necessary requires the practitioner to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

Patient Preparation

The patient's airway is the priority during assessment. Similarly, as in any episode of potential major blood loss, hemodynamic stability should be established. Although epistaxis can appear to be more severe than actual measured blood loss would indicate, a large amount of bleeding would require large-bore intravenous access, serial measurement of blood volume, and replacement interventions.[5]

Materials

- Rhinoscope or otoscope
- Headlamp, if available

- Oxymetazolidine (Afrin)
- Suction collection system
- Cotton or gauze pledgets
- 2% lidocaine with epinephrine, or 4% cocaine solution
- Silver nitrate sticks
- Electrocautery pen
- Commercial nasal tampon product or commercial balloon system

Procedure

Assessment of Epistaxis

1. The initial portion of the examination is usually performed during triage. At this point, the majority of minor episodes of epistaxis can be identified and treated by the triage clinician. Stable patients can be treated initially by cleansing of the nares (asking the patient to blow the nose is usually sufficient), administering two sprays of intranasal oxymetazolidine (Afrin) to the affected side by the clinician, and constant pressure of at least 15 minutes duration be self-applied; this period should be timed and observed.[8]
2. The **end of the nose** (anterior aspect at the nasal ala) should be clamped between the thumb and the index finger and held tightly for sufficient compression against the septum. The clinician can demonstrate this for the patient and instruct the patient to "hold your nose tightly as if putting your head under water." Of patients examined in medical settings, 60% respond to this treatment.[3,4] Compressing the bony portion of the nose is ineffective.[5]

The end of the nose should be clamped between the thumb and the index finger and held tightly for sufficient compression against the septum for at least

15 minutes. Many patients will respond to this treatment.

3. The medical history should be obtained to determine the historical presence or absence of the etiologic factors (discussed earlier) and any important family or personal history of coagulopathies or epistaxis. Confirmation of systemic causes may lead the clinician to perform further tests, including a complete blood count, coagulation studies, and studies of renal and hepatic function.[5] Routine laboratory testing, including coagulation studies, are otherwise not indicated.
4. After initial patient assessment and local bleeding control, the formal focused physical examination should be performed. A **rhinoscope** and good lighting will be necessary. The patient should be positioned upright in the sniffing position, the neck and head slightly extended. The base of the nose should remain parallel with the floor (Fig. 10.4). The clinician should look for an anterior or posterior **bleeding site** during the examination.

A rhinoscope and good lighting should be utilized to allow a clear, ample view. Use of the otoscope in this setting, although common, is inadequate.

The main purpose of the examination is to identify the site of the bleeding.

NOTE: If anterior, the bleeding may have already stopped as a result of local treatment with pressure and oxymetazolidine. Some areas of slow oozing may be identified on examination, and these will likely be from an anterior source. If brisk bleeding continues, it may be possible to identify an anterior source after suction and immediate direct visualization. Suction is used to ensure a clear field of vision, as necessary. Use suction before vasoconstriction and anesthesia if blood or clots obstruct the nares.

5. Pledgets with vasoconstrictors may be used at this point to aid in adequate diagnostic examination (Fig. 10.5). Two percent lidocaine with epinephrine, or 4% cocaine solution pledgets, if available, are useful. Anecdotally, cocaine solutions are most effective. Phenylephrine is contraindicated.[9]
6. If bleeding slows or stops after local treatment and examination, pressure should be maintained for an additional 15 to 25 minutes and the patient then reexamined.
7. Every attempt should be made to identify the source of bleeding, especially if it continues despite pressure and vasoconstriction. At times, this can be difficult even with rhinoscopy. In these instances, direct endoscopic examination may be necessary to identify the site.[3] If anterior epistaxis cannot be ruled in at this point, treatment options include definitive interventions for posterior epistaxis. Unilateral or bilateral involvement should be confirmed; bilateral treatment may be necessary. If in doubt, intervention should include treatment for bilateral bleed and anterior or posterior pathologic processes.

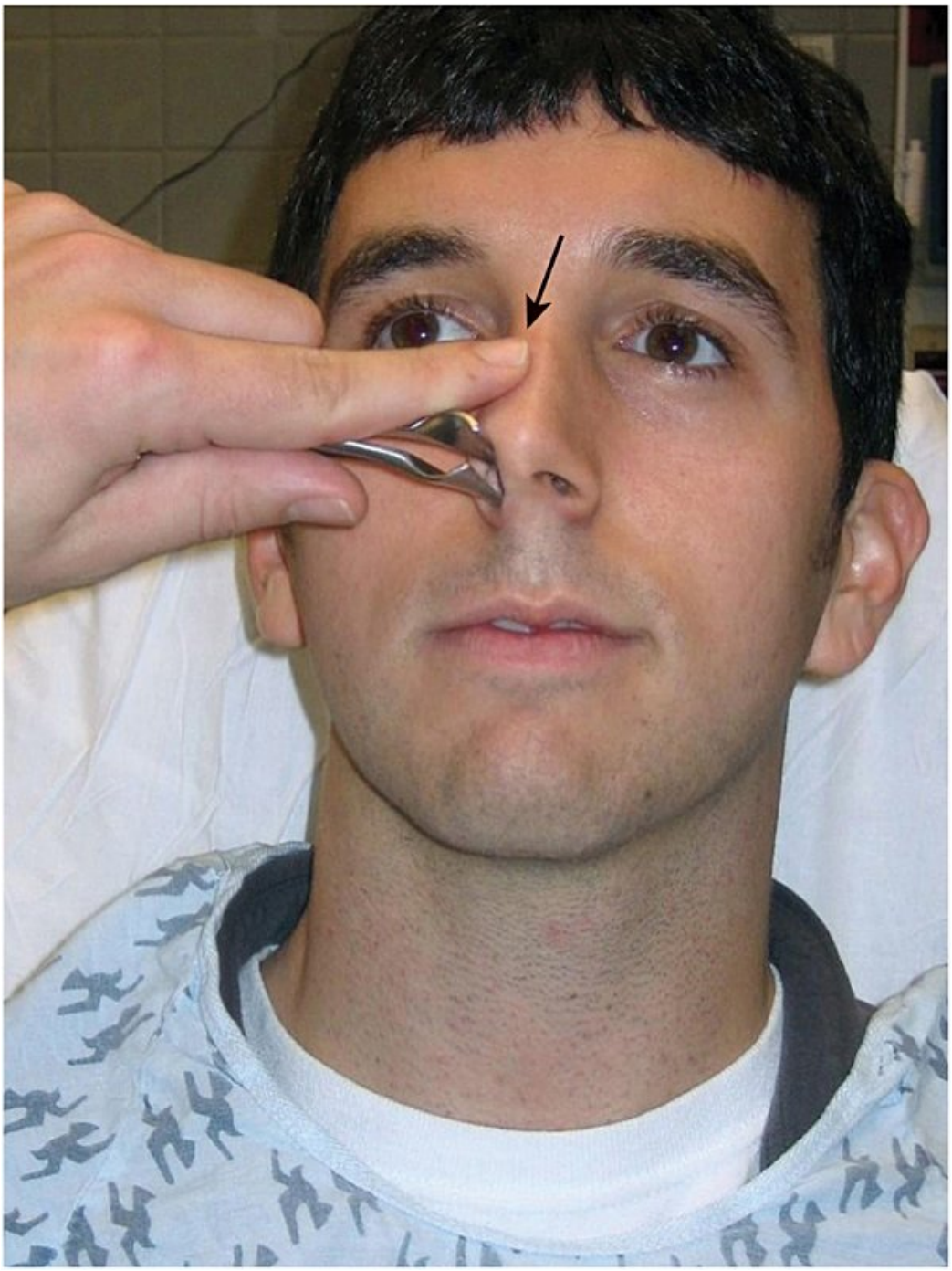


FIGURE 10.4 To examine a nose properly, use a nasal speculum.
The clinician rests the index finger on the bridge of the nose (arrow) and spreads the speculum in an inferior-to-superior direction. (From Roberts JR, Hedges JR: Clinical Procedures in Emergency Medicine, ed 5. Philadelphia: Saunders; 2009. pp. 1178-1216.)

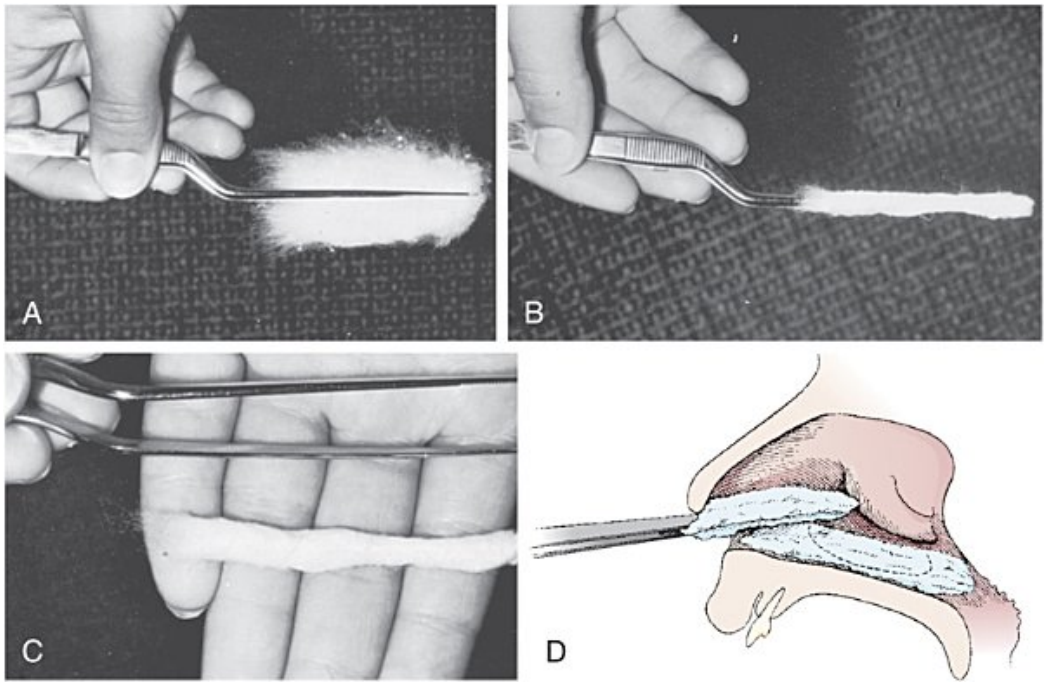


FIGURE 10.5 Topical anesthetic and vasoconstrictors are applied on individual cotton pledgets.
The size of the pledget may be changed according to the extent of the nasal cavity to be anesthetized and the size of the patient. **A.** Grasp an appropriately sized cotton pledget with bayonet forceps. **B.** Grasp the cotton with the opposite hand and rotate the forceps. **C.** The pledget is removed and is ready for insertion. **D.** To anesthetize the nasal cavity completely, three pledgets are necessary. The first is placed on the floor of the nose, the second in the middle meatus between the inferior and middle turbinates, and the third in the roof of the nasal cavity and anterior nasal vestibule. (From Roberts JR, Hedges JR: Clinical Procedures in Emergency Medicine, ed 5. Philadelphia: Saunders; 2009.)

Procedure

Anterior Epistaxis

1. If brisk active bleeding continues and an anterior source has been positively identified, further procedures are necessary.
2. Next, use **silver nitrate** cauterization for anterior sites.[5,8] It is useful to cauterize around the site circumferentially before

the bleeding point itself.[5]

Silver nitrate can perforate the nasal septum and should not be used bilaterally.

NOTE: Chemical cauterization is effective in approximately 50% of patients who fail treatment with local vasoconstrictors and pressure.[5,8]

NOTE: Laser and electrocautery can also be used but will require local anesthesia provided by an otolaryngologist.

3. If chemical cautery fails or is otherwise unavailable, mechanical packing is the next step.

NOTE: Historically, gauze impregnated with petrolatum was used for packing; the petrolatum facilitated removal. This type of packing can be tedious and painful in terms of placement and may not be as effective as other options. Rebleeding upon removal is not uncommon. Commercial epistaxis tampons may have some advantage; particularly, they are thought to be less hospitable to bacterial colonization.[1]

NOTE: Several commercial products made of synthetic polymers, resembling tampons, have been evaluated in the literature (Fig. 10.6). An initial study compared Rapid Rhino (ArthroCare) with Rhino Rocket (Shippert Medical Technologies).[10] These products were equally successful in treatment of epistaxis. The Rapid Rhino had less pain on insertion and extraction, increased ease of insertion, and less rebleeding. The Rapid Rhino product was compared with the Merocel tampon, with equivalent results in controlling epistaxis, but insertion and extraction were easier with the Rapid Rhino product.[5] A third study found Rapid Rhino to be less painful with

less bleeding in contrast to Merocel packs, with very few side effects.[11]

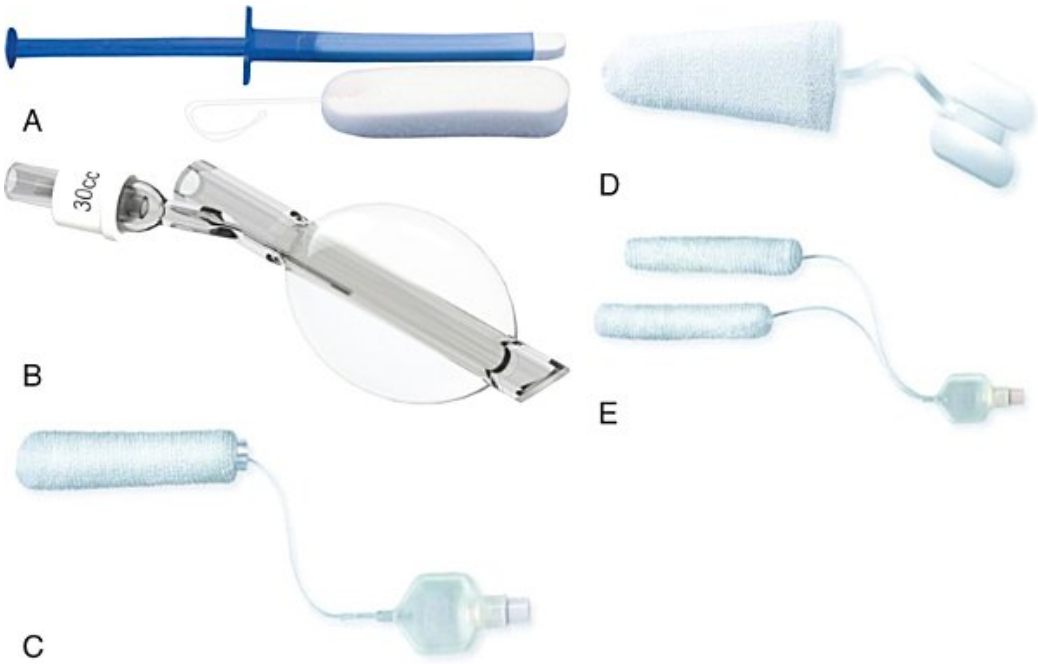


FIGURE 10.6 Commercial nasal packings are commonly used in place of the traditional gauze packing.
A. Rhino Rocket (Shippert Medical, Centennial, CO). **B.** Epi-Stop Balloon Catheter (Summit Medical, St. Paul, MN, USA). **C,** Rapid Rhino (Smith + Nephew, Inc., Andover, MA, USA). **D.** Rapid-Pac (Smith + Nephew, Inc., Andover, MA, USA). **E.** Rapid Rhino Dual Nasal Pack (Smith + Nephew, Inc., Andover, MA, USA). (From Roberts JR, Hedges JR: Clinical Procedures in Emergency Medicine. 5th ed. Philadelphia, PA: Saunders; 2009. pp. 1178-1216)

Procedure

Commercial Nasal Tampons

1. Position the patient on a gurney with 45 degrees of head elevation and pretreat as discussed previously for rhinoscopic examination.

2. Soak the catheter in sterile water according to the manufacturer's directions. Most commercial catheters do not require additional lubrication (always review manufacturer's directions).
3. **Insert the catheter**; sliding it along the floor of the nasal cavity until the end point (the markings differ across brands) is positioned at the external nares.

> With all of the tamponade devices, the pack should be inserted parallel to the nasal floor, which is parallel to the ground and the hard palate. The most common mistake made is angling the pack upward.

4. Inflate the balloon with air.
5. After 10 to 15 minutes, assess the cuff and add air, as needed.
6. Tape the cuff to the patient's cheek.

Approximately 90% and 95% of patients with anterior bleeds will respond positively to this type of intervention. Most clinicians prefer these newer commercial nasal tampon and balloon systems for the management of both anterior and posterior bleeding. The longer, single-balloon Rapid Rhino, while retaining ease of insertion and comfort, is effective against many posterior bleeds from the more anterior locations of the sphenopalatine artery, protecting the patient and clinician against an inadvertent missed diagnosis of posterior bleed.

Procedure

Posterior Epistaxis

Exterior pressure, cautery, and vasoconstriction are of limited to no utility in cessation of posterior bleeding.

1. It is critical to identify a posterior bleed as early as possible. This will allow appropriate intervention in a timely fashion rather than many futile attempts with other techniques and interventions.
2. Initiate consultation with otolaryngology or oromaxillofacial surgery immediately upon recognizing a posterior bleed.

NOTE: Posterior bleeding comes primarily from the sphenopalatine artery (Fig. 10.7). These bleeds are optimally managed, and should be definitively managed within the hospital setting because of concerns regarding security of the airway. The choanal arch should be occluded in the treatment of posterior bleeds.

NOTE: Success of posterior packing ranges from 48% to 83%. For this reason, most posterior bleeds are treated surgically with direct cauterization or arterial ligation.[1]

NOTE: Frequently, the patient is hospitalized after posterior packing for monitoring purposes.[3,5] The rate of complication is higher the longer the packing is left in place, but the rate of rebleed is lower. Patients with comorbid conditions and traditional posterior packing or double-balloon systems should be closely monitored in the hospital setting.

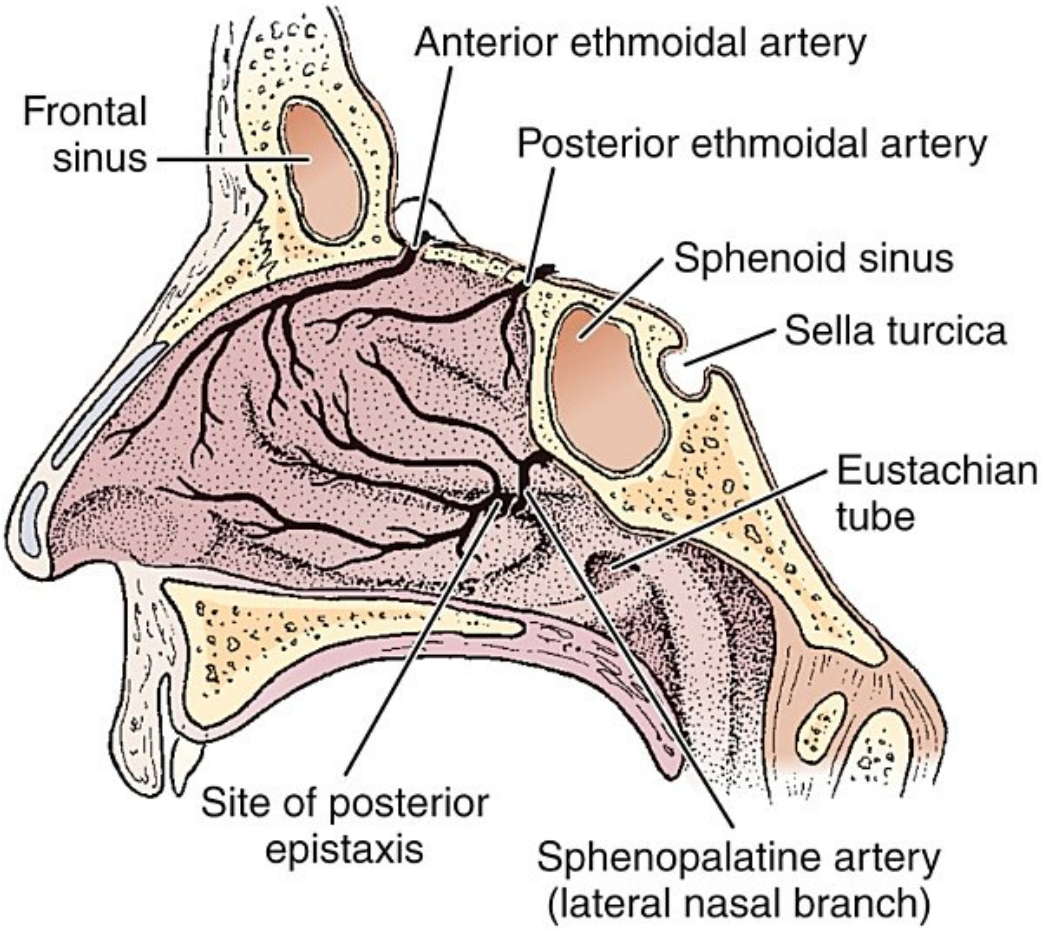


FIGURE 10.7 Vascular supply to the lateral wall. The most common site of posterior epistaxis is the sphenopalatine artery as it emerges posterior to the middle turbinate. (From Maceri DR. Epistaxis and nasal trauma. In: Cummings CW, ed. Otolaryngology: Head and Neck Surgery, ed 2. St. Louis: Mosby–Year Book; 1993, p. 728.)

Procedure

Commercial Balloon Systems

Various single- and double-balloon systems are available for the management and control of posterior epistaxis. The most traditional and readily available is the 10- to 14-Fr Foley urinary catheter with a single balloon.

1. Before the procedure, pretreat the patient with topical anesthesia and vasoconstrictors (primarily to prevent traumatic bleeding) and lubricate the catheter well.[3]
2. When using a Foley catheter for posterior epistaxis:
    a. Insert the Foley device into the posterior oropharyngeal area. This should be visible when looking into the mouth. Some recommendations encourage grasping of the tip of the Foley with clamps once it is visible and pulling it into the oral cavity before proceeding to the next step.
    b. Partially inflate the balloon with air or sterile saline.
    c. The device should then be retracted gently until resistance is encountered (Fig. 10.8)
    d. Fully inflate the balloon. Clamp the Foley and secure it firmly to the patient's cheek to prevent balloon movement.
    e. Patient discomfort and operator dissatisfaction with the difficulty of insertion are relatively common. Pharmaceutical agents for patient comfort (e.g., lorazepam) are sometimes recommended.
3. When using a commercially available epistaxis specific device:
    a. Alternatively, pass a custom commercial nonpadded double balloon device to the posterior oropharyngeal area and inflate the posterior balloon (Fig. 10.9).
    b. Retract the catheter until the anterior balloon can be inflated in the space usually reserved for an anterior packing device, to prevent both retrograde and forward movement of the catheter. Ensure the nasal ala is protected.
    c. Take care not to overinflate the posterior balloon and cause necrosis of the area.

These balloons (both the commercial system and the Foley catheter) cause a relatively high pressure and

carry with them the increased potential for complications and patient discomfort.

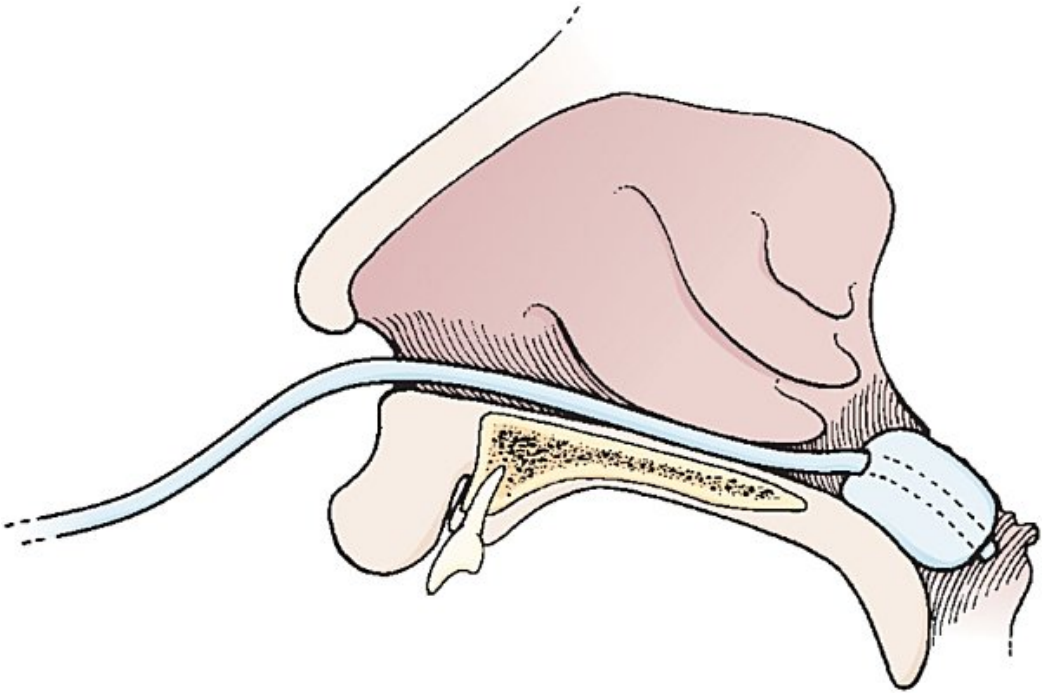
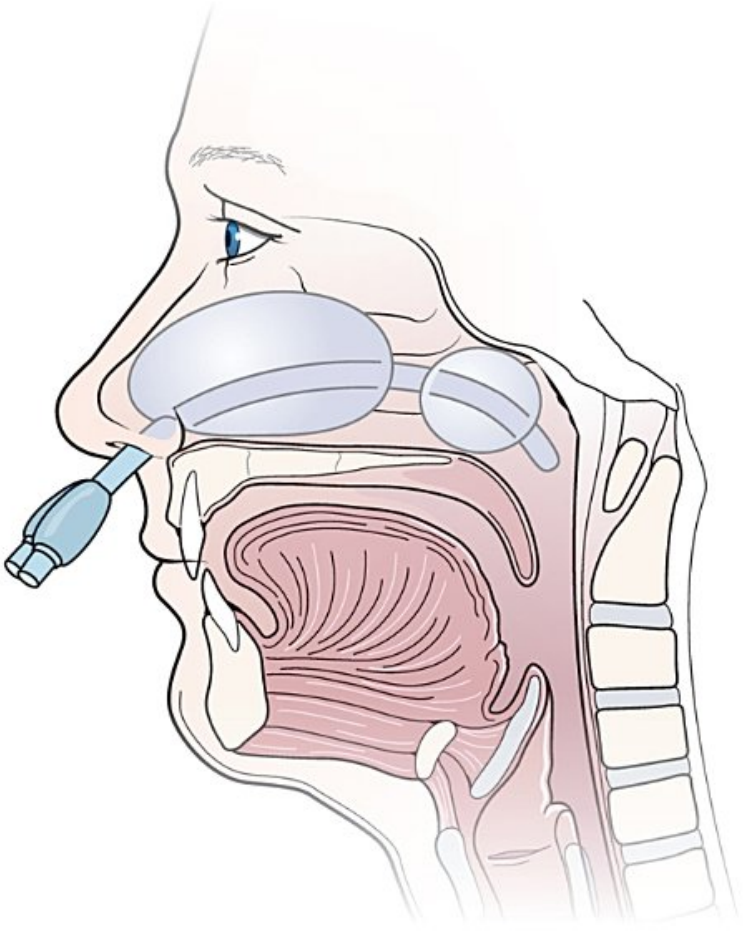


FIGURE 10.8 Foley catheter is placed into the nasopharynx, inflated with water, and retracted into position.
The distal tip of the catheter has been cut off. Then, an anterior pack (not shown) is placed around the catheter. The ala and columella are protected with gauze padding, and a plastic umbilical clamp or nasogastric clamp is attached to the catheter to maintain slight tension on the balloon. (From Roberts JR, Hedges JR: Clinical Procedures in Emergency Medicine, ed 5. Philadelphia: Saunders; 2009. pp. 1178-1216.)

A



B

FIGURE 10.9 **A.** Epi-Max Balloon Catheter (Summit Medical, St. Paul, MN, USA). The balloon tamponade device serves as both an anterior and a posterior pack. It is easily inserted and is often successful for the temporary control of posterior epistaxis in the emergency department. Such devices rarely fail in the initial control of bleeding in the emergency department. **B.** The inflated Epi-Max. (From Roberts JR, Hedges JR: Clinical Procedures in Emergency Medicine, ed 5. Philadelphia: Saunders; 2009. pp. 1178-1216.)

Follow-Up Care and Instructions

The following should be considered in follow-up care and patient instructions for epistaxis:

- Follow-up can occur with a primary care physician in most cases of nonsevere anterior epistaxis. Posterior epistaxis should generally be followed up by an otolaryngologist.
- The pack can be removed in 2 to 4 days.[5] It should remain in place for at least 48 hours unless the patient is intolerant of the pack, complications occur, or rebleeding ensues.
- The most common time advised for follow-up and potential removal of packing is 48 hours. Preventing future bleeds should be discussed at the follow-up visit.[4,5]
- Systemic causes generally can be prevented by recognizing and treating coagulopathies and optimizing anticoagulant treatment, avoiding unnecessary use of anticoagulants, and optimal medical management of other problems. Moisturizing during winter months, avoiding breathing topical or environmental irritants, and using petrolatum lubricants on the nares is also useful. Initial home treatment should be emphasized; every patient should be aware of pressure and topical vasoconstriction techniques.
- In the case of treatment failure, open or endoscopic surgical intervention or other advanced procedures may be necessary. This is more common in posterior bleeds, as discussed previously.

- Rebleeding is more common in patients whose packs are removed in fewer than 48 hours or in patients whose original bleed was severe.[11] Packing is usually left in place for 48 to 92 hours.[11] Local complications increase after 48 hours, but incidents of rebleeding diminish.

Nasal Foreign Body Removal

Indications

Removal of a nasal foreign body is indicated in anyone with a retained foreign body within the nasal cavities. These patients are generally in the early pediatric age range, although adults with long- or short-term compromise of mental status or intellectual ability are also at risk. Commonly encountered nasal foreign bodies include small toys, beads, food particles (e.g., popcorn, peas, nuts, candy); seeds, paper, pills, cloth, and small metal batteries (of special concern and requiring removal as soon as feasible).[12,13] Visible and graspable nasal foreign bodies can almost always be removed without referral to a subspecialist.

Contraindications

Patients unable to protect their airway generally require a surgical setting for removal.

Essential Anatomy and Physiology

Foreign bodies within the nose can be located anywhere. Most commonly they are on the floor of the nasal cavity just below the inferior turbinate or just in front of the anterior turbinate.[13]

Materials

- Oxymetazolidine and lidocaine with 1% epinephrine
- Alligator or other surgical forceps, tissue hooks, or a cerumen loop

- A small suction catheter
- A thin balloon-tipped catheter (5 or 6 Fr) and lubricant
- Surgical cyanoacrylate skin closure glue and a hollow plastic straw

Procedure

Foreign Body Removal

Especially in younger pediatric patients, the best chance for successful removal occurs with noninvasive methods or the **first invasive method**. Cooperation diminishes substantially after the first attempt at assisted or instrumented removal. Escalating combativeness is a poor prognostic sign for successful foreign body removal. Light procedural sedation can be used in settings with the equipment and personnel to support this practice.

> Cases of nasal foreign bodies that are not visible or have resisted two attempts at removal should be referred to a subspecialist.

1. Instruct the patient to close the nonoccluded nostril and then breathe forcefully out through the occluded nostril. If this is unsuccessful after one or two good efforts, begin assisted removal.
2. Before instrumentation, provide anesthesia and vasoconstriction with oxymetazolidine and lidocaine with 1% epinephrine; take care not to push the foreign body posteriorly. Given the "one attempt" rule, this first step actually may be counterproductive, especially in pediatric patients. The patient may also be placed in a supine position and drops of these agents gently instilled in the nose (not sprayed) so that they drip down and cover the nasal mucosa.

3. Grasp the foreign body with alligator or other surgical forceps, tissue hooks, or a cerumen loop. (The patient should remain at least partially upright (45 degrees) during these attempts.)

Nasal foreign bodies that may be displaced posteriorly and cause compromise of the airway should be removed in a setting with equipment and personnel capable of easily handling this complication. The patient should remain upright if the airway might be at risk.

4. Instrumentation is not indicated for certain objects (i.e., too smooth). Use of a small suction catheter is reasonable in these situations, although sometimes obtaining a good seal is difficult.
5. If instrumentation is unlikely to be successful, lubricate a very thin balloon-tipped catheter (5 or 6 Fr), carefully advance it past the foreign body, inflate it slightly with approximately 2 mL of air, and withdraw it.[13]

NOTE: Positive-pressure ventilation can be applied to the patient's mouth with the nonoccluded nostril closed, forcefully expelling the foreign body. A brief, soft puff of air may be used. This works best for a very small child who can easily be controlled by a parent. A good technique is to place the patient in the supine position; then the parent tells the child he or she is getting a big kiss and delivers a quick sharp breath to the child's mouth while occluding the unaffected side of the nose.[7,13]

NOTE: A pediatric Ambu bag may also be used, but masks and noisy positive-pressure ventilators frighten children.

NOTE: Barotrauma can be a complication of this procedure[13,14] when high-pressure or unmodulated positive-pressure delivery systems are used inappropriately.

NOTE: Surgical cyanoacrylate skin closure glue also has been used, especially for very smooth foreign bodies in the anterior portion of the nose. The tip of a hollow straw is dipped into the

glue so that the distal end is covered. This is then attached to the foreign body for 60 seconds and then removed.[13] Care must be taken to avoid any attachment to tissue; acetone can dissolve glue but is extremely irritating to mucosa.

> Cases of chronic nasal foreign bodies with occluding edema, granulation, or tissue necrosis should be referred to an otolaryngologist for evaluation.

> Chronic or organic foreign bodies are responsible for unilateral foul nasal discharge. Any patient with this sign should be thoroughly examined for foreign body or tumor.

Follow-Up Care and Instructions

The following should be considered in follow-up care and patient instructions for foreign body removal:

- Instruct the patient to watch for signs of infection or retained pieces of the foreign body that can cause further occlusion.
- Inform the patient to contact the provider if experiencing fever, **purulent nasal discharge**, continued or worsening nasal occlusion, epistaxis, or nasal pain.

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CHAPTER 11

Foot Examination of the Patient With Diabetes

Nikki Katalanos

Abstract

This chapter describes the essential steps in examining the lower extremities of the patient with diabetes mellitus. It provides the rationale for performing this examination, a description of commonly used equipment, as well basic anatomy and physiology of the lower extremity. Normal and abnormal findings are reviewed and discussed along with potential complications. Patient education and methods of providing self-care are included.

Keywords

Diabetes
Foot examination
Neuropathy
Self-care
Lifestyle

Procedure Goals and Objectives

GOALS: To perform a thorough routine foot examination on the patient with diabetes.
OBJECTIVES: The student will be able to:

- Describe the indications, contraindications, and rationale for performing a routine foot examination on the patient with diabetes.
- Describe the essential anatomy and physiology associated with examination of the foot of the patient with diabetes.
- Describe the logical order of steps used to perform a foot examination of the patient with diabetes.
- Describe normal and abnormal findings associated with examination of the foot of the patient with diabetes.
- Describe foot self-care information to be provided to the patient with diabetes for the prevention of future complications.

Background and History

Diabetes mellitus is a group of diseases that are characterized by higher than normal levels of blood sugar. The disease is a result of defects in insulin production or insulin action, or both (Table 11.1). The Centers for Disease Control and Prevention (CDC) (2017)[1] estimates that the prevalence (existing cases) of diabetes across all ages is 30.3 million Americans, including 23.1 million diagnosed and 7.2 million undiagnosed cases (2015 data). The incidence (new onset) is 1.5 million people aged 20 years and older per year. Regardless of

type, the morbidity from this ubiquitous disease is quite costly, with total costs for direct and indirect care reaching $245 billion (indirect care includes time lost from work, disability, and early death).

Table 11.1

Categories of Diabetes Mellitus

Type 1 diabetes: results from autoimmune beta-cell destruction, usually leading to absolute insulin deficiency
Type 2 diabetes: results from a progressive insulin secretory defect in a background of insulin resistance
Diabetes owing to other causes: genetic defects, diseases of the exocrine pancreas, drug or chemical induced
Gestational diabetes: diagnosed during second or third trimester of pregnancy; not previously diagnosed

From American Diabetes Association: Standards of medical care in diabetes. *Clinical* Diabetes. 2018;36(1):14–37. https://doi.org/10.2337/cd17-0119

Lifestyle changes and early detection (Table 11.2) can delay or prevent many of the complications from diabetes. Estimates of the number of people with nervous system damage, ranging from mild to severe, directly caused by diabetes are as high as 60% to 70%. As a result, the person with diabetes often has sensory or pain impairments in their hands and feet. In the United States, more than 60% of all nontraumatic amputations of the lower limb are among people with diabetes. According to the CDC (2012),[2] aggressive foot care can reduce amputation by as much as 45% to 85%.

Table 11.2

Criteria for the Diagnosis of Diabetes

A1C 5.7% to 6.4%
Or
Fasting plasma glucose 100–125 mg/dL. Fasting is defined as no caloric intake for at least 8 hours.
Or
2-hour postload glucose 140–199 mg/dL during an oral glucose tolerance test (not recommended).
Confirm by repeat testing on a different day.
Or
Classic symptoms of hyperglycemia or hyperglycemic crisis. A random blood sugar of ≥ 200 mg/dL

From American Diabetes Association: Standards of medical care in diabetes. *Clinical Diabetes*. 2018;36(1):14–37. https://doi.org/10.2337/cd17-0119

Indications

The most common sequelae of diabetic neuropathy are foot ulceration, infection, and, ultimately, amputation. Early recognition and aggressive management of foot care can prevent or delay the associated morbidity. The longer the person has diabetes, the greater the risk for foot ulcerations. Evidence indicates that these events are strongly related to poor glucose control and/or vascular comorbid conditions.

Risk factors that increase the potential for ultimate foot damage that may lead to amputation include the following:

- Peripheral neuropathy
- Increased pressure on the foot
- Deformities of the foot or toenails
- Peripheral vascular disease
- Previous history of foot ulcers (or amputation)
- Acute or chronic infection of the foot or toenails
- Poor foot hygiene

The patient with diabetes should be **asked at each routine visit** whether he or she has pain, numbness, or tingling sensations in the extremities. The patient should also be asked if he or she has any problems or leg cramping with walking. Any positive response to these questions warrants a comprehensive foot examination. In addition, note how far the patient can comfortably walk, and if the patient's shoes are a comfortable fit.

The patient with diabetes should be asked at each routine visit whether he or she has pain, numbness, or tingling sensations of the extremities.

The value of the foot examination in a person with diabetes is well documented. The American Diabetes Association (2018)[3] recommends that a comprehensive foot examination be performed annually on the low-risk patient and that a visual examination be conducted at each routine visit. Patients with any of the above-mentioned risk factors should be closely examined on a quarterly basis, at minimum.

Contraindications

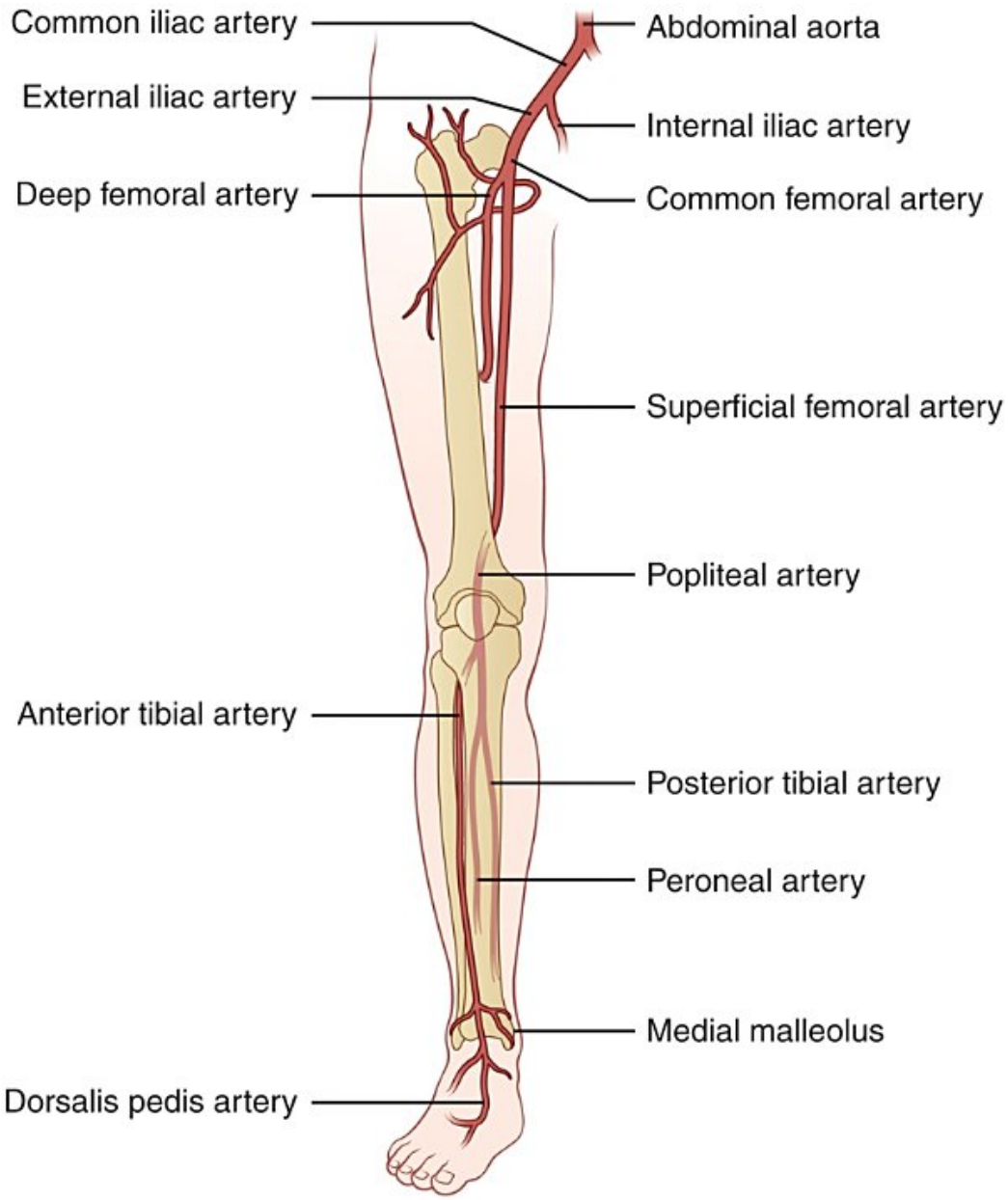
There are no medical contraindications to the examination of the foot in a person with diabetes. In some cultures, however, the foot is considered unclean and should be the last part of the body that is examined.

Potential Complications

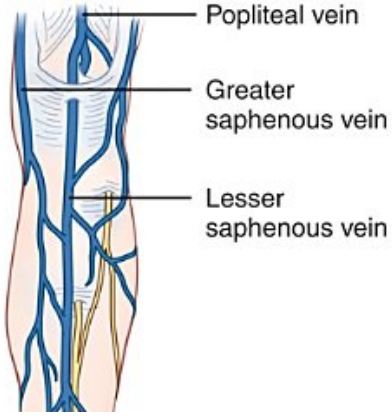
There are no reported complications to this examination when the procedure is performed as described. The medical-legal concerns are that the clinician performs the examination incorrectly and too infrequently. It is essential that the method and tools used for examination be fully documented in the medical record. Many facilities use a diabetes flow chart for routine examinations.

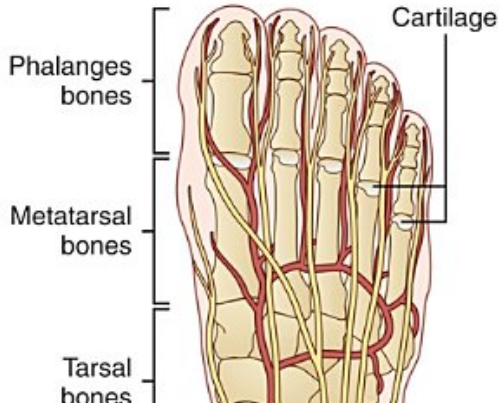
Review of Essential Anatomy and Physiology

In order to perform the foot examination, an understanding of the anatomy of the vascular system is needed. Fig. 11.1 shows the basic anatomy of the foot and the vascular supply of the lower extremities.


Common iliac artery
External iliac artery
Deep femoral artery
Abdominal aorta
Internal iliac artery
Common femoral artery
Superficial femoral artery
Popliteal artery
Anterior tibial artery
Posterior tibial artery
Peroneal artery
Medial malleolus
Dorsalis pedis artery

A


Popliteal vein
Greater saphenous vein
Lesser saphenous vein


Cartilage
Phalanges bones
Metatarsal bones
Tarsal bones

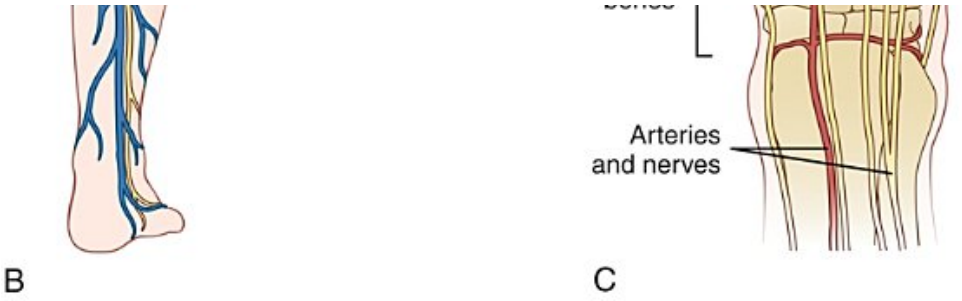


FIGURE 11.1 **A**. Arterial system of the lower extremity. **B**, Venous system of the lower extremity. ***C***. Anatomy of the foot.

Patient Preparation

After the diagnosis of diabetes has been made, the patient needs time to adjust and accept that many lifestyle changes will need to be made. The first visit is usually best spent discussing the disease itself and answering any questions the patient may have. The patient should be encouraged to view this as a partnership, one in which he or she will make many of the actual decisions with regard to self-care and treatment. A thorough history and physical examination should then be performed if time permits or, at a minimum, at a timely follow-up visit. A foot examination, as described later, should be included in this initial evaluation.

Preparation of the patient should include having the patient remove shoes and socks before the examiner enters the room.

The diagnosis of diabetes, in particular type 2 diabetes, brings with it many preconceived notions and fears. Often there are family members with diabetes who have had bad experiences. Patients have heard stories of blindness, amputations, dialysis, and early death. The patient is often already conditioned to fear the disease and its consequences; therefore, it is essential that the initial approach to the patient with diabetes be reassuring and optimistic. Above all, the patient (or parents) should not be led to feel at fault for having developed diabetes.

After the first visit, the preparation of the patient should include having the patient remove his or her shoes and socks before the examiner enters the room.

Materials Utilized for Performing the Diabetic Foot Examination

- Semmes-Weinstein monofilament 5.07 (10 g) (Fig. 11.2)
- 128-Hz tuning fork

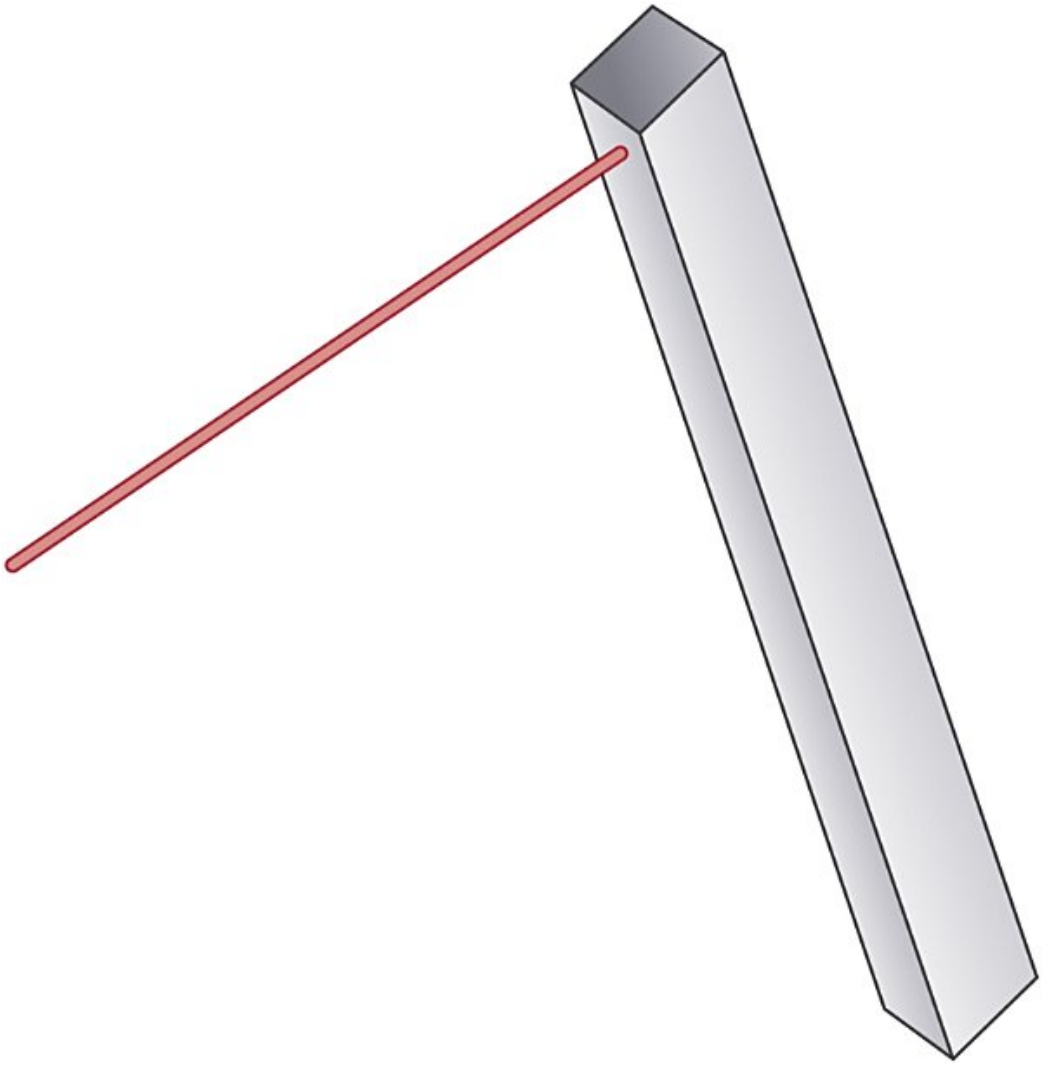


FIGURE 11.2 **Semmes-weinstein monofilament.**

Procedure

Procedure for Performing the Diabetic Foot Examination

The **comprehensive foot examination** entails visual inspection, palpation, and tests for sensation.

> The foot examination should include visual inspection, palpation, and tests for sensation.

Visual Inspection

The foot should always be examined with the shoes and socks off. The foot should be visually inspected at each routine visit for the following:

1. Color: Pale, bluish, or dusky coloration of the feet may mean poor perfusion. Erythema may indicate an area of excessive friction or it may be evidence of an ongoing or new infection. Yellow toenails may indicate a long-standing fungal infection.
2. Callus: Look for areas of skin thickening, particularly corns, callus, and over bunions. There may be an infection beneath the build-up. Evaluate the cause of the callus. Do the shoes fit well?
3. Fissures: Tears in the skin, particularly between the toes, are easy access to future infection. It may be a sign of a fungal infection or excessive moisture.
4. Ulcers: Look for signs of old or healing ulcerations. New ulcerations need to be immediately evaluated.
5. Maceration: Signs of excessive sweating, skin breakdown, or tinea pedis may also open avenues for infection.
6. Lack of hair: A possible indication of vascular disease—or is it just where the socks rub?

7. Toenails: Look for signs of fungal infections or injury. Are the toenails solidly adhered to the nail bed? Are they thickened or "flaky" looking?
8. Appearance: Look for misshapen feet that may forewarn of potential problems, such as bunions, hammertoes, "rocker" bottoms, or other soft-tissue and bony deformities. Is the skin of the foot thin looking or shiny? Note hygiene as well.
9. Shoewear: Evaluate the shoes for signs of excessive pressure or friction on the feet. Are the shoes capable of protecting the foot from punctures or injury? Do they support the foot properly? Are they eligible for diabetic shoes?
10. Socks: Do they fit the foot well? Are there areas of wear or holes? Are they clean?

Palpation

The foot should be palpated for the following:

1. Temperature: A cool or cold foot may mean poor perfusion. A warm foot, especially if the heat is localized, may be a sign of infection.
2. Pulses: Evaluate the pedal pulses. They should be strong (2 +) and equal in both feet.
3. Perfusion: Press on the toenail and observe the capillary filling. A healthy foot reperfuses in 3 seconds or less. Greater than 5 seconds is an indication of poor perfusion.
4. Edema: Press on the ankle and evaluate for pitting. If edema is present, the skin may crack easily.

Tests for Sensation

The tests for sensation allow the practitioner to evaluate for the presence of neuropathy. A focused history and physical examination should help to establish both the presence and degree of the neuropathy. Pain or temperature may also be checked, using great care, as part of the sensory evaluation.

1. Vibration: Press the vibrating tuning fork (256 Hz is preferred, 126 is optional) against the bony prominence of the first (big) toe on the dorsal-lateral aspect. Ask the patient to tell you when he or she feels the vibration start and when it stops.
2. Pressure: Press the monofilament lightly against the specified areas of the foot until it bows (Fig. 11.3). Record the presence or absence of sensation for each area tested.

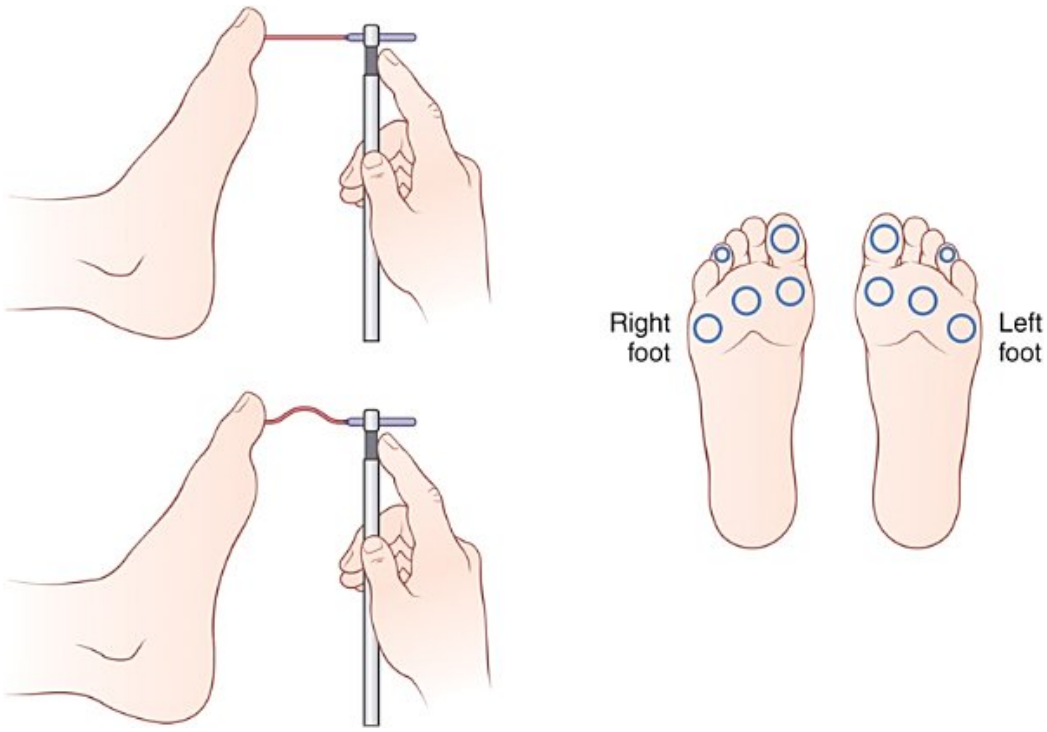


FIGURE 11.3 **Demonstration of monofilament testing and areas of the foot that should be tested.**

Special Considerations

Consideration should be given to previous pathology (e.g., foot ulcers, deformities, tinea pedis). Tinea pedis can be very difficult to eradicate in any patient, but it is especially difficult in the patient with diabetes. Tinea pedis, minor infections, and shallow ulcerations

can often be treated in the office. More severe cases and most deformities are best referred to podiatry or, in the case of infection, to an infectious disease consultant or vascular medicine. Insurance may cover podiatry for patients with diabetes.

Follow-Up Care and Instructions

Patient education is critical in the prevention of future morbidity. Many prepared handouts are available, and a few of these resources are listed at the end of the chapter.

Patient education is critical in the prevention of future morbidity.

General advice to the patient:

- Check your feet every day. Look for cuts, sore spots, red spots, and blisters. A mirror can be used to see the bottom of the feet. A good way to use it is to mount it on the lower wall.
- Wash your feet everyday. Use only warm water and a mild soap. Check the temperature of the water before getting into the tub or shower. Use the back of your hand. Clean carefully between the toes and dry the foot thoroughly. Apply a mild lubricating ointment to the heels and any dry areas. Do not use lotion between the toes.
- Keep the toenails trimmed. Be sure to trim straight across. Gently file the edges. Do this twice a month. Women should take off any toenail polish before being checked at the office.
- Always wear shoes and socks. Make sure the shoes are a good fit and do not pinch anywhere. Closed-toe shoes are safer, but sturdy sandals are fine. Check your shoes for foreign objects before putting them on. Socks should fit well, be without holes, and be kept clean and dry. Never, ever walk barefoot! Not even at the beach, where the sand can be hot enough to burn you.
- Check your blood sugar regularly. The best prevention of foot problems is well-controlled blood sugar.

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CHAPTER 12

Incision and Drainage of an Abscess

Charles Stream

Kelli Kruzel

Abstract

Procedure goals and objectives are to incise and drain an abscess successfully while observing standard precautions and with the minimal degree of risk to the patient. The student will be able to: describe the indications, contraindications, and rationale for performing incision and drainage of an abscess; identify and describe common complications associated with incision and drainage of an abscess; describe the essential anatomy and physiology associated with the performance of incision and drainage of an abscess; identify the materials necessary for performing incision and drainage of an abscess and their proper use; and identify the important aspects of postprocedure care after incision and drainage of an abscess.

Keywords

abscess complication
complications
contraindication drainage

incision
indications
postprocedure care

Procedure Goals and Objectives

GOAL: To incise and drain an abscess successfully while observing standard precautions and with the minimal degree of risk to the patient.
OBJECTIVES: The student will be able to:

- Describe the indications, contraindications, and rationale for performing incision and drainage of an abscess.
- Identify and describe common complications associated with incision and drainage of an abscess.
- Describe the essential anatomy and physiology associated with the performance of incision and drainage of an abscess.
- Identify the materials necessary for performing incision and drainage of an abscess and their proper use.
- Identify the important aspects of postprocedure care after incision and drainage of an abscess.

Background and History

The world's oldest medical manuscript is a small clay tablet written in Sumerian around 2100 BC. A portion of it translates as, "If a man,

his skull contains some fluid, with your thumb press several times at the place where the fluid is found. If the swelling gives way (under your finger) and (pus) is squeezed out of the skull, you shall incise, scrape the bone and (remove) its fluid…."[1] Advances made over the last 4100 years in the use of minor surgical procedures to treat abscesses are discussed in this chapter.

Indications

Draining of an abscess is indicated in a localized collection of infection that is tender and is not resolving spontaneously. The cardinal signs of infection (pain, fever, redness, swelling, and loss of function) are usually present.

Contraindications

The contraindications to abscess drainage are as follows:

- Facial furuncles should not be incised or drained if they are located within the triangle formed by the bridge of the nose and the corners of the mouth. These infections should be treated with antibiotics and warm compresses, because the risk for septic phlebitis with intracranial extension can follow incision and drainage of a furuncle in this area.
- Abscesses that occur very near the rectum or genitalia must be carefully evaluated, and consideration should be given to referring these patients to a general surgeon for treatment.
- Patients with diabetes, debilitating disease, or compromised immunity should be observed after incision and drainage of an abscess.

Potential Complications

Potential complications in draining abscesses are as follows:

- Cellulitis or recollection of pus: Bacteremia and septicemia are complications of an inadequately treated abscess. In patients with diabetes or disease that interferes with immune

function, an abscess on an extremity can be complicated by severe cellulitis or gangrene, with subsequent loss of the affected extremity.

- Perianal abscess incision and drainage results in a chronic anal fistula up to 50% of the time in adults.
- An abscess in the palmar aspect of the hand can extend from superficial to deep tissue via the palmar fascia.
- Deep infection is suspected when the simple incision and drainage fails to reduce the erythema, pain, pus, or swelling. More extensive surgical debridement, hospitalization, and intravenous antibiotics may be necessary in a patient with deep palmar abscess.

Essential Anatomy and Physiology

An abscess is a focal circumscribed accumulation of purulent materials (pus and other inflammatory tissue).

An acute or "hot" abscess has all the **characteristics** of a classic inflammatory episode, producing redness, heat, pain, and swelling. It is a suppurative reaction caused by the invasion of pyogenic (pus-forming) bacteria into a tissue or organ. Grossly (on the skin or surface of an organ), abscesses appear as focal, round, or ovoid areas of swelling covered by skin or other tissue. On palpation, usually an area can be detected where the covering is thin and comes to a head (point). When palpated, that area is more easily compressible or fluctuant because of its liquid or gel-like contents. If an abscess is not promptly drained, it will enlarge, destroying tissue in the process.

The physical examination characteristics of an abscess are pain, fever, redness, swelling, induration, and loss of function.

A dry abscess is one that resolves without rupture. A sterile abscess is one from which bacteria cannot be cultured. A chronic or cold abscess lacks the redness, heat, pain, and swelling of an acute abscess and usually is associated with liquefactive necrosis of tuberculous lesions.

Clinical Evaluation

The patient usually reports **pain and swelling**. Abscesses commonly occur in the perianal region. A subcutaneous abscess often is seen. Evaluation includes a search for the underlying cause of the abscess, that is, infection secondary to a puncture wound or foreign body, exposure to unusually pathogenic organisms, a faulty or overwhelmed immune system, the presence of hyperglycemia, bacteremic spread from another focus, and development of a deep abscess in badly contused muscle tissue in which there was no preceding penetration of skin. When a sweat gland or hair follicle forms an abscess, it is called a *furuncle* or *boil.* When the furuncle extends into the subcutaneous tissue, it is referred to as a *carbuncle.* Paronychia is an abscess that involves the nail. Perifollicular abscesses are commonly found on the extremities, buttocks, or breasts or in hair follicles. A subcutaneous abscess often is seen. When signs and symptoms of localized infection or an abscess are present, incision and drainage should be considered.

An abscess present on the skin arises in the dermis, subcutaneous fat, muscle, or deeper structures. Frequent sites for skin abscess are the hands, feet, extremities, head, neck, buttocks, and breast.

When an abscess is suspected but cannot be identified initially, it is imperative to repeat the examination in a follow-up visit. The most common reason for delayed diagnosis and therapy is failure to repeat the physical examination.

Treatment

A small abscess may respond to warm compresses and may drain spontaneously. If done properly, such treatment renders antibiotics unnecessary.

If the abscess enlarges, the inflammation, collection of pus, and walling off of the abscess cavity render such conservative treatments ineffectual.

A culture should be obtained by aspiration or swabbing of the abscess cavity, because unusual organisms may have caused the abscess. The infection may also warrant the administration of antibiotics.

Source of Infection

Healthy skin and its protective mechanisms are usually successful at fending off potentially pathogenic microorganisms. However, if this barrier is interrupted through trauma (mechanical, chemical, or thermal) to the stratum corneum, inflammation, or the often more ingenious mechanisms of infectious agents themselves, skin infections and abscesses develop. Methicillin-sensitive *Staphylococcus aureus* (MSSA) and methicillin-resistant *Staphylococcus aureus* (MRSA) are the predominant **causative agents** of abscesses, but some abscesses are caused by *Streptococcus* species or a combination of microorganisms, including gram-negative and anaerobic bacteria.

Methicillin-sensitive *Staphylococcus aureus* (MSSA) and methicillin-resistant *Staphylococcus aureus* (MRSA) are the predominant causative agents in abscesses.

The flora found in the affected area usually **causes the abscess**. Puncture wounds or the presence of foreign bodies are common underlying causes of abscess formation. The skin of the obese; those with poor personal hygiene; those who are debilitated, elderly, or diabetic (hyperglycemic state); or otherwise immunocompromised patients (human immunodeficiency virus/acquired immunodeficiency syndrome [HIV/AIDS] or hyper-IgE syndrome) also may offer a damaging agent easier access. Chronic carriers of *S. aureus* are also at risk.

Risk factors for MRSA infection and other abscesses include intravenous drug abuse, dental disease, contact sports, incarceration, and a high prevalence of infection in the community. The skin of the obese; those with poor personal hygiene; those who are debilitated, elderly, diabetic (hyperglycemic state); or

otherwise immunocompromised patients (HIV/AIDS, hyper-IgE syndrome) also may offer a damaging agent easier access. Chronic carriers of *S. aureus* are also at risk.

Histologically, an abscess is a central area of pus composed of dead white blood cells, bacteria, degenerating tissue debris, and proteins from the immune response to the bacteria. Surrounding this is a zone of healthy neutrophils. Depending on the age of the abscess, peripheral to this is a circumferential area of vascular dilation, macrophages, fibroblasts, and fibrocytes in varying stages of development and collagen formation. Ultimately, a connective tissue capsule surrounds the area, which inhibits the penetration of anti-infective agents.

Abscesses can interfere with normal function of nearby tissue, either by expansion and subsequent pressure on adjacent structures (e.g., an abscess adjacent to the trachea) or through expulsion of its contents and seeding of bacteria into surrounding areas or the vascular system, with resultant septicemia.

A diffuse abscess is a localized accumulation of pus that is not well encapsulated.

In the treatment of abscesses, the important anatomic structures underlying the abscess must be appreciated and anticipated before an incision is performed. The location of the abscess is critical to the direction of the incision. Referral to the appropriate provider is indicated for treatment when suspicious lesions of the nasolabial facial folds, soles of the feet, and palms of the hand are identified.

The abscess locations listed here are in close proximity to major vessels and should be aspirated with an 18-gauge needle attached to a 10-mL syringe before drainage to avoid inadvertent incision into an artery:

- Peritonsillar and retropharyngeal regions
- Anterior triangle of the neck
- Supraclavicular fossa

- Deep in the axilla
- Antecubital space
- Groin
- Popliteal space

Standard precautions

Every practitioner should use standard precautions at all times when interacting with patients, especially when performing procedures. Determining the level of precaution necessary requires the practitioner to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further dis-cussion, see Chapter 35).

Patient Preparation

The following should be considered in preparing the patient for draining of an abscess:

- Advise the patient regarding the potential benefits and risks associated with the procedure.
- Discuss the possibility of scar formation.
- Be sure to describe the care required to pack the wound after the procedure.
- Provide an opportunity for the patient to ask questions and receive answers.
- Assist the patient into a comfortable supine position that affords complete access to the abscess site.

Materials

- Ocular protection provided by face shield
- Alcohol or povidone-iodine (Betadine) wipe
- Draping for a sterile procedure
- 1% to 2% lidocaine (Xylocaine) without epinephrine
- 19- to 22-gauge needle
- No. 11 or 15 scalpel blade

- Scalpel handle
- Kelly clamps
- Adson forceps
- Curved hemostats
- 4 × 4-inch gauze pads
- Sterile gloves
- 500 mL of normal saline solution
- ¼- to ½-inch Nu Gauze strip for packing the wound
- Bandage scissors
- Dressing of choice to cover wound

Procedure

Performing Incision and Drainage of an Abscess

Skin Preparation

1. Apply a single layer of povidone-iodine to the abscess and allow to air-dry before performing the incision.

Anesthesia

1. Use a regional field block anesthetic technique to anesthetize the abscess by injecting a ring of anesthetic agent approximately 1 cm away from the erythematous border of the abscess around its perimeter.

NOTE: This will allow the lesion to be anesthetized circumferentially. The onset of action of the anesthetic is approximately 5 to 10 minutes. Complete anesthesia is difficult to provide, especially when breaking the septum within the cavity of the abscess with a hemostat.

2. After alcohol preparation of the skin, with care not to rupture the abscess prematurely, superficially infiltrate the skin in a linear course across the abscess and then traverse

the second linear course directly perpendicular to the first. Be careful to remain superficial to the abscess cavity.

Drapes

1. Place sterile drapes to ensure isolation of the abscess and the prepared surrounding skin.

Incising and Drainage

1. Make the incision along the relaxed skin tension lines (Langer lines) to reduce scarring (Fig. 12.1).
2. Open the abscess widely by extending the incision across its full dimension (Fig. 12.2). If more drainage is desired, make a second incision perpendicular to the first, forming a cruciate pattern.

NOTE: This technique typically results in a less aesthetically pleasing scar when fully healed.

3. Obtain a specimen for culture as soon as the purulent material is expressed from the abscess cavity.

NOTE: If a culture is obtained, it should be from the abscess cavity and not from the superficial skin over the abscess. Alternatively, the abscess cavity can be aspirated with a large-bore (18-gauge) needle before the incision is made. The aspirated contents can then be sent for the appropriate cultures in more complicated cases. It is rarely helpful in routine cases.

4. Explore the abscess cavity thoroughly. This can be accomplished with a sterile cotton-tipped applicator or with hemostats. Insert the blunt end of the hemostat into the abscess cavity and spread the hemostat to break up the septum and loculations within the abscess, thus releasing any further pockets of purulent material (Fig. 12.3).

5. Thoroughly irrigate the cavity with normal saline before any gauze is inserted to pack the cavity (Fig. 12.4).
6. After complete drainage of the cavity, insert packing material, such as iodoform gauze, into the abscess cavity, with 1 cm of gauze exiting from the cavity (Fig. 12.5), and then pack the cavity with iodoform gauze. The length and width of the gauze depend on the abscess size.

NOTE: The iodoform gauze serves two purposes: it prevents the incision from sealing over and provides for adequate drainage of the abscess cavity. The iodoform gauze is optimally removed and reinserted every 12 to 24 hours by either the patient or a caregiver. Gauze removal and replacement serve as a means of debridement.

NOTE: Healing should progress from the inside out; that is, epithelialization of the abscess cavity should occur before healing of the incision site to minimize the chance of recurrence. As the abscess heals, the internal volume decreases and the packing should decrease proportionally.

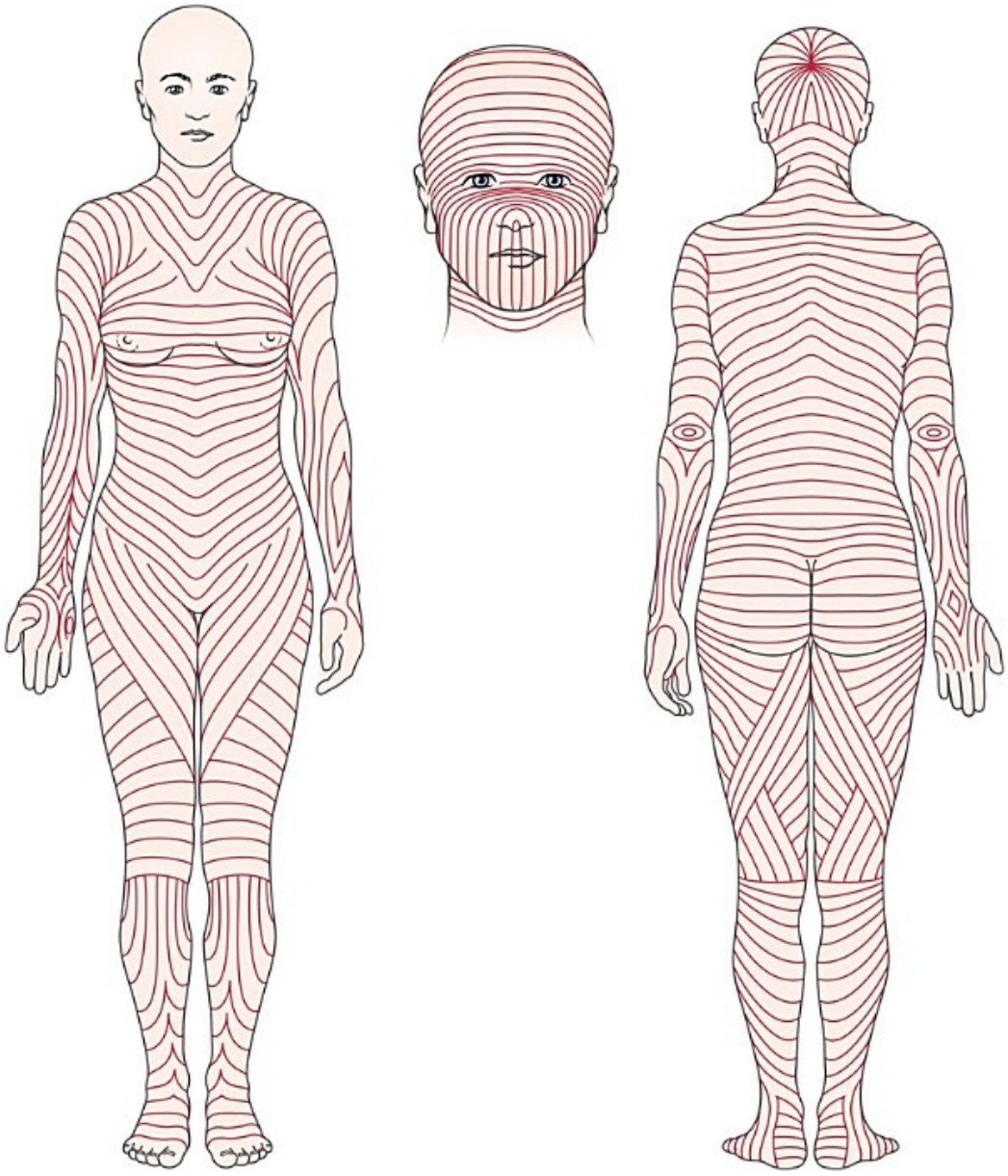

FIGURE 12.1 **Skin tension lines of the body surface.**
(Modified from Trott AT. *Wounds and Lacerations: Emergency Care and Closure,* ed 2. St. Louis: Mosby–Year Book; 1998, p. 17.)

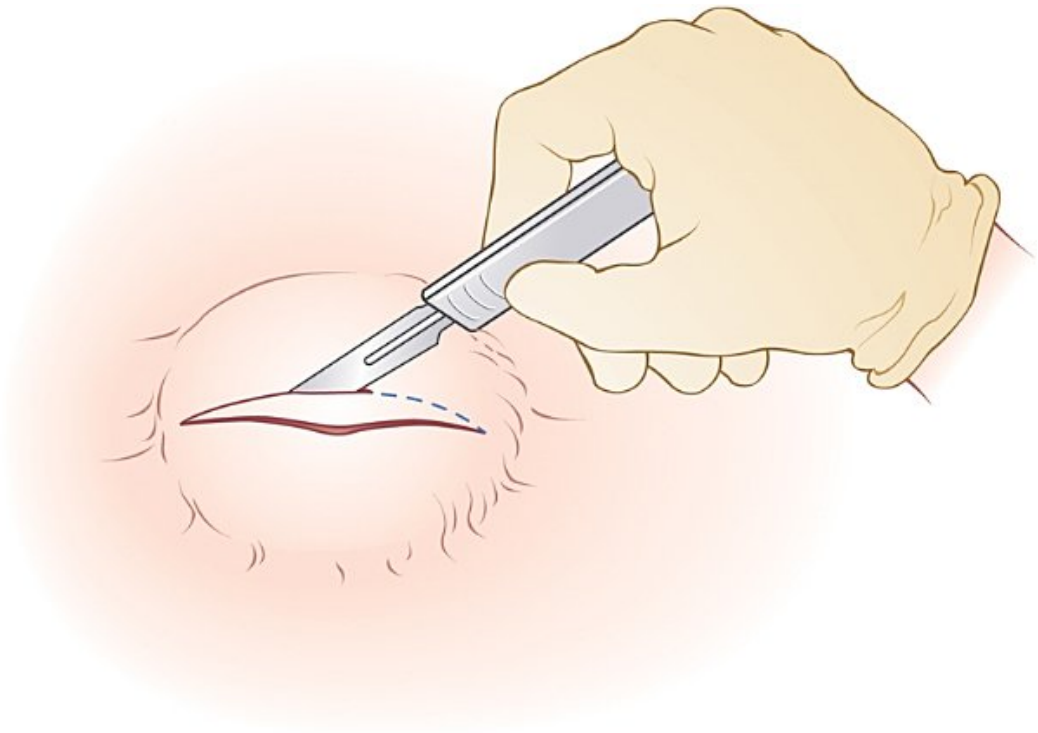

FIGURE 12.2 (Modified from Rosen P, Barkin R, Sternback G. *Essentials of Emergency Medicine.* St. Louis: Mosby–Year Book; 1991, p. 645.)

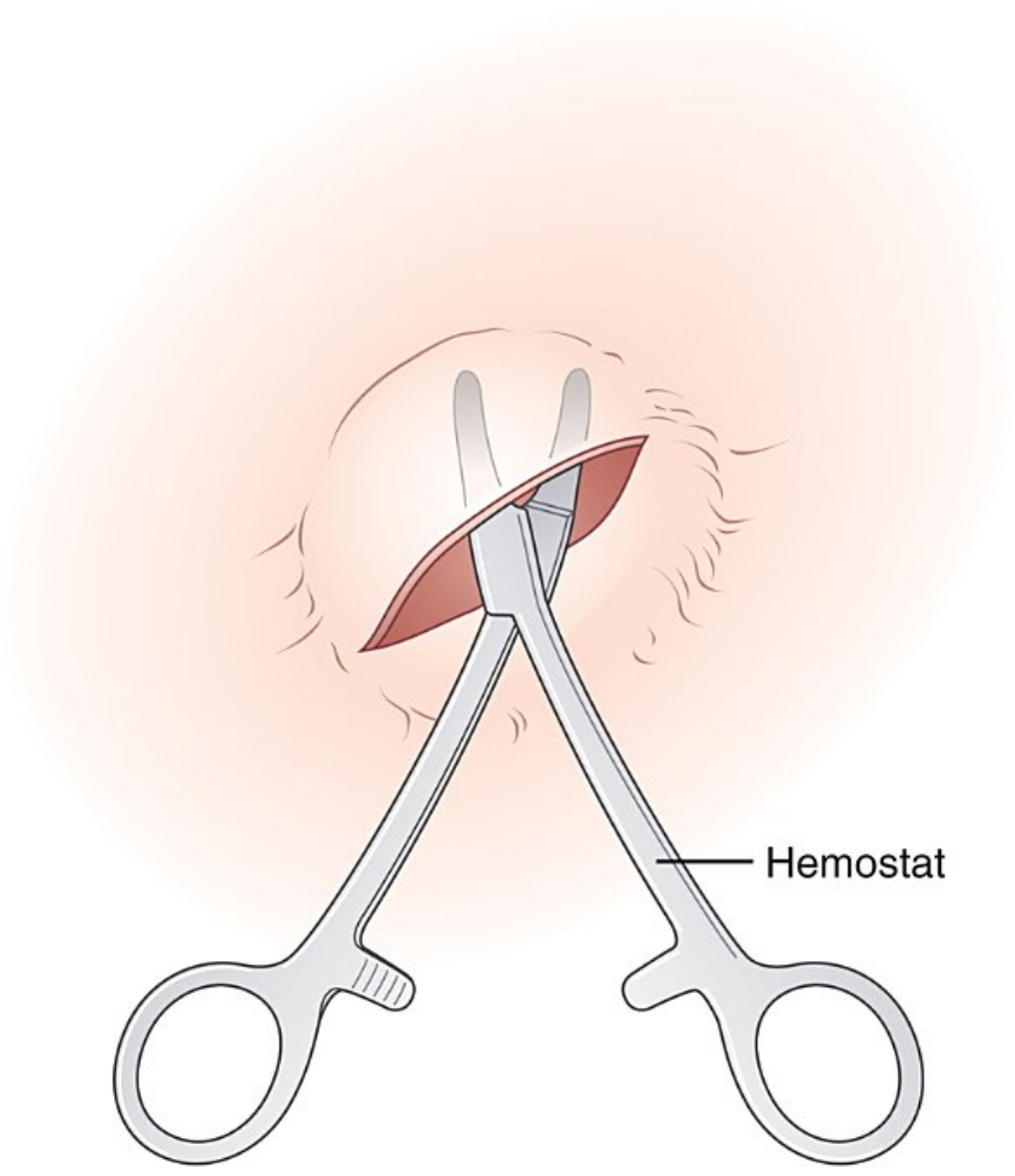

FIGURE 12.3

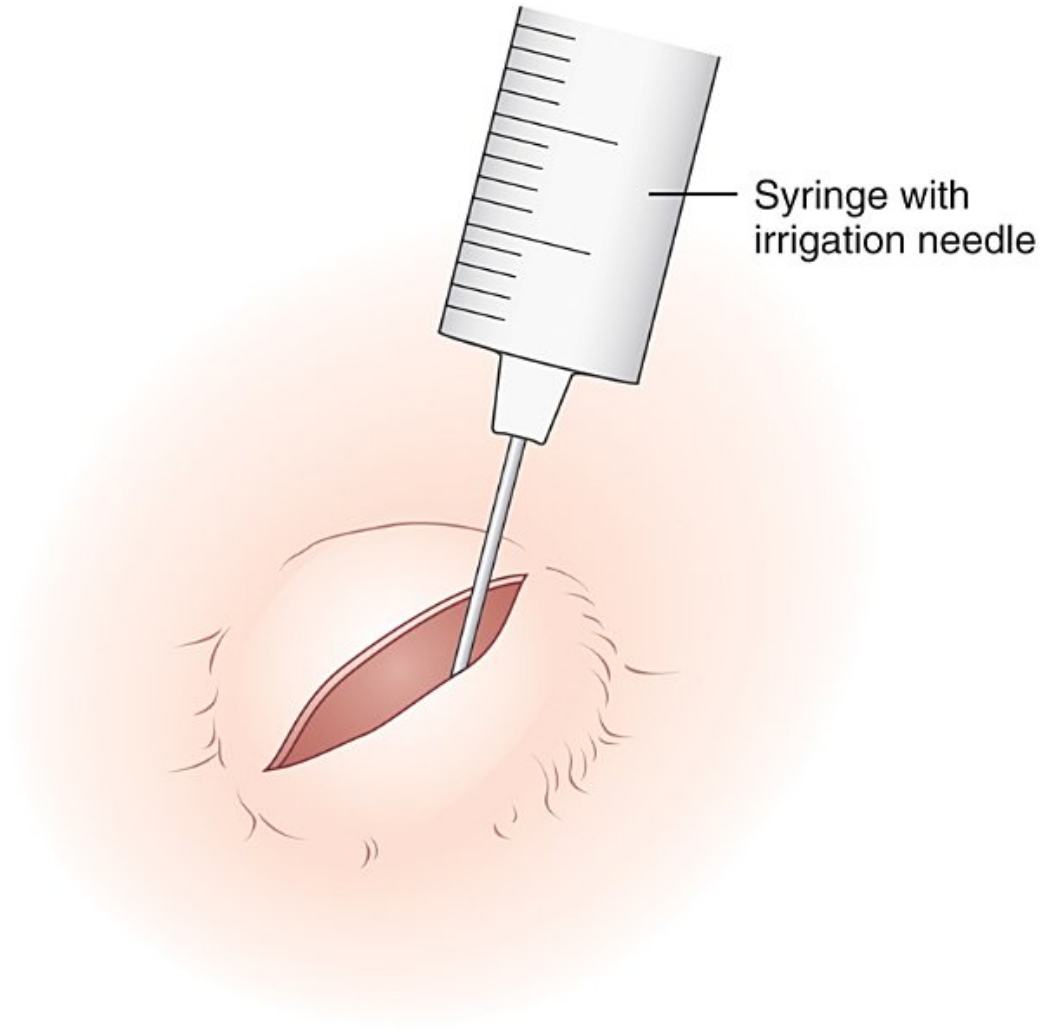

FIGURE 12.4

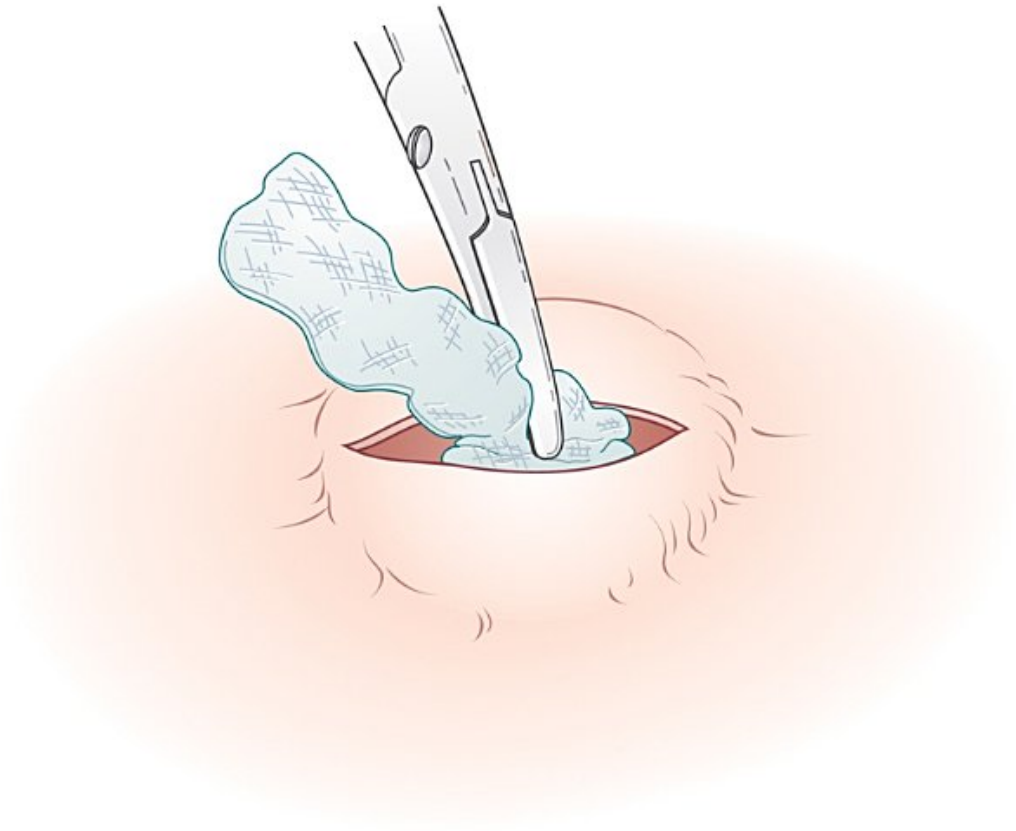

FIGURE 12.5 (Modified from Rosen P, Barkin R, Sternback G. *Essentials of Emergency Medicine.* St Louis: Mosby–Year Book; 1991, p. 645.)

Special Considerations

Primary management of abscesses should be incision and drainage and routine culture. Usually incision and drainage is sufficient treatment to cure an abscess. Antibiotic therapy is not indicated for the typical abscess in patients with normal defenses. However, additional treatment may be necessary for patients in the following situations:

Primary management of abscesses should be incision and drainage and routine culture. However, additional treatment may be necessary for patients with special circumstances.

- Abscesses that are surrounded with lymphangitis or a large area of cellulitis should be treated with antibiotic therapy. The cellulitis is determined by tenderness peripheral to the area of the abscess and increased warmth and redness, as opposed to the nontender induration palpated around an abscess that is well localized and that would not benefit from the addition of oral antibiotics. Patients with multiple abscesses, lack of response to incision and drainage alone, or at extremes of age should also be treated with oral antibiotic therapy. Antibiotics should cover MRSA organisms as first-line therapy until the culture results have been returned and a more specific antibiotic treatment is determined. Suggested antibiotic regimens are listed below.
  - Purulent material from immunosuppressed patients (including patients with diabetes) should be cultured, with the patient placed on oral antibiotics pending the culture results. Antibiotics may be used in conjunction with surgical incision and drainage in patients who are immunocompromised (i.e., those who have diabetes, leukemia, or AIDS or those undergoing chemotherapy). This purulent material should be examined by Gram stain, and the specimen should be sent for culturing (both aerobic and anaerobic) and sensitivity testing before any antibiotic treatment is started.
  - Aspiration is used for diagnostic confirmation. The rationale to drain the abscess is to avoid incision of a mycotic aneurysm and imminent exsanguination. The aspiration confirms that the material within the cavity is purulent and not serosanguineous or pure blood.
  - In nonlactating women, a breast abscess that is not subareolar is rare and should prompt the consideration of a biopsy in addition to incision and drainage of the abscess. A sample for culture should be obtained by aspiration or swab of the abscess cavity, because unusual organisms may have caused the abscess. The infection also may warrant the administration of antibiotics.

Pain Relief

If the packing is tight in the abscess cavity, the pain can be sufficient to warrant the use of acetaminophen or nonsteroidal antiinflammatory drugs. Opioids are rarely needed beyond the initial incision and drainage procedure. The procedure alone may provide sufficient pain relief from a tense abscess so that no pain medication is needed.

Follow-Up Care and Instructions

The following should be considered in follow-up care of the patient:

- Some patients can be taught to change their own packing, replace the dressings, and advance the drain. The patient may need regularly scheduled out-patient visits for this procedure.
- Advise the patient to apply warm wet soaks to the area four to six times per day for 5 to 7 days.
- A nonadherent dressing should be applied over the wound, covered with sterile gauze, and changed daily. Advise the patient to keep the wound clean and dry when not applying the warm wet soaks.
- Thorough washing of the hands and other contaminated areas is important to prevent spread to other close contacts.

Immobilization

- Advise the patient that in some areas of the body (particularly hand and foot injuries involving joints), motion may interfere with healing.
- Instruct the patient to elevate an injured extremity to help improve venous and lymphatic drainage and control swelling and pain and focal edema control.

Suggested Antibiotic Regimens

- If the patient is **afebrile and the abscess is less than 0.5 cm** in diameter: incision and drainage, culture, hot packs, and no antibiotics.
- If the abscess is greater than 0.5 cm in diameter: trimethoprim-sulfamethoxazole double-strength (TMP-SMX DS) 1 or 2 tablets orally twice daily for 7 to 10 days. Culture is recommended prior to initiation of antibiotics.
- Alternative adult dosage: doxycycline 100 mg capsules twice a day for 7 to 10 days or clindamycin 300 to 450 mg orally four times a day for 7 to 10 days with signs of mild to moderate systemic infection.
- Immunocompromised: Vancomycin 15-20mgs/Kg, telavancin 10 mg/kg IV every 12 hours or clindamycin 600 mg IV every 8 hours. Admit to the hospital, consider intensive care unit admission for sepsis. Purulent cellulitis with moderate to severe systemic infection: linezolid 600 mg IV every 12 hours or daptomycin 4 mg/kg IV every 24 hours with admission to the hospital and consideration of intensive care unit admission in patients with sepsis.

If afebrile and less than 0.5 cm in diameter, incision and drainage, culture, hot packs, and no antibiotics. If greater than 0.5 cm, in diameter, TMP-SMX DS 1 or 2 tablets orally twice daily for 7 to 10 days. Alternate adult dosage: doxycycline 100 mg capsules twice a day for 7 to 10 days or clindamycin 300 to 450 mg orally four times a day for 7 to 10 days. Wound culture is recommended. Immunocompromised: vancomycin 15 mg/kg IV every 12 hours, telavancin 10 mg/kg IV every 12 hours or clindamycin 600 mg IV every 8 hours. Admit to the hospital, consider intensive care unit admission for sepsis. Purulent cellulitis with moderate to severe systemic infection: linezolid 600 mg IV every 12 hours or daptomycin 4 mg/kg IV every 24 hours with admission to the hospital and consideration of intensive care unit admission in patients with sepsis.

General Follow-up Care

- Advise the patient to keep the wound clean and dry.
- Instruct the patient to **watch for signs of recurrence** of the abscess or for evidence of further infection, such as cellulitis.
- Instruct the patient to notify the clinician immediately if any of the following occurs: recollection of pus in the abscess, fever and chills, increased pain or redness, red streaks near the abscess, or increased swelling in the area.

Instruct the patient to notify the clinician immediately if any of the following occurs: recollection of pus in the abscess, fever and chills, increased pain or redness, red streaks near the abscess, or increased swelling in the area.

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CHAPTER 13

Injections

Virginia L. Valentin

Abstract

This chapter summarizes the history of injections and provides information on the indications, contraindication, complications, anatomy, and physiology related to injections. Contains detailed descriptions on the procedures of intradermal, subcutaneous, and intramuscular injections. Provides instructions on special considerations and follow-up care.

Keywords

injections
intradermal
intramuscular
subcutaneous

Procedure Goals and Objectives

GOAL: Safely administer an injection while maintaining standard precautions and proper technique.
OBJECTIVES: The student will be able to:

- Describe the anatomy of the skin and underlying structures affecting the manner in which injections are

administered.

- Identify the most common types of injections, including subcutaneous, intradermal, and intramuscular.
- Describe the indications, contraindications, and complications for each type of injection.
- Recognize the importance of equipment preparation and proper technique when administering injections.
- Identify safe injection practices to limit infection, contamination, and harm.

Background and History

Medical therapy is administered in a variety of ways, with some of the more common routes being oral, rectal, dermal, and ***parenteral***. Specific routes of parenteral delivery include intradermal, subcutaneous, intramuscular, and intravenous. Particularly, **injections** are indicated for therapeutic treatment, diagnosis of medical conditions (i.e., allergen response, tuberculosis), and disease prevention (i.e., immunization).

The term ***parenteral*** simply means that the administration of medical therapy is in a manner not involving the gastrointestinal or alimentary tract.

Injections are indicated for therapeutic treatment, diagnosis of medical conditions (i.e., allergen response, tuberculosis), and disease prevention (i.e., immunization).

During the 1650s, the scientist Sir Christopher Wren used dried animal bladders as a syringe and a goose quill as a needle to inject opium and ethanol intravenously into dogs.[1] A few years later, European scientists administered intravenous injections to humans; however, this new form of medication delivery was plagued by high rates of morbidity and mortality. Eventually, in 1853, Charles Pravaz and Alexander Wood developed a syringe and needle capable of effectively piercing skin.[1] This led to the development of calibrated syringes, which were instrumental in the treatment of syphilis. Mass production of disposable glass syringe and

needle systems began in the early 1950s to fight the polio epidemic. Shortly thereafter, disposable plastic syringes were readily available for medication delivery and vaccine administration. The use of microneedles and needleless systems is becoming more prevalent. The microneedle patch, approved to deliver flu vaccinations in adults, contains hundreds of microscopic silicon-based needles, delivering medication through the skin painlessly.[2] Alternatively, needleless systems use powder-based medication that is sprayed (using pressurized helium) onto the skin for absorption.

With the increased use of injections has come some risks. Despite advances in needle-retraction devices, unsafe injection practices may increase the risk of exposure to infectious diseases such as hepatitis B and C and human immunodeficiency virus (HIV) infection.[3] Infection control is not limited to the prevention of needlestick injuries. The Centers for Disease Control and Prevention (CDC)[4] cited the reinsertion of used needles into multidose vials or solution containers, such as saline bags and tubing, as a contributing factors.

Indications

General

The general indications for injections are as follows:

- Diagnosis (i.e., skin testing)
- Treatment or management of a condition through medication delivery
- Disease prevention through immunizations

Specific indications vary for each of the injection types, which are differentiated by tissue penetration and absorption properties.

Intradermal

- Injected into the dermal layer of skin
- Useful for conditions requiring skin testing, such as allergens and tuberculosis

Subcutaneous

- Injected into the subcutaneous layer
- Useful for low-volume medication delivery (e.g., insulin or enoxaparin) and some vaccinations

Intramuscular (IM)

- Injected deep into the musculature for distribution through the vasculature
- Useful for higher volume medication delivery and some vaccinations

Contraindications

Specific information about contraindications to specific vaccines is available from the CDC Recommendations of the Advisory Committee on Immunization Practices[5] at https://www.cdc.gov/vaccines/hcp/acip-recs/general-recs/contraindications.html

Potential Contraindications

Potential **contraindication** for injections are as follows:

- Allergy to any component of the injected substance (medication, preservative, etc.). When administering vaccines, ask patients about egg and or gelatin allergies.

Contraindications are conditions in a patient that increase the risk for a serious adverse reaction. For example, a history of anaphylactic allergy to eggs is a **contraindication** to the influenza and yellow fever vaccines.

- Coagulopathy (especially for IM injections)
- Pregnant patients should not be administered live virus vaccines (i.e., measles, mumps, and rubella [MMR], varicella, live attenuated influenza vaccine).
- Active infection at the injection site

Potential Complications

Potential complications that may occur with injections are as follows:

- Pain, burning, and erythema at the injection site
- Techniques to reduce pain: Ensure the patient is relaxed, because muscular contraction intensifies pain; allow antiseptic to dry completely before injection; and gently massage the area after injection.
- Infection (reduced with proper aseptic technique) and abscesses from irritating solutions
- Lipodystrophy
- Patients administering multiple and repeated injections (i.e., insulin administration) may develop atrophy of the subcutaneous fat, which may interfere with absorption. Rotation of injections sites can prevent atrophy.
- Injury to surrounding structures such as nerves and arteries. The risk is increased with IM injections.
- Allergic reaction (including anaphylaxis) to injectant
- Medical error (see Patient Preparation section)

Essential Anatomy and Physiology

Anatomic location and tissue composition needed for absorption are important considerations when choosing the injection site (Fig. 13.1). With increasing depth of needle penetration, systemic absorption of an injected agent is enhanced. Accordingly, intramuscular injections allow better absorption than do subcutaneous or intradermal injections. Below the epidermis is the dermis, which varies from 1 to 4 mm in thickness and is composed of connective tissue. The subcutaneous (adipose) layer lies directly beneath the dermis and above the muscles. This layer is composed of hair follicles, sebaceous glands, sweat glands, blood vessels that supply the dermis, and nerves of the autonomic nervous system.

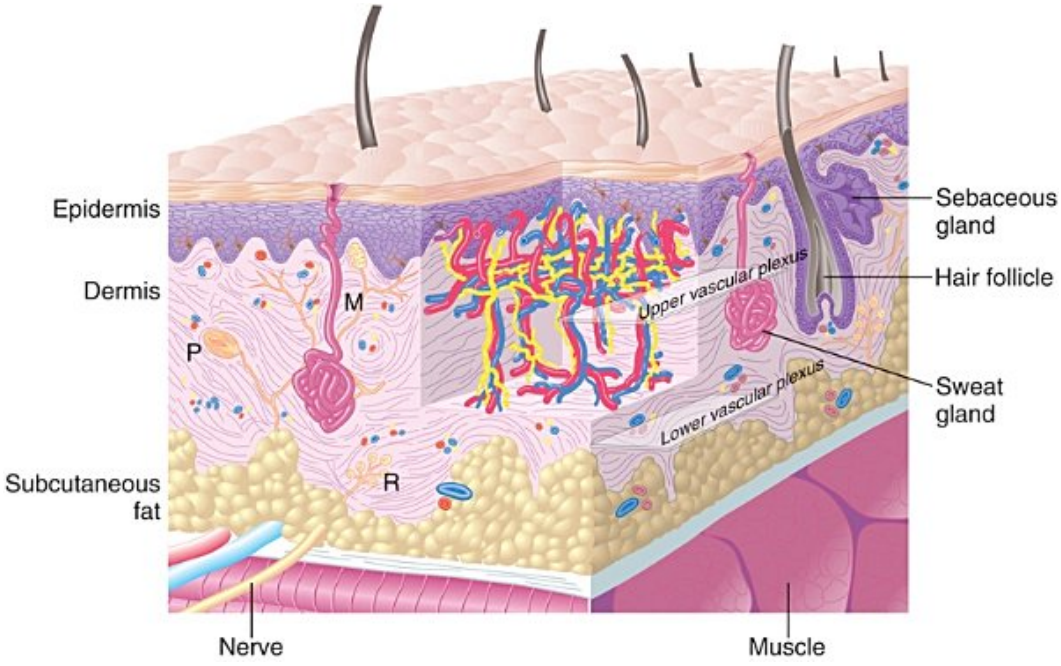

FIGURE 13.1 The layers of the skin include the epidermis and dermis, which overlie subcutaneous fat and muscle. (From Adkinson NF, Holgate ST, Busse WW, et al. *Middleton's Allergy: Principles and Practice,* ed 7. St. Louis; Mosby Elsevier; 2008.)

Intradermal injections provide a localized effect just beneath the epidermal skin layer. The optimal site for placement of an intradermal injection is on the ventral forearm, approximately 10 cm from the antecubital fossa.[6] Allergen testing may require more surface area; therefore, the lateral side of the upper arms or upper back may be used as well.

Intradermal antigen placement has a slow absorption rate, which is effective to diagnosis delayed-type hypersensitivities (type IV cell-mediated, tuberculin). Reactions do not typically develop until 24 to 48 hours after injection.

Optimal absorption for **subcutaneous injections** occurs in the adipose regions of the lower abdomen, anterior or posterior thigh, upper buttocks, lateral lower back, and lateral upper extremities. To prevent **lipodystrophy** (atrophy and scarring) with subcutaneous injections, the rotation of sites is necessary.

Common subcutaneous injections include patient self-administered insulin, enoxaparin, and heparin.

Lipodystrophy may impair insulin absorption and effectiveness. Patients with poor glucose control should be encouraged to rotate injection sites.

Intramuscular injections offer faster absorption because the muscle contains blood vessels that transport medication through the cardiovascular system.

The most advocated **sites for IM injections** include the deltoid, ventrogluteal, and vastus lateralis (Fig. 13.2).[7] In addition, many injectants are specifically manufactured to become activated within the muscle.[7] Injury can be minimized by ensuring correct patient positioning, exposing the skin completely, and palpating landmarks (Table 13.1 and Fig. 13.3).

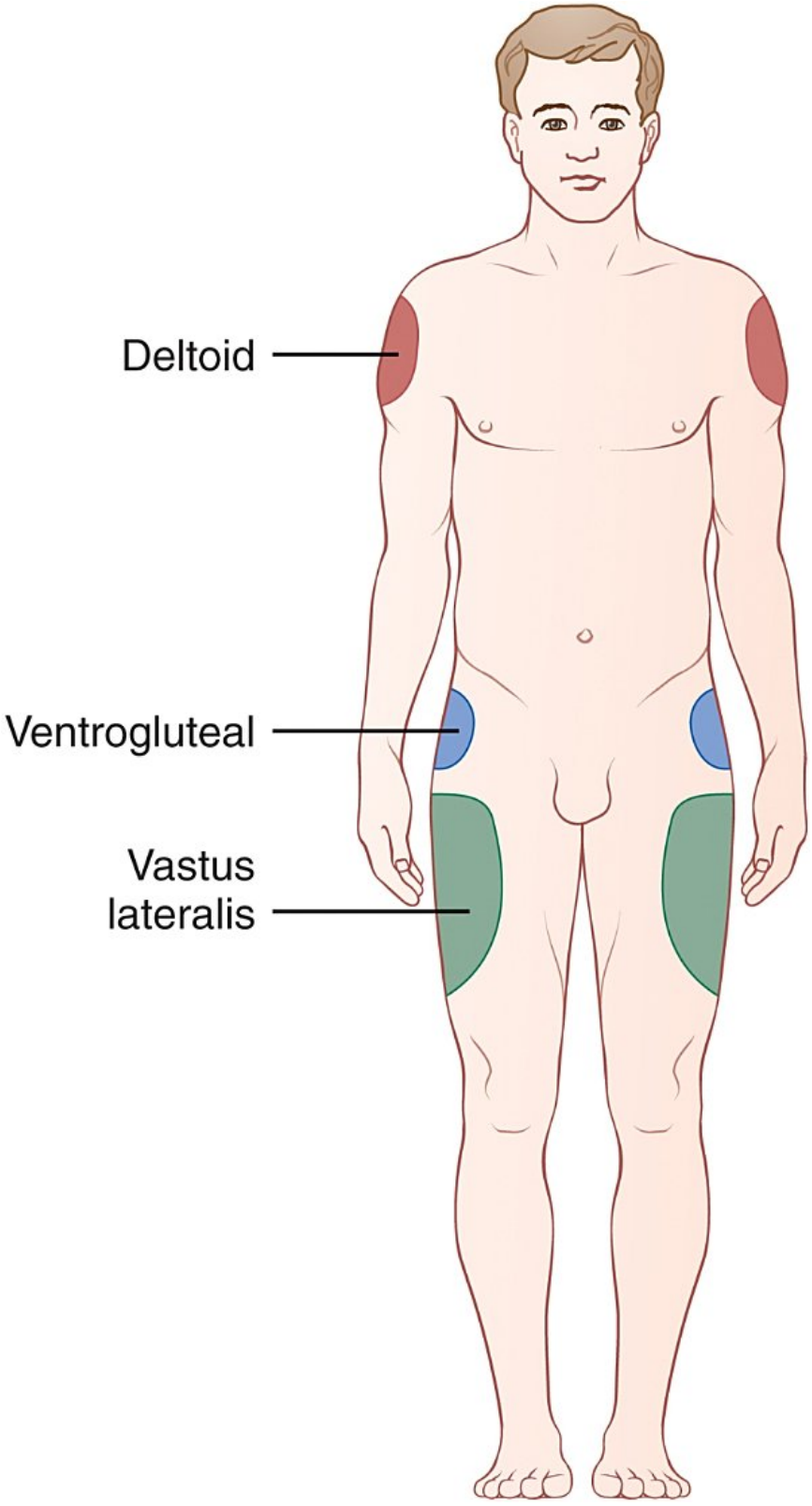

FIGURE 13.2 **The deltoid, ventrogluteal, and vastus lateralis are the most common intramuscular injection sites.**

Table 13.1

Comparison of Muscular Locations for Intramuscular Injections

Site	Location	Landmarks	Recommendations
Deltoid	Lateral side of humerus	Place four fingers across deltoid, with the top finger lying along the acromion process. Inject 2 to 3 fingerbreadths below the acromion process.	Risk for injury to radial and ulnar nerve or brachial artery

Site	Location	Landmarks	Recommendations
Ventrogluteal (see Figure 13.3)	Gluteus medius and minimus	Place heel of hand over the greater trochanter, with thumb pointing toward the groin and fingers toward the head. Place the index finger on the anterosuperior iliac spine, extending the third digit along iliac crest (a "V" is formed by the first and third digits). Inject into center of the "V."	Advocated as the first choice because of distance from major nerves and blood vessels
Vastus lateralis	Anterior thigh	Place hand above the knee and then below the greater trochanter of the femur. The area between the hands is the vastus lateralis. Inject into the middle third of the area.	Preferred choice by clinicians for infants and commonly used in children and adults.

Site	Location	Landmarks	Recommendations
Dorsogluteal	Gluteus medius	Draw an imaginary line between the posterior superior iliac spine and the greater trochanter of the femur. Inject above and lateral to the imaginary line. *Less reliable method:* Divide buttocks into quadrants, injecting into upper outer quadrant, 2 to 3 inches below the iliac crest.	*Note*: Most resources do *not* advocate routine immunization administration in the buttocks because of the risk for sciatic nerve and superior gluteal artery injury.[7]

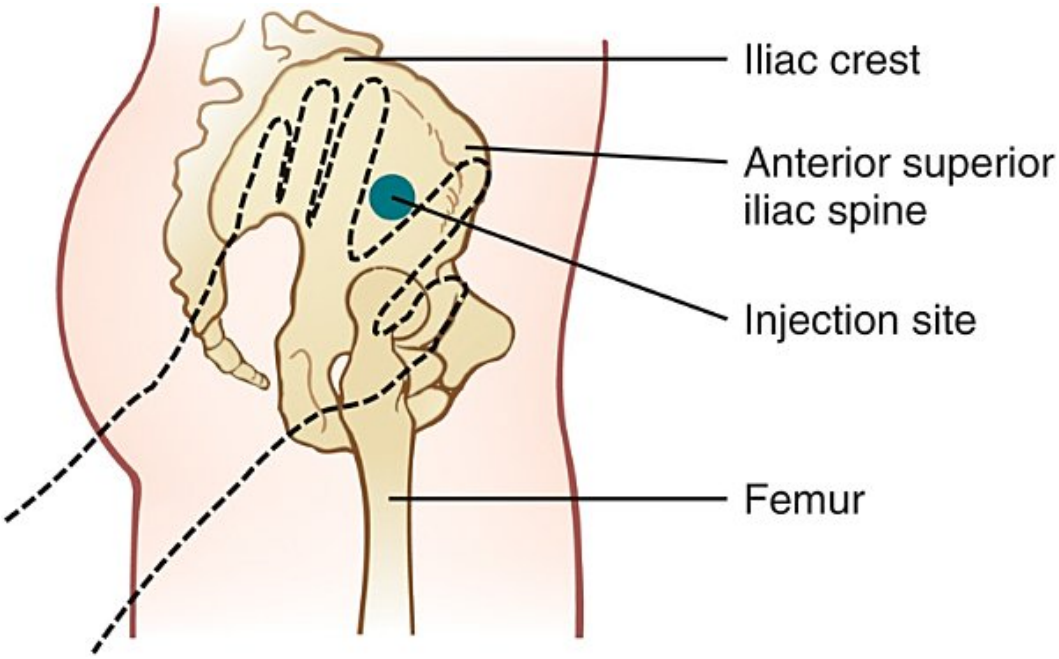

FIGURE 13.3 Ventrogluteal location.
Placement of the hand and fingers to form a "V." (From O'Toole MT. Miller-Keane Encyclopedia and Dictionary of Medicine, Nursing, and Allied Health, ed 7. Philadelphia: Saunders; 2003.)

Most resources no longer advocate using the dorsogluteal site because of the close proximity to the sciatic nerve.[7] There is a much higher risk for nerve and arterial injury.

Standard precautions

Clinicians should use standard precautions at all times when interacting with patients. Determining the level of precaution necessary requires the clinician to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

Patient Preparation

One of the most important aspects of patient preparation involves maintaining patient and provider safety. Safe injection practices prevent transmission of infectious diseases and reduce medical errors. **Unsafe injection practices** have been linked to several outbreaks of hepatitis B and C and HIV.[3] Practicing infection control and aseptic technique

throughout the preparation and **administration of injections** is paramount. A variety of devices for postinjection safety are available in some needle systems. A sharps container is necessary to ensure proper disposal of needles (Fig. 13.4).

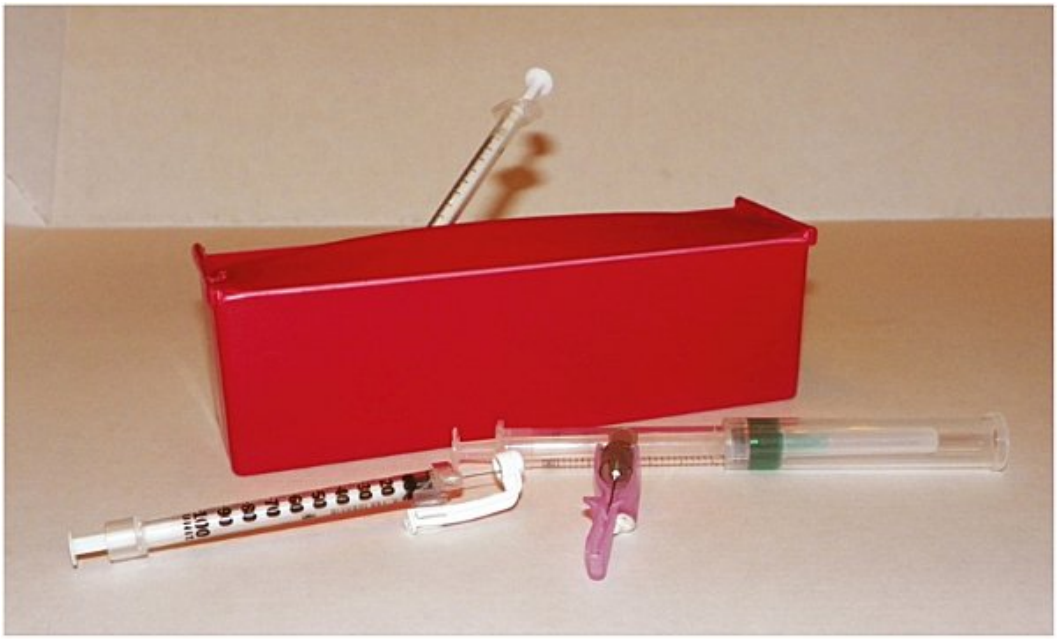

FIGURE 13.4 Some needle systems provide self-deployment of a safety system that protects the needle and bevel. (Courtesy Clifford L. Snyder, MPAS, PA-C.)

Never administer medications from the same syringe even if the needle itself was changed.

For decades, the "rights of medication administration" have provided a useful safety check for providers, caregivers, and patients.

1. Right patient
   - Ask patients to state their name and date of birth.
   - Verify information on an identification bracelet or the unique patient number.
2. **Right drug**

In 2004, the national accrediting body of health care, The Joint Commission,[8] created its "do not use" list of abbreviations, which includes abbreviations that can be mistaken or confused for another. For example, the abbreviation "MS" can imply morphine sulfate or magnesium sulfate.

- Verify medication or vaccination labels three times.
- Verify whether generic or brand name drug is to be administered.
- Be cautious about drugs with similar names or abbreviations.

3. Right dose
   - Verify medical order for accuracy.
   - Have calculations checked by another person or a computer.
   - Be cautious of abbreviations, numbers, and units of measurements.
4. Right time
   - Some medications may need to be administered at a certain time (in the morning, before food ingestion, etc.).
   - If this is a series of injections, verify date and time of the last injection.
   - Verify expiration date of the medication or vaccine.
5. Right route
   - Verify the correct route of injectable medication administration.
   - Verify the indication and equipment necessary.
6. Right site
   - Look for signs of active infection at site.
   - Verify the appropriate site for route and indication.
   - Evaluate patient's body habitus, because this may determine needle sizing adjustments.
   - With repeated injections, rotate sites to prevent lipodystrophy.
7. Right documentation
   - A copy of a Vaccine Information Statement (VIS) is required by law to be given to the patient and/or legal guardian for each dose. Each statement describes the risks and benefits associated with the vaccine.
   - Record in the patient's chart that a VIS (date of administration and publication date of VIS) was given to the patient and/or legal guardian.

In addition to reducing medical errors and limiting infectious disease transmission, patient preparation includes informing the patient or caregiver about the indication, process, and side effects.

- Before obtaining a verbal consent, inform the patient about the indication, benefits, and risks. Patients have the right to refuse an injection.
- Always verify allergies in the patient chart and ask if patients are allergic to any medications or components of injections (e.g., eggs, gelatins, preservatives).
- Inform the patient about the site of administration and **potential sensations on needle insertion**.

Do not tell a patient that the injection is painless. Mild pain is anticipated and may be interpreted as a "pinch" or "sting" caused by the needle itself or the injectant composition.

- Advise the patient of warning signs and symptoms and whom to contact if these should occur.

Materials

- Syringe (Fig. 13.5)
- A 2- or 3-mL syringe is adequate for most injections.
- Be aware that dedicated insulin and tuberculin syringes hold less content to produce a finer calibration (Fig. 13.6).
- Insulin syringes are measured in units.
- Tuberculin syringes are measured in 0.01-mL units.
- **Needle** (see Fig. 13.5)
- Needles vary in length (inches), so choose the needle length according to patient size or weight and the route of administration. Needles also vary in diameter (gauge) to administer a range of viscosity (thickness) of the fluid (Fig. 13.7). Commonly used sizes include the following:
  - Intramuscular: 20 to 25 gauge, 1.5 inches
  - Subcutaneous: 25 to 27 gauge, 3/8 to ⅝ inches
  - Intradermal: 25 to 27 gauge, 0.5 to ⅝ inches

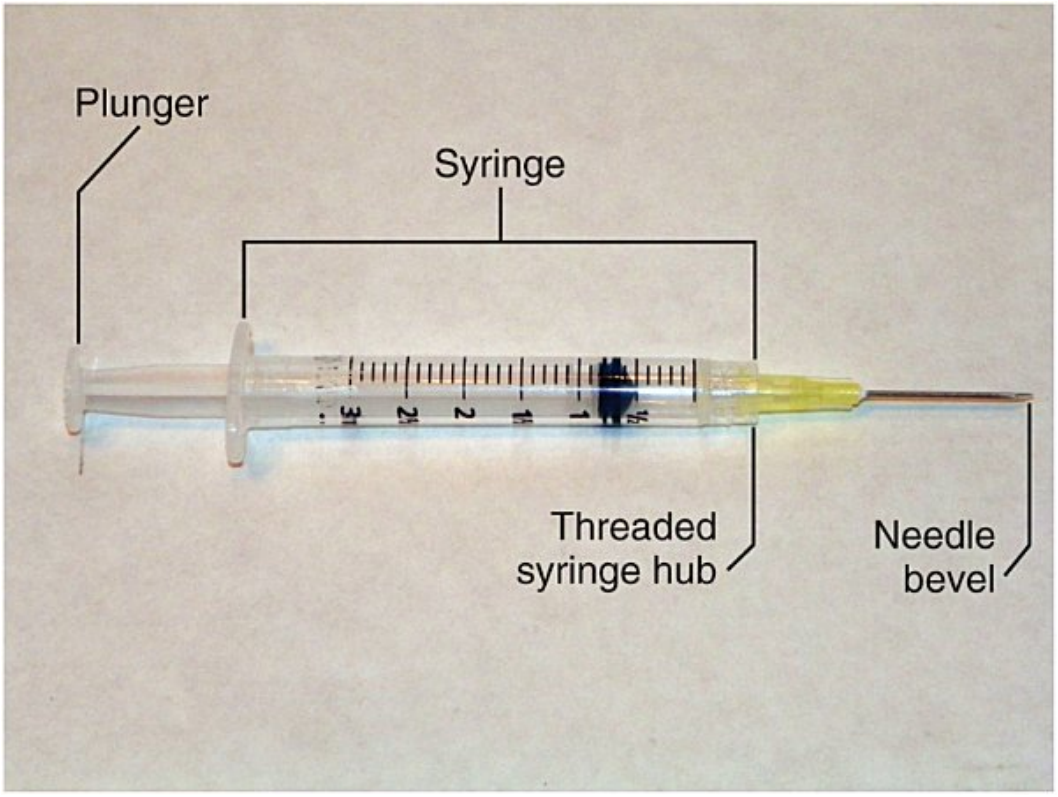

FIGURE 13.5 The syringe (barrel), which holds the plunger, consists of a threaded hub for securing the needle. The bevel of the needle is located at the most distal portion. (Courtesy Cliff L. Snyder, MPAS, PA-C.)

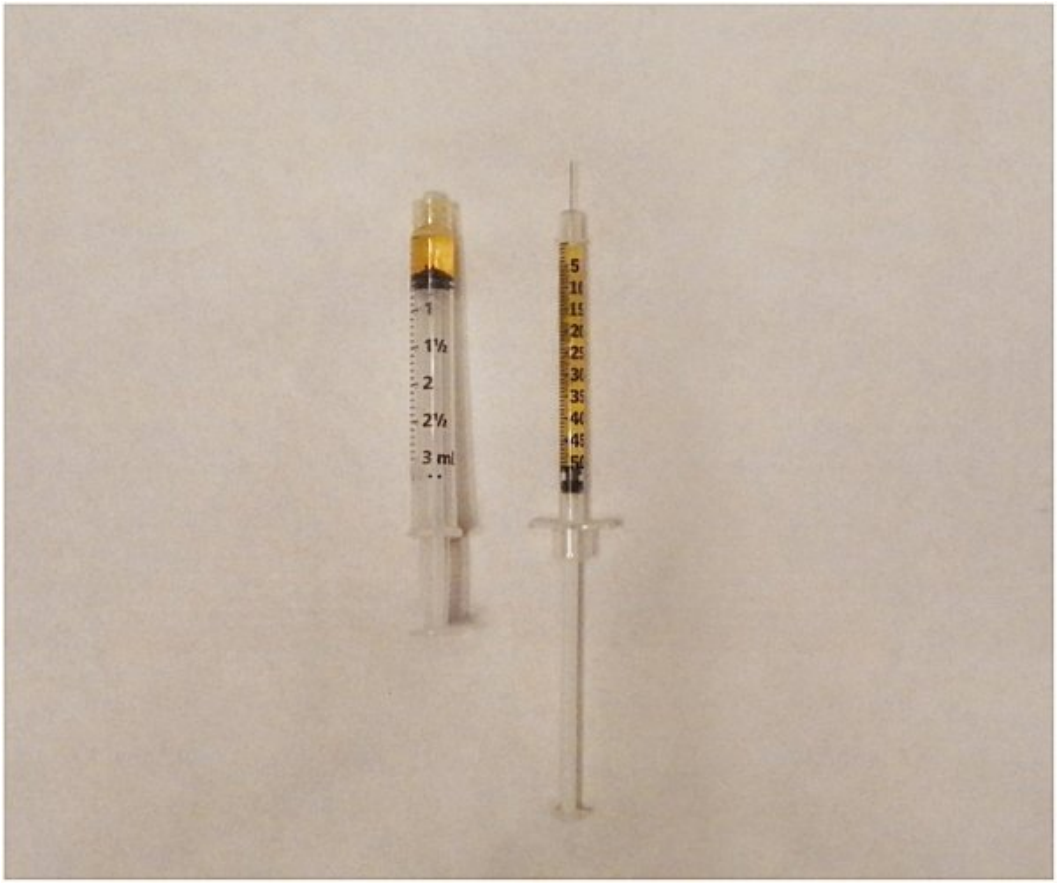

FIGURE 13.6 The 3-mL syringe *(left)* and insulin syringe *(right)* contain equivalent amounts of fluid (0.5 mL). (Courtesy Cliff L. Snyder, MPAS, PA-C.)

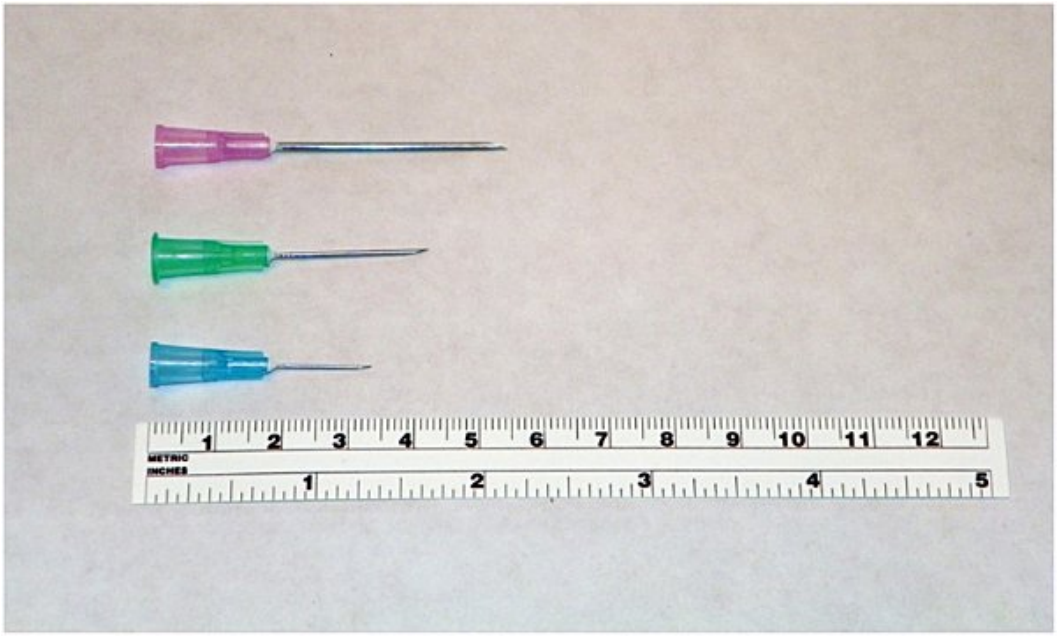

FIGURE 13.7 Note the length and thickness of the needle types. Progressing from the shorter length and thinner gauge to the longer length and larger gauge are the intradermal, subcutaneous, and intramuscular needles. (Courtesy Cliff L. Snyder, MPAS, PA-C.)

Size of the needle: The larger the gauge, the smaller the diameter. Thus a 26 gauge is thinner than a 20 gauge.

Never recap a needle, even if it has not been injected into a patient. After the cap has been removed from a needle, utilize the safety needle system that covers the needle to protect the provider, patient, and others who may come into contact with the device.

- Injectable substance (medication, vaccine)
- Ampules are typically single drug doses.
- Vials contain single or multiple drug doses.
- Vials with powder require the addition of a sterile substance or solvent.
- Alcohol pad to cleanse the skin surface
- Gloves (typically nonsterile)
- Needle or "sharps" container for disposal
- Gauze pad
- Bandages

Procedure

Aspirating From an Ampule

1. Follow the "rights of medication administration."
2. Gather supplies, wash hands, and don gloves.

NOTE: If the patient has a known latex allergy, nonlatex gloves should be worn for the procedure.

3. Inspect ampule for breaks or cracks (Fig. 13.8A).
4. Tap out any liquid from the neck of the ampule. Using a gauze square, break the ampule at the neck if it is glass (Fig. 13.8B) or twist off the top if the ampule is plastic.

NOTE: Glass ampules have very sharp edges that can cause injury to the fingers. Using a gauze square, paper towel, or ampule breaker helps minimize injury.

5. Aspirate contents by inverting the ampule (Fig. 13.8C). Use a filter needle with glass ampoules.
6. Remove air as needed by either tapping the syringe or pushing out excess air with the plunger.
7. Dispose of materials properly.

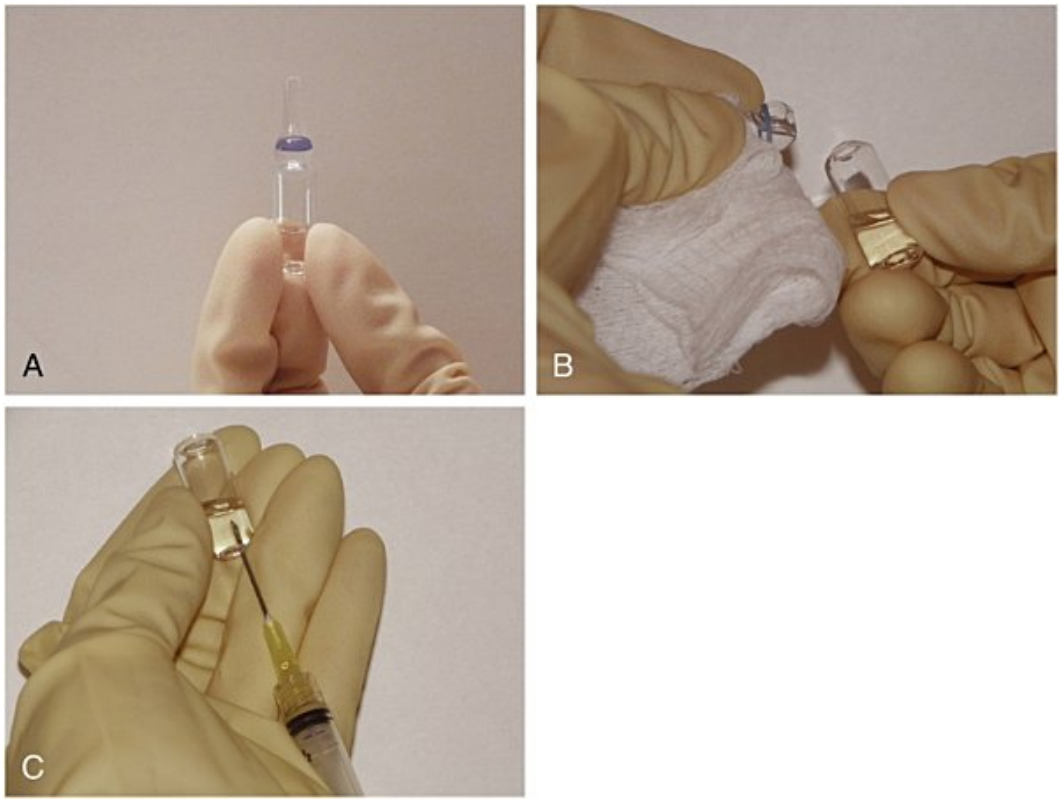

FIGURE 13.8 **Aspirating from an ampule.**
A. Ampule. **B.** Breaking ampule. **C.** Ampule aspiration. (Courtesy Cliff L. Snyder, MPAS, PA-C.)

Procedure

Aspirating from A Vial

1. Follow the "rights of medication administration."
2. Gather supplies, wash hands, and don gloves.

NOTE: If the patient has a known latex allergy, nonlatex gloves should be worn for the procedure.

3. Disinfect top of vial with an alcohol pad.
4. Select a syringe with twice the volume of injectant.
5. Secure the needle to the syringe.
6. Draw air into the syringe. The amount should be equivalent to the volume of injectant.

7. Insert the needle into the top of the vial (rubber stopper) and turn upside down.
8. **Inject air into the vial.** Limit bubbles in the fluid by injecting the air above the fluid surface line (Fig. 13.9).

> Vials have an air pressure vacuum inside. After injection of air into the vial, the inside has a slightly higher pressure, making the solution easier to aspirate.

9. Aspirate the medication dose. Limit bubbles and air trapping by aspirating with the tip of the needle below the fluid surface line. Carefully adjust dose, because even small deviations from the measured units can affect efficacy.
10. Remove the needle from the vial slowly.

NOTE: Current safe injection practices recommend never inserting a used syringe or needle into a vial, bag, or bottle.[4] Therefore, ensure the adequate amount has been aspirated before removing the needle from the vial.

11. Remove air as needed by either tapping the syringe or pushing out excess air with the plunger.
12. Dispose of materials properly.

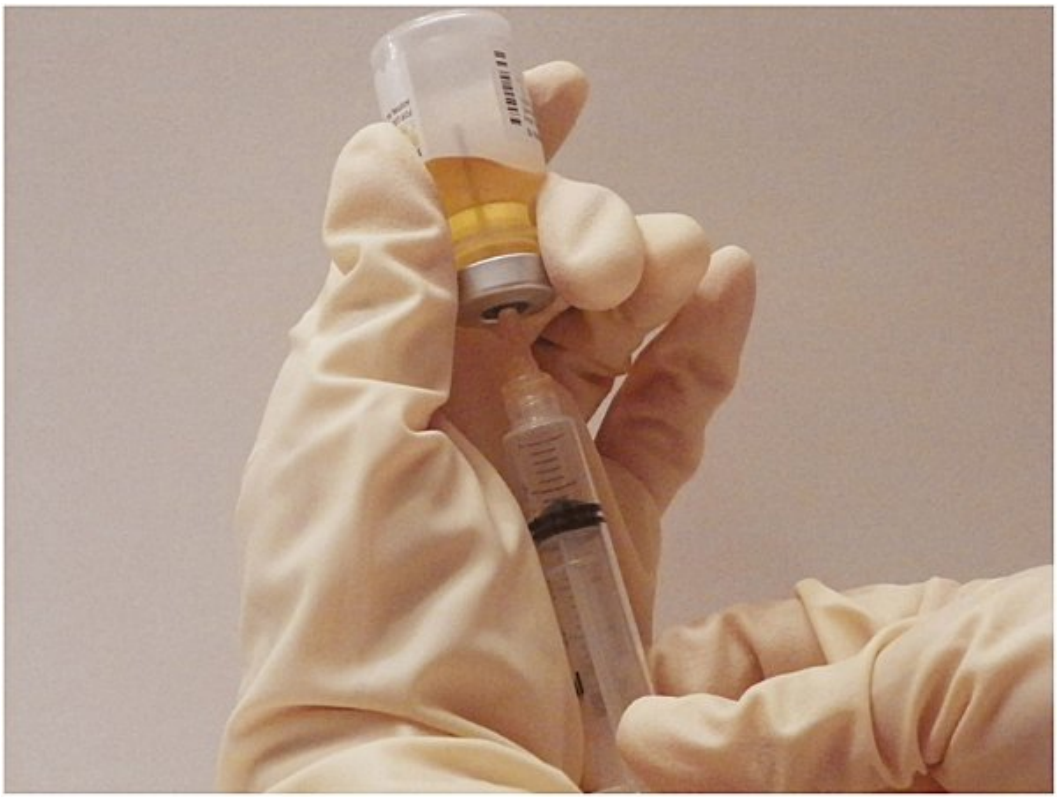

FIGURE 13.9 Adding air to vial prior to aspiration.
The bevel of the needle should be above the fluid surface line.
(Courtesy Cliff L. Snyder, MPAS, PA-C.)

Procedure

Intradermal Injections

1. Follow the "rights of medication administration."
2. Gather supplies, wash hands, and don gloves.

NOTE: If the patient has a known latex allergy, nonlatex gloves should be worn for the procedure.

3. For a ventral forearm injection have the patient in a seated position with the ventral forearm exposed and lying on a hard surface. Prepare the site (10 cm from the antecubital crease) with an alcohol pad by beginning at the center of the site and continue moving outward in a circular motion. Let dry.

4. Hold the patient's forearm, gently stretching the skin with the thumb. Insert the needle, bevel up, at a 15-degree angle into the upper layers of skin (Fig. 13.10).
5. Inject slowly. You will see a small wheal or bleb form on injecting, signaling proper intradermal placement.

NOTE: If a wheal or bleb does not appear on injection of an antigen, remove the needle and attempt again in another location (at least 2 inches from first injection).

6. Withdraw the needle at the same 15-degree angle.
7. The wheal or bleb should disappear gradually; do not rub the site.
8. Dispose of the supplies properly.
9. Depending on the antigen injected, assessment of the patient's response should be performed at 24 to 48 hours.
10. Document the procedure as reviewed below in the Documentation and Follow-Up Care section.

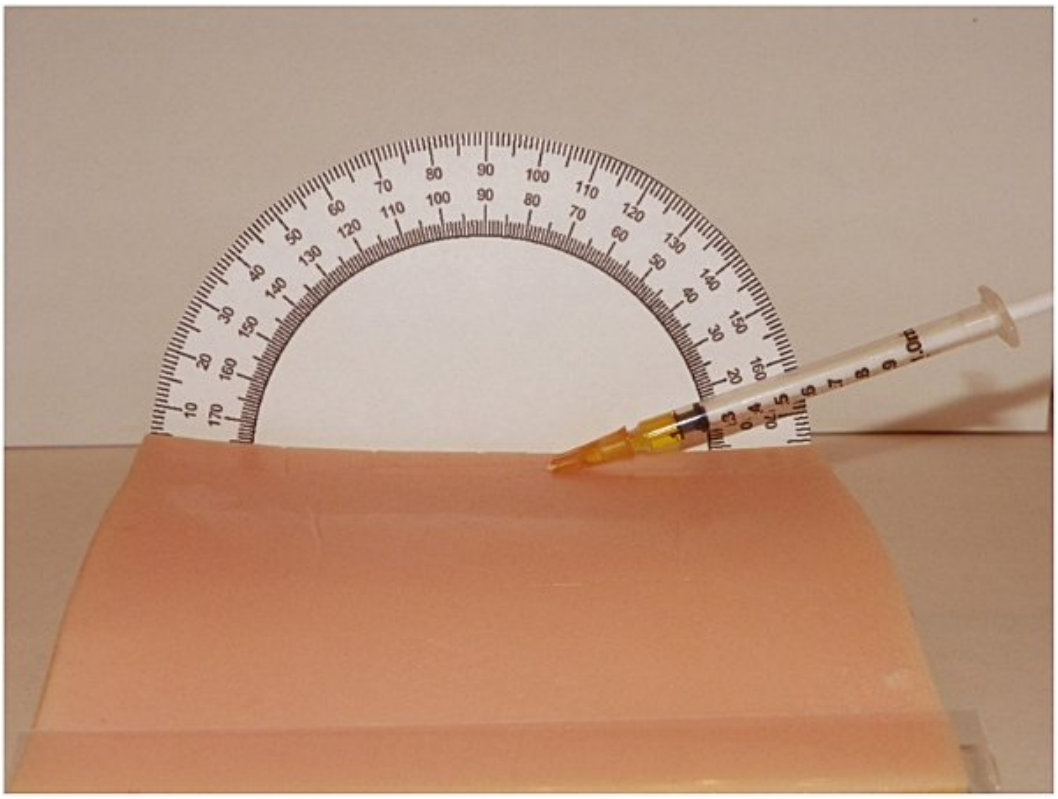

FIGURE 13.10 Intradermal needle placement at a 15-degree angle. (Courtesy Cliff L. Snyder, MPAS, PA-C.)

Procedure

Subcutaneous Injections

1. Follow the "rights of medication administration."
2. Gather supplies, wash hands, and don gloves.

NOTE: If the patient has a known latex allergy, nonlatex gloves should be worn for the procedure.

NOTE: Obese patients may require a longer needle, and a thin patient may require a shorter needle.

3. Prepare the site with an alcohol pad by beginning at the center of the site and continue moving outward in a circular motion. Let dry.
4. With the thumb and index finger of your nondominant hand, bunch the skin, pulling the subcutaneous tissue gently away from

the musculature.

5. Insert the needle, bevel up, at a 45-degree angle into the subcutaneous layer (Fig. 13.11).

NOTE: Recent studies have shown that aspiration before injection of vaccines is unnecessary because of the lack of large blood vessels in the recommended sites.[3]

6. Inject the drug slowly.
7. Withdraw the needle and apply pressure with a gauze square. A bandage is typically unnecessary.
8. Properly dispose of supplies.
9. Document the procedure as reviewed below in the Documentation and Follow-Up Care section.

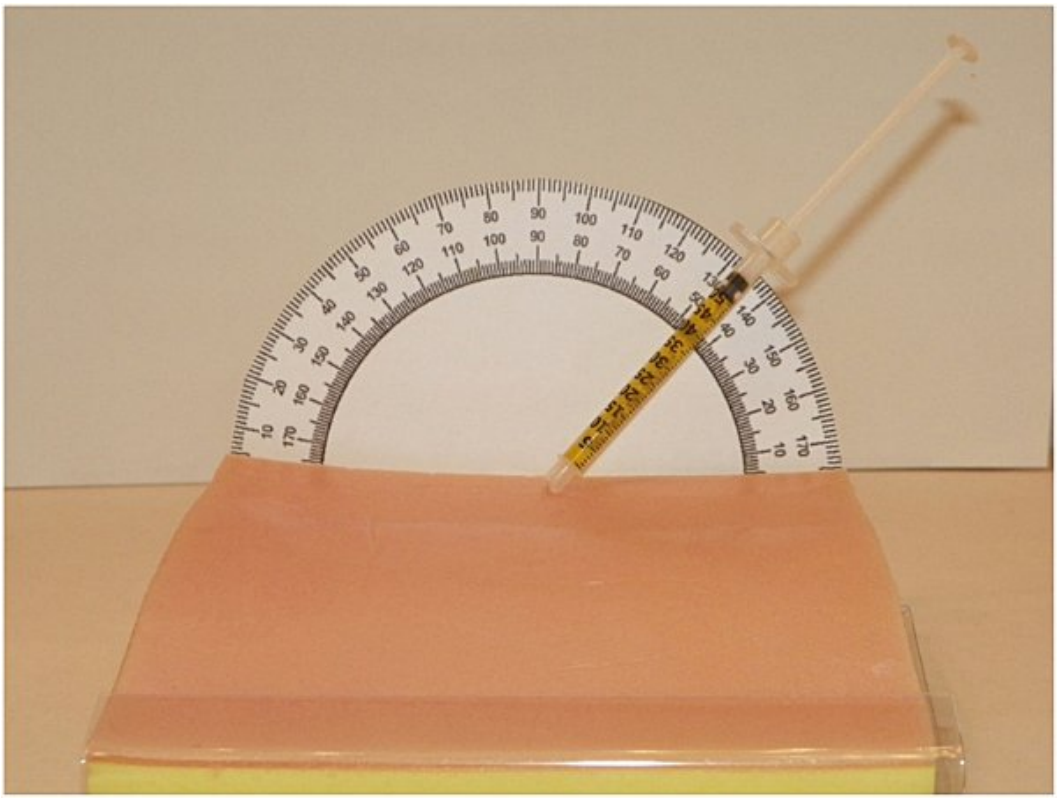

FIGURE 13.11 Subcutaneous needle insertion at a 45-degree angle. (Courtesy Cliff L. Snyder, MPAS, PA-C.)

Procedure

Intramuscular Injections

1. Follow the "rights of medication administration."
2. Gather supplies, wash hands, and don gloves.

NOTE: If the patient has a known latex allergy, nonlatex gloves should be worn for the procedure.

3. Prepare the site with an alcohol pad beginning at center of the site and continue moving outward in a circular motion. Let dry.
4. Ensure the patient is relaxed, because a contracted muscle increases pain. With the thumb and index finger of your nondominant hand, gently stretch the skin, pressing down slightly, which reduces the subcutaneous tissue at the site.
5. Insert the needle with a quick thrust, at a 90-degree angle deep into the muscle (Fig. 13.12).

NOTE: Recent studies have shown that aspiration before injection of vaccines is unnecessary because of the lack of large blood vessels in the recommended sites.[3]

6. Withdraw the needle and apply pressure with a gauze square.
7. After any bleeding has stopped, apply a small bandage.
8. Dispose of supplies properly.
9. Document the procedure as reviewed below in the Documentation and Follow-Up Care section.

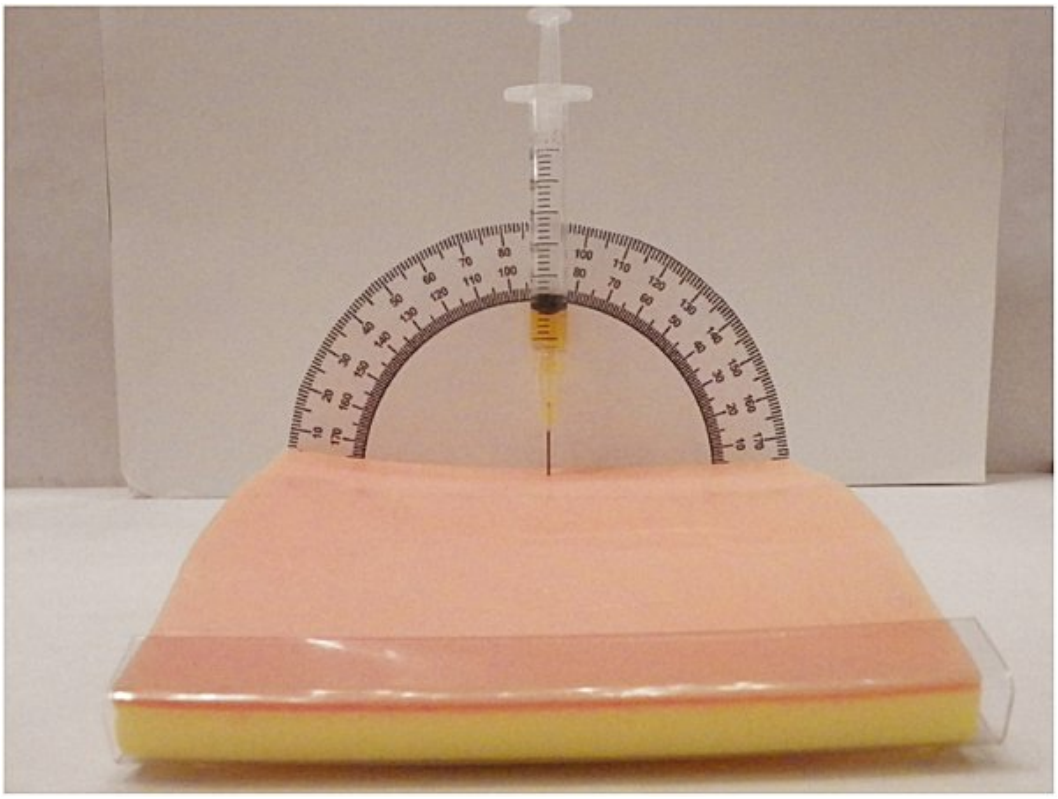

FIGURE 13.12 Intramuscular needle insertion at a 90-degree angle. (Courtesy Cliff L. Snyder, MPAS, PA-C.)

Special Considerations

Pediatric Patients

Special considerations for the pediatric population are as follows:

- To reduce the risk for blood vessel or nerve damage, infant and children site recommendations must be followed (Table 13.2).

Table 13.2

Injection Site Recommendations for Infants and Children[10]

Injection Route	Infant (<12 Months)	Toddler (12-24 Months)	Children (>36 Months)
Subcutaneous (e.g., MMR, varicella, IPV, PPV23)	Fatty tissue over the anterolateral thigh	Fatty tissue over the anterolateral thigh or outer upper arm	Fatty tissue over the anterolateral thigh or outer upper arm
Intramuscular (e.g., Tdap, Td, Hib, hepatitis A and B, TIV, PCV, IPV, PPV, HPV, MCV4)	Vastus lateralis (anterolateral aspect of upper thigh)	Vastus lateralis (anterolateral aspect of upper thigh) or deltoid if muscle developed	Upper deltoid

Hib, Haemophilus influenzae type b; *HPV,* human papillomavirus; *IPV,* inactivated polio; *MCV4,* quadrivalent meningococcal conjugate; *MMR,* measles, mumps, and rubella; *PCV,* pneumococcal conjugate; *PPV,* pneumococcal polysaccharide vaccine; *Td,* tetanus and diphtheria; *Tdap,* tetanus, diphtheria, and pertussis; *TIV,* trivalent inactivated influenza.

Insulin Administration

Special considerations in the administration of insulin are as follows:

- A variety of insulin preparations are available. Ensure that the type of insulin, dose, and syringe are correct.
- Only compatible types of insulin should be combined.
- Insulin preparations typically require that the vial be gently rolled in the palm of the hands to ensure proper distribution. Shaking the bottle can alter the potency.
- Patients need education on injection site rotation to limit lipodystrophy. Typically, sites such as the arms, abdomen, thighs, and buttocks provide effective absorption of insulin.

Documentation and Follow-Up Care

Documentation and patient follow-up care after injections are as follows:

- The following documentation is required for any injected substance.
  - Name and manufacturer of agent, lot number, expiration date
  - Injection method (specific site, needle, route)
  - Date, time, and person who administered injection
  - Vaccination Information Statement for vaccines
- It is recommended to observe the patient for at least 15 minutes after vaccination.[9] Syncopal episodes may occur during or after a vaccination. Preceding symptoms include weakness, pallor, dizziness, palpitations, and diaphoresis. Adequate preparation includes having the patient seated or lying down during and after injection.
- Health care providers should report significant adverse events after vaccination to the Vaccine Adverse Event Reporting System (VAERS) at https://vaers.hhs.gov/.

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CHAPTER 14

Inserting Intravenous Catheters

Carol Gorney

Abstract

Insertion of a peripheral intravenous (IV) line is a common procedure performed by most providers. Providers must be familiar with standard precautions and basic anatomy as well as the indications and contraindications before inserting an intravenous catheter. The benefits of placing an IV catheter should be considered and should outweigh the risk of infection or complications. Providers should be instructed in the equipment necessary, proper technique to prepare the site, where to place and secure the catheter, what care to provide after placement, and be able to identify common complications of placement.

Keywords

anatomy
complication
indication
materials
patient preparation
procedure

Procedure Goals and Objectives

GOAL: Use standard precautions to insert a peripheral intravenous (IV) catheter following guidelines that minimize risk or injury to the patient and increase the likelihood of success.

OBJECTIVES: The student will be able to:

- Identify the anatomy associated with the insertion of a peripheral IV catheter.
- Describe the indications and contraindications of insertion of IV.
- Identify the material necessary to insert an IV catheter.
- Identify proper aftercare for an IV catheter insertion site.
- Discuss common complications associated with IV catheter placement.

Background and History

The inspiration for the "little plastic tubes that revolutionized medicine" began during the Puritan revolution in Britain when a group of young scientists, including William Harvey, who described circulation; Richard Lower, an anatomist and physiologist; and Christopher Wren, a microscopist and physiologist, began experiments at Oxford. Wren used a quill and pig's bladder in 1658 to create the first IV device. It was used to instill fluid mixtures into dogs' veins. These initial attempts were fraught with complications, and IV insertion was banned for over 100 years. By the early 1800s, successful human-to-human transfusions were medically documented. The Parisian cholera epidemics of the 1800s revitalized the science of IV access and began Claude Bernard's experimentation with the infusion of IV fluids into dogs in 1843. Hollow needles and

syringes were invented in the 1850s, and the cornerstones of IV access and fluid therapy as we know them were in place.[1]

Indications

Intravenous access is indicated in the following situations[2]:

- Fluid administration is done by IV access in clinical settings in which it is deemed medically necessary, including illness, volume depletion or loss, burn, blood loss, electrolyte disturbance, heat stroke, shock, and trauma.
- Medical emergency situations may require IV administration.
- Administration of antibiotics, chemotherapeutics, or other medically necessary treatments may require IV access.
- Administration of blood products requires IV access.
- Administration of diagnostic substances, such as dyes or contrast, may require IV access.
- Administration of some nutritional components require IV access.[2]

Contraindications

Contraindications to IV access are as follows[1]:

- Extremities with significant burns, edema, or injury should not be used, to avoid more mechanical trauma.
- Extremities with cellulitis or significant infection should not be used, to avoid introducing bacteria into the blood circulation.
- Insertion should not be performed distal to prior failed IV catheter insertion attempts.
- Insertion should be avoided distal to any area of preexisting phlebitis.
- Insertion should be avoided in extremities with **impaired circulation**: mastectomy, axillary lymph node dissection,

lymphedema, clot, peripheral vascular disease, venous insufficiency.

- Extremities with indwelling fistula should not be used.
- Care should be taken when performing IV access in a patient with a known bleeding diathesis.
- Consideration should be given to placing a peripherally inserted central catheter if the medication being infused is too caustic, hypertonic, a sclerosing agent, a vasopressive agents, or is to be given for longer than 6 days.[3]
- When appropriate therapy can be given by a less invasive route (orally)

IV insertion should be avoided in extremities with impaired circulation: mastectomy, axillary lymph node dissection, lymphedema, clot, peripheral vascular disease, venous insufficiency.

Potential Complications

Technique

- If no flash of blood is obtained, the catheter is probably not in the vein and should not be advanced.
- If a flash is obtained, but catheter cannot be advanced, a vessel valve may be occluding the catheter and should not be forced; remove it and apply pressure.
- If the catheter is threaded, but fluid does not flow freely, it is likely the catheter is kinked or has clotted; remove it and apply pressure.

Local

The following apply at the site of IV insertion[4]:

- Failure to cannulate a vein properly may result in fluid or medication being infused in the surrounding tissue outside

of the vessel, causing pain, tissue irritation, and swelling of the area. Certain medications can be caustic to adipose tissue and may cause necrosis of the tissue.

- Minor bleeding can occur at the site.
- Thrombophlebitis can occur as a result of the mechanical trauma to the vein when the catheter is inserted and an indwelling foreign body is present in the vein. This can be minimized by avoiding trauma at the time of insertion, securely taping the cannula in place, and avoiding placing the catheter near a joint line, where frequent movement may cause more mechanical injury. Reducing the risk for thrombophlebitis reduces the risk for infection and patient discomfort.
- **Local site infection** or cellulitis is commonly seen in catheters left in place for longer than 72 to 96 hours or if aseptic technique is not strictly adhered to at the time of insertion.

Local site infection is commonly seen in catheters left in place for longer than 72 to 96 hours or if aseptic technique is not strictly followed.

Systemic

Systemic complications, which are rare, include the following:

- Septicemia or bacteremia most commonly occurs if aseptic technique is not followed when placing the IV line or in the aftercare: skin is not cleansed, catheter is placed in an anatomic area that is heavily colonized with bacteria, and so forth. Care should be taken with close observation for signs of local infection and the IV line promptly removed if signs are present.
- Catheter embolization is very rare and results from the distal portion of the catheter end being shearing off by the beveled end of the needle. It can be avoided by not pulling the catheter sheath back over the needle once it has been

threaded (advanced). If the catheter cannot be threaded completely, follow proper technique to remove the partially threaded cannula and needle and apply pressure.

- Pulmonary emboli can occur with centrally placed peripheral lines as a result of clot formation at the tip of the catheter that dislodges and travels to the lung.
- Air emboli occur when lines are not properly flushed to remove all air before being connected to the catheter.

Essential Anatomy and Physiology

Knowledge of the venous anatomy of the upper arm and hand is important in obtaining IV access (Fig 14.1). The forearm is used, if possible, because it offers easy accessibility, avoids the wrist, and contributes to increased patient comfort. Avoiding valves and bifurcations is frequently easier in the lower arm. The dorsum of the hand offers good IV access. Bifurcations and valves should be assessed before IV placement to help determine the best insertion site. The bifurcations can be visualized and the valves can be palpated as knotlike lumps or tortuous areas in the vein. This helps determine the longest section of obstruction-free vein so the catheter will thread without resistance. The metacarpal, basilic, and cephalic veins in the upper extremity are commonly used. Fig. 14.2 illustrates the venous anatomy of the foot. In the pediatric population, the foot and ankle have adequate circulation, so concern for infection is not increased; therefore, it is an equally acceptable IV site. It offers easy IV access and is less visible to small children, which decreases anxiety and the likelihood the IV device will be placed in the mouth. Having the catheter and tubing on the lower extremity may physically interfere less with parent–child bonding and breastfeeding. Commonly used lower extremity veins are the greater and lesser saphenous and medial marginal veins.

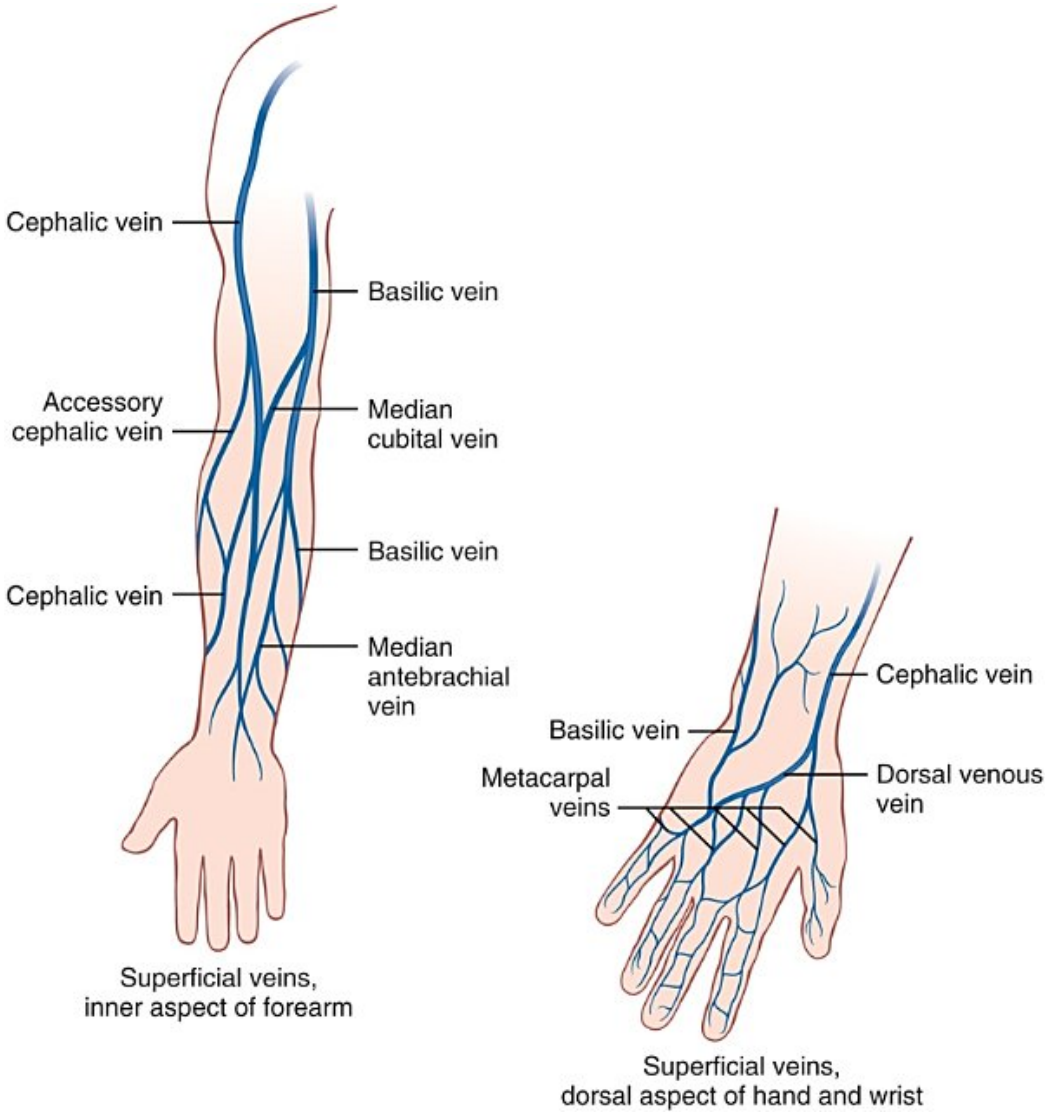

FIGURE 14.1 Anatomy of the veins of the upper extremity most commonly used in starting intravenous catheters.

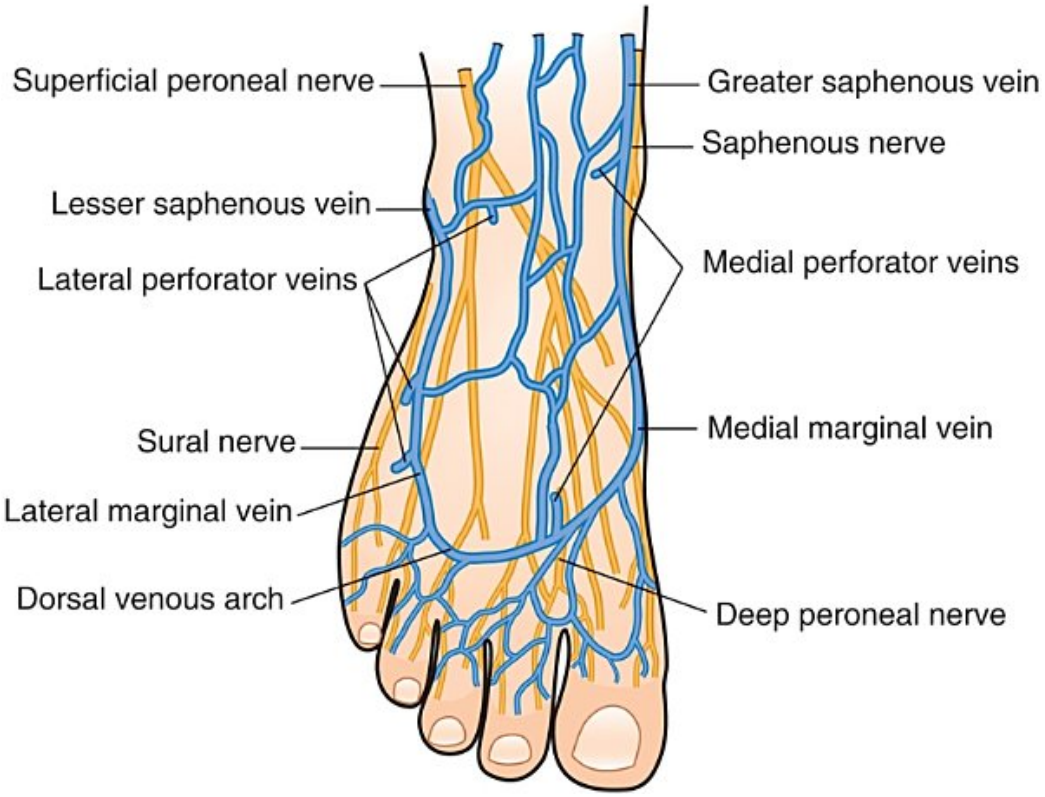

FIGURE 14.2 **Anatomy of veins of the lower extremity most commonly used in starting intravenous catheters in pediatric patients.**

Standard precautions

Every practitioner should use standard precautions at all times when interacting with patients, especially when performing procedures. Determining the level of precaution necessary requires the practitioner to exercise clinical (for further discussion, see Chapter 35).

Patient Preparation

- Identify the patient.
- Verbal consent is sufficient. For the usage of intravenous catheters, the risk-benefit ratio and the indication for placing are considered to be common knowledge for a competent and alert patient. The patient is assumed to have consented if

they extend the extremity to have the IV placed. Time should be taken to explain the indication, the pain involved the procedure, the expected time for the therapy and alternatives if available.

- Identify allergies (iodine, latex, adhesives, and lidocaine).
- Have all necessary supplies prepared.
- Offer saline or lidocaine injection for anesthesia (if appropriate) to patients.

Materials

- Appropriate-gauge intravenous catheter (have multiple gauges of catheters at the bedside)

NOTE: Over-the-needle catheters with safety devices are the most commonly used catheters. Many brands and sizes are commercially available, and one should take time to get familiarized with the types offered at your institution. Most institutions offer only IV catheters with safety devices that retract the needle to reduce the risk for needlestick. Many institutions offer closed system sets with needle connectors to reduce the chance of blood contamination or spills and the traditional over-the-needle safety devices (Fig. 14.3). Patient age, location of insertion, and indication should all be considered in choosing the catheter gauge (size). A 24-gauge (small bore), 0.5-inch catheter is commonly used in a neonate or small infant. The delivery of blood products or trauma necessitates larger bore IV devices, such as 16 or 18 gauge (remember the smaller the number of the gauge, the larger the bore of the IV catheter). Peripheral catheters range in size from 24 to 14 gauges.

- Gloves and other equipment to practice **standard precautions** (latex-free if the patient is allergic) and eye protection
- IV fluid
- Administration set (tubing with a drip chamber that has been primed with IV fluid and has a roller clamp flow regulator and standard connecting)

- IV pole
- Infusion pump preset for infusion based on the desired infusion rate, age of patient, or fluid to be administered
- Antimicrobial agent to cleanse the site (70% alcohol, tincture of iodine, an iodophor or chlorhexidine gluconate)[3,4]
- Tourniquet
- Scissors
- Tegaderm or other nonocclusive dressing and precut ½-inch tape
- 2 × 2-inch gauze or 4 × 4-inch gauze
- Arm board if IV placement requires decreased flexion of a joint to ensure adequate flow
- Biohazard waste and needle container
- Antiseptic ointment

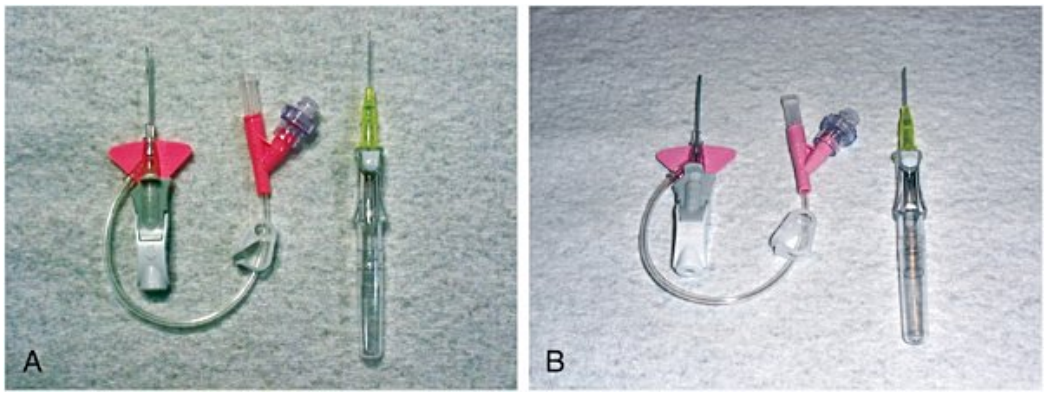

FIGURE 14.3 Over-the-needle catheter with retraction safety device (**A**) and closed needle system (**B**).

Procedure

Insertion of an Intravenous Catheter

1. Apply the tourniquet above the elbow in the upper extremity and the ankle in the lower extremity to ensure adequate vein filling. Do this to both arms and feet (only in pediatric patients) to identify the most suitable vein for IV catheter

placement. Usually the largest, straightest, most peripheral vein that can accommodate the size of the catheter to be started is chosen.

2. Palpate the vein for stability and valves (a compressible, stable vein that is free of valves for 1 inch is ideal).
3. Release tourniquet, double-check and secure all required materials, turn on infusion pump, flush tubing with fluid, and ensure tubing is free of trapped air bubbles.
4. Apply tourniquet snuggly and well proximal to the chosen site (use less pressure for the very old and very young because the skin is thinner and easier to damage).
5. Put on gloves and eye protection.
6. Allow vein to distend to assist the placement of the catheter (tips to facilitate distention: pat the vein gently, place extremity in a gravity-dependent position below the level of the heart, and apply heat).
7. Cleanse the site with approved aseptic cleanser (70% alcohol, tincture of iodine, an iodophor, or chlorhexidine gluconate).[3,4] The site should be cleansed with a back-and-forth motion for a minimum of 30 seconds and then allowed to dry. Do not blow on or fan the site.[3]
8. With the nondominant hand, hold the patient's hand (or foot) securely and use the thumb to gently retract the skin distal to the insertion site toward the fingers. This will secure the vein to reduce venous rolling and hold the skin taut.
9. Puncture the vein using direct or indirect entry (Fig. 14.4):
    - Warn patient of the impending "stick."
    - Direct (one step, used for larger veins): Hold the over-the-needle assembly at 15 to 20 degrees above the site and enter the vein directly.
    - Indirect (two steps, used for smaller veins): hold the assembly 15 to 20 degrees above the site and 20 degrees lateral to the vein, insert the catheter into the skin, and then advance into the vein.

When the vein is punctured, blood should appear in the flash chamber (Fig. 14.5). Once the flash is seen, lower the needle assembly to almost parallel with the skin and thread the catheter appropriately depending on the type of device—either standard over-the-needle or self-shielding.

NOTE: *Standard over-the-needle catheter:* Advance the device 2 to 3 mL more to ensure both the needle and catheter tip are inside the vein and the catheter will not be inadvertently removed when the needle is removed. Hold the needle securely and thread the catheter while maintaining skin traction, remove the needle, and use the retraction device.

Self-shielding device: Advance the entire assembly, thread the catheter while maintaining traction and holding the needle secure, press the retraction button, and remove the assembly.

10. Apply gentle pressure to the vein just proximal to the insertion site to secure the catheter with the nondominant hand, and release the tourniquet (Fig. 14.6).
11. For nonclosed systems, secure the hub to the catheter and start IV fluids (Fig. 14.7). For closed systems, flush with saline as fluid or flush run. Inspect the site for patency. Significant pain or swelling indicates the catheter is not successfully placed and should be removed.
12. If fluid runs free, secure the catheter with Tegaderm or other nonocclusive dressing so the site may be observed for signs of patency and infection. Apply it securely. Tape the tubing securely to the arm and minimize tape-to-skin contact (Fig. 14.8).

NOTE: If IV placement attempt is unsuccessful, never reinsert the needle into the catheter because it may sheer off the tip and lead to an embolus. Never reuse the catheter once it has been removed from the skin; discard and use a new catheter. If the catheter site is painful or swollen when fluid is initiated, discontinue fluid, remove catheter, and attempt again proximal to the unsuccessful site.

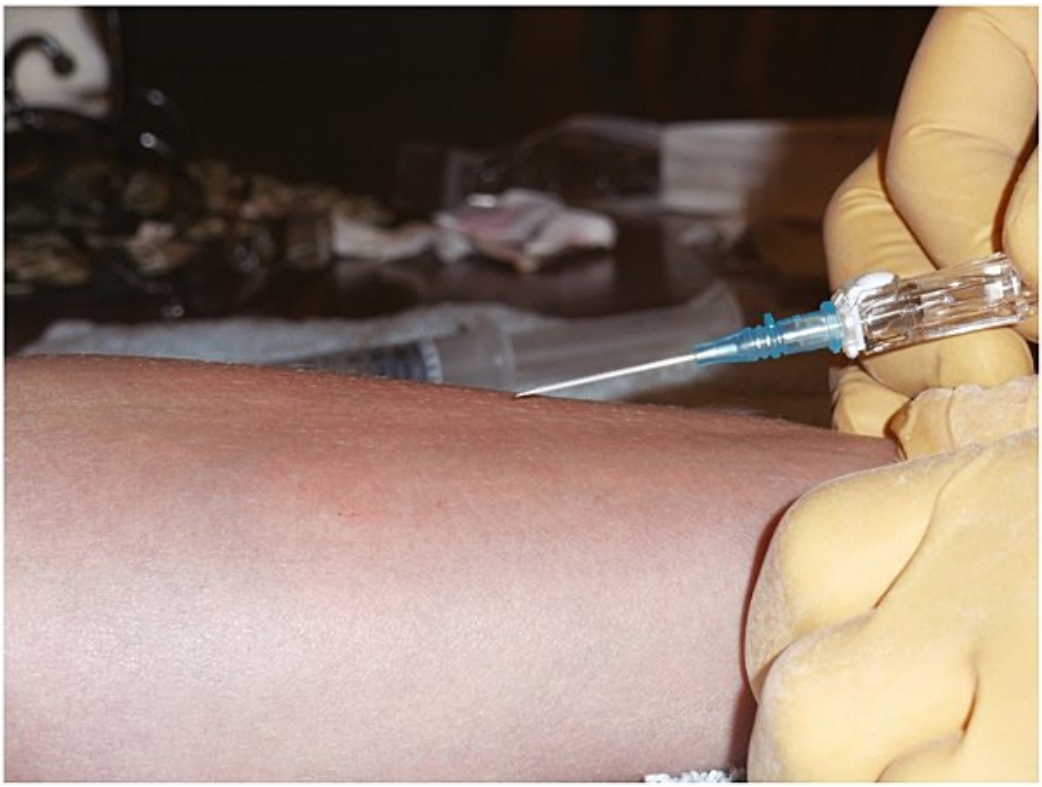

FIGURE 14.4 Puncture the vein using direct (right into vein) or indirect (into skin then vein)

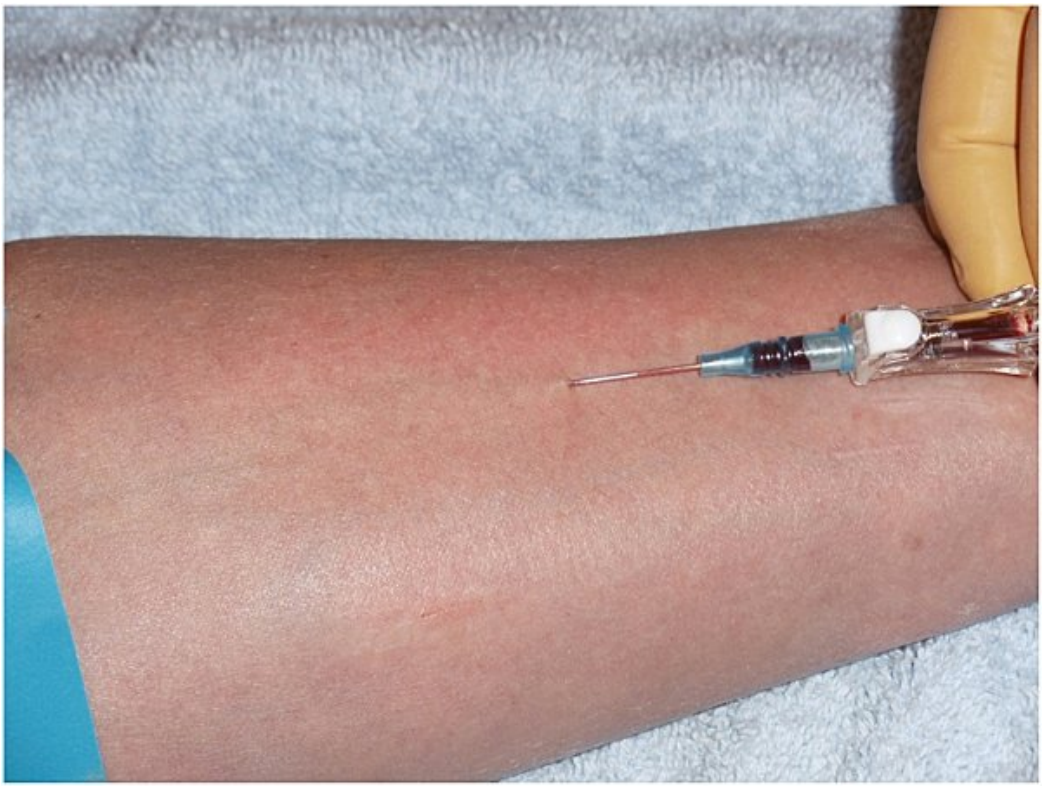

FIGURE 14.5 When the vein is punctured a flash of blood appears in the chamber.

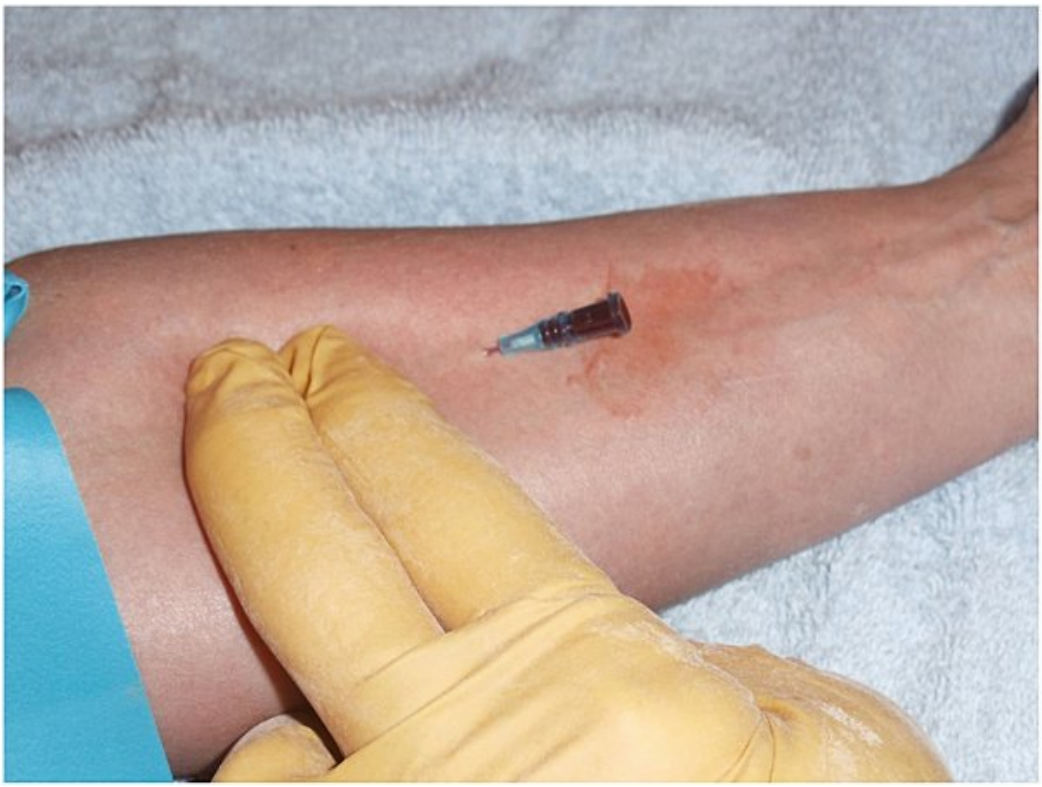

FIGURE 14.6 Gentle pressure with the nondominant hand is applied to catheter to secure while releasing the tourniquet with the dominant hand.

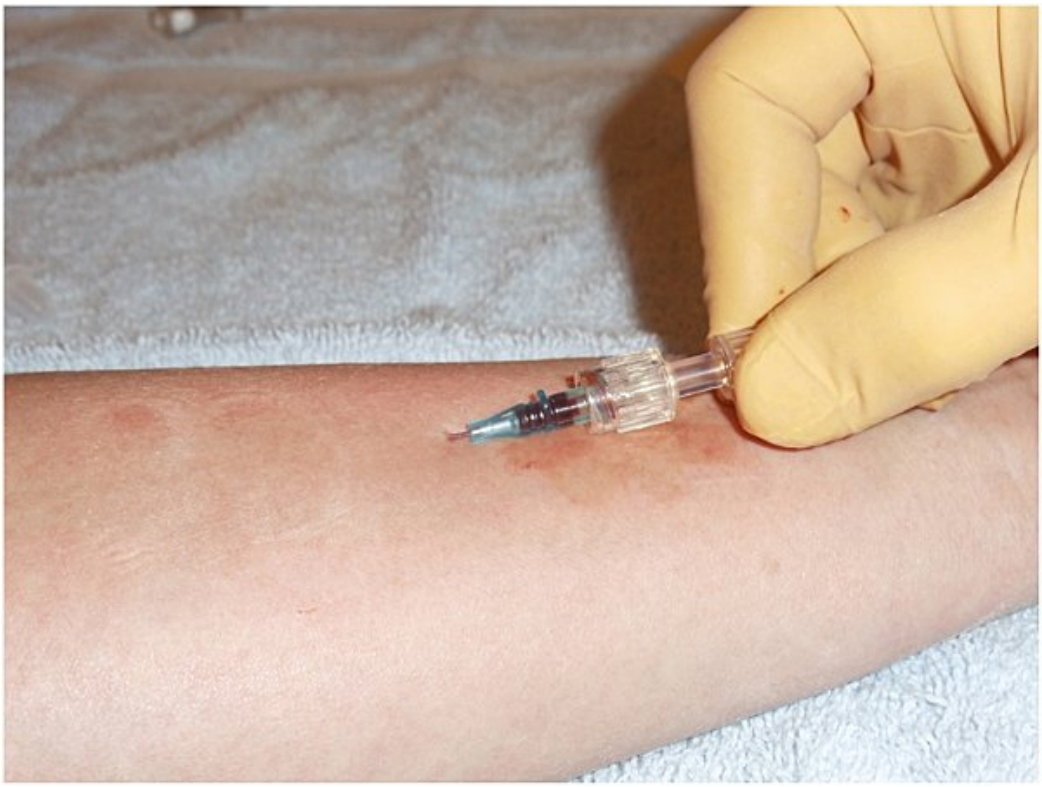

FIGURE 14.7 Secure the hub to the catheter to begin IV fluids/therapy.

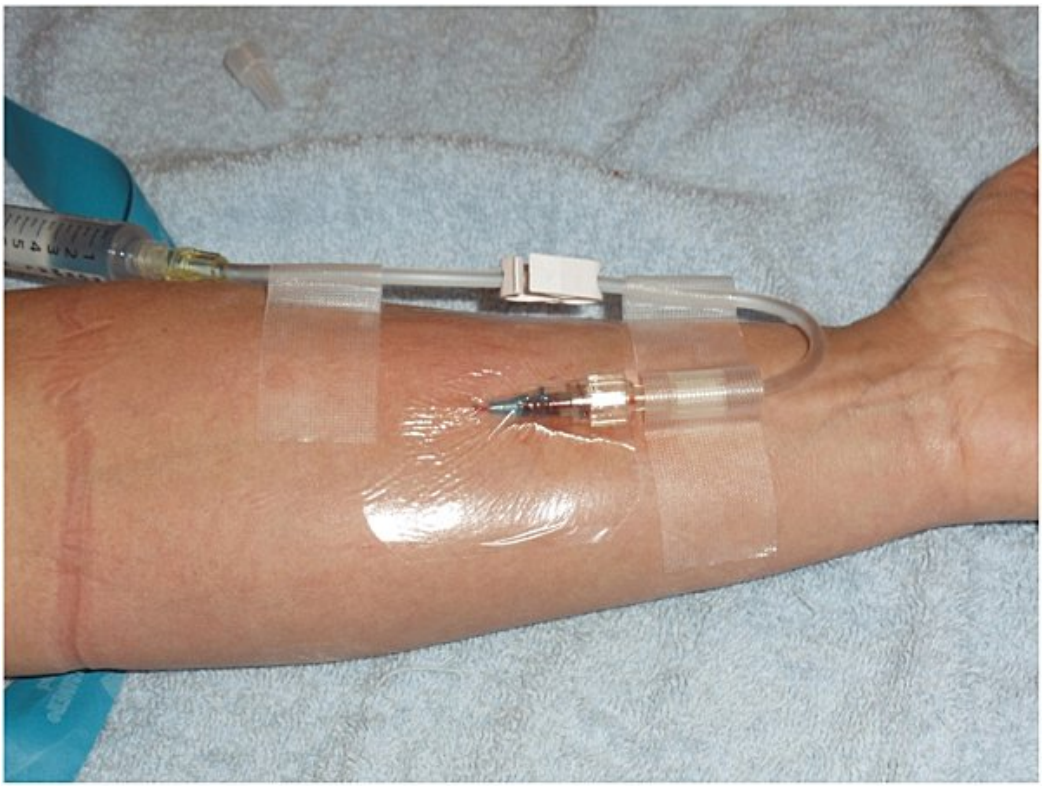

FIGURE 14.8 Tape tubing securely to the arm.

Special Considerations

The **geriatric and pediatric populations** are more likely to have smaller, more fragile veins, and fewer venous options may be present; thus, careful inspection of all options should be done before attempting IV placement. Avoid the lower extremity in the elderly or with any patient who has vascular insufficiency. If blood products are not being given, use a smaller catheter, such as a 24 gauge. In patients younger than 1 year of age, this is the preferred catheter size. In children, securing the line is critical because they tend to be more active and more likely to remove the catheter. No recommendation can be made for the safety or efficacy of chlorhexidine in infants aged less than 2 months of age.[4] In the geriatric population, it may be equally difficult to start an IV in a very large vessel because it may be sclerotic. This makes the vein more difficult to puncture and the catheter more difficult to thread.

Geriatric and pediatric populations are more likely to have fragile, smaller veins, and not as many venous options may be present; thus, careful inspection of all options should be done before attempting IV placement.

Follow-Up Care and Instructions

Instruct the patient on signs of infection, including increased discomfort or pain, redness, or swelling. Have the patient notify the caregiver immediately if any of these occur. The IV site should be changed every 96 hours to reduce the likelihood of infection.[4]

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CHAPTER 15

Joint and Bursal Aspiration

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Mary F. Winegardner

Abstract

This chapter provides guidance on how to perform aspiration of the knee joint and olecranon bursa. Knee joint and olecranon bursa aspiration are commonly performed in the primary care practice setting. Both procedures offer diagnostic and therapeutic benefits. Prior to performing joint and bursal aspiration clinicians, need to be knowledgeable of the respective indications, contraindications and rationale. A thorough understanding of the essential regional anatomy, appropriate patient preparation and procedural steps are vital to maximize the clinical benefit and minimize the risk of complications when aspirating a knee joint or olecranon bursa.

Keywords

joint aspiration
bursal aspiration
knee joint
olecranon bursa
arthrocentesis

Procedure Goals and Objectives

GOAL: To aspirate a knee joint or olecranon bursa properly while observing standard precautions and with the minimal degree of risk to the patient.
OBJECTIVES: The student will be able to:

- Describe the indications, contraindications, and rationale for performing knee joint or olecranon bursa aspiration.
- Identify and describe common complications associated with knee joint or olecranon bursa aspiration.
- Describe the essential anatomy and physiology associated with the performance of a knee joint or olecranon bursa aspiration.
- Identify the materials necessary for performing a knee joint or olecranon bursa aspiration and their proper use.
- Identify the important aspects of postprocedure care after a knee joint or olecranon bursa aspiration.

Background and History

Joint aspiration offers both diagnostic and therapeutic benefits when managing joint effusion or inflammation.

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Diagnostically, aspiration permits acquisition of synovial fluid or bursal fluid for analysis. Therapeutically, joint aspiration in the face of painful effusion decreases the patient's discomfort, restores range of motion, and may facilitate a more accurate joint examination. Aspiration of bursal distention relieves discomfort and restriction of motion and decreases the risk for chronicity, spontaneous drainage, or infection within the stagnant bursal fluid.[1,2] The aspiration techniques can be used for the administration of intraarticular or intrabursal medications.

Despite the benefits, joint and bursa aspirations are invasive procedures with the potential for infection if not performed under strict sterile conditions. Both procedures always necessitate careful sterile preparation and sterile technique.

Each joint has specific anatomic landmarks by which the joint space is outlined and the needle can be placed for aspiration. Likewise, specific anatomic landmarks guide needle placement for bursa aspiration. In addition to reliance on anatomic landmarks, musculoskeletal ultrasound increasingly is used to guide needle placement.[2,3] The general steps in a joint aspiration procedure and bursa aspiration procedure are the same, regardless whether the joint or the bursa. For the purposes of this chapter, knee joint aspiration and olecranon bursa aspiration are described.

Both traumatic and rheumatic processes affect the knee joint, although relatively more aspirations are performed at the knee for traumatic effusion than at other joints, where inflammation and effusion are more likely to be rheumatic.

Indications

Joint aspiration is indicated in the following situations:

- When there is a painful effusion of a joint, a monoarticular inflammation of a joint, or suspicion of a systemic rheumatic disorder of uncertain cause. In the mature patient, trauma can result in painful joint effusion, which can be remedied easily by joint aspiration.[4]

- In the case of articular inflammation of unknown cause, the synovial fluid analysis—including viscosity, crystal examination, cell count, bacterial culture, Gram stain, and polymerase chain reaction studies—may be the most accurate diagnostic tool.[1,2]

Bursal aspiration is indicated in the following situations:

- When painful bursal swelling persists despite conservative treatment or when questions arise about its cause.
- When olecranon bursitis is aggravated by or interferes with normal activities.

Contraindications

The following contraindications should be taken into consideration:

- Joint aspiration is contraindicated when circumstances exist in which entering the joint facilitates the seeding of bacteria into the joint. Introduction of a needle into the joint space through burns, infected skin, or infected subcutaneous tissue is contraindicated. Aspiration increases the risk for introducing bacteria into the joint in the presence of overlying soft-tissue cellulitis or impetigo; joint aspiration should not be performed in these situations.
- Aspiration of a bursa is likewise contraindicated when risks exist for introducing bacteria outweigh the benefits of aspiration.
- Joint aspiration by the generalist is contraindicated after total joint arthroplasty except under the supervision of an orthopedic specialist. If **effusion or inflammation** occurs any time after joint replacement, the patient must be returned to the care of an orthopedist.

If effusion or inflammation occurs at any time after joint replacement, the patient must be returned to the care of an orthopedist for joint aspirations.

- In the rare circumstance in which aspiration of a hemarthrosis is undertaken in a patient with hemophilia, the hemarthrosis will reaccumulate if bleeding has not been controlled before the procedure. Similarly, aspiration is relatively contraindicated in the patient who has undergone anticoagulation and has an International Normalized Ratio (INR) greater than 2.5.[2]

Potential Complications

Joint Aspiration

The following complications may occur in joint aspiration:

- The most common complications of joint aspiration include bleeding, infection, pain, intraarticular injury, and reaccumulation of fluid. When providing patients with adequate information for informed consent, these complications should be outlined.
- Inadvertent injury to vascular or neural structures near joint spaces can occur, as can a scoring injury of the intraarticular joint surface from the needle. An awareness of the proximity of nerves, arteries, and veins is necessary, as is caution when introducing a needle or infiltrating medications. As with any injection procedure, drawing back on the syringe plunger before administering medication is recommended to confirm that the needle is not within the lumen of a blood vessel.
- Careful history-taking concerning topical and systemic allergic reactions, with specific focus on iodine and anesthetic drug sensitivities, further minimizes complications associated with the procedure. With any parenterally administered medication, prompt access must be available to epinephrine (1:1000) for subcutaneous administration, and resuscitation equipment must be nearby in the event of a severe adverse reaction. Using a minimal volume of anesthetic is reasonable, and some authors

recommend injecting no more than 5 mL of anesthetic solution (e.g., 1% lidocaine) within 30 minutes.[5] When adequately anesthetizing the needle track for a joint aspiration, it is not difficult to exceed 5 mL of administered anesthetic. By respecting the landmarks and anatomy unique to each joint, complications associated with an aspiration procedure can be minimized.

Bursal Aspiration

The following complications may occur in bursal aspiration:

- The **most common complications** of bursal aspiration are infection, pain, chronic recurrence, chronic drainage via a sinus tract, and acute recurrent swelling. Bursal communication with joint space is important to remember as part of a potential complication. Baker's cysts, or popliteal bursae, are herniations of the joint capsule. Communication between the olecranon bursa and elbow joint may develop in rheumatoid arthritis.

The most common complications of bursal aspiration are infection, pain, chronic recurrence, chronic drainage via a sinus tract, and acute recurrent swelling.

- When aspirating the olecranon bursa, a lateral aspiration approach is recommended to prevent subsequent development of a chronic sinus tract that can result from introducing a needle directly into the tip of the elbow bursa.[5] Despite the best technique, recurrence of olecranon bursitis with chronic painful inflammatory changes may necessitate definitive orthopedic resection of the bursa.[2,6]

Essential Anatomy and Pathophysiology: Joint Aspiration

Pathophysiology

The knee is a diarthrodial joint with a synovial lining containing secretory cells and a fine capillary system from which synovial fluid is derived. Plasma transudation and mucin production within the joint combine to give synovial fluid its viscous, lubricating quality that reduces joint surface friction. Synovial fluid diffusion is an important factor in providing nutrition to the intraarticular structures.[7] Noninfectious effusions do not generally develop in fibrocartilaginous joints, such as the sacroiliac joint, because of the absence of synovial lining, but effusions do develop within bursae, which are cavities lined with secretory cells that function much like synovial cells.[7]

When **trauma, inflammation, or infection** occur within the joint, the synovial fluid is characteristically altered, and sampling of the synovial fluid can be diagnostic.

When trauma, inflammation, or infection occurs within the joint, the synovial fluid is characteristically altered, and sampling of the synovial fluid can aid in the diagnostic process.

In the case of an inflammatory reaction, the synovium produces increased synovial volume as a response to mechanical trauma or crystalline precipitants within the joint. **Traumatically induced bleeding** within the synovial fluid directly damages the synovial cartilage through the release of destructive proteolytic enzymes from blood cells. Hemarthrosis management should include aspiration to eliminate biochemical injury to the joint in addition to decreasing discomfort from mechanical distention.

Traumatically induced bleeding within the synovial fluid directly damages the synovial cartilage through the release of destructive proteolytic enzymes from blood cells. Hemarthrosis management should include aspiration to eliminate biochemical injury to the joint in addition to decreasing discomfort from mechanical distention.

Aspiration of a bloody synovial effusion is best attempted within the first couple of days after swelling develops. The clotting process makes aspiration nearly impossible between 3 and 7 days after injury, but aspiration becomes possible again 7 days after injury because of the breakdown of intraarticular clot. However, some cartilaginous damage is likely to have occurred by the time liquefaction of the intraarticular clot is noted.

The synovial surface also can be transformed by chronic inflammatory changes that lead to proliferative changes on the synovial surface.[5] This tissue proliferation can make aspiration techniques difficult or ineffective when the proliferative tissues obstruct the intraarticular needle and prevent aspiration of the joint fluid. Proper placement of the needle can reduce the likelihood of obstruction by avoiding areas commonly affected by synovial proliferation (Fig. 15.1).

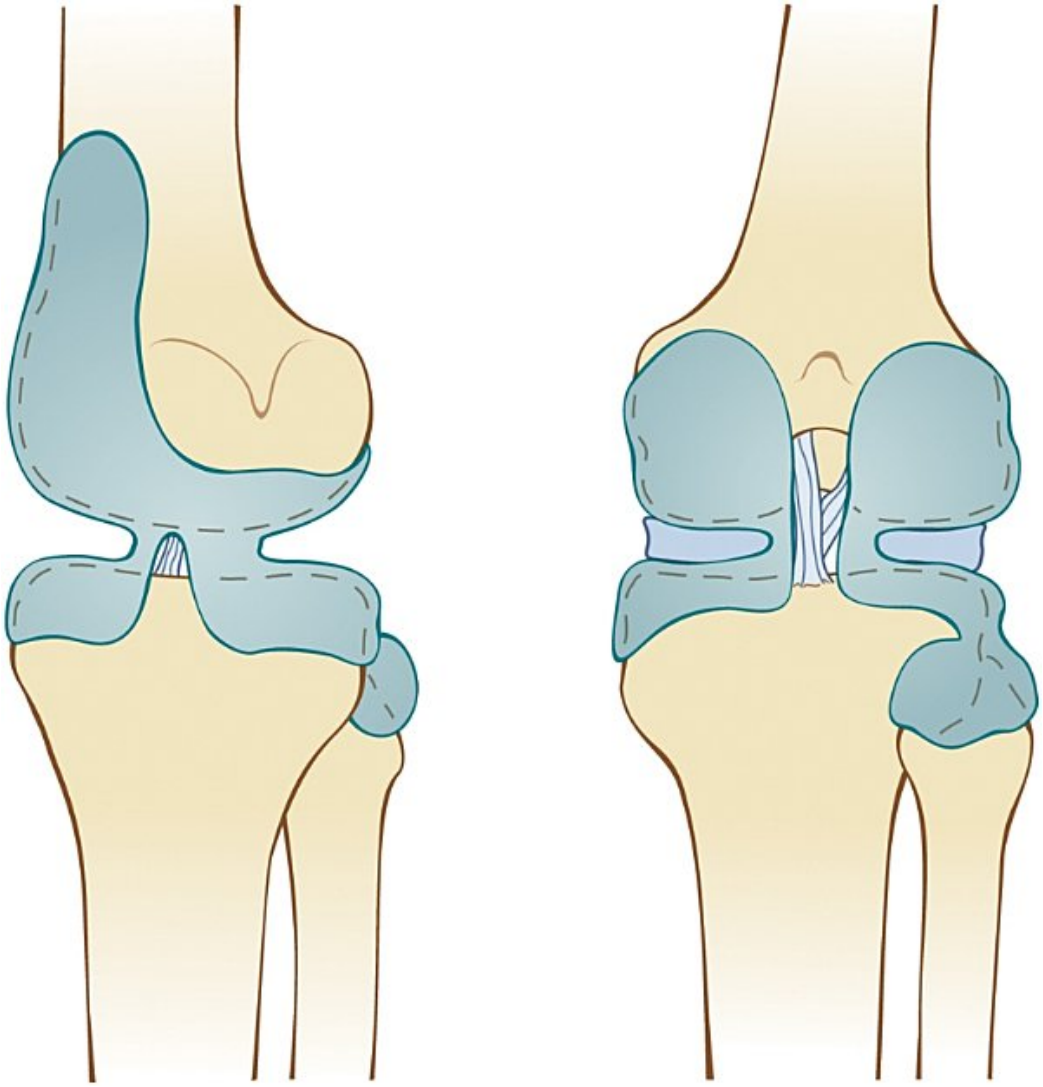


FIGURE 15.1 **Synovial surfaces of the knee joint.**

Anatomy and Pathomechanics

The knee joint is formed between the distal femur and proximal tibia, with the synovium covering the femur in a saddle configuration and reflecting anteriorly and superiorly on the femur behind the patella and draping inferiorly and posteriorly on the caudad surface of the femur, medially and inferiorly over the lateral surfaces of the cruciate ligaments, and down to the tibial articular surfaces. A small synovial draping also occurs over the proximal fibula. The pommel of the synovial saddle lies on the anterior distal

femur behind the patella, reflecting at the upper margin anteriorly toward the patella. The space medially between the femoral condyles and behind the patella generally permits better synovial aspiration because the probability of encountering synovial proliferation or abutting a bony surface is less, particularly when the knee is extended (Fig. 15.2). A significant volume of joint effusion can collect within the knee joint. When assembling equipment for a therapeutic knee aspiration, it is important to recognize that there may be a significant volume of fluid to be aspirated and to plan accordingly.

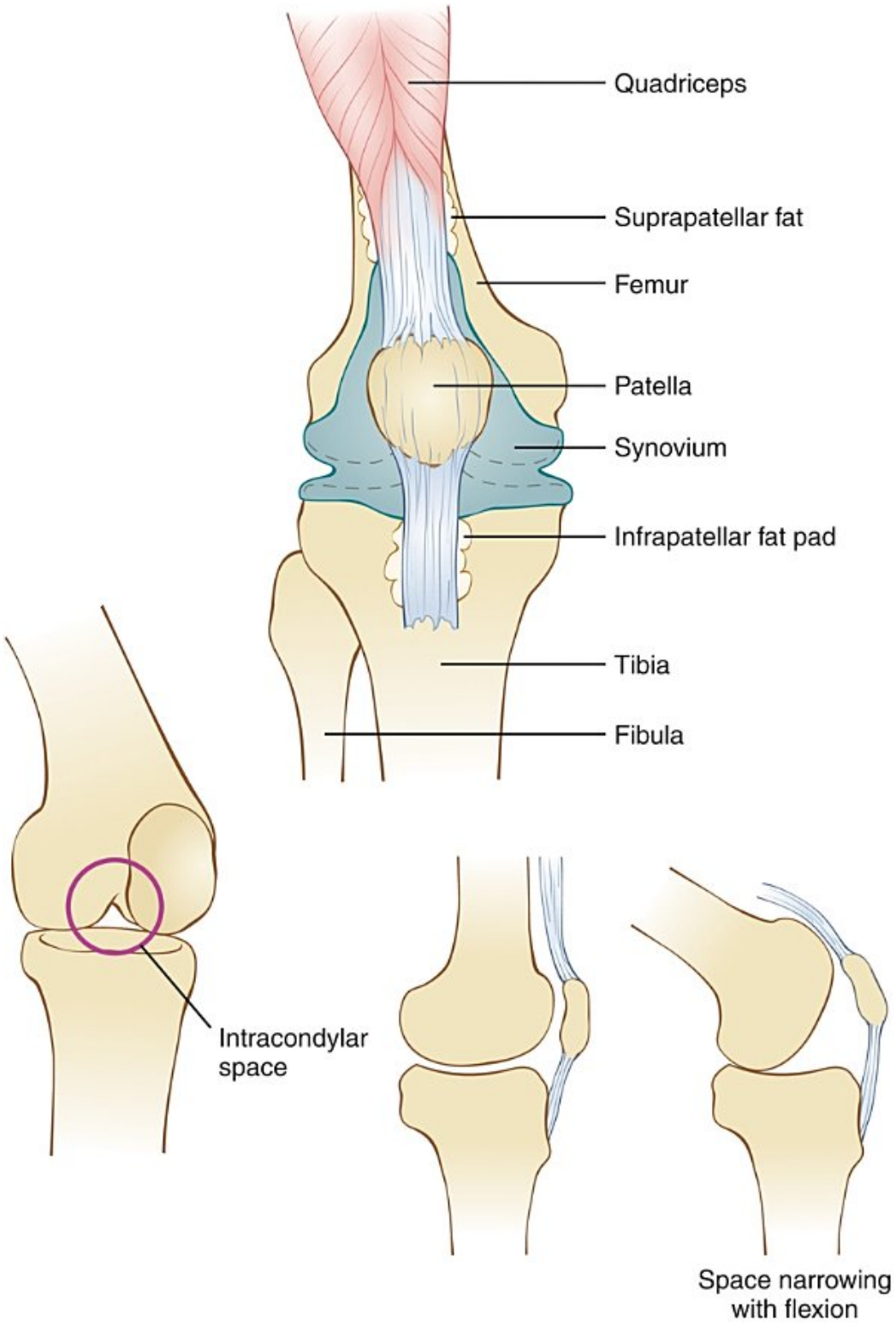


FIGURE 15.2 **Anatomy of the knee joint.**

Standard precautions

Every practitioner should use standard precautions at all times when interacting with patients, especially when performing procedures. Determining the level of precaution necessary requires the practitioner to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

Patient Preparation: Joint Aspiration

The following should be considered in preparing the patient for joint aspiration:

- Informed consent is appropriate for any invasive procedure. Whether using a formal written consent form or simply documenting the risks and benefits discussed, patients should be apprised of the risks for infection, bleeding, adverse reactions to anesthesia, intraarticular injury, pain, and reaccumulation of fluid.[4]
- For some patients whose effusion has stabilized the knee, the removal of the fluid may uncover previously unnoticed knee instability. It is helpful to prepare patients for this by discussing the possibility before aspirating the joint.
- Let patients know that additional management after aspiration may include immobilization of the joint, antibiotic or antiinflammatory therapy, hospitalization, or referral to a specialist, depending on the findings on aspiration.
- Inform the patient that the procedure takes approximately 5 to 10 minutes after a 10-minute scrub of the joint area to ensure asepsis.
- Patients must be reminded that once the preparation has begun, it is essential that the patient refrain from touching, pointing, or reaching over the area being prepared. Patients do well with this when told not to touch anywhere within the "covered area," when drapes are used, or where the "soap" was applied until the procedure is completed.

- Patients should be prepared for a brief episode of stinging discomfort when the lidocaine anesthetic is administered subcutaneously. The "bee-sting" sensation lasts less than 30 seconds for most patients.
- Considering overall safety for the patient and the position for optimal access of the effusion, it is preferable to have the patient in a supine position with the knee extended as much as the effusion permits. Knee flexion allows the patella to ride more closely to the femur, narrowing the retropatellar space. The widest patellofemoral space is afforded by placing the knee at the fullest extension allowable. Because the tension on the anterior cruciate ligament is greatest when the knee is in full extension or deep flexion, the patient may prefer to maintain a 30- to 70-degree flexion to maintain laxity of the anterior cruciate ligament and allow for comfort. Likewise, effusive distention of the joint may prevent full extension.

Materials Used for Performing Joint and Bursal Aspiration

- Tray table
- Sterile drapes
- Sterile gloves
- Povidone-iodine solution (or other topical antiseptic if iodine allergic)
- 1% lidocaine (unless contraindicated by allergy)
- Sterile 1-inch, 25-gauge needles; sterile 1½-inch, 18-gauge needles
- Three sterile 20- or 30-mL syringes, sterile 5- or 10-mL syringe
- Sterile hemostat
- Sterile cup
- Green-top sodium heparin tube or other Vacutainer tubes as indicated (Table 15.1)

Table 15.1

Synovial Fluid Testing

Test	Collection Tube/Container	Amount of Fluid Needed	Special Considerations*
Crystals	Red- or green-top tube (sodium heparin)	0.5 mL	Caution with other tubes containing EDTA—may be mistaken for joint fluid crystals
RA latex	Red-top tube	0.5 mL min	
Total protein	Red-top tube	0.5 mL min	
Glucose	Red- or gray-top* (sodium heparin)	0.5 mL min	
Mucin clot	Red-top tube	0.5 mL min	
Cell count	Purple-top tube (EDTA)	1.0 mL min	
Routine culture	Sterile syringe* Yellow top (ACD)*	0.5 mL min	Send to laboratory in syringe
Gram stain	Sterile syringe* Yellow top (ACD)*	0.5 mL min	Send to laboratory in syringe

Test	Collection Tube/Container	Amount of Fluid Needed	Special Considerations*
TB culture syringe	Sterile syringe* Yellow top (ACD)*	0.5 mL min	Send to laboratory in syringe
Fungal culture	Sterile syringe* Yellow top (ACD)*	0.5 mL min	Send to laboratory in syringe

ACD, Anticoagulant citrate dextrose; *EDTA,* ethylenediaminetetraacetic acid; *min,* minimum; *RA,* rheumatoid arthritis; *TB,* tuberculosis.

* Individual microbiology and chemistry laboratories may have specific criteria for tests; confirm the laboratory's preference for the tests you are running.

Procedure

Performing Joint Aspiration

1. Determine the position that will allow the patient to be most comfortable and the effusion to be most easily accessed.
2. Perform a 10-minute scrub of the knee with povidone-iodine solution. The preparation must encircle the knee and extend 2 to 3 inches above and below the knee.
3. Draping of the knee is not essential, but it reduces the risk for infection. If performed, the draping should allow adequate visualization of the joint space for the ballottement of fluid and determination of landmarks.
4. Prepare a sterile field on which to assemble all needed sterile equipment, including syringes, needles, hemostat, and sterile cup.
5. Once the materials are prepared, don sterile gloves, drape if desired, and define the superior pole of the patella. Identify

the joint spaces lateral to the patella by ballottement of fluid beneath the patella (Fig. 15.3).

6. Draw up 3 to 5 mL 1% lidocaine in a 5- or 10-mL syringe. Place the 25-gauge needle on the syringe.
7. Identify the landmarks to determine the location for needle placement.

NOTE: The needle may be introduced into the joint space either anteromedially or anterolaterally.

8. Draw a visual line along either lateral margin of the patella to intersect with the line of the superior patellar margin (Fig. 15.4) and, entering the skin at that point, or slightly more laterally and superiorly, and administer a small amount of the anesthetic subcutaneously. Angle 45 degrees off the sagittal plane and 30 degrees off the frontal plane, directing the needle caudally (Fig. 15.5).
9. Advance the needle as deep as anesthesia is desired, aspirating for blood prior to injection.

NOTE: When advancing to the joint capsule, resistance is encountered at the level of the joint capsule.

10. While withdrawing the needle, administer the anesthetic along the track from the joint capsule out to the skin.
11. Remove the smaller-gauge needle and syringe and assemble the 18-gauge needle on a 20- or 30-mL syringe. Hold the needle–syringe like a pencil and align to advance medially and caudally into the joint space behind the patella.
12. Introduce the 18-gauge needle into the anesthetized track angled 45 degrees laterally and directed 30 degrees caudally. Place gentle pressure on the syringe plunger while advancing and aspirate the synovial fluid on entering the joint space as the needle is directed medially and downward behind the patella (Fig. 15.5).

NOTE: Entering the joint space is briefly painful for the patient.

13. When the syringe is full, place the hemostat on the needle hub, remove the syringe, and replace it with an empty syringe or discharge the synovial fluid into a sterile cup. Repeat this step until the knee joint is no longer visibly distended or fluid can no longer be aspirated.

NOTE: Pressure applied above the knee joint can "milk" additional fluid centrally for aspiration. Caution must be exercised not to compromise sterile conditions.

14. Intraarticular medication can be administered after the aspiration, if indicated.
15. Withdraw the needle from the joint space and apply direct pressure with sterile dressing over the puncture site for several minutes.
16. Confirm that the wound site is dry and active bleeding has stopped, then dress with sterile adhesive dressing.
17. Maintaining sterile conditions, observe the synovial fluid for evidence of a cloudy appearance and obtain Gram stain, cell counts, and cultures if infection is suspected.

NOTE: Gram stain and cultures are usually collected in sterile syringes and transported promptly to the laboratory. Rapid transport and inoculation on special medium are essential for growth of fastidious bacteria such as *Neisseria gonorrhoeae.* Specimens sent for crystal analysis should not be drawn into an ethylenediaminetetraacetic acid (EDTA) tube, because the EDTA crystals can be confused with intraarticular crystals. See Table 15.1 for guidelines on acquiring samples for the laboratory.

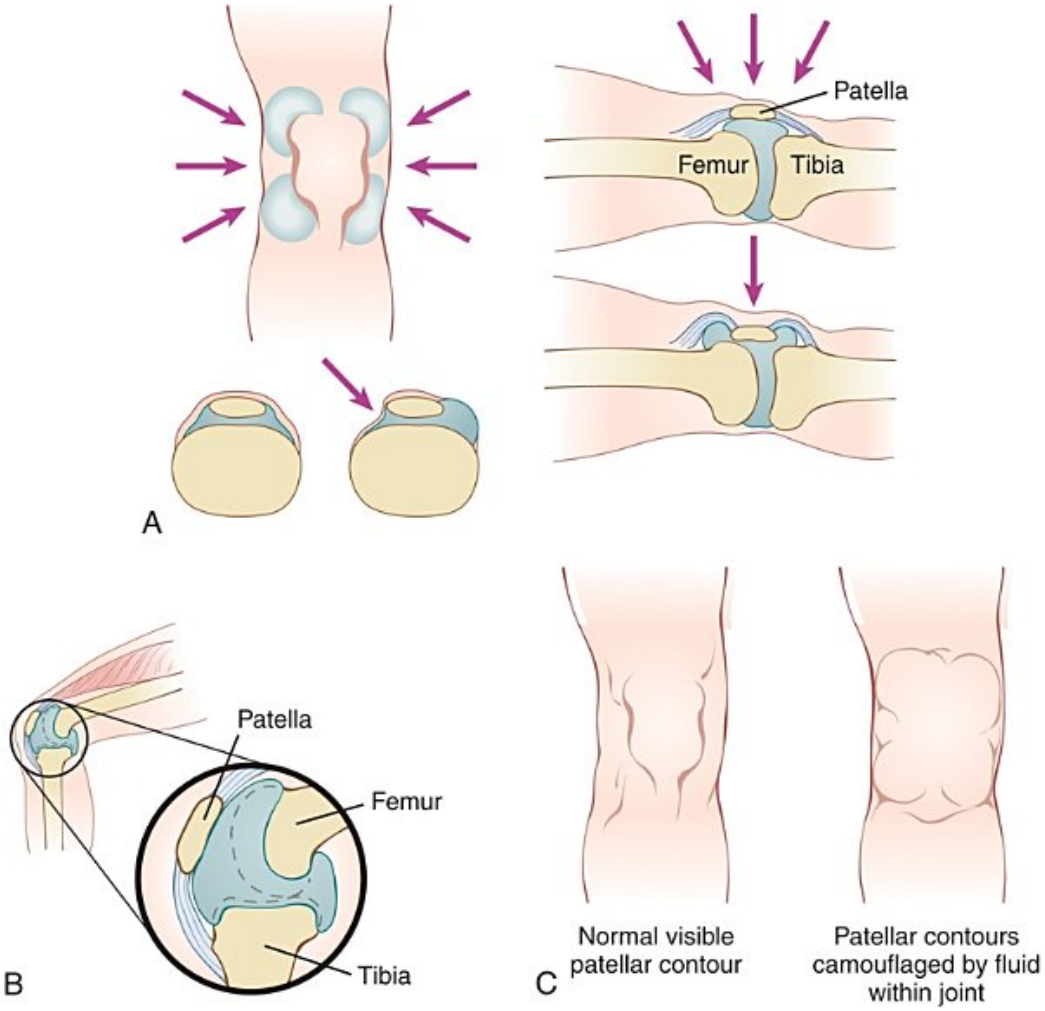


FIGURE 15.3 **Effusion distribution and ballottement.**

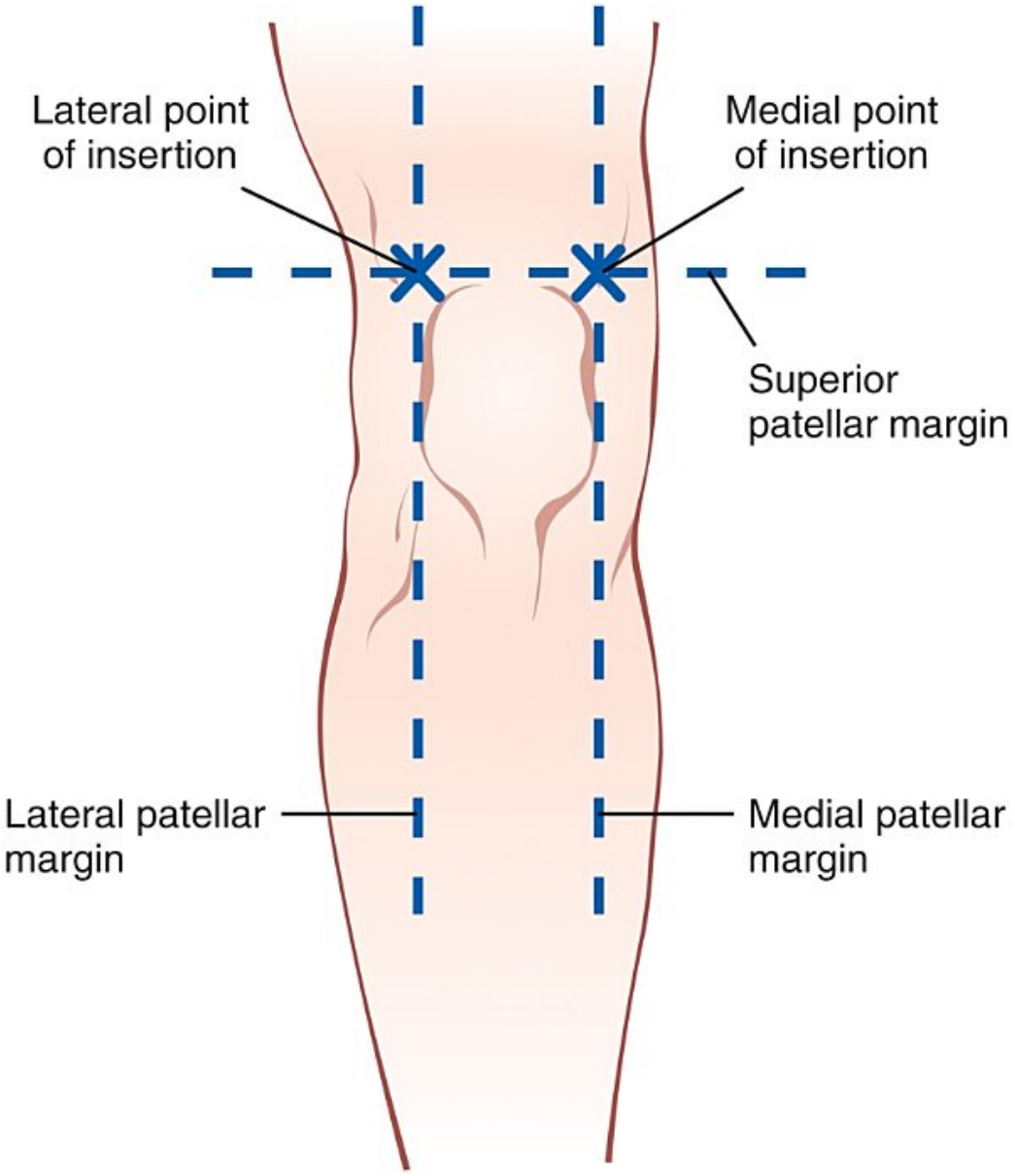


FIGURE 15.4 **Landmarks for needle placement.**

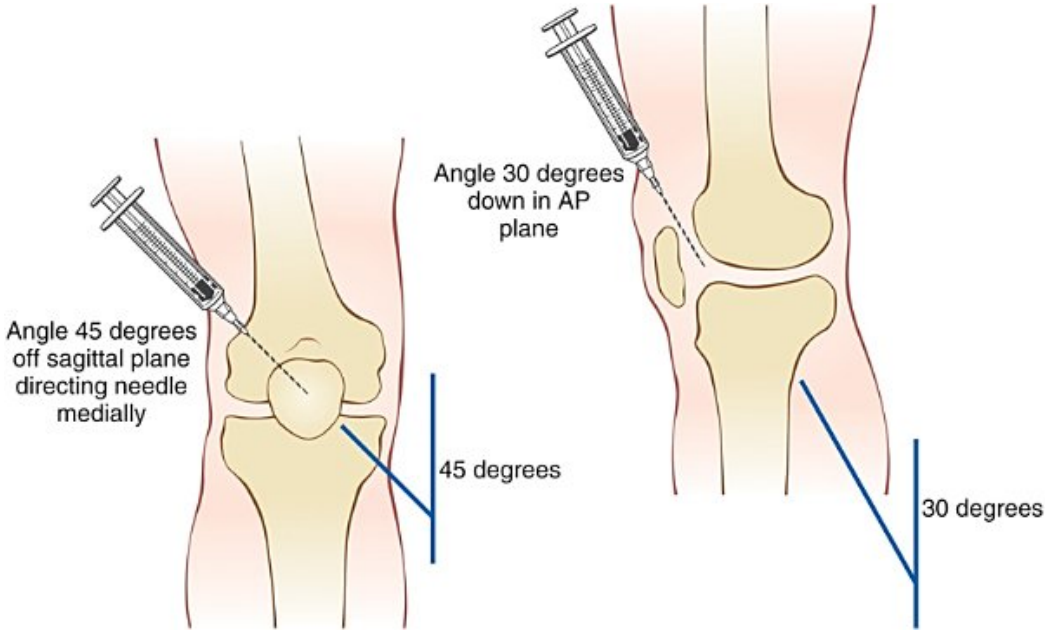


FIGURE 15.5 Positioning the needle for joint aspiration.
AP, Anteroposterior.

Follow-Up Care and Instructions: Joint Aspiration

The following should be taken into consideration in patient follow-up and instructions after joint aspiration:

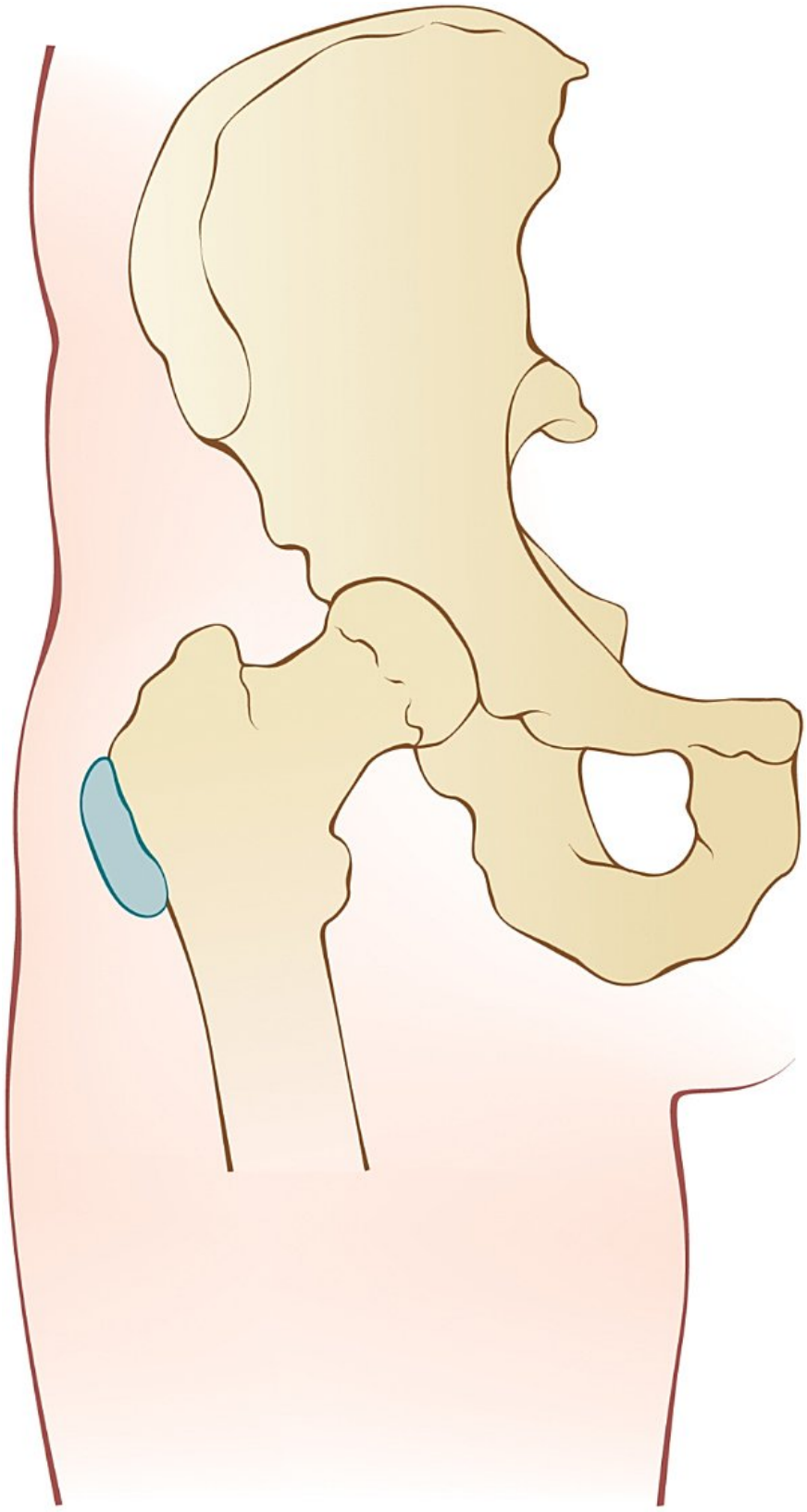
- Advise patients to avoid the use of the joint for at least 1 day. If traumatic injury preceded the effusion, immobilization and/or avoidance of weight bearing may be indicated. When aspiration eliminates internal splinting, the instability of the joint may become apparent and should be managed as would otherwise be indicated.
- Instruct the patient to call the office in the event of sudden reaccumulation of fluid, increased heat at the joint, fever, chills, or a severe increase in pain, which would necessitate the patient's prompt return for further evaluation.
- Evidence or strong suspicion of infection at the time of aspirating necessitates emergent treatment or immediate referral.

Essential Anatomy and Physiology: Bursal Aspiration

Numerous bursae are found around the joints, many of which may accumulate excessive fluid as part of an inflammatory process. The olecranon bursa is one that can become visibly distended because of inflammation. This easily accessible bursa may swell slowly over time or accumulate excess fluid suddenly from trauma or infection. Because of the relatively exposed and superficial anatomy of the bursa, external mechanical irritation plays a significant role in the initiation and perpetuation of olecranon bursitis. Other differential considerations include ulnar fracture, gout, acute rheumatoid arthritis, or a synovial cyst of the elbow joint.[6]

Intrabursal scar tissue, which feels like small nodules within the bursa, can develop rather early as a sequela to olecranon bursitis. These "nodules" may result in chronic pain and tenderness when the elbow is mechanically aggravated.

The general approach to aspirating an olecranon bursitis can be applied to other bursae. Few others have such easily accessible anatomy. Some, such as the trochanteric bursae, are difficult to isolate anatomically because of overlying structures (Fig. 15.6). Others, such as the prepatellar bursae, are nearly as accessible as the olecranon bursae (Fig. 15.7).



Trochanteric bursa

FIGURE 15.6 **Trochanteric bursae are difficult to isolate because of overlying structures.**

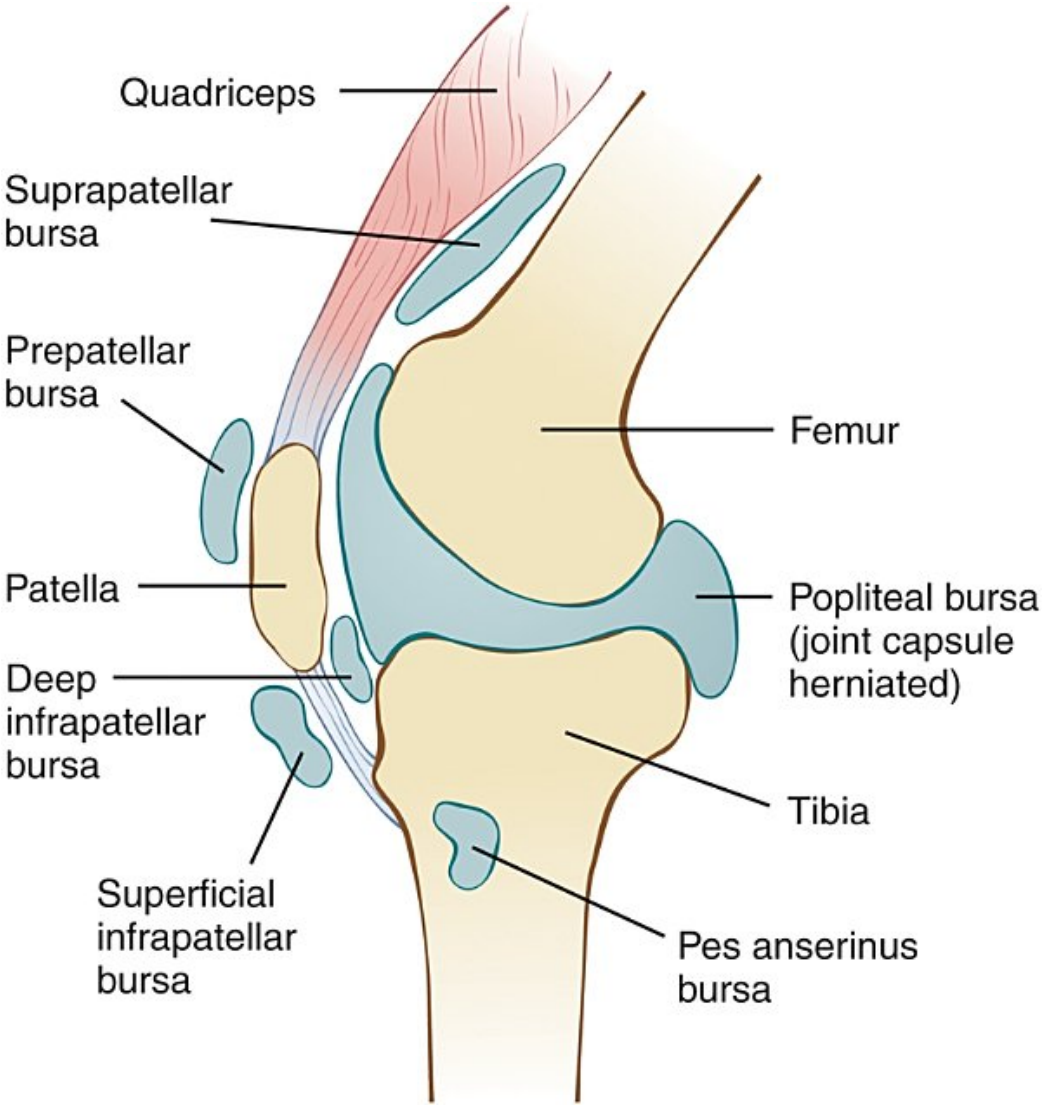


FIGURE 15.7 **Knee bursae.**

Patient Preparation: Bursal Aspiration

The following should be considered in preparing the patient for bursal aspiration:

- Apprise the patient of the risks for infection, bleeding, adverse reactions to anesthesia, pain, and reaccumulation of fluid.
- Let the patient know that additional management after aspiration includes resting and protecting the elbow, antibiotic or antiinflammatory therapy if indicated, or hospitalization or referral to a specialist, depending on the findings.
- Inform the patient that the procedure takes approximately 5 to 10 minutes after a 10-minute scrub of the joint area to ensure asepsis. Patients must be reminded that once the preparation has begun, it is essential that the patient refrain from touching, pointing, or reaching over the area being prepared.
- Warn the patient to be prepared for a brief episode of stinging discomfort when the lidocaine is administered subcutaneously. The "bee-sting" sensation lasts less than 30 seconds for most patients.

Procedure

Performing Bursal Aspiration

1. Have the patient sit well supported or prone for the procedure. If the patient is sitting, the arm must be supported on a Mayo stand flexed at the elbow to 90 degrees. If the patient is prone, have the patient rest the arm on the examination table with the elbow flexed and the shoulder comfortably abducted to allow access to the lateral olecranon bursa.
2. Prepare a sterile field on which to assemble all needed sterile equipment, including syringes, needles, hemostat, and sterile cup.
3. Perform a 10-minute scrub with povidone-iodine solution, covering the entire olecranon process and the lateral elbow surface.

4. Once the patient is prepared, don sterile gloves and drape the area so that the bursa is easily accessible but sterility is maintained.
5. Draw up 1 mL of 1% lidocaine in a syringe. Identify the landmarks to determine the location for needle placement.

NOTE: The olecranon bursa is usually readily visible and distended beyond the typical elbow contour. Anesthesia to the skin and subcutaneous tissues may be administered as desired using a 25- to 27-gauge needle.

6. Administer the anesthetic under the skin of the elbow, centering the needle over the lateral surface of the distended bursa (Fig. 15.8).
7. With the elbow flexed to 90 degrees and resting comfortably, switch to an 18-gauge needle and syringe. Enter into the distended olecranon bursa at 90 degrees to the plane of the arm. Aspirate the fluid slowly until the bursal sac is flat.
8. Apply direct pressure over the puncture site. Dress with an adhesive bandage and wrap the elbow with an elastic compression bandage to retard a reaccumulation of fluid.
9. Observe the bursal fluid for evidence of a cloudy appearance and perform Gram stain and cell counts and obtain cultures if infection is suspected. Tests for crystals or other rheumatoid parameters should be performed as described in the procedure for joint aspiration (see Table 15.1).

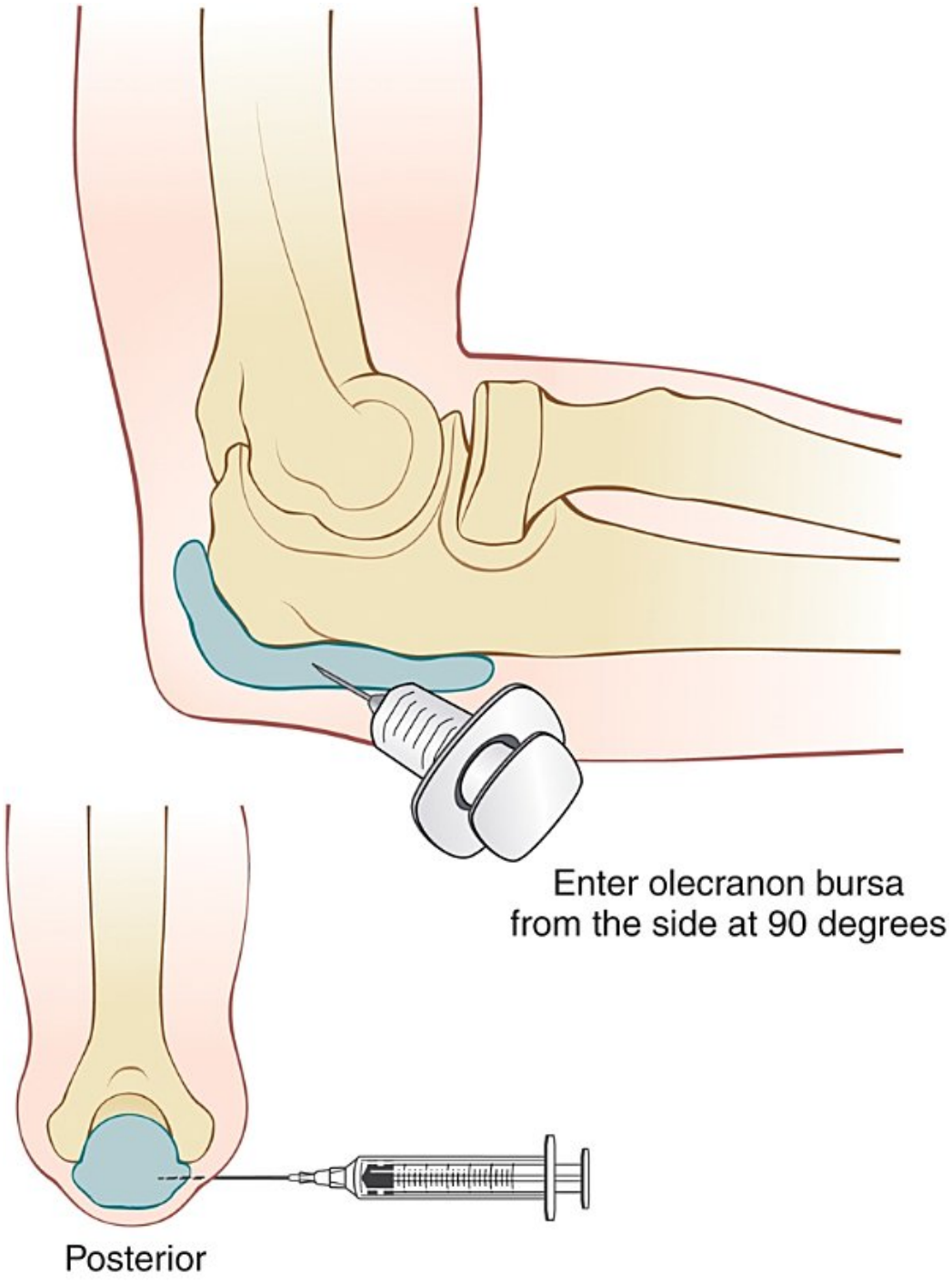


FIGURE 15.8 **Positioning the needle for bursal aspiration.**

Follow-Up Care and Instructions: Bursal Aspiration

The following should be taken into consideration in patient follow-up and instructions after bursal aspiration:

- Advise the patient to avoid general use of the joint for at least 2 days. Recurrence of bursal effusion is more likely with persistent mechanical irritation of the bursa. Avoiding resting the elbow on tables, automobile arm rests, and chair arms decreases irritation. For some patients, these activities are so habitual that the elbow is inevitably chronically irritated, and an elbow protector may be indicated. Another option is the placement of a posterior plaster splint after aspiration to limit elbow motion for the first week after the procedure. For those who go on to develop chronic bursitis, surgical excision may become necessary.
- Instruct the patient to call the office in the event of the development of a warm elbow, fever, chills, or severe increase in pain, which would necessitate prompt return for further evaluation.[6] Recurrence of olecranon bursitis more than three times probably indicates a need for surgical bursal excision, as does the development of a draining sinus tract.

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CHAPTER 16

Local Anesthesia

Michelle DiBaise

Abstract

Proper administration of local anesthesia requires knowledge of the essential anatomy and physiology of the area to be anesthetized; the indications, contraindications, and rationale for administering local anesthesia; and the common complications associated with administering local anesthesia. This chapter contains information on the important aspects necessary for successful administration of topical anesthesia, local anesthetic infiltration, including digital and field blocks, and the observation of standard precautions. A list of commonly used local anesthetics will be reviewed, including the addition of epinephrine and buffering with sodium bicarbonate. Tips for decreasing patient anxiety during local infiltration will be provided in addition to follow-up care of the patient.

Keywords

digital block
epinephrine
field block
lidocaine
local anesthesia
topical anesthesia

Procedure Goals and Objectives

GOAL: To perform local anesthesia successfully while observing standard precautions and with the minimal degree of risk to the patient.
OBJECTIVES: The student will be able to:

- Describe the essential anatomy and physiology associated with administering local anesthesia.
- List the indications, contraindications, and rationale for administering local anesthesia.
- Determine and describe common complications associated with administering local anesthesia.
- Identify the materials necessary for the administration of local anesthesia and their proper use.
- Define the important aspects of care after administration of local anesthesia.

Background and History

Local anesthesia provides reversible blockade of nerves, leading to loss of pain sensation. Topical application and direct infiltration anesthetize the immediate area. Regional blocks are designed to anesthetize larger areas via a nerve or field block. Local anesthesia is used for a variety of reasons, including elimination of pain as a therapeutic modality or performing procedures such as repair of lacerations, skin surgery, treatment of painful oral or genital lesions, and removal of superficial lesions by chemical or physical means.

Local anesthesia is used to eliminate pain as a therapeutic modality or for repair of lacerations, skin surgery, treatment of painful oral or genital lesions, and removal of superficial lesions by chemical or physical means.

Nearly painless anesthesia may be achieved in wound repair or skin surgery when the location, surface area involved, and estimated length of time for the procedure are considered. A patient's emotional response is also critical in ensuring nearly painless anesthesia, because most patients fear the injection will be painful. Throughout this chapter, a combination of certain anesthetics and procedural techniques are discussed that can help lessen the patient's pain and anxiety.

Essential Anatomy and Physiology

Local anesthetics block the conduction of nerve impulses by selectively binding to voltage-dependent sodium channels. The vast majority of local anesthetics may be divided into two main categories: esters and amides. Local anesthetics contain a hydrophobic and a hydrophilic end joined by an ester or amide linkage.[1–4] The hydrophilic portion allows the anesthetic to be water-soluble so that it can be injected in solution and diffuse to the nerves requiring blockade. The hydrophobic portion allows the anesthetic to be lipid-soluble and enter the neuronal membrane. It is the hydrophilic end that subsequently binds to the voltage-dependent sodium channel. The ester anesthetics include benzocaine (e.g., Anbesol), cocaine, procaine (Novocaine), and tetracaine (Cetacaine, Pontocaine). The amide anesthetics include lidocaine (e.g., LMX, Xylocaine), mepivacaine (Carbocaine), bupivacaine (Marcaine), and prilocaine (EMLA, Citanest) (Table 16.1).[1,4,5]

Table 16.1

Drugs for Local Anesthesia

Drug	Drug Class	Trade Name	Concentration Available (%)	Onset of Local	Onset of Nerve Block	Duration	Maximal Dose	Maxima Dose wi Epinepl
Topical Agents								
Benzocaine	Ester	Anbesol	5–20	Rapid		Short		
Cocaine	Ester		1–11.8	1–5 min		30 min	2–3 mg/kg	
Tetracaine	Ester	Cetacaine	0.25, 0.5, 1.0	20–30 min		45–60 min	1–3 mL	
Lidocaine	Amide	LMX	4.0–5.0	30 min		20–60 min	1–2.5 g of mixture	
		LET	2–10	20–30 min		45–60 min	1–3 mL	
Prilocaine + lidocaine	Amide	EMLA	2.5/2.5	30–60 min		60–120 min	1–2 g of mixture	
Injectable Agents								
Lidocaine	Amide	Xylocaine	0.5, 1, 2	Rapid	10–20 min	50–120 min*	4–5 mg/kg of 1%	5–7 mg/ of 1%
Mepivacaine	Amide	Carbocaine	1, 2	2–5 min	10–20 min	50–120 min	5 mg/kg of 1%	5–7 mg/ of 1%
Procaine	Ester	Novocaine	0.5, 1, 2	5–10 min	5–10 min	60–90 min	7 mg/kg	9 mg/kg
Bupivacaine	Amide	Marcaine	0.1, 0.25	5–10 min	15–30 min	120–180 min	0.3–1.4 mg/kg	

* Epinephrine added to lidocaine increases the duration of action to 60 to 180 minutes.

Data from Miller RD, Eriksson LI, Fleisher LA, et al. Local anesthetics. In: Miller RD, ed. *Miller's Anesthesia*, ed 7. New York: Churchill Livingstone; 2009, pp. 913–39; Miller RD, Butterworth JF, Lahaye L. Clinical use of local anesthetics in anesthesia. In: Maniker R, ed. *UpToDate*. Retrieved April 15 2018 from https://www.uptodate.com/contents/clinical-use-of-local-anesthetics-in-anesthesia?search=clinical%20use%20of%20local%20anesthetics&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1; Hsu DC. Topical anesthetics in children. In: Stack AM ed. *UpToDate*. Retrieved April 15 2018, from https://www.uptodate.com/contents/topical-anesthetics-in-children?search=topical%20anesthetics&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1.

The two categories of local anesthetics are esters and amides; they also contain a hydrophobic and a hydrophilic end. The degree of how hydrophobic or hydrophilic are given anesthetic partially determines the rapidity of onset and the duration of action.

When proper concentrations of anesthetic are used, the conduction of action potentials is blocked. This effect is reversible and nonspecific. Once anesthetics are absorbed by the local circulation and

metabolized or excreted, nerve function returns to normal. Because local anesthetics are nonspecific, they can act on all sensory nerves, temperature sensation, pain, touch, deep pressure, and motor, depending on the dose administered. Various factors affect the rate of onset, intensity, and duration of sensory nerve anesthesia.

Rate of Conduction

Local anesthetics are much more likely to bind to sodium channels that have rapid action potentials (such as those that carry pain impulses) than those with slower action potentials.

Nerve Fiber Diameter

Larger doses of drug are needed to anesthetize larger nerve trunks, such as digital nerves, and the onset of action is slower. In large-diameter nerves, the peripheral fibers are blocked before the core fibers. This leads to blockade progression in a proximal to distal manner.[2]

Presence of Myelin

A successful block of myelinated fibers requires exposure to three or more nodes of Ranvier, which implies a requirement for larger doses of anesthetic. However, animal studies show that unmyelinated nerve fibers (such as C-type pain and temperature fibers) are more resistant to blockade by local anesthetics because they are smaller in diameter and lack the lipid barrier of the myelin sheath.[2] Although future studies will further delineate the susceptibility of blockade, most authors agree that the pK_a of the anesthetic compared with the pH of the tissue is the best indicator of onset and duration of blockade.

Anesthetic Solution, pK_a, and Tissue pH

Nonionized forms of anesthetic solutions can diffuse more rapidly through the tissue and nerves, leading to a more rapid onset of action. However, the ionized form binds to the sodium channel to cause the blockade. Anesthetics must convert to the ionized form once in the nerve. The pK_a is the pH at which 50% of the drug is ionized and 50% is nonionized.[2,3] When the pH of the tissue is higher than the pK_a, more of the drug will become nonionized. Manipulating the anesthetic pH can therefore affect the onset and duration of the drug.

Most anesthetic solutions are **acidic** to maintain their stability or shelf-life. Once injected, however, they equilibrate to the pH of normal tissues. This leads to the sensation of burning on injection. Buffering the anesthetic solution with sodium bicarbonate can effectively eliminate this undesirable side effect. Buffering increases the onset of action and the duration of the blockade, but it decreases the shelf life. Plain lidocaine buffered with bicarbonate has a shelf-life of approximately 7 days.[3] In addition, buffering can degrade epinephrine.[3] Adding epinephrine decreases the pH of the anesthetic, thereby increasing the sensation of burning on injection.

Because anesthetic solutions work best at physiologic pH, they are less effective in infected tissues than in normal tissues because of the resultant metabolic acidosis, which decreases pH.[2,3]

Vascularity of The Location Anesthetized

In highly vascular areas, drug is rapidly removed from the area that requires anesthesia, leading to the need for more drug or a vasoconstricting agent. A shorter duration of action also results. All the local anesthetics are vasodilatory in nature, except cocaine, which is a vasoconstrictor.

Use of Epinephrine

Adding a vasoconstricting agent, such as epinephrine, decreases blood flow, reduces systemic absorption, shortens onset, and extends duration of action. Epinephrine tends to be more effective with the less lipid-soluble agents (lidocaine and mepivacaine) than with the more lipid-soluble agents (bupivacaine).[1,3] As a general rule, the use of epinephrine doubles the duration of anesthesia achieved

with lidocaine.[1,3] Epinephrine allows larger doses of anesthetic to be provided by decreasing the toxic potential.[3] Caution must be exercised in using vasoconstrictive agents in regions of the body supplied by a single vascular source, because tissue necrosis may result.

Method and Technique of Injection

The nerve fibers are present at the junction of the dermis and the subcutaneous fat. Direct infiltration of an open wound at this level provides immediate blockade.[2,4,6] Direct infiltration of intact skin, if started at the junction of the dermis and the subcutaneous fat, also provides immediate and **nearly painless** anesthesia. If the injection is started higher in the epidermis or at the dermal–epidermal junction, the blockade is slightly slower and more painful. Digital nerve block is slower in onset because of the larger nerve fibers. Technique is important because placement of anesthetic immediately adjacent to a digital nerve can lead to blockade within minutes, whereas delivery that is further from the nerve trunk can delay onset and lead to inadequate blockade and the possible need for repeat injections.

Concentration of Solution

Solutions of higher concentration may lead to a slightly shorter onset of action in contrast to solutions of lower concentration, but this difference is not markedly significant. For example, adding epinephrine to 1% lidocaine achieves the same effect as using 2% lidocaine.[3]

Total Dose Provided

Increasing the dose leads to more effective blockade; however, too much can lead to side effects. Maximal doses of anesthetic solutions are provided in Table 16.1.

Rate of Metabolism

The **ester anesthetics** undergo metabolism first by being hydrolyzed by plasma cholinesterases and then being excreted by the kidneys.[1,2] Patients with low levels of pseudocholinesterase (severe liver disease, renal failure, pregnancy, neonates) will have decreased clearance of the ester anesthetics. Amide anesthetics are metabolized by enzymatic degradation in the liver, particularly cytochrome P450 (CYP450).[2] Drugs that inhibit this enzyme can increase the risk for the toxicity of amide anesthetics. Decreased hepatic blood flow and reduced enzyme function in the liver also lead to the potential risk for toxicity of the amide group. This includes patients undergoing general anesthesia, patients taking propranolol, and those who have congestive heart failure, cirrhosis, or hypothermia.[2] The duration of action lengthens relative to the increase in binding of an anesthetic to proteins. However, in patients with low plasma proteins, such as in liver failure and neonates, more drug is available and toxicity risk increases.[1,2]

Indications

Local anesthesia is indicated for any procedure confined to one area of the body in which pain or discomfort associated with the procedure can be anticipated. The most common indication is in minor surgical procedures, including repair of lacerations, incision and drainage of abscesses, removal of lesions, biopsies, and nail removal.

Contraindications

Topical Anesthetics

Cocaine-containing products are occasionally used to anesthetize adult nasal mucosa; however, contact with these agents should be avoided in infants and neonates, individuals sensitive to catecholamines, and those who take monoamine oxidase inhibitors.[5] Cocaine-containing products can cause coronary constriction through contact with mucosal surfaces; therefore, caution should be used in elderly patients with coronary disease.[2,5] Cocaine-containing products have been predominantly replaced by other topical anesthetics because of their increased cost, the abuse potential, and the risk of systemic toxicity.

Few relative contraindications exist to the use of non–cocaine-containing topical anesthetics. Studies are mixed concerning the possibility of the development of methemoglobinemia in patients at risk who were given prilocaine in a topical eutectic mixture of lidocaine anesthetics (EMLA), but overall, EMLA appears to be safe and effective in most infants and children.[1,5] Prilocaine is contraindicated in premature infants, newborns under 3 months of age, in and patients with metabolic disorders, such as glucose-6-phosphate dehydrogenase (G6PD), or those who are on medications that induce methemoglobinemia, such as antimalarials, acetaminophen, phenobarbital, and sulfonamides.[1,5] All patients should use caution with prilocaine if they have anemia, G6PD deficiency, or pulmonary or cardiovascular disease.[5]

Local Anesthetics

Contraindications to the use of local anesthetics include the following[1,3]:

- Severely unstable blood pressure
- True allergy
- Severe liver disease when amide anesthetics are being considered
- Severe renal disease when ester anesthetics are being considered

Epinephrine

Absolute **contraindications** to the use of epinephrine include the following[1,3]:

- Untreated hyperthyroidism or untreated pheochromocytoma.
- Patients with severe hypertension and coronary artery disease
- Patients taking ergot-containing medications
- Patients require periorbital infiltration who have narrow angle glaucoma

Administration to locations of the body that have a single, dependent blood supply, such as the tip of the nose and pinna of the ear. Epinephrine has traditionally not been advocated for use in a digital blocks. Newer studies show that it may be used in certain digital block techniques, but only if patients do not have compromised circulation.[3,4,6,7]

Relative contraindications to the use of epinephrine include the following[1,3]:

- Untreated hypertension
- Pregnancy
- Narrow-angle glaucoma with infiltration other than in the periorbital area
- Use in patients taking beta-blockers, phenothiazines, monoamine oxidase (MAO) inhibitors, or tricyclic antidepressants

Contraindications of topical anesthesia include:

- Cocaine-containing products in infants and neonates, individuals sensitive to catecholamines or who take MAOs, in elderly patients with coronary disease, and on areas with a single vascular source, such as the fingers, toes, penis, nose, and pinna of the ear.
- Prilocaine can induce methemoglobinemia and should be avoided in premature infants, newborns under 3 months of age, and in infants, 3 to 12 months, with metabolic disorders or on medications that induce methemoglobinemia, such as antimalarials, acetaminophen, phenobarbital, and sulfonamides. All patients should use caution with prilocaine if they have anemia, G6PD deficiency, or pulmonary or cardiovascular disease.

Potential Complications

The **most common complication** seen with injection of anesthesia is the development of anxiety over the impending injection and a subsequent vasovagal reaction demonstrated by hypotension,

bradycardia, and syncope.[1,3]

Local complications of injection, which are not common, include the following:

- Bruising
- Edema
- Infection
- Prolonged or permanent nerve damage
- Temporary motor nerve paralysis[1-3]

Systemic complications are uncommon; when they occur, it is usually because the anesthetic is inadvertently injected into a vessel. This complication can be avoided by making sure that blood cannot be aspirated before injecting the anesthetic. Systemic reactions include the following:

- Hypotension
- Bradycardia
- Central nervous system depression or stimulation, leading to dizziness, drowsiness, disorientation, tremor, restlessness, weakness, seizures, paralysis, loss of consciousness, and cardiac dysrhythmias

Central nervous system symptoms are more common with bupivacaine than with the other anesthetics and are even more profound in pregnant women.[1,3] For this reason, bupivacaine is contraindicated in pregnancy.

Epinephrine can lead to the following side effects[1-3]:

- Cardiac dysrhythmias
- Increased blood pressure
- Anxiety
- Cardiac arrest
- Cerebral hemorrhage
- Ischemia if used in areas of end artery flow such as the digits, penis, nose, and pinna of the ear, leading to skin necrosis, especially in patients with poor circulation

Treatment of vasovagal complications tends to be supportive. Should such occur, the provider should stop the injection and the patient should be placed in the Trendelenburg position, which usually reverses hypotension and bradycardia.[1,3] If local anesthetic systemic toxicity occurs, the provider should call for assistance and establish an intravenous access. Advanced cardiac life support measures should begin, including managing the airway, control seizures, providing supplemental oxygen, monitoring and managing cardiac arrhythmias, and administering lipid rescue.[3,8] Seizures are generally controlled by administration of intravenous low-dose benzodiazepines.[3,8] Lipid emulsion (20%) in conjunction with ACLS have proved successful in local anesthetic systemic toxicity-related cardiac arrest.[3,8]

The metabolite of the ester anesthetics is *para*-aminobenzoic acid (PABA), which is the agent responsible for the vast majority of allergic reactions in patients.[1,2,5] Benzocaine, an ester commonly used topically, has a tendency to cause allergic contact dermatitis because of the PABA derivative. Patients hypersensitive to benzocaine also may be sensitive to other ester anesthetics, such as procaine (Novocaine), which is rarely used as an anesthetic, but is found in procaine penicillin G, and tetracaine, but they will not be sensitive to the amide anesthetics.

True allergic reactions are rare among amide anesthetics. Allergic reactions in amide anesthetics may be caused by the preservative methylparaben or bisulfites, which are used in multiple-dose vials. True allergy is characterized by a skin rash, localized or general urticaria, angioedema, and, rarely, anaphylaxis with hypotension and bradycardia. Only 1% of all patients receiving local anesthesia demonstrate a true allergic response.[2]

Contraindications for infiltrated anesthetics include:

- Severely unstable blood pressure
- True allergy
- Severe liver disease with amide anesthetics
- Severe renal disease with ester anesthetics

Allergic reactions are handled with airway management and administration of supplemental oxygen, intravenous access, and administration of epinephrine, diphenhydramine, and corticosteroids, as needed.[3,8]

In patients with true allergies to both ester and amide anesthetics, injectable diphenhydramine can be used as an alternative.

Contraindications for epinephrine include:

- Untreated hyperthyroidism or untreated pheochromocytoma
- Administration to areas with a single, dependent blood supply, such as the tip of the nose and pinna of the ear.

Standard precautions

Practitioners should use standard precautions at all times when interacting with patients. Determining the level of precaution necessary requires the practitioner to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

Patient Preparation

Several techniques can be used to decrease the pain and anxiety that can accompany an injection of anesthetic.

- Because of the way local anesthesia affects the sensory nerve impulses (see discussion of essential anatomy and physiology), an anxious patient may perceive touch as if it were pain. Therefore reassuring the patient and explaining the expectations of the procedure are key to ensuring nearly painless anesthesia.
- Because the most common reaction to local anesthesia is a vasovagal response or syncope, the patient needs to be in the supine position, placed so that he or she cannot see the injection being administered.
- Engage in conversation to distract the patient.
- Inform the patient what is being done at each step.
- Encourage the patient to take deep, slow breaths to avoid hyperventilation.
- Continue to reassure the patient throughout the procedure of injection.
- For anxious patients or children, conscious sedation may be necessary; however, detailing its use is beyond the scope of this chapter.
- Use cryoanesthetic, such as ice, ethyl chloride, trichloromonofluoromethane, dichlorodifluoromethane, or liquid nitrogen, before an injection. This technique can also be used for anesthesia before curettage of superficial lesions, as described in Chapter 6. Cryoanesthetics provide short periods of decreased pain sensation. For purposes of anesthesia before injection, liquid nitrogen is not preferred because it can be painful and may lead to unwanted tissue destruction.
- Warming the local anesthetic to body temperature has been shown to reduce the pain of anesthetic injection significantly, but it requires time and effort to warm the vial or syringe to 37° to 40 °C (98.6° to 104 °F) and then rapidly inject the anesthetic before it cools.[3]

Near-painless anesthesia is best achieved by having the patient supine with the biopsy site out of view; engage the patient and let the patient know what you are doing. Pinch the skin before the injection and start the injection at the dermal–subcutaneous fat junction.

Materials Used for Administering Anesthetics

Topical Anesthesia

Topical anesthesia has several benefits in contrast to injection, including lack of injection (therefore no discomfort), ease of administration, decreased need for physical restraints, and no distortion of the anatomy. Topical anesthesia tends to work better on the highly vascular face and scalp than on the trunk or proximal extremities.[1,5] When using topical anesthesia for wound closure, it should be limited to lacerations of 5 cm or less to avoid the complication of systemic absorption.[5]

Topical anesthetics can be used to decrease the pain of anesthetic injection or as the primary means to anesthetize skin. They work best on highly vascular sites, such as the face.

Topical anesthetics are divided into amides (lidocaine, prilocaine), esters (benzocaine, tetracaine), and nonamide/nonesters (dyclonine, pramoxine). Each specialty tends to have one topical anesthetic that is preferred over others. Topical benzocaine is commonly added as an agent for sunburn relief. It is, however, a common contact sensitizer and should generally be avoided. Anesthetics available for use on the superficial mucous membranes include dyclonine (Dyclone), benzocaine (Anbesol and others), tetracaine (Cetacaine), viscous lidocaine, and lidocaine jelly. Deeper anesthesia of the mucous membranes can be accomplished with a solution of cocaine. Cocaine-containing products increase the cost of the anesthetic and need to be stored and disposed of under strict protocols. Cocaine-containing products also may be used to anesthetize lacerations. An example of cocaine-containing products is:

A variety of topical anesthetics are available either prepared by the pharmacy department, such as TAC gel or solution, or in prescription single-use packaging such as EMLA or LMX.

- TAC: Tetracaine (0.25% - 0.5%), epinephrine (0.025% - 0.05%), cocaine (4% - 11.8%)

Other topical agents without cocaine used for wound repair include:

- LET: lidocaine 4%, epinephrine 0.1%, tetracaine 0.5%
- EMLA: eutectic mixture of local anesthetics: lidocaine (2.5%) and prilocaine (2.5%)
- LMX: liposomal lidocaine (4%) (formerly ElaMax)

The products TAC and LET can be prepared by a pharmacist as a liquid or gel; however, gels decrease the risk for mucosal exposure.[5] Some authors have stated that TAC/LET combinations provide inconsistent anesthesia for lacerations on the extremities, leading to the need for supplemental anesthetic injection.[5]

For intact skin, superficial anesthesia can be achieved with EMLA (eutectic mixture of local anesthetics) or LMX (4% lidocaine). Although studies have examined the use of EMLA on mucous membranes or conjunctiva, it should be avoided in these areas because of the risk for greater absorption leading to potential systemic side effects.

Other materials required for topical anesthesia:

- Cotton-tipped applicators or gauze pads
- Materials to clean the wound or anesthesia site

The most common infiltrative anesthetic is 1% lidocaine, which has an onset of 2 to 5 minutes and a duration of action of 30 to 60 minutes. Buffering with sodium bicar-bonate will increase the duration of action, but decrease the shelf-life of the anesthetic.

Injection Anesthesia

The most commonly used agents are as follows:

- Lidocaine (Xylocaine 1% and 2%, with and without epinephrine)
  - Rapid onset of action
  - Readily penetrates nerve sheaths, leading to an almost immediate anesthesia with local infiltration.
  - For direct wound infiltration, the duration of action is approximately 20 to 60 minutes and is approximately 50 to 120 minutes for nerve blocks

CAUTION: A subset of patients, particularly neonates, pregnant women, and patients with uremia, can absorb local anesthetics rapidly from the site of injection, which may require repeat injections to maintain anesthesia. The increased absorption can, however, lead to an increased risk of systemic toxicity.

NOTE: The use of epinephrine with lidocaine increases the duration of action and improves local hemostasis.

- Method of buffering lidocaine: 1 mL bicarbonate + 10 mL 1% lidocaine

NOTE: Buffering of 2% solutions may cause precipitation.

NOTE: The shelf-life of buffered lidocaine is 7 days, but epinephrine is degraded with buffering in 24 hours.

- Mepivacaine (Carbocaine 0.5% and 1%)
  - Slightly longer onset of action with direct infiltration (2 to 5 minutes), with a duration of action approximately 50 to 120 minutes
  - Does not cause as much vasodilation as lidocaine; therefore does not require epinephrine for hemostasis
  - Method of buffering mepivacaine: 0.5 to 1 mL of bicarbonate + 9 mL of mepivacaine
  - Shelf-life unknown; therefore do not use after 24 hours
- Bupivacaine (Marcaine 0.25% and 0.5%)
  - Slow onset of action (5 to 10 minutes) with direct infiltration, but duration of action is much longer than with either lidocaine or mepivacaine (120 to 180 minutes) offering significant postsurgical relief from pain.
  - Buffering of bupivacaine is not used because the solution tends to precipitate as the pH rises.
- Diphenhydramine (Benadryl)
  - For allergic reaction to amide or ester anesthetics, or both, alternatives include diphenhydramine and normal saline or no anesthesia.
  - Provides adequate anesthesia for at least 30 minutes.
  - Benadryl 5% should be diluted to 1 mL diphenhydramine + 4 mL normal saline.

NOTE: The technique for direct infiltration with diphenhydramine is the same as with other anesthetics. Diphenhydramine, however, is more painful to inject than lidocaine and is not reduced by buffering.

- Other materials to perform anesthetic infiltration:
  - Materials to ensure sterile technique
  - 27- or 30-gauge needle ½- to ¼-inch length
  - A syringe: size dependent on the quantity of anesthetic to be injected
  - The injectable anesthetic

Procedure

Topical Anesthesia

1. For intact skin, achieve superficial anesthesia with EMLA (lidocaine and prilocaine in an acid-mantle cream) or LMX (4% lidocaine).

NOTE: Neither cream should be used on mucous membranes or conjunctivae because of the risk for greater absorption leading to potential systemic side effects. Young children should be observed closely to avoid accidental ingestion.

2. When applying LMX, do not keep on skin for more than 2 hours at a time.

NOTE: Anesthesia with EMLA and LMX works best for removal of superficial skin lesions, for some laser procedures and also before injection of anesthetic. With both creams, the depth of anesthesia is directly proportional to the duration of application and lasts for several hours. LMX appears to have a more rapid onset of action than EMLA. Neither cream appears to cause irritating effects or hypersensitivity reactions with repeated or prolonged use.

3. For wound repair, select TAC or LET.
4. Gently remove blood clots from the area.
5. Saturate a gauze sponge or cotton swab with anesthetic.
6. Fold the anesthetic-saturated sponge into and around the wound and tape into place.
7. Have the parent or assistant (or yourself) apply constant, gentle pressure for 15 to 20 minutes.

NOTE: The person applying pressure should wear gloves to avoid absorption.
NOTE: Anesthesia is complete when blanching is observed around the wound. One report stated that about 5% of wounds require supplemental injection of local anesthetic to achieve complete anesthesia. Studies have also shown that approximately 1 to 3 mL of topical anesthetic is sufficient to provide anesthesia for most wound repairs.[4,5]

8. If administering EMLA or LMX to intact skin, cover the area requiring treatment with a ¼-inch-thick layer of cream.

NOTE: EMLA is then occluded with a plastic adhesive dressing 1 hour before the procedure. LMX does not require occlusion, although this may be performed.

9. Remove both creams before the start of the procedure.

Procedure

Administering Local Anesthetic by Injection

Nearly painless anesthesia is more likely with the use of a 27- or 30-gauge needle. This occurs not only because the caliber of the needle is smaller but also because it decreases the speed with which anesthetic is injected. Rapid tissue expansion is more uncomfortable for the patient, so the provider should aim for a slow injection technique, which will be facilitated by selecting a 1- to 3-mL syringe.

> Topical anesthetics can be used for wound repair, with an onset of anesthesia in 15 to 20 minutes. Additional injection may be required because infected wounds tend to have uneven anesthesia.

Needle length varies from ½ to 1¼ inch. The shorter length is adequate for small punch biopsies, and longer needles are better for larger excisions, wound infiltration, and field and digital blocks.

Direct Infiltration of Wounds

1. Initiate the injection on the side where sensory innervation originates and then proceed distally.

NOTE: Direct wound infiltration is recommended in most minimally contaminated wounds. The injection should be located between the dermis and the subcutaneous fat. Tissue resistance is less, and the sensory nerves are rapidly affected by the anesthetic at this level.

2. Once the needle is inserted, **aspirate** to ensure that the needle is not in a vessel. If no blood is withdrawn, inject a small amount of anesthetic.
3. Reposition the needle adjacent to, but still within, the area where anesthetic was placed.
4. Aspirate and proceed to inject if no blood is withdrawn.
5. Continue to repeat the preceding steps until all edges of the wound are anesthetized.
6. If at any time bloody aspirate is obtained, withdraw the needle slightly and aspirate until clear. A 3- to 4-cm laceration should require about 3 to 5 mL of anesthetic[3] (Fig. 16.1).[1,2]

> Always aspirate before injecting anesthetic. If bloody return is seen, reposition the needle and aspirate until clear.

Local Infiltration of Intact Skin

1. Clean the intended procedure site with an alcohol wipe or alternative antiseptic.
2. Pinch the skin in the vicinity of the injection site. This decreases the sensation of pain from the injection.
3. Angle the needle at 90 degrees to inject, rather than 45 degrees, to decrease discomfort.
4. Infiltrate at the junction of the dermis and subcutaneous fat, then reposition the needle to the level of the epidermis and inject a small amount of anesthetic.

NOTE: Always remember to aspirate before injection. For punch biopsies, only 1 to 2 mL of anesthetic is generally required.

Field Block

Field block is an alternative to direct wound infiltration when a larger area requires treatment or, in wounds that are grossly contaminated, to avoid bacterial spread. It has the advantage of fewer injections than direct wound infiltration.

> Field blocks are used for larger areas and in wounds that are grossly contaminated, to avoid bacterial spread.

1. Start the injection in the subcutaneous layer as described in local infiltration of intact skin; however, a larger-bore (25- to 27-gauge), 1¼- to 2-inch needle is required.
2. Insert the needle into the skin and advance to the hub parallel to the dermis and subcutaneous fat. After aspiration, a slow injection of anesthetic is left as the needle is withdrawn to the insertion site.

3. Reinsert the needle at the end of the first track and repeat the procedure until a wall of anesthesia surrounds the area to be treated (Fig. 16.2).[3,7]

Digital Block

Lidocaine (1%) without epinephrine, with or without bicarbonate, is most commonly used for **digital blocks.**[1,6] Bupivacaine is an alternative. Bupivacaine's onset of action is slower, but it does accord longer duration of action for extended procedures and significant postoperative relief of discomfort for the patient. Epinephrine has been historically discouraged for use in areas with a single vascular source. Recent studies show digital blocks with epinephrine are safe and effective except in patients with compromised circulation.

> Digital blocks can be accomplished with two injections on either side of the joint or as a single injection either from a dorsal or palmar approach.

A digital block is generally recommended for procedures distal to the midproximal phalanx of the digit and is preferred for nail avulsion, paronychial drainage, and repair of lacerations of the digits.

1. A traditional digital nerve block is accomplished by injecting anesthetic just distal to the web space in the middle of the digit.
2. After aspirating, inject 0.1 mL of anesthetic locally into the epidermis.
3. Advance the needle to the bone, withdraw slightly, and then move dorsally, where 0.5 mL of anesthetic is injected after aspiration.
4. Withdraw the needle again to the midline, advance to bone, and move ventrally, where another 0.5 to 1 mL of anesthetic is injected after aspiration.
5. Withdraw the needle and repeat the whole procedure on the other side of the digit (Fig. 16.3).

NOTE: Larger volumes of anesthetic are not required if injected near the nerve. The needle should always be withdrawn between dorsal and ventral injections to avoid nerve and vessel damage. Anesthesia is reported to occur 2 to 20 minutes after injection, depending on the anesthetic and technique used.

NOTE: There are alternatives to the method described for performing a digital block.

Alternatives to Performing a Digital Block: Dorsal Injection Without Epinephrine

1. Because the second to fifth toes are small, one technique uses a dorsal midline injection. Anesthetic is then deposited on one side of the toe.
2. Withdraw the needle and move to the opposite side without completely withdrawing the needle from the skin.[6,7]

CAUTION: This technique is not recommended for the great toe.

NOTE: For surgery on the distal nail unit, periungual administration may be performed. It is essentially a field block technique of the nail unit (see Chapter 29). It is more painful than a digital block but has a more rapid onset.

3. It is completed by injecting first along one lateral nail fold, then perpendicularly along the proximal nail fold, and then along the opposite lateral nail fold. Finally, anesthetic is administered in the hyponychial area.[6,7]
4. Another alternative is to inject at a 30-degree angle into the middle of the proximal nail fold, where the needle is then advanced distally under the nail matrix.
5. After aspiration, inject anesthetic as the needle pierces the nail plate, the nail matrix, and the nail bed.

NOTE: The nail matrix and nail bed will blanch with injection of anesthetic. It is painful, but anesthesia is immediate. This type of anesthesia can be used for most procedures performed on the proximal half of the nail unit, but not for removal of the nail matrix or complete nail avulsion.[6,7]

Palmar Injection Buffered With Sodium Bicarbonate

Recent studies have shown that a single injection in the palmar flexor tendon sheath may be performed without risk for inciting ischemia in the digit, but is more painful and can cause injury to the flexor tendon.[6] Lidocaine 1% buffered with sodium bicarbonate is used.

1. The hand is placed in the supine position and the joint flexed to 45 degrees.
2. The needle is introduced distal to the distal crease of the palm lined up with the midline of the digit.
3. After aspiration, inject 1 to 2 mL of anesthetic.

NOTE: If there is resistance, the needle is most likely against the tendon.[6]

NOTE: Other digital blocks include supraorbital, supratrochlear, infraorbital, mental, auricular, median, ulnar, radial, sural, and tibial. These are used for procedures or repair of lacerations covering a large surface area; however, their description is beyond the scope of this book.

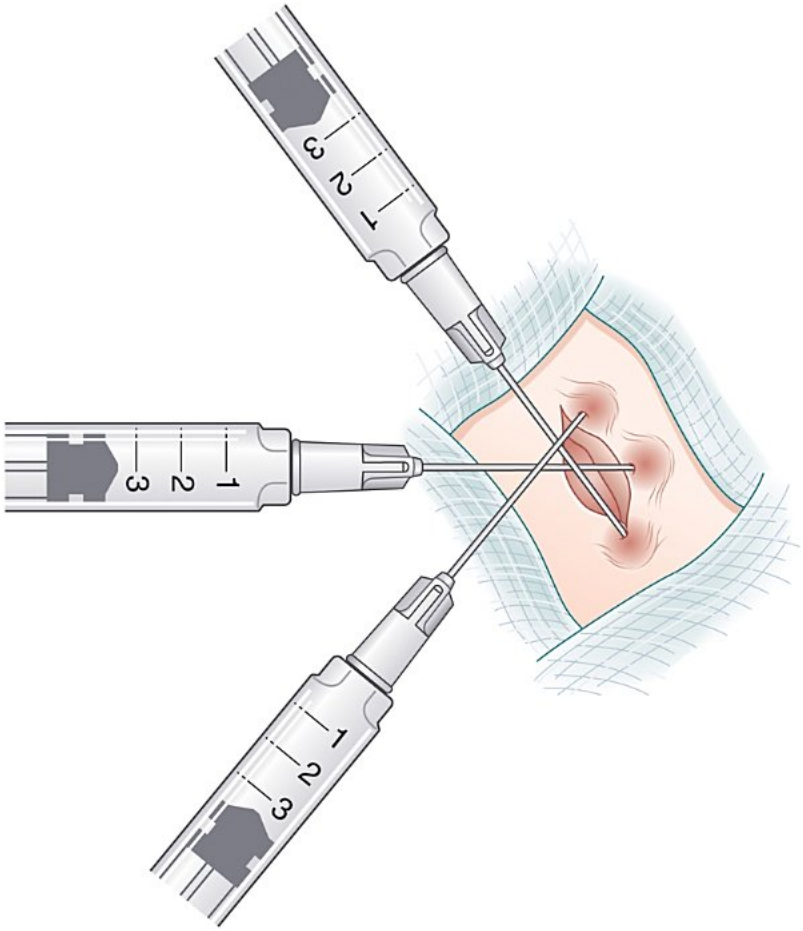

FIGURE 16.1 **Direct Infiltration of Wound.**

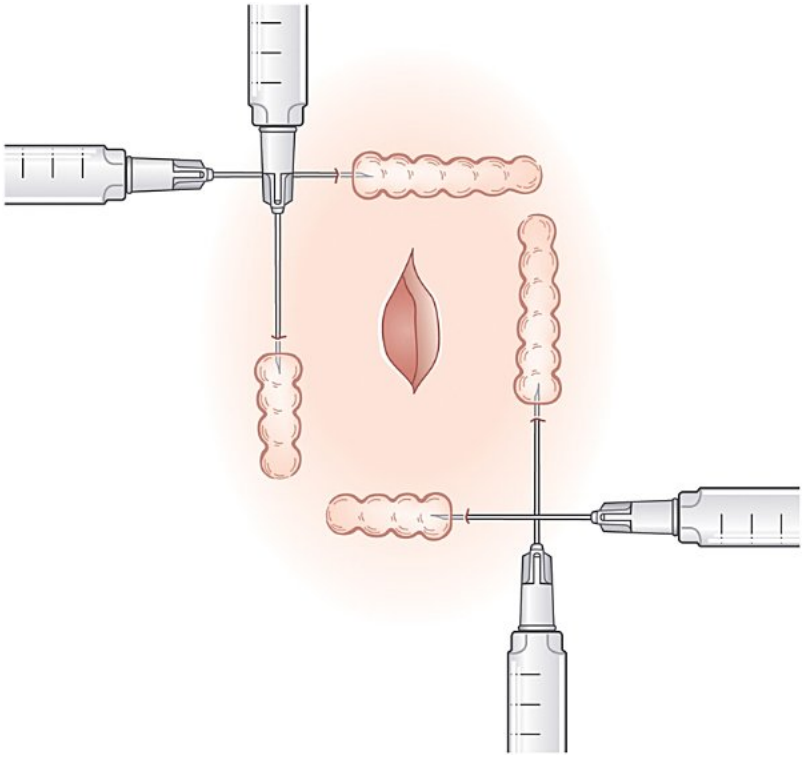

FIGURE 16.2 Field Block. (Modified from Pfenninger JL, Fowler JC. *Procedures for Primary Care Physicians.* St. Louis: Mosby–Year Book; 1994, pp. 147.)

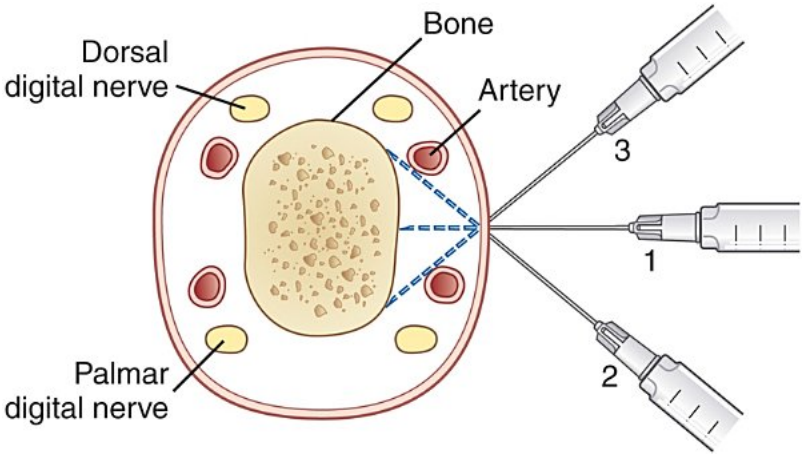

FIGURE 16.3 Digital Block. (Modified from Pfenninger JL, Fowler JC. *Procedures for Primary Care Physicians.* St. Louis: Mosby–Year Book; 1994, p. 149.)

Follow-Up Care and Instructions

Complications from local anesthesia are uncommon. Occasionally a patient exhibits sensitivity to a component of the anesthetic, which may later present as a rash or inflammatory reaction. Instruct the patient to notify the office if unusual skin color, itching, or pain occurs in the area where the anesthetic was injected or if sensation does not return promptly after the anesthesia has worn off.

Follow-up care should occur if unusual skin color, itching, or pain occurs in the area where the anesthetic was injected, or if sensation does not return promptly after the anesthesia was to have worn off.

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CHAPTER 17

Lumbar Puncture

Virginia F. Schneider

Abstract

Lumbar puncture is a common procedure in both adult and pediatric practice. It is primarily used to evaluate patients for meningitis and other central nervous system infections and diseases. Therapeutically it is used to administer medications directly into the cerebrospinal fluid and to remove fluid in cases of hydrocephalus while awaiting a more definitive procedure to reduce intracranial pressure. For most patients it is performed with local anesthesia in the outpatient setting. The most common complication is postdural puncture headache, the incidence of which is significantly reduced by using atraumatic lumbar puncture needles. Risk factors for more serious complications include suspected increased intracranial pressure, coagulopathies, bleeding dyscrasias, and local infection or structural abnormalities at the site. Appropriate radiologic imaging should be obtained prior to performing lumbar puncture if increased intracranial pressure is suspected. Thorough explanation of the anatomy and procedural steps is important to reassure patients who often have heard negative anecdotal accounts of lumbar puncture risks. During the procedure, adequate analgesia, good positioning, and the help of an assistant to keep the patient in a stable position are important aids to success.

Keywords

lumbar puncture

meningitis
spinal tap

Procedure Goals and Objectives

GOAL: To understand the rationale for performing lumbar puncture and the steps necessary to prepare for and perform the procedure to maximize patient safety.
OBJECTIVES: The student will be able to:

- List the indications and contraindications for performing lumbar puncture.
- Identify and describe complications associated with lumbar puncture.
- Identify the essential anatomy and physiology associated with lumbar puncture.
- List the materials needed for lumbar puncture and describe their proper use.
- Describe the steps to perform a lumbar puncture and collect a cerebrospinal fluid (CSF) sample.
- Describe how the procedure varies when performed on infants, children, and adults.
- Instruct patients and staff in postprocedure care, including monitoring for complications.

Background and History

The first known lumbar punctures occurred around 1890 to treat childhood hydrocephalus and as a diagnostic test for "purulent" meningitis and tuberculosis. The procedure was adopted and widely

used within a few years. Over time, recognition of complications and risk factors led to the development of new equipment and techniques resulting in a procedure that is relatively simple, safe, and often used in the diagnosis and treatment of a variety of conditions.[1]

Indications

Indications for **lumbar puncture** are both diagnostic and therapeutic. It is used to evaluate central nervous system (CNS) infections[2]:

Lumbar puncture is most commonly performed to evaluate for CNS infection.

- Bacterial meningitis, the most common reason for lumbar puncture, is suggested by a CSF sample with an elevated white blood cell count, an elevated polymorphonuclear cell count, and a low glucose level. The Gram stain may tentatively identify organisms and guide antimicrobial therapy while awaiting culture results.
- Viral meningitis typically causes CSF mononuclear pleocytosis, a normal glucose level, an elevated protein level, and a negative Gram stain result.
- In immunocompromised patients, nonspecific CSF abnormalities may indicate fungal meningitis, CNS tuberculosis, neurosyphilis, and unusual viral infections.

Lumbar puncture can also be used to diagnose subarachnoid hemorrhage.

- Subarachnoid hemorrhage is generally characterized by CSF with a xanthochromic color at the time of the lumbar puncture and an elevated erythrocyte count in the fluid.
- A traumatic lumbar puncture is differentiated by initially red CSF with subsequent clearing as fluid collection progresses.

Some neurologic diseases can be identified through lumbar puncture:

- The CSF of patients with Guillain-Barré syndrome has an isolated, very high protein concentration, generally greater than 200 mg/dL.
- CSF analysis may be useful in evaluating patients for diseases that present with neurologic dysfunction such as multiple sclerosis, amyotrophic lateral sclerosis, and Alzheimer disease.

Lumbar puncture is used therapeutically:

- To relieve intraventricular pressure from hydrocephalus while the patient is awaiting a more definitive procedure, such as CSF shunt placement.
- To administer intrathecal pharmacologic agents, including antibiotics, antivirals, and antineoplastic agents.

Contraindications

The contraindications for lumbar puncture are as follows:

- **Increased intracranial pressure** is the primary contraindication for lumbar puncture. Signs and symptoms of increased intracranial pressure (ICP) include progressive headache, focal neurologic abnormalities, heart rate and blood pressure lability, progressive deterioration of mental status, and papilledema on funduscopic examination. Lumbar puncture and the associated removal of CSF fluid results in decreased pressure in the spinal column relative to the brain. In patients with increased ICP, creation of this area of lower pressure may result in herniation of the brain through the foramen magnum. Any patient suspected of having increased ICP, especially from an intracranial mass, should be evaluated by computed tomography before a lumbar puncture is attempted.[2–5]

Patients with signs or symptoms of increased intracranial pressure, especially suspected intracranial mass lesions, should have a computed tomography scan before lumbar puncture.

- Known or suspected coagulopathies and thrombocytopenia are relative contraindications to lumbar puncture. This may include hemophilia, leukemia, liver disease, or anticoagulant therapy. The benefit of the procedure must be carefully weighed against the risks.[2,5]
- Local infection overlying the site of the lumbar puncture risks direct inoculation of organisms into the CSF when the skin is punctured.[2,5]
- Surface abnormalities, such as nevi, hair tufts, and sinuses, or visual/palpable bony abnormalities in the area may be associated with spinal column structural abnormalities. If possible, the anatomy should be delineated with diagnostic imaging before proceeding.[11,5]
- Critical illness or medical instability is a relative contraindication to lumbar puncture.

Potential Complications

The potential complications of lumbar puncture include the following:

- **Postdural puncture headache** (PDPH) is the most common complication of lumbar puncture. The headache is always bilateral, generally occipital, and usually described as "throbbing" or "pressure." Intensity is increased in the upright position and by movement, coughing, straining, and sneezing. It is relieved by lying supine. Patients may also report neck stiffness, nausea, vomiting, dizziness, or visual symptoms. Adults with a prior history of PDPH or migraines are at higher risk. PDPH is less common in children (< 3%).[6–8]

Postdural puncture headache is bilateral, generally occipital, and has a throbbing or pressure quality.

- Some back discomfort at the site for several days after lumbar puncture is common, but pain with other symptoms (e.g., swelling, erythema, or systemic symptoms) should prompt reevaluation.
- Infection may be introduced by improperly preparing the skin, contaminating the needle, performing the procedure through an area of local infection, or introducing blood into the subarachnoid space in the presence of bacteremia. Consequences may range from local cellulitis to meningitis and empyema of the epidural or subdural space.[1,2]

- **Nerve damage** can occur when the needle inadvertently moves laterally, penetrating a segmental nerve in the extradural space, causing transient pain, electric shocks, and dysesthesias. Transient cranial nerve dysfunctions, including cranial nerves III through VIII, are unusual but have been reported.[5,10,8]

If the patient develops pain or paresthesias during needle insertion, readjust the needle position. Remove the needle if symptoms do not resolve quickly and recheck anatomic landmarks.

- Herniation into the foramen magnum may occur when lumbar puncture is performed in the presence of increased intracranial pressure. The absence of papilledema and focal neurologic symptoms does not guarantee normal intracranial pressure. The patient's presentation and differential diagnosis should guide the need for computed tomography or magnetic resonance imaging before lumbar puncture.[2-5,9]
- Significant bleeding locally or into the CNS is rare and occurs almost exclusively in patients with coagulopathies or other

risk factors for bleeding. Before the procedure, perform tests such as platelet count, clotting studies, or liver function studies as clinically indicated. In infants, inquire about a family history of blood dyscrasias, verify receipt of vitamin K, and evaluate for signs and symptoms of disorders predisposing to thrombocytopenia.[2,5] Hold anticoagulants for an appropriate interval prior to lumbar puncture to minimize the risk of bleeding. In emergent situations, administering appropriate anticoagulant reversing agents appears to decrease the risk of bleeding events.[10]

- Intraspinal epidermoid tumors are rare, but may be induced by lumbar punctures in which epidermal fragments are carried in by the needle and implanted into the spinal canal. Use of a stylet minimizes this risk. Symptoms consist of pain at the site or neurologic symptoms in the lower extremities, usually presenting months after the procedure.[2,9]
- Other rare complications include disk herniation and infection, epidural fluid collections, and cauda equina syndrome.[6]

Essential Anatomy and Physiology

Cerebrospinal fluid is produced primarily in the lateral ventricles of the brain, with small amounts added in the third and fourth ventricles. From the fourth ventricle, the CSF flows into the cisterna magna, under the base of the brain, and up over the sulci between the cortical convolutions. The CSF is transferred back into the bloodstream by filtration and osmosis, chiefly through arachnoid villi and granulations in the supratentorial region. **The spinal cord** terminates at the L1 to L2 level in most adults (Fig. 17.1), but can extend lower. In the absence of spinal abnormalities, little danger of injuring the spinal cord exists when lumbar puncture is performed at the L4 to L5 or L3 to L4 interspace. In infants the spinal cord terminates at the L3 level. More care should be used to ensure appropriate interspace identification, and use of those above L3 to L4 should never be attempted.[2,9]

In most adults, the spinal cord ends at the L1 to L2 level, but in infants it is at L3.

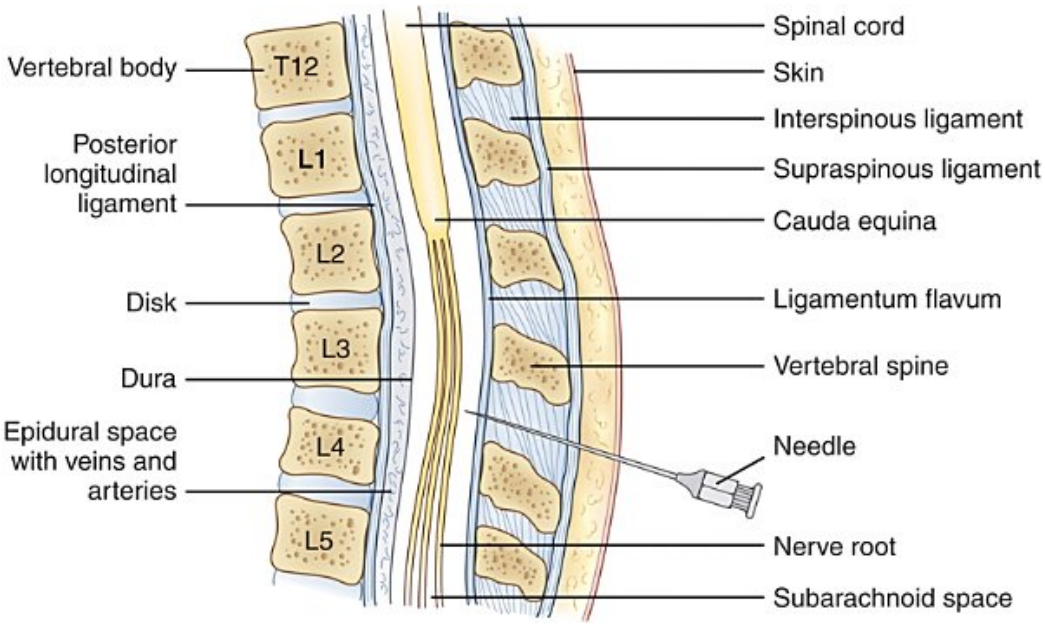

FIGURE 17.1 Anatomic orientation for performing lumbar puncture. (Redrawn from Taft JM: How to perform a lumbar puncture. *JAAPA*. 1990;3:473–476.)

Standard precautions

Practitioners should use **standard precautions** at all times when interacting with patients. Determining the level of precaution necessary requires the practitioner to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

Patient Preparation

Because this **procedure** involves placing a relatively large-appearing needle into the spinal column, it can be anxiety-producing for patients and parents. Not infrequently, patients and families have

heard negative anecdotal experiences about the procedure from others. Establishing a good rapport by thoroughly explaining the procedure, answering questions, and addressing concerns does a great deal to reduce anxiety before the procedure.

As with all procedures, standard precautions should be observed at all times.

- Obtain informed consent.
- Although **complications** are possible and can be serious, remind patients that for most patients the risk for complication is low. Explain the steps of the procedure, using drawings to illustrate the anatomy of the spine to emphasize the low risk for spinal cord damage with correct procedure technique.

Reassure patients that for most the risk of a serious complication is extremely low.

- All patients may benefit from the use of atraumatic lumbar puncture needles. In a recent meta-analysis, use of an **atraumatic pencil point needle**, which separate rather than lacerate the dural fibers, reduced the risk of PDPH by 60%.[7] These needles are included in many adult and pediatric lumbar puncture kits. Patients with a history of PDPH may also benefit from a period of bedrest after the procedure and other prophylactic measures.[7,8]

Use of atraumatic (pencil point) needles reduces the incidence of PDPH.

- Most patients tolerate lumbar puncture with minimal anxiety and discomfort. Anxiolytics can be administered before the procedure if needed. For young children, patients with severe procedure-related anxiety, or those in whom

prolonged immobility is needed for instillation of medication, lumbar puncture should ideally occur in a facility capable of providing procedural sedation.[8]

- If the procedure is performed in the outpatient setting, the patient can expect to remain for 1 to 2 hours afterward for observation and monitoring.

Materials

1. Suitable facility with personnel and equipment available to deal with an emergency complication
2. An assistant to help position and support the patient
3. A lumbar puncture tray (Fig. 17.2) or the following sterile items:
    - Three sterile skin swabs or sponges with skin cleansing solution
    - 1% lidocaine solution 5 mL
    - Fenestrated sterile drapes
    - 3-mL syringe
    - Sterile bandage or dressing
    - Sterile gauze pads
    - 20- and 25-gauge skin infiltration needles
    - Four sample collection vials, numbered and capped
    - Pressure manometer with three-way stopcock
    - Spinal needle, preferably atraumatic needles:
        - Adults: 20- or 22-gauge 3 ½-inch spinal needle (for obese patients consider a 5-inch needle)
        - Infants/Children: 22- or 25-gauge spinal needle with stylet (1½ to 3 inches depending on patient size)

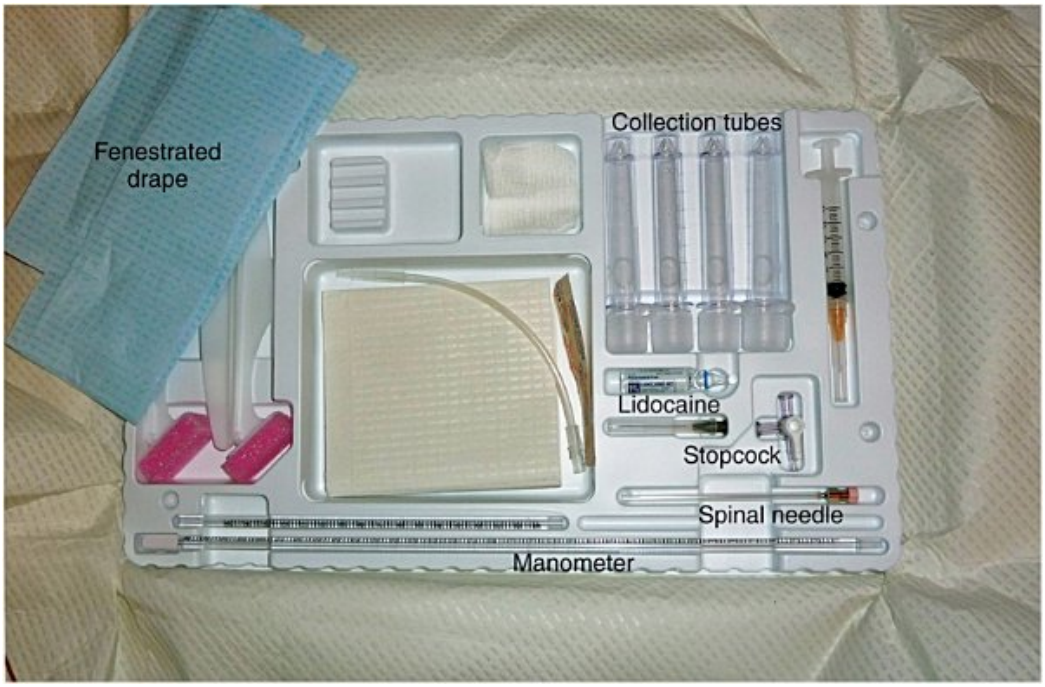

FIGURE 17.2 **Typical lumbar puncture tray.**

Procedure

Lumbar Puncture[2,3,5]

1. Position the patient in either a **lateral recumbent** or upright sitting position based on the position of greatest comfort and safety for the patient, and the purpose of the lumbar puncture. Opening CSF pressure can be assessed only with the patient in the lateral recumbent position. The assistant can help avoid sudden patient movements during the procedure by supporting the patient in a flexed back position with arms and legs held stable. Good back flexion widens the space between the spinous process.

To measure opening pressure, the lateral recumbent position must be used.

- Lateral recumbent position (Fig. 17.3): The patient is side-lying with neck and trunk flexed; the chin and knees are drawn toward the chest in a semifetal position. The patient's back should be parallel to and at the edge of the table.
- Upright sitting position (Fig. 17.4): The patient sits on the side of the bed and leans forward, flexing the trunk over a pillow or bed table, with the arms forward for support. The head is flexed toward the chest.

2. A line drawn between the most superior point of the two iliac crests across the spine identifies the **L4** spinous process (see Fig. 17.4). Inspect and palpate the site for abnormalities. Mark the site with a skin pen or leave a shallow indentation by applying gentle pressure on the skin with a fingernail.

> A line drawn between the highest points of the two iliac crests over the spine falls at L4.

3. Put on sterile gloves and open the lumbar puncture tray using sterile technique.
4. Set up the four collection tubes in numbered order and unscrew the tops.
5. Preassemble the manometer and attach the three-way stopcock if intracranial pressure is to be measured.
6. Check the spinal needle by partially withdrawing then reinserting the stylet to check for smooth function.
7. Check to make sure all necessary equipment is in the tray before beginning the procedure.
8. Keep the sterile tray within easy reach and maintain it as a sterile field.
9. Clean the patient's back with skin preparation cleansing solution. Start at approximately the L3 level and work in a circular pattern outward, cleansing a large area upward to

the lower thoracic spine, downward over the buttocks and sacroiliac area, and sideways over the iliac crests. Repeat this procedure a total of three times with a new sponge or swab each time.

10. Place the fenestrated sterile drape over the patient's back, with the circular opening centered over the L3 to L4 area. Most drapes have an adhesive strip to secure them to the patient's skin. Ideally, the drape should be large enough that it will extend from the patient to the adjacent bed or table to provide additional sterile workspace.
11. Palpating through the sterile drape, identify the iliac crest and repeat identification of the L4 vertebra. Identify the L3 to L4 interspace and anesthetize the overlying skin with 1 to 2 mL 1% lidocaine solution.
12. When the area is anesthetized, position the needle with stylet in place so that the bevel is inserted parallel to the longitudinal dural fibers.
13. Slowly insert the spinal needle and stylet (Fig. 17.5) into the L3 to L4 intervertebral space. The needle should be precisely in the midline and directed toward the patient's umbilicus. Advance the needle slowly. A **"popping" sensation** is usually appreciated when the needle passes through the ligamentum flavum into the thecal sac. When this occurs, remove the stylet and CSF should flow.

When the needle passes into the thecal sac, a "popping" sensation usually occurs.

14. Attach the manometer as soon as fluid appears in the hub of the needle and measure the opening pressure. Have the patient gently relax the legs and breathe slowly. Allow 30 to 60 seconds for the pressure to stabilize, then measure the

pressure. You can release and collect the fluid by turning the manometer stopcock before removing it.

15. Collect approximately 1 mL of CSF in each of the four collection bottles provided, using them in numerical order.
16. If closing pressure measurement is needed, reattach the manometer and obtain the reading.
17. When sufficient fluid is collected, replace the stylet. With a quick, smooth motion then remove the needle and stylet. Have sterile gauze ready to apply pressure to the site. Hold pressure for a minimum of several minutes or until there is no CSF leakage when the gauze is removed.
18. When no bleeding or fluid leakage can be detected at the lumbar puncture site, clean the area again to remove the skin cleanser and apply an adhesive bandage.

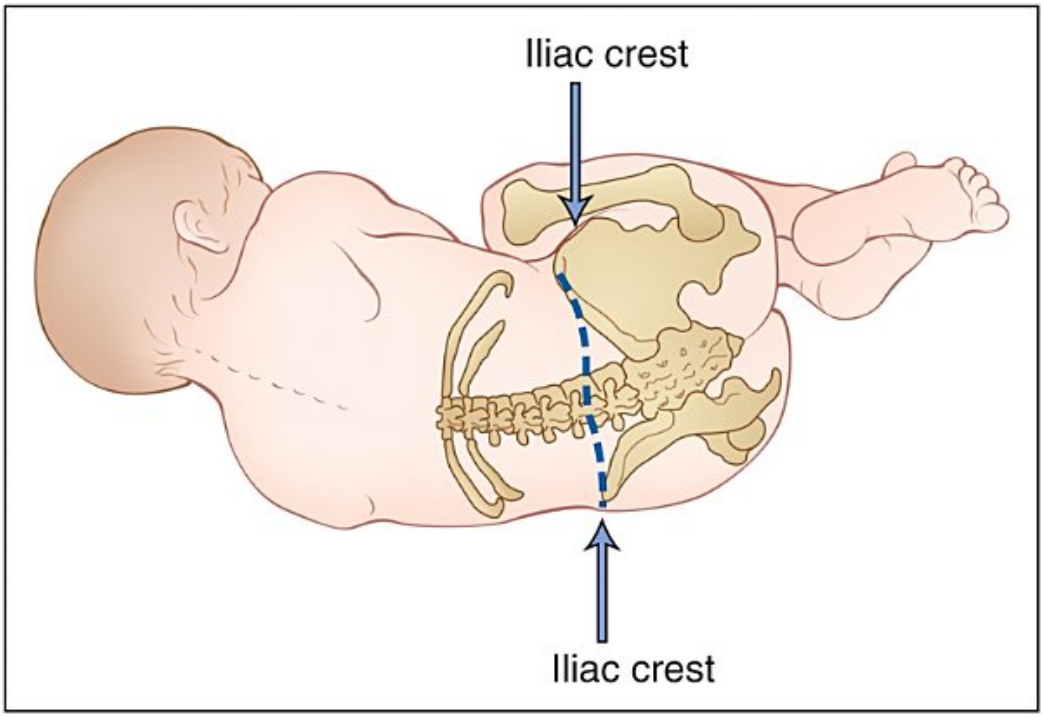

FIGURE 17.3 Patient positioning in lateral recumbent position (adult and pediatric). (Redrawn from Hughes WT, Buescher ES. *Pediatric Procedures*, Philadelphia: WB Saunders; 1980, p. 180.)

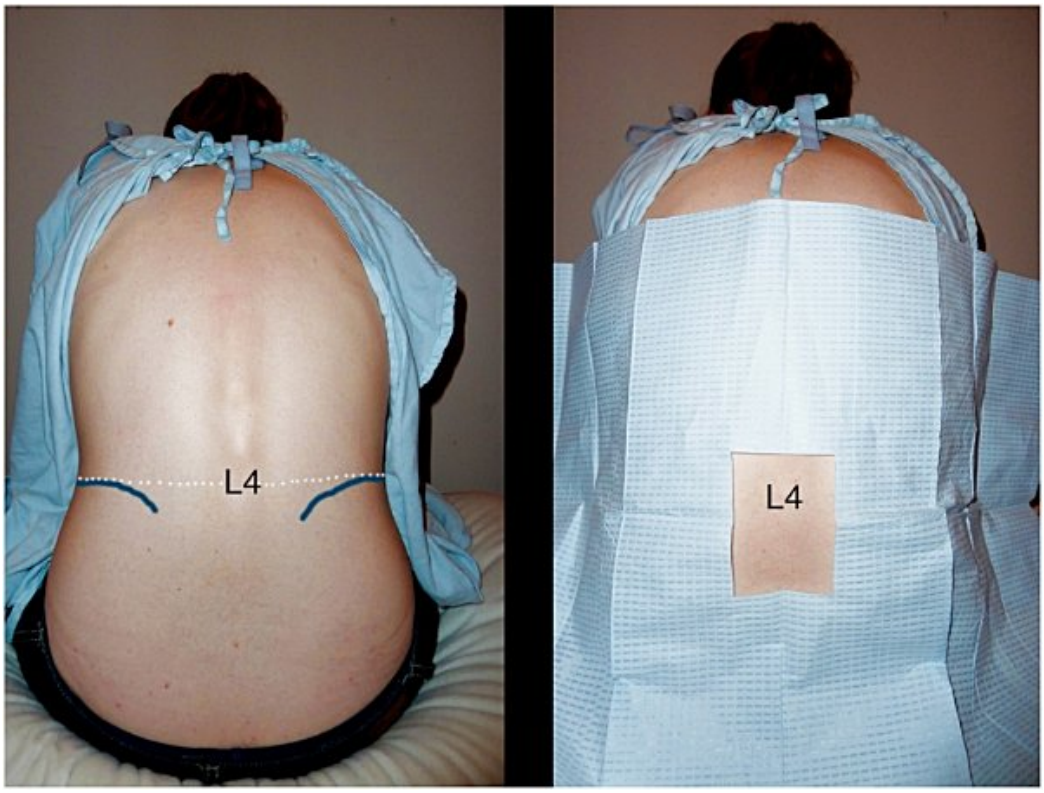

FIGURE 17.4 **Upright positioning and assessment of anatomic landmarks.**

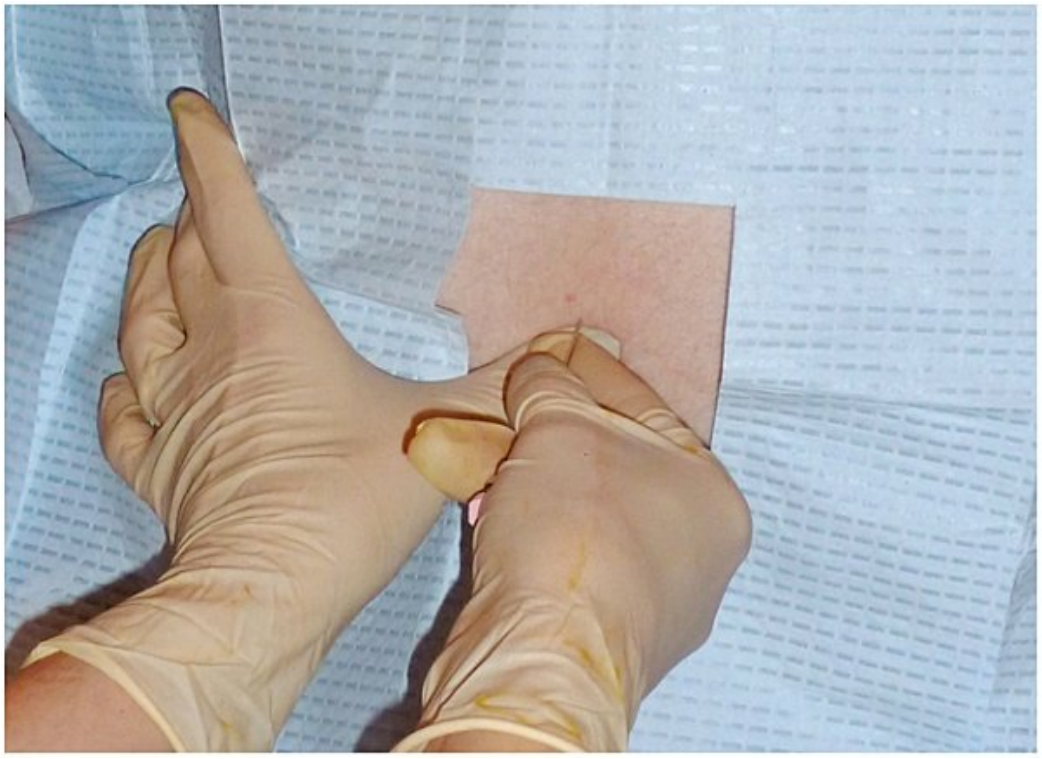

FIGURE 17.5 **Needle insertion for lumbar puncture using landmarks for correct placement.**

Special Considerations

The following should be considered when performing the lumbar puncture procedure:

- As you are advancing the spinal needle with the stylet, you may check whether you have entered the epidural space by removing the stylet and watching for CSF flow into the needle hub. If it does not occur, replace the stylet before continuing to slowly advance the needle.[5]
- Despite careful positioning, you may inadvertently hit bone. If this occurs, reposition the needle and gently reattempt the procedure. If you still meet resistance, remove the needle, recheck landmarks, and consider repositioning the patient with increase spinal flexion.
- **Traumatic** lumbar punctures are common. If vessels are punctured during needle insertion causing bloody fluid,

several maneuvers can be attempted. First, rotate the needle 45 degrees from the original orientation. This may move the needle bore away from the site of bleeding and allow the fluid to clear. Second, be patient and allow a few minutes with the stylet in place to see if the bleeding site seals over and allows clearing of the fluid. Finally, if these maneuvers are unsuccessful, you may attempt to repeat the lumbar puncture at the next higher interspace if that is an appropriate site within usual guidelines for the patient's age.[6,7]

Attempt to clear bloody CSF by rotating the needle 45 degrees or reinserting the stylet and waiting a few minutes for hemostasis.

- If nerve root irritation occurs with pain or paresthesias during the lumbar puncture, repositioning the needle slightly may eliminate the symptoms. If it does not, remove the needle. If symptoms do not resolve immediately, defer additional attempts.[1,2]
- Needle breakage is rare. If the needle breaks and the fragment is near the skin surface, leave the stylet in place and use it as a guide to perform a superficial skin incision. Once the end is found, it can be removed with a hemostat. If this is not quickly and easily accomplished or there is any question that fragments may remain, consult a neurosurgeon.[1,2]
- Occasionally, no fluid is obtained at lumbar puncture—a "dry tap." The most common reason for this is that the epidural space was not pierced, and repositioning of the needle is indicated. Other things to consider are dehydration, blockage to fluid circulation, and congenital anomalies.[1,9]

Lumbar Puncture in Children

1. The same precautions, positioning, and general procedure outlined for adults applies to children (see Fig. 17.3).[8]
2. The key to a **successful lumbar puncture** in children is adequate restraint. Age, medical condition, and personality are all factors to consider in procedure planning. Many children can undergo lumbar puncture with only local anesthesia. Sedation can be provided, ranging from a mild anxiolytic to monitored anesthesia care (MAC) anesthesia. For procedures that include instillation of medications, such as antineoplastic drugs, MAC anesthesia is often preferred.

Secure restraint is key to a successful lumbar puncture in a child. Sedation may be needed.

Because of their smaller size and overall CSF volume, collect the smallest amount of fluid necessary for the tests required, usually 1 mL in each of the four tubes for standard testing.

Lumbar Puncture in Infants

The preparation and procedure for lumbar puncture is not substantially different in an infant compared with a child or an adult.[9,8] Maintenance of body temperature and a patent airway during positioning and recognizing anatomic differences in the spinal cord are key to performing a safe and successful lumbar puncture. When performing a lumbar puncture on any ill or premature infant, electronically monitor the heart and respiratory rate during the procedure to identify apneic episodes or respiratory compromise. In addition, the assistant should monitor the baby visually for cyanosis or respiratory symptoms.

1. Bring the baby to an infant **treatment warmer.** Attach a skin temperature probe and set the warmer to maintain the baby at normal body temperature during the procedure.

Take measures to maintain body temperature, monitor heart rate and breathing, and avoid overflexing the neck, which may obstruct the airway in infants.

2. Lumbar puncture in infants is most easily performed in the sitting position, with the holder flexing the thighs on the abdomen, allowing him or her to grasp the right knee and elbow with the right hand and the left knee and elbow with the left hand. Gently flex the spine, using care not to cause excessive abdominal pressure or overflex the neck and occlude the infant's airway (Figure 17-6).
3. If the infant is premature or has an unstable airway, respiratory problems, or abdominal distention, lateral recumbent positioning may be preferred. The assistant positions the infant using one hand to flex the thighs to the abdomen and secure the extremities while the other hand flexes the neck and spine.
4. Use the same process to identify the L3 to L4 interspace, but remember that the spinal cord in an infant terminates at the L3 level and extra care should be used to assess anatomic landmarks for correct needle placement.

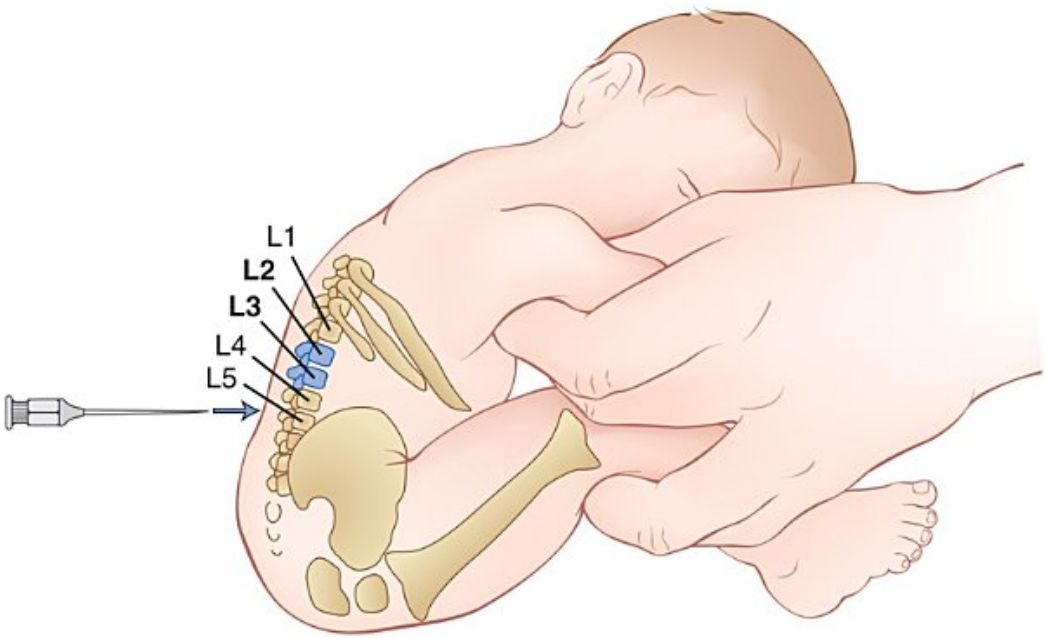

FIGURE 17.6 Upright infant positioning for lumbar puncture. (Redrawn from Hughes WT, Buescher ES. *Pediatric Procedures*, ed 2. Philadelphia: WB Saunders; 1980, p, 181.)

Follow-Up Care and Instructions

Aftercare and patient instructions are as followed:

- **Before the patient leaves the procedure area,** ensure that the lumbar puncture site has sealed over and no leakage of CSF persists.

Before releasing the patient, check that no leakage or bleeding is present at the puncture site.

- At home, the bandage may be removed in 12 to 24 hours. The patient should keep the area clean and dry, monitor for signs of infection or CSF leakage, and return for revaluation if symptoms occur.
- Recommendations for treatment of PDPH[11]

Intravenous caffeine and other medication infusions may be tried if oral medications are not effective. If the PDPH persists beyond 24 hours, an **epidural blood patch** is the most effective treatment. The assistant performs venipuncture collecting 10 to 20 mL of the patient's blood in a syringe. The proceduralist, who has sterilely draped and prepared the patient's back, essentially repeats the lumbar puncture up to the point of entering the thecal sac. The stylet is withdrawn and the patient's blood is injected into the epidural space. A blood patch is believed to work by exerting a mass effect compressing the dural sac, sealing the CSF leak. The patient should remain in the decubitus position for 1 to 2 hours after the procedure for maximal benefit. Headache relief is usually rapid.

An epidural blood patch is the most effective treatment for persistent PDPH.

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CHAPTER 18

Nasogastric Tube Placement

Daniel T. Vetrosky

Abstract

This chapter covers the background, indications, contraindications, potential complications, essential anatomy and physiology, patient preparation, materials, procedure, special considerations, and follow-up care and instructions for the placement of a nasogastric tube (NG). The objectives of this chapter will allow the student/practitioner to:

- Describe the indications, contraindications, and rationale for performing NG tube placement.
- Identify and describe common complications associated with performing NG tube placement.
- Describe the essential anatomy and physiology associated with the performance of NG tube placement.
- Identify the materials necessary for performing NG tube placement and their proper use.
- Describe the steps for correctly inserting an NG tube.
- Discuss aspects of post-NG tube placement care and follow-up.

Keywords

anatomy and physiology
aspiration

complications
contraindications
facial trauma
gastric decompression
gastric sampling
indications and rationale
materials
precautions procedure
radiography

Procedure Goals and Objectives

GOAL: To perform nasogastric (NG) tube placement in a patient safely and accurately.
OBJECTIVES: The student will be able to:

- Explain the indications, contraindications, and rationale for performing NG tube placement.
- Identify and discuss common complications associated with performing NG tube placement.
- Describe the essential anatomy and physiology associated with the performance of NG tube placement.
- Identify the materials necessary for performing NG tube placement and their proper use.
- Demonstrate the steps for correctly inserting an NG tube.
- Discuss aspects of post-NG tube placement care and follow-up.

Background and History

The first recorded use of a tube placed into the esophagus for feeding was reported to have been by Capivacceus in 1598, when he introduced nutrient substances into the esophagus using a hollow tube with a bladder attached to one end. In 1617, Fabricius ab Aquapendente reported using a silver tube passed through the nostril into the nasopharynx to feed a patient with tetanus. In 1867, Kussmaul introduced a flexible orogastric tube for gastric decompression, and Ewald and Oser introduced the soft rubber tube for gastric intubation in 1874.[1]

The passage of a hollow tube into the stomach has been used for research and medical-surgical purposes for many years. Sampling the gastric contents, decompressing a distended stomach, preventing aspiration during surgery, and performing gastric lavage are just a few of the current and past **uses for the NG tube**. This chapter covers the indications, rationale, and complications of NG tube placement, as well as types of NG tubes and insertion and removal techniques.

An NG tube has many uses, which include gastric sampling, gastric decompression, prevention of reflux during anesthesia, and in prolonged surgical procedures.

Indications

Indications for the insertion of an NG tube are many and range from severe diverticular disease to unrelenting vomiting. NG tubes are indicated as follows:

- Sampling gastric contents
- Removing air, blood, ingested substances, and gastric contents
- Providing nutritional support for patients who cannot eat but have a functional gastrointestinal (GI) tract

Table 18.1 outlines some of the indications and the rationale for the insertion of the NG tube.

Table 18.1

Indications and Rationale for Nasogastric Tube Insertion

Indications	Rationale
Diverticulitis (usually severe)	To rest the gastrointestinal tract, especially if bowel obstructive symptoms exist; relieves abdominal distention and vomiting, if present
Gastric outlet obstruction	As above, and can be diagnostic if > 200 mL foul-smelling fluid obtained in the presence of obstructive symptoms
Gastrointestinal bleeding	Diagnostic if bright red blood or "coffee grounds" material is aspirated; can intermittently suction to assess presence of active bleeding (should not perform lavage in these patients because it may increase the chance of aspiration)
Intestinal obstruction	To relieve abdominal distention and vomiting
Near drowning	To empty swallowed water and to prevent aspiration
Vomiting	To prevent aspiration and in intestinal obstruction, if present
Surgery (stomach, abdominal)	Decompresses stomach and may help lessen the chance for aspiration; can monitor postoperative bowel function return
Severe burns	Patients in the immediate postburn period are likely to develop ileus; NG intubation helps empty the gastric contents and lessens the chance of aspiration

Indications	Rationale
Nutritional support	Used in patients who cannot take in adequate amounts of nutrition orally; must be used only in patients who are able to sit up in bed and can protect the airway; aspiration is a concern
Gastrointestinal lavage/aspiration	Used in patients with suspected or known overdose to lavage and evacuate any residual medication or ingested agents

Contraindications

Nasogastric tube placement is **contraindicated** when the intended path of the tube is obstructed or any of the structures the NG tube would traverse are damaged, as well as in the following situations or conditions:

- Choanal atresia
- Significant facial trauma or basilar skull fracture
- Esophageal stricture or atresia
- Esophageal burn
- Zenker diverticulum
- Recent surgery on the esophagus or stomach
- History of gastrectomy or bariatric surgery

Major contraindication for NG tube placement include severe facial trauma and cribriform plate disruption, with the potential of placing the tube intracranially.

Potential Complications

The potential **complications** in NG tube placement are as follows:

- Trauma to the turbinate, nasopharynx, or both during passage of the tube: Bleeding from the nares and spitting of

blood from the mouth are signs of trauma to the nasopharyngeal region caused by NG tube placement. Proper insertion techniques, gentle pressure during tube passage, and ensuring patient cooperation will help prevent these problems.

- Erroneously assuming that the tube is in the stomach: Irrigation of an NG tube that is in the lungs can cause serious complications, such as pneumonia.
- Placement of the NG tube into the trachea and lung: This can result in pneumothorax if the tube is advanced forcefully into the lung tissue.

A main complication of NG tube placement is aspiration; thus, suction must be available during the insertion procedure.

The best way to avoid complications associated with NG tube placement in anatomic locations other than the stomach is to obtain radiographic confirmation. If radiography is not available, placing the NG tube in a glass of water once it has been passed can confirm poor placement. If the tube is placed in the lung, submerging the end of the tube in water reveals bubbles during exhalation. When this occurs, the tube must be removed completely and another NG tube inserted. Other potential complications are as follows:

- Gastric erosion with hemorrhage
- Erosion or necrosis of the nasal mucosa
- Aspiration pneumonia
- Sinusitis
- An NG tube passed in a patient with significant head, neck, thoracic, or abdominal trauma: In this setting, the NG tube may traverse a break in the nasopharynx, larynx, esophagus, or stomach. Advancement of the tube in this setting may result in severe damage to the brain, lungs, or peritoneal cavity.

Essential Anatomy and Physiology

Insertion of an NG tube involves passing it through one of the nares into the nasopharynx. It is then passed into the posterior oropharynx and further inferiorly until it reaches the level of the larynx. At the level of the larynx, the tube may pass either anteriorly into the trachea or posteriorly into the esophagus (Fig. 18.1). Having the patient swallow greatly facilitates the passage of the NG tube into the esophagus. With swallowing, the vocal cords of the larynx are strongly approximated and the epiglottis swings backward, covering the opening of the larynx. These factors help prevent the passage of food (or in this case the NG tube) into the trachea.

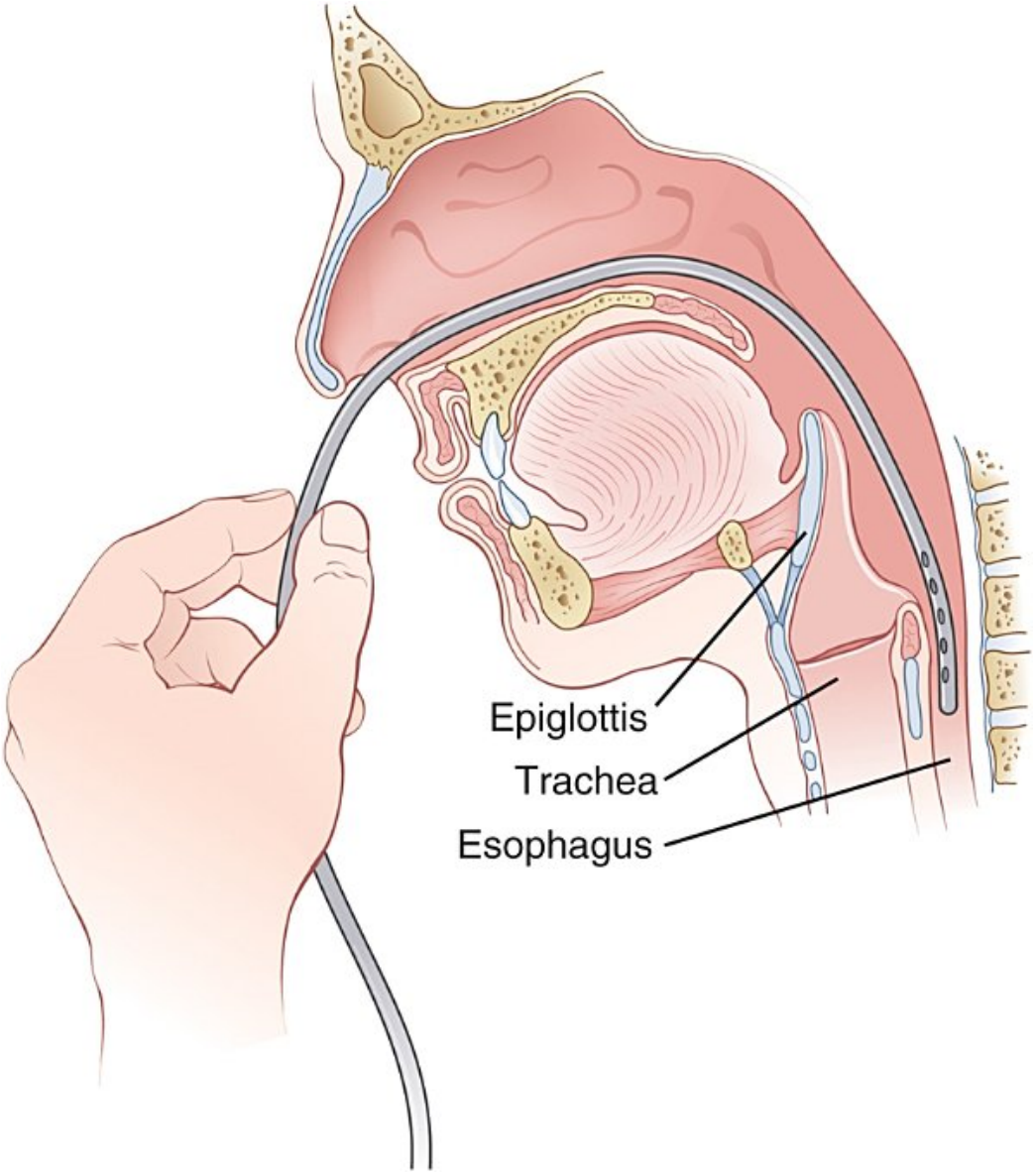

FIGURE 18.1 Passage of the nasogastric tube. (Modified from Rosen P, Bankin RM, Sternback GL. *Essentials of Emergency Medicine.* St. Louis: Mosby; 1991, p. 615.)

During swallowing, the entire larynx is pulled upward and forward by muscles attached to the hyoid bone. This movement causes the opening of the esophagus to stretch. Simultaneously, the upper portion of the esophagus (upper 3 to 4 cm) relaxes, and thus food moves more easily into the upper esophagus.

The esophagus is a muscular tube that begins at the level of the cricoid cartilage and is an average of 20 cm long and 3 cm in

diameter in most adults. It courses through the posterior mediastinum, behind the heart and aorta, and penetrates the esophageal hiatus of the diaphragm. It then joins the cardia portion of the stomach just below the level of the diaphragm. Once the NG tube reaches the upper esophagus, rapid peristaltic waves are initiated that assist in passing it down the length of the esophagus and facilitate its advancement into the stomach. The esophagus has two sphincters, one at each end, which physically isolate the remainder of the GI system from the outside environment. The esophagus, like other organs in the thoracic cavity, undergoes negative pressure during inspiration; without sphincters, gastric contents would be sucked into the esophagus with each breath.

Anterior flexion of the cervical spine during NG tube insertion also facilitates passage into the esophagus. This occurs by causing the tube to rest or press against the posterior portion of the oropharynx as the NG tube is advanced. Consequently, it is better aligned to pass into the esophagus when it reaches the level of the larynx.

Standard precautions

Practitioners should use standard precautions at all times when interacting with patients. Determining the level of precaution necessary requires the practitioner to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

Patient Preparation

The patient should be prepared as follows:

- The patient should be alert and able to cooperate with the procedure.
- Informed consent typically is not required.
- Before beginning, explain and discuss the procedure to help facilitate patient cooperation.

- Explain the importance of keeping the neck flexed until the tube is in the esophagus. This is essential to avoid placement of the tube in the trachea.
- Patients should be informed that the introduction of the tube normally produces some degree of gagging.
- Ask the patient to take small sips of water through a straw and swallow to facilitate placement of the tube into the esophagus.

Materials

Typical equipment needed for placement of an NG tube can include the following (equipment may vary slightly from setting to setting):

- Nonsterile procedure gloves, goggles, and gown
- Portable or wall suction equipment and connection availability
- Hypoallergenic tape, an occlusive seal dressing, or a premanufactured NG tube holder (some hospitals keep them available)
- Tincture of benzoin
- Emesis basin
- Cup of water and a straw
- Stethoscope
- 20- to 60-mL irrigation syringe (an irrigation-tip Toomey syringe, not a Luer-Lok syringe)
- 100 mL of water (tap or sterile) for irrigation
- Towels to protect patient gown and bed linen in case of emesis
- Malleable stylet if small feeding tube is used
- Appropriate size and type of NG (Levin) tube

The most common type of NG tube currently used is the Levin tube. These tubes range in size from 3 to 18 French (Fr). Tubes larger than 18 Fr should not be passed nasally because of the increased risk for trauma. Larger tubes, which are placed through the oral cavity,

are reserved for extreme emergency procedures and can be as large as 26 to 32 Fr.

The size of the NG tube used depends on the patient's age and size, purpose of the NG intubation, length of time the tube will be required, viscosity of the fluids being instilled or evacuated, and disease processes present, if any. Neonates, infants, and patients with sinus or esophageal problems may require very small sizes (3 to 8 Fr), whereas typical, otherwise healthy adult patients require NG tubes from 10 to 18 Fr. Patients who require gastric lavage for medication overdose, ingestion of certain toxic substances, or evacuation of blood clots require larger-bore NG tubes or may require oral gastric intubation.

Specialized NG tubes, such as those with weighted ends, are used to facilitate passage into the duodenum and small intestine. Double-lumen NG tubes that have one opening at the distal end (for feeding or instillation of fluids) and other openings along the distal sides of the tube allow for gastric decompression and jejunal feeding. NG tubes with multiple openings along the distal length, known as sump tubes, are used when it is necessary to irrigate or evacuate large amounts of fluids from the stomach.

Procedure

Nasogastric Tube Insertion

1. Ensure the patient is sitting in a 45-degree angle or greater.
2. Ensure that all necessary materials and personnel are readily available before beginning the procedure.
3. Wash hands and don gloves, goggles, and gown.
4. Place a protective sheet in place over the patient's chest and abdomen.
5. Check for nasal patency and examine each nasal passageway. Choose the appropriate, most patent nostril for tube placement.
6. Using the tube to be inserted, measure from the tip of the nose to the earlobe and from the earlobe to the xiphoid to

determine the appropriate tube insertion length and distance (Fig. 18.2).

NOTE: Either count the markings on the tube or place a small piece of tape at the measured insertion length. If the tube is to be placed below the stomach, add an additional 15 to 25 cm to the premeasured mark.

7. Lubricate the first 2 to 3 inches of the tube with lidocaine jelly lubricant.
8. Before inserting the tube, ensure the beveled opening or side of the tube is positioned toward the nasal septum to avoid trauma to the turbinate.
9. Have the patient flex the neck forward, bringing his or her chin toward the chest.
10. Slowly and gently begin inserting the tube into the nostril straight back at a 90-degree angle to the long axis of the head.
11. Have the patient begin taking small sips of water through a straw and swallow as you gently advance the tube. Timing the advancement of the tube in conjunction with the patient swallowing greatly facilitates the passage of the NG tube into the stomach.

CAUTION: If any obstruction is encountered, do not force the tube, because this may damage the turbinate.

NOTE: If resistance is met, withdraw the tube slightly and try placing the tube again. If continued resistance is met, try the other nostril.

12. If the tube advances without resistance, continue having the patient swallow while gently inserting the tube until the premeasured mark or tape is reached.
13. Have the patient slowly begin raising the chin from the chest as the tube passes, because this helps facilitate the tube's passage.

14. If the patient begins to gag, pause, have the patient take deep breaths until the gagging has stopped or calmed down, and then continue with the insertion as described.
15. If the tube curls up in the posterior pharynx, which typically causes the patient to gag, gently pull back on the tube until it uncurls.

CAUTION: Do not pull the tube out completely. Wait until the patient has stopped gagging or has calmed down.

16. Make sure the patient takes sips of water and swallows while gently advancing the tube again.
17. Check the position of the tube by:
    - Making sure the tube is inserted the measured or calculated distance.
    - Injecting approximately 10 mL of air through the tube while listening over the left upper quadrant of the abdomen with the stethoscope for the "rush of air."
    - Aspirating gastric contents and checking the pH: If the pH reading is less than 3.0, the tube is in the stomach.
    - Obtaining radiographs: Because there is a radiopaque strip in all Levin tubes, radiography is the gold standard for determining correct placement of feeding tubes or NG tubes. When radiography is readily available and not contraindicated, all NG tube placements should be confirmed radiographically as soon as conveniently possible.
18. Tape the tube in place; this is important for ensuring maintenance of proper tube placement.
19. Use tincture of benzoin to facilitate the adherence of the tape, premanufactured NG tube holder, or occlusive seal dressing.

CAUTION: Taping the tube so that no torsion or pressure is placed on the nares while the tube remains in place is paramount (Fig. 18.3).

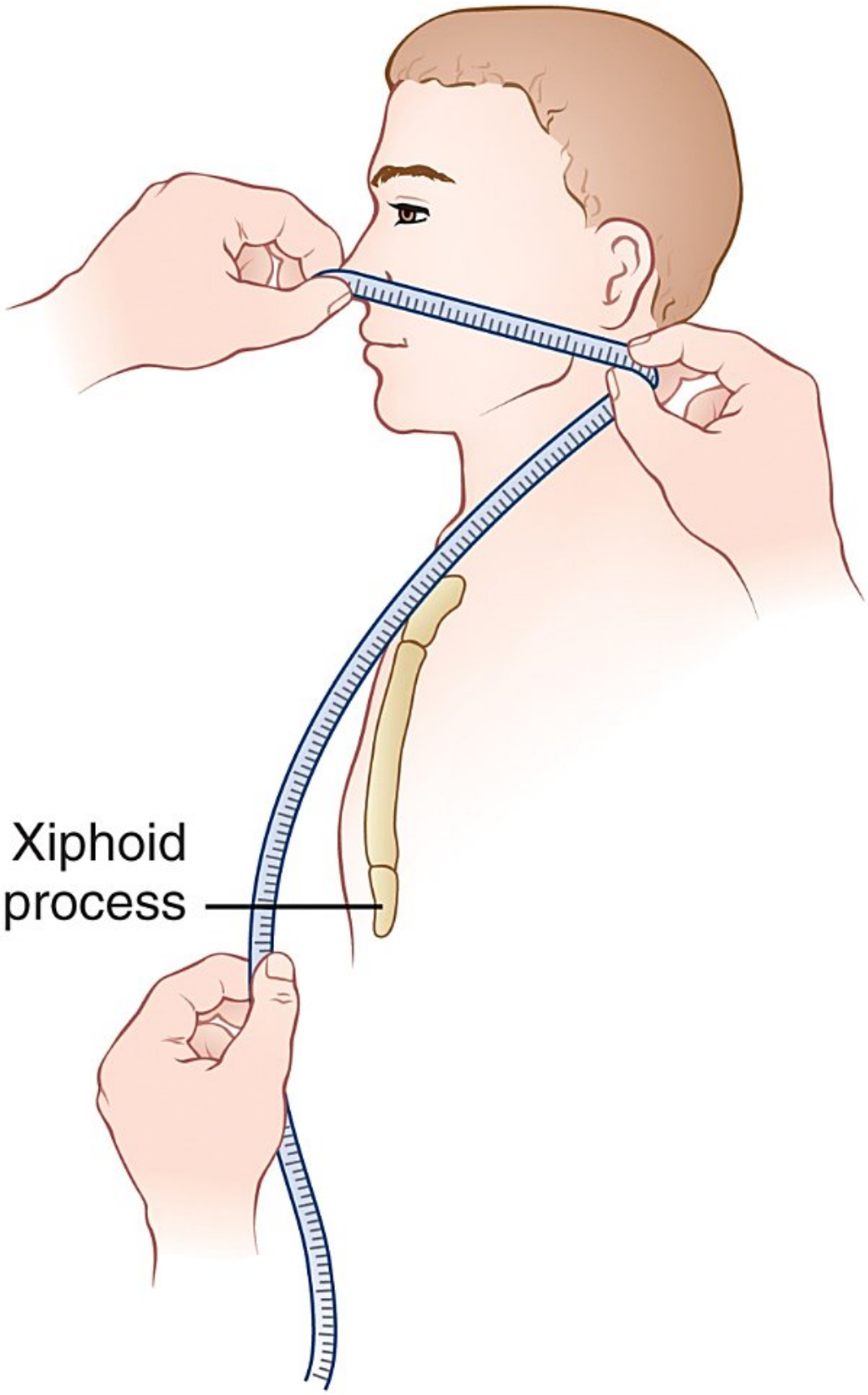
Xiphoid
process

FIGURE 18.2 Measuring tube insertion length and distance. (Modified from Potter PA, Perry AG. *Fundamentals of Nursing: Concepts, Process, and Practice,* ed 4. St. Louis: Mosby–Year Book; 1997, p. 1407.)

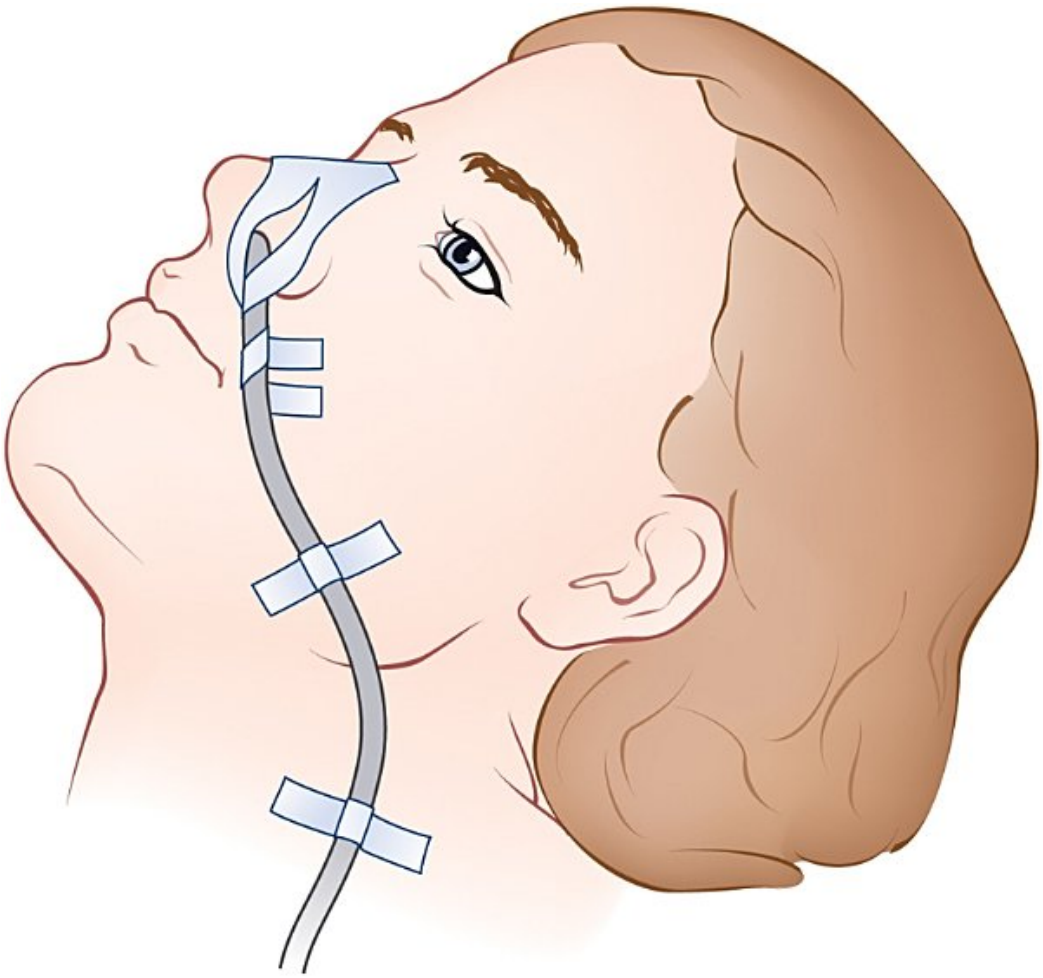

FIGURE 18.3 Proper taping technique. (Modified from Rosen P, Bankin RM, Sternback GL. *Essentials of Emergency Medicine.* St. Louis: Mosby; 1991, p. 615.)

Special Considerations

Patients with impaired mentation or who are comatose and cannot assist with important aspects of the procedure may present technical challenges. In this instance, placing the NG tube in an ice bath before

insertion may help by causing the tube to become temporarily somewhat more rigid and less likely to kink. Also, it may be necessary to pass the tube to the level of the oropharynx and then pass the tube into the esophagus using a Magill forceps.

Insertion of an NG tube in patients with endotracheal tubes can be challenging. In some instances, deflating the cuff on the endotracheal tube is necessary to pass the NG tube into the esophagus.

Follow-Up Care and Instructions

Aftercare and patient instructions should include the following:

- Ensure that the NG tube is functioning properly.
- The tubes are ineffective when they are not patent. To ensure the patency, disconnect the tube from the suction device.
- Using a large syringe, inject 20 to 30 mL of air through the NG tube. Free flow of air through the tube indicates that the tube is functioning properly.
- It is important to assess the nares and nasopharynx periodically to ensure that no pressure ulcer or tissue necrosis is occurring from irritation or pressure from the NG tube.
- Remove the NG tube as soon as it is no longer needed or indicated.

Procedure

Nasogastric Tube Removal

Once it has been determined that the NG tube should be removed, it is important to prepare the patient for this activity by answering any questions the patient may have and informing the patient of the process. Equipment that may be needed includes a small towel or pad, normal saline solution, catheter tip syringe, and facial tissues.

1. Be sure to observe standard precautions.

2. If the tube is connected to suction, turn the suction off and detach the NG tube from the suction tubing and insert the end cap if available.
3. Position a towel or pad on the patient's chest and place the patient in a semi-Fowler's position.
4. Flush the tube with 25 to 30 mL of normal saline to eliminate gastric content from tube.
5. Remove the tape from the nose that had been utilized to anchor the NG tube as well as any clips or pins that may have been used to attach the NG tube to the patient's gown.
6. Clamp off, pinch, or cap the NG tube.
7. Instruct the patient to take a deep breath and gently with continuous motion remove the tube. Once the tube is removed it should be placed in an appropriate wrapper/pad/bag and appropriately disposed of.
8. Provide the patient with an opportunity to do oral care and cleaning.

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CHAPTER 19

Obtaining Blood Cultures

Cody Sasek

Abstract

Reliably and safely obtaining blood samples for culture is an important skill and invaluable to the diagnostic workup of certain febrile and possibly septic patients. Knowledge of the indications, contraindications, and rationale for, and skill in, the performance of this procedure will not only help the clinician obtain accurate samples and avoid contamination, but will also aid in the interpretation of results. Skills in venipuncture and sterile technique will be addressed as central to obtaining appropriate blood samples for culture.

Keywords

bacteremia
blood culture
fever or unknown origin
fungermia
intravascular infection
sepsis
SOFA and SIRS criteria
venipuncture

Procedure goals and objectives

GOAL: To obtain quality blood culture samples successfully with a minimal degree of risk to the patient and provider.

OBJECTIVES: The student will be able to:

- Describe the indications, contraindications, and rationale for obtaining a blood culture.
- Identify and describe common complications associated with obtaining a blood culture.
- Describe the essential anatomy and physiology associated with obtaining a blood culture.
- Identify the materials necessary for obtaining a blood culture and their proper use.
- Identify important aspects of patient care after a blood culture is obtained.

Background and History

Blood cultures are an important part of the evaluation for any patient in whom there is a suspicion of bacteria or fungi in the bloodstream leading to possible septicemia. This includes those patients with positive systemic inflammatory response syndrome (SIRS) criteria or the newer, more laboratory-and diagnostics-driven sequential organ failure assessment score (SOFA) score.[1] Markers of possible bloodstream infection include various combinations of fever, increased heart rate, increased respiratory rate, leukocytosis, or leukopenia (although a normal white blood cell count does not rule out septicemia).

Identification of pathogens within the bloodstream is accomplished primarily by blood culture. Culturing blood is one of

the most important procedures in individuals who are severely ill and febrile and those with suspected intravascular infection, because isolation and identification of an infectious agent from the blood has obvious diagnostic significance and provides an invaluable guide for selecting the most appropriate antimicrobial agent for therapy.[2] Sources of bacteria or fungi in the bloodstream include focal sites of infection most often associated with the respiratory tract, genitourinary tract, abdomen, skin, and soft tissues.

Indications

Indications for blood cultures include:

- Reasonable suspicion of the presence of a bloodstream infection, either bacteremia or fungemia. A thorough history and physical examination provide valuable information for determining the possibility of an infectious state.
- Need for identification of the specific infecting organism.
- Monitoring the efficacy of pharmacologic treatments for septicemia.
- Other specific indications include severely ill and febrile patients, suspected infective endocarditis, intravascular catheter site infection, meningitis, peritonitis, osteomyelitis, septic arthritis, pneumonia, and fever of unknown origin.

Contraindications

There are few contraindications to obtaining blood cultures. Relative contraindications include:

- Patients being treated with warfarin (Coumadin) and novel oral anticoagulants should be assessed carefully to determine if the benefit of the procedure outweighs the potential risk.
- Obtaining blood cultures should be avoided at the site of an active skin infection because of the risk of introducing bacteria into the bloodstream and the possibility of

contaminating the culture with organisms from the infected site.

- If multiple previous blood cultures have failed to identify an infecting agent, the likelihood of obtaining a useful result is diminished and must be considered in view of all available clinical evidence.

Potential Complications

Complications resulting from the collection of a blood culture are limited, but can include:

- Development of a hematoma at the venipuncture site.
- Continued bleeding from puncture site.
- Localized complications, such as focal cellulitis and phlebitis.
- Contaminated blood samples may result in the inappropriate use of antibiotics. This may enhance bacterial resistance, increase antibiotic-related complications, and possibly raise health care costs.[3]

In general, contamination should be suspected in the following cases[2]:

- A common component of the skin flora is recovered, and the patient's history does not warrant consideration of a "nonpathogen" as being significant.
- Multiple bacterial species are cultured.
- Growth is found with only one of several specimens from separate venipunctures.

Essential Anatomy and Physiology

It is important to recognize the specific anatomy of areas from which blood cultures will be obtained. At least two different **anatomic sites** should be used for specimen collection.[4] The median cubital vein usually is the easiest to locate. Other acceptable locations include the

cephalic and basilic veins and veins in the back of the hand (Fig. 19.1).

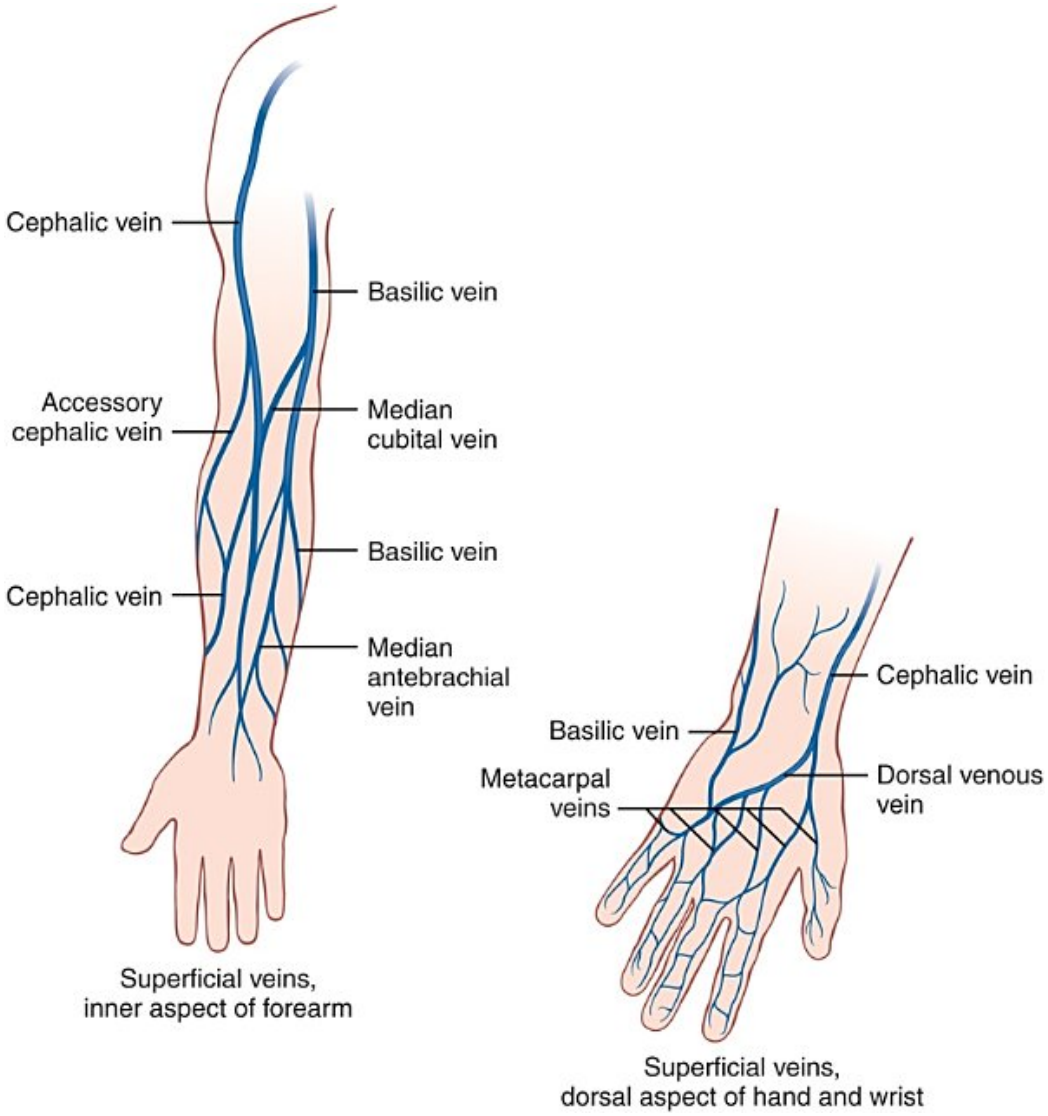

FIGURE 19.1 **Venous anatomy of the arm and hand.**

At least two, preferably three sets of blood cultures should be taken from separate venipuncture sites.

Standard precautions

Clinicians should use standard precautions at all times when interacting with patients, treating each as though there is a potential transmittable disease, whether this status is known or not. Determining the level of precaution and personal protective equipment necessary requires the practitioner to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

Patient Preparation

The patient should be educated about the need for the procedure and the potential benefits and risks associated with its performance. This should include:

- Explaining that the procedure includes skin preparation and the need to use two separate venipuncture sites
- Preparing the patient for the brief pain associated with a needlestick
- Asking about allergies. If the patient notes an allergy to iodine, use chlorhexidine or 70% isopropyl alcohol for site cleansing

Materials

- Nonlatex tourniquet
- Latex-free gloves, nonsterile (sterile glove use may reduce contamination occurrence)
- 70% isopropyl alcohol and chlorhexidine gluconate swabs or wipes
- 20-mL syringes with 21-gauge safety needle or vacuum tube adapter and needle
- Two blood culture bottles for each site (one for anaerobic and one for aerobic collection) with properly identified patient labels
- 2 × 2-inch gauze pads

- Bandages

Procedure

1. Identify the patient. Ask the patient to state his or her name, confirming this with other identification documentation.
2. Assemble and lay out equipment for collecting the blood culture specimen. Wash your hands before putting on gloves. (Chapter 31 contains specific details related to performing venipuncture.)
3. Position the patient in a comfortable and secure position with the arm appropriately supported.
4. Apply a tourniquet 3 to 4 inches above the intended site. Locate an appropriate vein and then release the tourniquet.
5. Clean the site using sterile 70% isopropyl alcohol wipes; starting at the intended site, move outward in concentric circles (Fig. 19.2). Repeat this 2 to 3 times, using a new, clean wipe each time.
6. Next, apply chlorhexidine in the same manner 2 to 3 times and allow the site to air dry. Once dry, the site should not be touched again. Sterile gloves must be worn if the site is to be repalpated.

NOTE: Lower contamination rates have been observed with iodine tincture and chlorhexidine than with povidone-iodine.[5,6]

7. Replace the tourniquet and reswab the area with 70% isopropyl alcohol before venipuncture.
8. Perform the venipuncture using a syringe or vacuum tube system.
9. Draw blood in the correct order. If specimens for multiple laboratory tests are to be obtained, always collect the blood culture specimens first before proceeding with other tubes, as needed.[7]
10. Swab the top of the blood culture bottle with an alcohol wipe before blood insertion. Inoculate the anaerobic bottle,

followed by the aerobic bottle.

11. Release the tourniquet after the first tube has been filled. The tourniquet should not be left on for more than 1 minute.
12. After the specimen has been collected, remove the needle and apply pressure to the puncture site until bleeding has stopped.
13. At completion of the blood draw with the safety syringe, secure the safety needle cover and aseptically dispose of the needle into a proper container. Do not attempt to recap needles.
14. Using the proper manufacturer's transfer device, fill the anaerobic bottle first with the desired amount of blood, followed by the aerobic bottle.
15. After the specimen has been collected, label all cultures with appropriate patient information, which should include patient's full name, identification number, culture site location, time, date, and your initials.
16. Clean the patient's arm of iodine and place an adhesive bandage. Check to make sure the site is not bleeding before covering with the bandage.
17. Pick up, account for, and dispose of materials appropriately. Remove gloves and wash your hands.

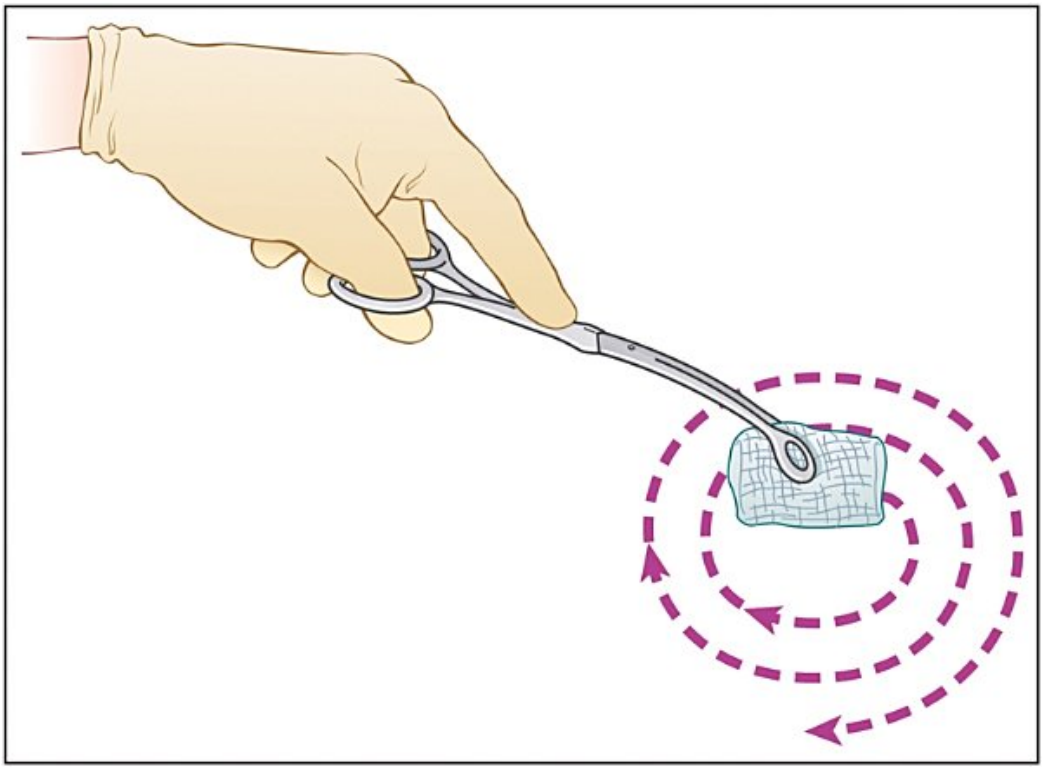

FIGURE 19.2 **Application of antiseptic.**

If specimens for multiple laboratory tests are to be obtained, always collect the blood culture specimens first. Inoculate the anaerobic bottle first, followed by the aerobic bottle.

Special Considerations

False-positive findingss: The impact of an improperly collected blood culture can be significant. The financial costs of a false-positive blood culture can add between $4385 and $8500 to the cost of treatment and between 1 and 5.4 days to the patient's hospital stay.[8–10] Determining if a positive blood culture represents contamination at the time of collection or a true bloodstream infection is a common and time-consuming issue for health care providers. Because of these implications, it is important to follow carefully the recommended steps in obtaining blood cultures to decrease the potential for contamination.

Focus on avoiding contamination with effective disinfection of the venipuncture site and avoidance of collection through existing intravenous lines and ports or through infected skin.

Number of cultures: A single culture is rarely sufficient and not recommended. At minimum, two blood cultures from different sites should be obtained. The optimal number of blood cultures varies with the condition of the patient, the likelihood of infection (pretest probability), and the urgency of treatment. Additional cultures may be indicated if the likely pathogen is a common contaminant, such as coagulase-negative staphylococci, but can also increase the risk of a false-positive finding.

Even a severely septic patient is likely to have a bacteremia that is intermittent and with low quantities of bacteria in the blood. Owing to this and to the possibility of contamination, multiple appropriate volume blood cultures are typically needed to detect bacteremia sufficiently.

Blood collection volume: The amount of blood collected per bottle is the most important factor in optimizing the identification of the pathogen (10 mL per bottle for adults). For infants, collect 1 to 5 mL of blood per 100-mL blood culture bottle.[7]

The amount of blood collected per bottle is the most important factor in optimizing the identification of the pathogen.

Timing: It is acceptable to obtain blood cultures from two separate sites within minutes of one another. There is no difference in result demonstrated whether blood samples are drawn simultaneously or at intervals in the first 24 hours.[2] Blood cultures should be obtained prior to initiation of antibiotic therapy. When monitoring efficacy of treatment, obtain blood cultures before the next scheduled dose of antibiotics.

Blood cultures should be obtained prior to initiation of antimicrobial therapy for any patient suspected of having bacteremia or fungemia.

Indwelling catheters: The issue of using indwelling central catheters for obtaining blood cultures is somewhat controversial, but should be avoided, if possible. If a blood sample for culture is to be obtained during the placement of a central venous catheter, the catheter must be placed in a completely sterile manner above the chest. If an indwelling central venous or arterial catheter is already in place, samples must be taken from both the catheter port and peripheral venipuncture sites to rule out line sepsis.[3,7]

Avoid obtaining blood cultures from intravascular catheters because they are commonly colonized with skin flora. If necessary, draw one set from the catheter and another from a peripheral venipuncture site.

Follow-up Care and Instructions

Aftercare and patient instructions should include the following:

- Advise the patient that he or she may experience minor discomfort and discoloration at the site of the venipuncture for the following 48 to 72 hours.
- Instruct the patient to keep the site clean and dry to reduce the likelihood of infection.
- Explain the signs of a hematoma, infection, and phlebitis, and instruct the patient to report any adverse events or continued bleeding from the site or to call or return to the office or clinic if any of these occurs.

Disposal of Materials

All supplies, tools, and items used that may have come into contact with bodily fluids should be disposed of in a biohazard container. Additionally, any sharps should be disposed of in a sharps container.

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CHAPTER 20

Office Pulmonary Function Testing

C. Chloe Powell

Abstract

The reporting and validity of office pulmonary function tests have come under scrutiny of the American Thoracic Society, which, in 2005, issued guidelines for standardization of spirometry. Additionally, the Global Initiative for Chronic Obstructive Lung Disease (GOLD) has issued guidelines for the diagnosis and treatment of chronic obstructive pulmonary disease (COPD). The standard of care today is that all providers diagnosing and treating patients with COPD have access to pulmonary function testing. For precise and reproducible results, those performing office spirometry must be able to distinguish valid from invalid tests. An advanced health care provider caring for patients with pulmonary disease must also know how to interpret spirometry to identify obstructive and restrictive patterns.

Keywords

ATS/ERS
FEV1
FVC
GOLD
obstructive lung disease

PFT
pulmonary disease
restrictive lung disease
spirometry

Procedure Goals and Objectives

GOAL: To perform and interpret office pulmonary function testing (PFT) on a patient successfully.
OBJECTIVES: The student will be able to:

- Describe the indications and contraindications for performing office spirometry.
- Identify and describe common complications associated with office spirometry.
- Describe the essential anatomy and physiology associated with the performance of office spirometry.
- Distinguish between an acceptable and unacceptable spirometry tracing.
- Interpret a spirometry report as a normal, obstructive, restrictive, or mixed pattern.

Background and History

Optimal pulmonary function provides for the metabolic needs of the body at rest and during physical activity. Lung perfusion, diffusion, and ventilation must be maintained. Spirometry assesses pulmonary ventilation and differentiates pulmonary dysfunction into an obstructive, restrictive, or mixed pattern. This pattern guides the

clinician to diagnosis pulmonary disease and monitor disease progression correctly. Pulmonary function tests (PFT) encompasses a variety of objective data that assess the lungs. The term PFT commonly replaces spirometry, which measures the maximal lung volume and airway flow rate. Adjunct assessments of pulmonary function include pulse oximetry, peak flow meter, body plethysmography, pulmonary exercise stress testing, bronchial provocation tests, diffusing capacitates, gas dilution tests, and arterial blood gas and electrolyte studies.

Pulse oximetry (SpO_2) is a noninvasive, real-time monitoring of arterial oxygen saturation. A sensor is placed on patient's fingernail, toenail, or earlobe. Pulse oximetry is a useful tool to assess the severity of an exacerbation in patients with chronic obstructive pulmonary disease (COPD) who are unable to perform an accurate spirometry.[1] Peak expiratory flow (PEF) can be measured on a handheld peak flow meter that can be used in the patient's home to assess changes in airflow, often before asthma symptoms are recognized. Body plethysmography is used to measure thoracic gas volume (V_{TG}), compliance or elasticity of the lungs (C_L), and airway resistance ($R_{aw.}$) These measurements require referral to a pulmonology laboratory where the tests are conducted in an airtight chamber. Exercise stress testing may be done to analyze ventilation and cardiovascular response to an increase in metabolic demand. Measurement of blood pressure and analysis of an electrocardiogram (ECG) and airflow patterns are generally sufficient; occasionally arterial blood gas sampling may be required.

Bronchial provocation with histamine or methacholine is useful to diagnose asthma in a patient presenting with normal spirometry. Carbon monoxide diffusing capacity (D_{LCO}) measures the efficiency of gas transfer from the alveolar air into the bloodstream. Measuring the diffusing capacity, also called the transfer factor, helps distinguish chronic bronchitis from emphysema, as well as differentiates intrinsic lung disease from other causes in a restrictive lung pattern.[2] Nitrogen washout and helium dilution are used to measure functional residual capacity (FRC) and residual volume

(RV). These measurements of pulmonary function all require the patient to inspire gases and exhale, and a response is calculated.

Arterial blood gases (ABG) are helpful in assessing the adequacy of ventilation. ABG is often necessary to qualify a patient for home oxygen therapy. More information about ABGs can be found in Chapter 2 *Arterial Puncture*. In this chapter, we will focus on obtaining and interpreting spirometry in the primary care setting.

Spirometry is taken from the Latin word "spiro," which means to breathe, and the Greek word "metron," meaning to measure. The focus of spirometry is the speed of air that is exhaled after taking a maximal inspiration. Office spirometry takes about 15 minutes to complete in an adult and 45 minutes for pre- and postbronchodilator testing. Spirometry testing may be done on children as young as 5 years old; however, an uncooperative patient will result in an invalid test.

The American Thoracic Society/European Respiratory Society (ATS/ERS) Task Force issued guidelines in 2005 meant to standardize lung function tests.[3,4] The Global Initiative for COPD also issues guidelines for interpretation of spirometry in patients with COPD.[5] Occupational Health and Safety Administration (OSHA) standards require training and certification for those who are not licensed physicians when performing an occupational spirometry.[6] Clinicians performing preemployment examinations, pulmonary impairment ratings, or disability forms should be familiar with government regulations and the required documentations, which are beyond the scope of this chapter.

Indications

Spirometry aids in differentiating pulmonary dysfunction as having an obstructive, restrictive, or a mixed cause. The provider must take into account the patient's medical history and physical examination before making a diagnosis. PFT provides objective measures of respiratory function, which aids the provider in establishing a diagnosis, leading to proper disease management. Common indications for the use of office-based spirometry include the following:

- Evaluation of patients with pulmonary complaints (wheezing, dyspnea)
- Diagnose and assess severity of airflow limitation in COPD[1]
- Identify those patients with COPD who have a progressive decline in lung function[1]
- Document the effectiveness of a therapeutic intervention[7]
- Document the progression of pulmonary disease[7,8]
- Identify patients with airway obstruction who will benefit from aggressive preoperative management[9]
- Establish the impact of related risks on lung function, such as smoking or occupational exposures
- Motivate smoker's attitude toward smoking cessation[10]
- As a component of periodic physical examination testing for individuals requiring certification in respirator use, for example, emergency personnel, carpenters, and many industrial workers (OSHA, National Institute for Occupational Safety and Health [NIOSH])
- As a component of a Social Security disability examination[11]

Bronchodilator and medication use just before testing needs to be evaluated. If the goal is to determine bronchodilator response, all short-acting and long-acting bronchodilators should be withheld.[3] There is no need to discontinue drug therapies if the goal is to establish a new baseline for patients with long-standing pulmonary disease. If patients are to withhold medication, the clinician must explain the risk of bronchospasm and short-acting bronchodilators must be readily available during testing.

Contraindications and Patient Considerations

Accurate spirometry is physically and mentally challenging, yet no absolute contraindications exist for performing the procedure. Despite the absence of absolute contraindications, the examiner should exercise common sense and not perform spirometry on a patient unable to tolerate the physical demands of the procedure. Patients with the following conditions may find the test to be physically demanding and lead to suboptimal test results:

- Recent myocardial infarction (within one month)[4]
- Current pulmonary embolism
- Pneumothorax
- Chest or abdominal wall pain of any cause[4]
- Stress incontinence[4]
- Dementia or confusion[4]
- Oral or facial pain exacerbated by a mouthpiece[4]
- Thoracic, abdominal, or cerebral aneurysm
- Recent eye surgery (within 6 weeks)
- Recent surgery involving the thorax or abdomen (within 6 weeks)
- Previous intolerance of spirometry for any reason (e.g., bronchospasm, syncope)
- Acute respiratory infection or ear infection (postpone for 3 weeks)

Potential Complications

Common complications of spirometry usually are related to the physical condition of the patient.

- Individuals with cardiopulmonary disease may suffer an exacerbation of symptoms related to their disease when spirometry is performed.
- Paroxysmal coughing, bronchospasm, and chest pain have been reported after spirometry, even in a "healthy patient."
- Lightheadedness or syncope may occur.
- Patient fatigue or lack of understanding of the test may compromise the results of the procedure.

For optimal results, the patient must be well motivated and understand that spirometry is a patient effort–dependent procedure. Consequently, providing patient education and instructions both before and during the procedure is essential. This is particularly useful in avoiding patient fatigue resulting from an incomplete understanding of instructions regarding performing the test. Finally,

a well-trained staff will maximize the quality of the procedure and reliability of the data.

Essential Anatomy and Physiology

Ventilation is the process of moving air in and out of the lungs. Inspiration occurs when the intercostal and diaphragm muscles contract. The lungs expand and the intrapulmonary pressure is reduced below atmospheric pressure, allowing air to inflate the lungs. Other accessory muscles including the pectoralis minor, scalene, and sternocleidomastoids may assist the diaphragm. Diffusion is the movement of oxygen from the lungs into the blood and the movement of carbon dioxide from the blood into the lungs to be exhaled. This gas exchange occurs in the alveoli. The total surface of the alveoli approximates 75 square meters, or about the size of a tennis court. During exhalation, the muscles relax and the alveoli recoil, maintaining the patency of the small airways. Age-related changes found on spirometry are caused, in part, by this loss of lung elasticity and the airways' decreased ability to recoil.

Obstructive Disease

Disorders that present with an obstructive pattern by spirometry are noted in Table 20.1. Congenital or mechanical impediments to airflow, such as a mass, may result in an obstructive dysfunction. Obstructive dysfunction is more commonly caused by an increase in airway resistance seen in asthma and COPD.

Table 20.1

Disorders That Commonly Yield an Abnormal Spirogram

Obstructive Pattern	Restrictive Pattern	Mixed Pattern
Asthma	Interstitial lung disease/fibrosis	Cystic fibrosis
Emphysema	Acute pneumonitis	Sarcoidosis
Chronic bronchitis	Pulmonary edema	Heart failure
Neoplasm	Asbestos-related (pneumoconiosis)	Langerhans Cell Histiocytosis
Foreign body	Obesity hypoventilation syndrome	
Tracheal stenosis or malacia	Guillain-Barre' Syndrome/ALS	
Vocal cord paralysis/laryngeal tumors	Multiple sclerosis, myasthenia gravis	
	Kyphoscoliosis	

Obstructive pulmonary diseases reduce the ability of the lungs to move air, whereas lung volumes and capacities remain normal or may even increase. This reduction in airflow is best demonstrated on spirometry during forced expiration. The forced expiratory volume in one second (FEV_1) records the maximal volume of air exhaled in the first second. The FEV_1 is the measurement that should be used to monitor disease progression or the effectiveness of therapeutic interventions. The forced vital capacity (FVC) measures the volume of air exhaled after full inspiration and is expressed in liters. A low FVC should warrant further pulmonary testing. The FEV_1/FVC ratio is the fraction of the FVC that can be exhaled in one second. Some clinicians prefer to substitute the FEV_6 for the FVC. The advantages

to using the FEV_1/FEV_6 ratio are less patient fatigue, less chance of syncope, and more reproducible results.[12] An obstructive lung pattern will present with a FEV_1/FVC and/or FEV_1/FEV_6 ratio below the lower limits of normal and a normal FVC.

Restrictive Disease

Restrictive lung disease is the result of a reduction in lung volume and may be intrinsic or extrinsic. Intrinsic lung disease, which causes inflammation, scarring, exudate, or debris within the lung tissue, may decrease the volume and compliance of the lungs. Extrapulmonary disease of the chest wall or pleura mechanically compresses the lung and may limit lung expansion. Neuromuscular disorders that decrease the ability of the respiratory muscles to inspire and expire will also show a restrictive pattern on spirometry. Restrictive disease prevents the lungs from expanding fully and total lung capacity is decreased. See Table 20.1 for examples of pulmonary disorders that result in a restrictive lung dysfunction pattern.

In pure restrictive disease, no obstruction to airflow occurs. FEV_1 and the other parameters of flow remain relatively normal (Fig. 20.1 and Table 20.2). Spirogram tracings from patients with restrictive disease reveal a low FVC (see Fig. 20.1 and Table 20.2). Patients with suspected restrictive pulmonary disease should undergo further pulmonary testing for better assessment of total lung volumes.[13]

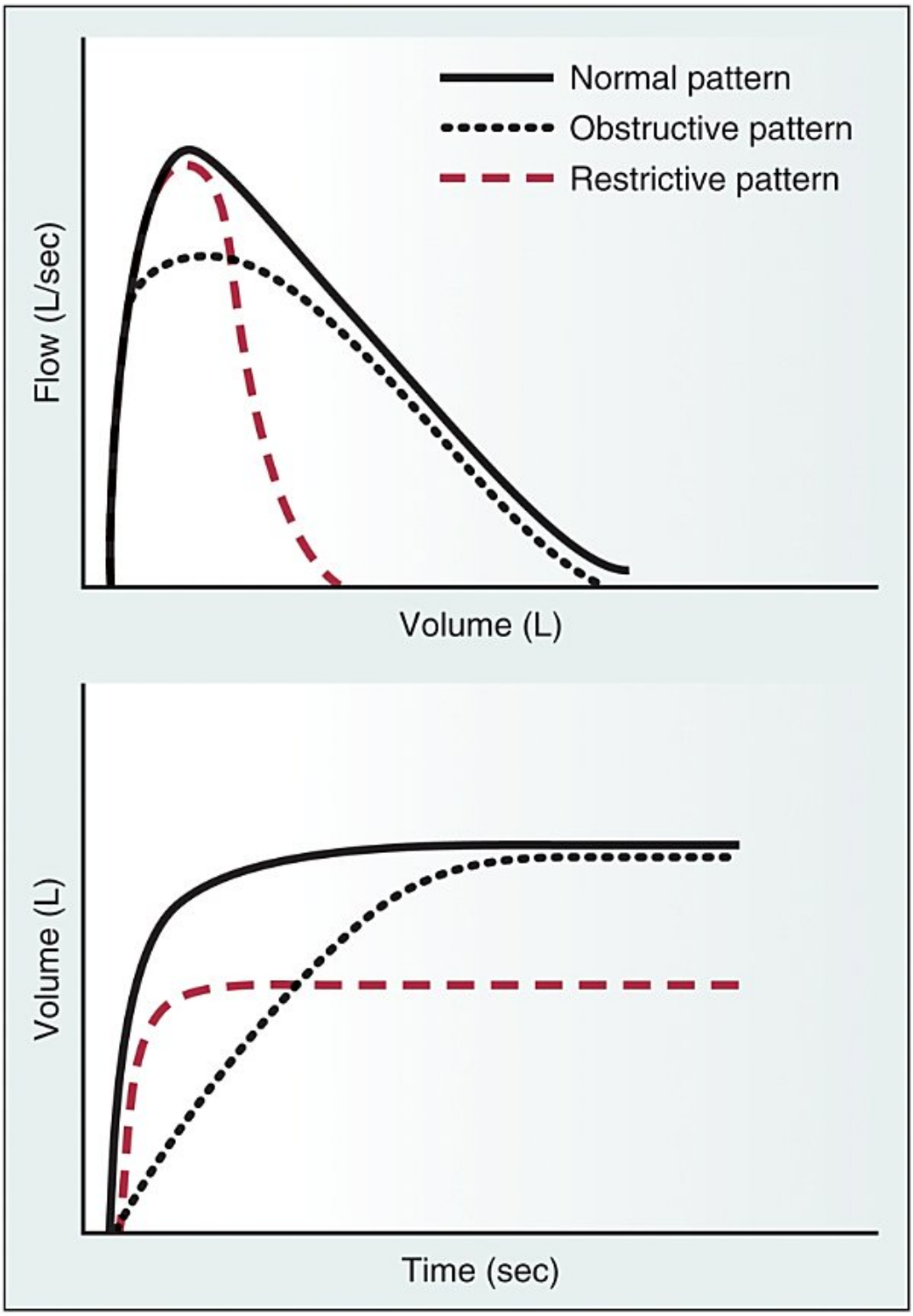

FIGURE 20.1 **Normal and abnormal spirographic patterns.**

Table 20.2

Volumes and Flows in Obstructive and Restrictive Disease

Interpretation	FEV_1	FVC	FEV_1/FVC
Normal	NL	NL	NL
Obstruction	Low	NL	Low
Restriction	NL	Low	NL
Mixed	Low	Low	NL/low

FEV_1, Forced expiratory volume, the volume of air forcefully exhaled in 1 second; *FVC,* forced vital capacity, the volume of air that can be exhaled forcefully after full inspiration; *NL,* normal.

Mixed Disease

A mixed pattern of obstructive and restrictive disease is typical in patients presenting with more than one disease, for example, asthma and fibrosis. More commonly, a mixed pattern is observed in smokers with advanced COPD. Caution must be exercised when attempting to make a diagnosis of restrictive disease if the comorbid obstructive disease is severe. In severe obstructive disease, the FVC may be decreased because of hyperinflation and air trapping from the obstructive process. If severe obstructive disease is suspected, the patient should be referred for body plethysmography and D_{LCO} testing.[14] In mixed diseases both FVC and FEV_1/FVC are reduced (see Table 20.2).

Standard precautions

Every practitioner should use standard precautions at all times when interacting with patients, especially when performing procedures. Determining the level of precaution necessary requires the practitioner to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

The following guidelines should be followed when performing spirometry to prevent transmission of infection.

- Practitioners must wash hands before and after administering test.
- Instruct patients to attach, remove, and discard a disposable mouthpiece.
- Do not reuse flow sensors designed for single patient use for flow spirometers.
- Consider using disposable spirometry filters for volume spirometers; use a clean breathing tube for each patient.
- Follow the spirometer manufacturer's recommendations for cleaning and disinfecting the equipment.

Patient Preparation

- Patient education and motivation is essential to obtaining a valid spirometry.
- Because the procedure requires the ability to follow instructions and give maximal effort, children younger than 5 years of age are not good candidates.[4]
- Advise the patient to wear loose-fitting clothing and not to eat a meal within 1 hour of testing. Patient should remove dentures for the test.
- If the patient is a smoker, instruct him or her not to smoke for at least 1 hour before spirometry.[4]
- Advise the patient about which medications should be withheld before the procedure. Note that withholding long-acting medications may cause acute bronchospasm during the test and that the purpose of the test should guide the practitioner in determining which medications to instruct the patient to withhold. Table 20.3 offers a guide for withholding medications based on drug half-life.[3]
- The use of a nose clip during the procedure is optional.

- The patient may be standing or seated for the procedure. A chair should be placed behind the standing patient should lightheadedness occur during the procedure. Patient position during the test should be documented and replicated during future tests.

Table 20.3

Suggested Times Medications Should Be Withheld

Agent	Withholding Time
Short-acting inhaled bronchodilators (e.g., albuterol)	4 to 6 hours
Long-acting inhaled bronchodilators (e.g., salmeterol)	12 to 24 hours
Anticholinergic inhalers (e.g., ipratropium)	4 to 6 hours
Long-acting anticholinergics (e.g., tiotropium)	24 hours
Leukotriene modifiers (e.g., montelukast)	24 hours
Mast cell stabilizers (e.g., cromolyn sodium) Corticosteroids (inhaled or oral)	Unknown

Materials

Measurements may be collected on a volume-type or flow-type spirometer. Most office-based spirometers in use today are flow-measuring devices; volume-measuring spirometers are seldom used. The instruments are computerized for data collection and analysis. The machine should display the airflow over volume as well as the airflow over time. The American Thoracic Society (ATS) has published accuracy and precision standards to follow when purchasing a machine. All machines should meet the ATS minimum specifications for accuracy and precision. The National Lung Health Education Program offers a spirometer review process and publishes

the names of the machines that are in compliance with their guidelines. OSHA has additional standards for spirometers used for occupational testing.[6] The type of instrument should be selected based on the need to store patient data and load computerized measurements into databases, ability to transmit data, cost per procedure, and maintenance requirements.

Procedure

Pulmonary Function Testing

> The specific operating instructions are important for each available machine because operation varies from model to model.

Calibration

1. The rationale for calibration is to provide data to the spirometer that corrects for fluctuations in ambient atmospheric pressure. Therefore, before performing PFT, the machine should be **calibrated** daily, every 4 hours, or both, if multiple tests are administered in a day.

> Calibration involves using a 3-L syringe to blow air through a mouthpiece a minimum of three times. The syringe usually is provided with the machine. In addition, results from each patient must be corrected to body temperature, ambient pressure, and saturation with water (BTPS). Modern machines may provide the BTPS correction automatically.

2. To complete the calibration, the altitude above sea level and the temperature must be entered into the machine.
3. For each test, the examiner must enter the patient's correct height (without shoes), weight, age, gender, and race. A waist circumference may also be entered.
4. Many modern instruments are programmed to input other patient information (e.g., smoking history, presence of chronic cough). Although not critical in terms of calculating the results, recording the patient's history may be informative when interpreting the spirogram.

Patient Instructions

> Providing patients with detailed instructions and active coaching during the test is critical in obtaining an acceptable spirogram.

5. Explain the maneuver to the patient by saying, "I want to see how hard and how fast you can breathe out your air." Instruct the patient to "take in a deep breath and close your mouth around the mouthpiece creating a tight seal. Blow the air from your lungs into the mouthpiece as hard and as fast as you can" (Fig. 20.2).
6. During the maneuver it is important to provide active coaching. As the patient begins to exhale, enthusiastically say, "Blow, blow, blow!" When it appears that the patient is nearing the end of expiration, say, "Keep blowing!" Exhalation should last a minimum of 6 seconds.
7. Allow the patient to rest and then repeat the maneuver. Patient instructions and active coaching should occur with each maneuver to obtain maximal effort.
    - No more than eight maneuvers should be performed at any one session, because fatigue can become a factor in

the quality of expiratory effort.[3] Most instruments allow the examiner know when an acceptable spirometry test has been accomplished.

Obtaining a Meaningful Spirogram

An acceptable maneuver is free from coughs, early termination, hesitant starts, and variable effort. Coughs typically show up as spiked notches on the volume-time curve.

- Early termination is defined as an inability of the patient to **plateau.**

> Most machines have a signal that identifies when the patient has reached a plateau (a change of 25 mL or less in 2 seconds), meets the length requirement of more than 6 seconds, or both. A plateau signifies the end of an acceptable maneuver. The maneuver may also be ended when the patient cannot or should not continue.

- Variable effort is an inconsistent curve and is often a sign of poor compliance with the procedure.
- Many computerized instruments have a built-in algorithm program that looks for and reports flaws in the patient's technique.
- If possible, it is best to save each maneuver, even if flawed.
- An acceptable spirometry test is composed of at least **three** acceptable maneuvers, with the two best curves for FVC being within 0.15 L of each other.[3]
- The largest acceptable FVC and the largest acceptable FEV_1 should be recorded and used for analysis even if they do not

come from the same curve.[3]

8. It is common for errors in technique to occur during spirometry. Frequently, the patient may give up too soon, resulting in an undermeasurement of FVC. Properly encourage the patient toward the end of the maneuver to prevent early termination.
9. Air leakage around the mouthpiece can give erroneous readings. Have the patient wet his or her lips to obtain a better seal.
10. Look for pursed lips and obstruction with the tongue, which are errors readily correctable by proper technique.
11. At the conclusion of the test, computerized instruments allow you to print the results of the test (Fig. 20.3).

Comparison of Results With Standards

Interpreting spirometry involves comparing the patient's actual results with predicted results from an accepted standard. Either the third National Health and Nutrition Examination Survey (NHANES III) or the Global Lung Function Initiative (GLI 2012) reference values may be used and must be identified in the patient's report.

12. Either the lower limits of normal (LLN) or the percentage of predicted may be used for interpretation.

Postbronchodilator Test

Spirometry in the office setting is sometimes used to evaluate a patient's response to an inhaled bronchodilator to determine if the airway obstruction if reversible. A pre- and postbronchodilator test is required for the diagnosis of COPD. Reversible airway obstruction suggests asthma.

13. To test for reversibility of pulmonary dysfunction, ask the patient first to perform prebronchodilator spirometry, for a minimum of three tracings.
14. After collecting the results, give the patient two puffs of albuterol by metered dose inhaler.
15. Fifteen minutes after administration of the albuterol, perform postbronchodilator spirometry; repeating the test a minimum of three times.

An increase in the FEV_1 of more than 12% and greater than 0.2 L suggests reversible airway obstruction.[15] Some patients with asthma may have a normal spirometry after bronchodilator therapy. According the GOLD guidelines, a postbronchodilator $FEV_1/FVC < 0.70$ is diagnostic for COPD.[5]

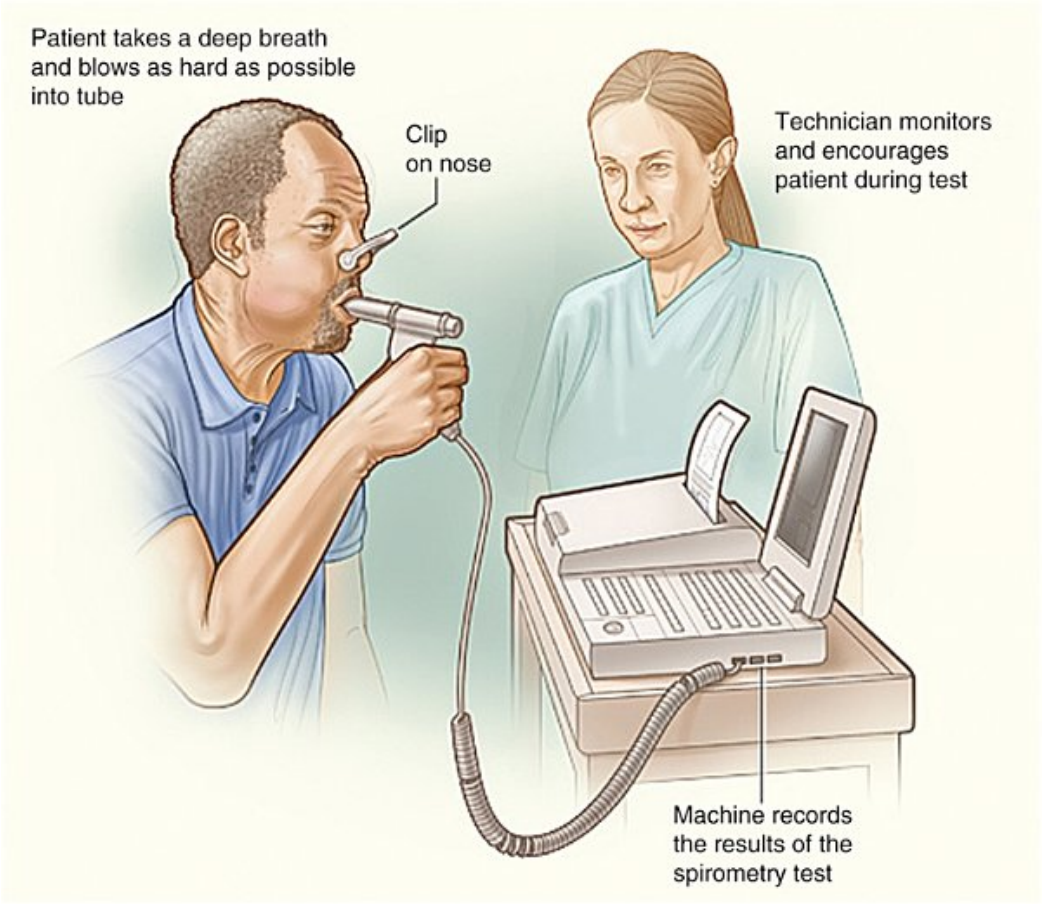

FIGURE 20.2 By National Heart Lung and Blood Institute (NIH). [Public domain]

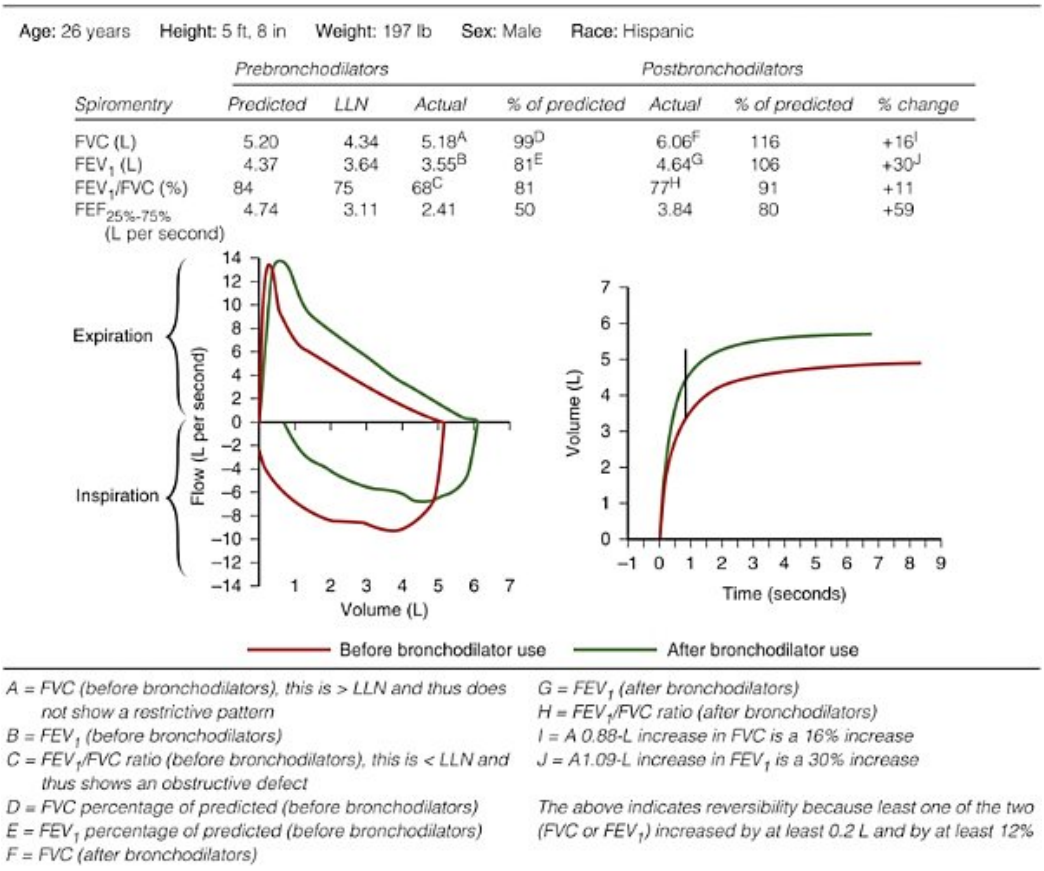

FIGURE 20.3 Obstructive defect with reversibility.
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Special Considerations

Test Interpretation

Spirometry tracings should be evaluated for adequacy and reproducibility following the guidelines discussed above. The study should then be classified as normal or abnormal by looking at the FVC and FEV1/FVC lower limit of normal and percentage of predicted value (see Fig. 20.3). Abnormal tracings are identified as having an obstructive, restrictive, or mixed pattern (see Table 20.2). Disease severity should be determined as mild, moderate, or severe by evaluation of the FEV_1 (Table 20.4). Latest guidelines by the ATS

support reporting the FEV_1/FVC as a decimal fraction rather than a percentage of the predicted value. The use of the LLN set at the fifth percentile is preferred by the ATS/ERS, whereas the GOLD guidelines support the use of a fixed ratio. Using a fixed ratio may result in more frequent diagnosis of COPD in the elderly and less frequent diagnosis of COPD in adults over the age of 45.[16,17] One approach is to use the GOLD criteria to diagnose COPD in patients 65 and over with risk factors and symptoms suggestive of COPD and use the ATS criteria for patients under the age of 65 and for all ages in patients without risk factors for COPD.[14]

Table 20.4

Grading Severity of Airflow Limitation

Mild	**FEV_1 >70% predicted**
Moderate	60% to 69% predicted
Moderately Severe	50% to 59% predicted
Severe	35% to 49% predicted
Very Severe	< 35% predicted

Patient Variability

Reference values for spirometry results vary with age, height, gender, and ethnicity. Interestingly, airflow in liters per minute increases linearly with increased height. However, age has an opposite effect, with a decline of FVC by about 0.2 L per decade after the age of 30. Gender also must be taken into consideration, with FEV_1 and FVC being approximately 10% less in women than in men of comparable height and age. FVC and FEV_1 averages will vary based on race; however, the FEV_1/FVC ratio is generally independent of ethnic group when the LLN criteria are used.[18]

Follow-Up Care and Instructions

In the management of pulmonary disease in the outpatient setting, it is crucial to be able to stabilize the airway using various pharmacologic approaches and to have rescue medications available in the event that stabilizing modalities fail.

- Provide patients with instructions on the mechanism of action for each medication, monitoring the progress of therapy, and follow-up care.
- Encourage patients to call if they are confused or have questions concerning medications. For patients with multiple medications, a simple outline may alleviate confusion and prevent exacerbations resulting from noncompliance.
- For patients who smoke, an unambiguous statement of the continued health risks of smoking should be emphasized at every visit.

The success of treating pulmonary disease depends largely on patient compliance with regimens. Providing patients with a peak flowmeter is a useful means of helping them monitor their lung function at home. Patient compliance with the management plan will increase if they understand the various treatment modalities and the central role of monitoring pulmonary function.

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CHAPTER 21

Introduction to Point-of-Care Ultrasonography (POCUS)

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Abstract

Contemporary use for point- of- care ultrasonography was initially adopted by Emergency Medicine providers in the 1990's. Since then, its use, due to better technology and portability, has grown exponentially. Point-of-care ultrasonography (POCUS) is performed by the clinician at the patient's bedside and results are interpreted in real time. Its use is limited to asking a specific question and/or assisting in various procedures. The results obtained by a POCUS must be integrated along with other components of the history, physical exam, and diagnostics. Clinicians proficient in POCUS will be able to add a valuable skill when evaluating patients and/or performing various procedures.

Keywords

Point-of-care ultrasonography
POCUS
informed consent
clinical question

differential diagnosis
clinical outcomes
proper technique
anatomy
hyperechoic
anechoic
hypoechoic
low frequency
high frequency
ultrasound device
linear probe
phased array
curvilinear

Procedure Goals and Objectives

GOAL: To provide an introduction to point-of-care ultrasonography (POCUS)
OBJECTIVES: The student will be able to:

- Provide an overview of the indications, contraindications, and rationale for performing a POCUS.
- Identify and describe potential complications associated with performing a POCUS.
- Identify the materials necessary for performing a POCUS and their proper use.
- Provide an overview for the proper steps for performing a POCUS.

Background and History

The history of ultrasonography began in approximately 1794 with the work of an Italian physiologist and biologist, Lazzaro Spallanzani.[1,2] Spallanzani discovered bats navigate in the dark through the reflection of high-frequency sounds (echolocation), and it was from this early work that the basis of ultrasound physics originated.[1,2] For the next several hundred years and through the work of many international scientists, entrepreneurs, and commercial companies, ultrasonography was developed into what we know it as today.

Initially, ultrasound's early commercial application was in the area of defense, whereas its early medical application was for therapeutic purposes.[1,3,4] However, in 1942, the first diagnostic application came from Karl Theodore Dussik who used ultrasonic beams transmitted through the head to diagnose brain tumors. Throughout the 1950s, diagnostic use continued to evolve as Drs. Wild and Reid confirmed relevance specifically for breast pathology and colon tumor diagnosis and detection.[3,4] In 1969 and again in 1972, the first and second "World Congress on Ultrasonic Diagnostics in Medicine" were held. These meetings brought together clinicians and scientists who had made significant development toward the advancement of ultrasonography. Regardless of its application or use, ultrasound represented a major advancement in diagnostic imaging because it allowed for the creation of cross-sectional images without the use of ionizing radiation.[2]

Contemporary use for bedside POCUS was initially adopted by emergency medicine providers in the 1990s owing, in part, to the increased portability and affordability of the technology.[5] Significant evidence has demonstrated utilizing POCUS: rapidly narrows differential diagnoses,[6] improves clinical outcomes,[7] shortens time to definitive treatment,[8] lowers costs,[8] and reduces failure and complication rates during procedures. Since then, its use, along with ever-improving technology, has grown exponentially.

Understanding the basic physics of ultrasonography will aid in its application. Ultrasound is sound wave frequencies that exceed the range of human hearing. The human audible range is 20 to 20,00 Hz, whereas ultrasonography is greater than 20,000 Hz.[1] Propagation of the sound waves causes other molecules to vibrate back and forth. The vibration causes a reflection of an image, which can be recorded in real time dimension. The images are determined by the density of the molecular structure and by the frequency or the rate in which the waves will travel.[1]

- Bone reflects very bright waves back: HYPERECHOIC or white.
- Fluid has no reflection as waves travel through it: ANECHOIC or black.
- Organs vary between waves that reflect to waves that travel through it: HYPOECHOIC or gray.

Low-frequency rates allow for deeper structure visualization but with some sacrifice in resolution.

High-frequency rates create the best resolution with clinical implications for structures less than 6 cm deep or with use on a small child.

Indications

Point-of-care ultrasonography is performed by the clinician at the patient's bedside, and the results are interpreted in real time. Its use is limited to asking a focused question and/or to assisting in various procedures. The results obtained by a POCUS must be integrated along with the other components of the history, physical examination, and other diagnostics to develop a complete evaluation of a patient. Currently there are 11 basic core applications recognized by both emergency and family medicine.[7] These include:

- **FAST** (focused assessment with sonography in trauma)

Repeat a scan on the same patient, especially in an emergency setting.

- Abdominal aortic aneurysm
- Emergent echocardiography
- Gynecology
- Hepatobiliary
- Renal
- Deep vein thrombosis
- Thoracic
- Musculoskeletal
- Ocular
- Procedural guidance
  - Basic: thoracentesis, paracentesis, peripheral IV placement, central line placement, lumbar puncture, knee aspiration and injection, foreign body identification and removal
  - Advanced: nerve blocks, fine needle aspiration/biopsy, shoulder, ankle hip, wrist aspiration and injection

Although currently no specific policy statement exists for Pediatric POCUS implementation, the following are being incorporated into pediatric emergency medicine fellowship training[8,9,10]:

When getting started, learn the proper technique **and always use it.**

- FAST (focused assessment with sonography in trauma)
- Cardiac
- Hepatobiliary
- Musculoskeletal
- Renal
- Thoracic
- Procedural guidance
  - Basic: line placement, lumbar puncture
  - Advanced: nerve blocks, chest tube, fluid drainage

Getting Started

Training

Numerous high-quality educational courses now available can provide an introduction into POCUS use. These courses range from online training to real-time training using cadavers. Alternatively, a skilled colleague can provide hands-on training and/or self-directed learning sessions. Currently, POCUS is competency-based with no formal certification or testing required. Regardless of a clinician's experience, *knowing anatomy is a must*. Reviewing CT images can help facilitate visualizing images in shades of black, white, and gray.

After becoming experienced, continue to evaluate using the same scanning approach.

Orientation

1. Find the ultrasound device in your practice setting: ultrasound devices now range from pocket sized (newest technology) to a laptop-shaped device on a rolling stand.
2. Review the manual of the ultrasound model available and become familiar with it. After learning where to turn the device on and off, next locate the B-mode (the main ultrasound mode) and M-mode (allows a still image to depict motion). Learn how to control the gain or brightness to optimize visualization. Many devices now have multiple Doppler options to further enhance imaging and diagnostics.
3. Understand the four main probe options (Each probe may not be available for every ultrasound model).

Probe Type	Frequency	Best Use	Clinical Indications
Linear probe	High	Structures < 6 cm deep, small child	Deep vein thrombosis, soft tissue, vascular/ for procedures
Phased array	Low	Deep structures, small space	Cardiac
Curvilinear	Low	Deep structures	Renal, FAST scan, pelvis
Endocavitary	High	Intravaginal, rectal	Pregnancy evaluation

4. Most ultrasound screens have a small dot on one side to help orient the user. They tend to correspond to a dot or line on one side of the probe, but some models are opposite. The clinician can check by tapping a finger on one side of the probe and matching it up with the screen. Align the probe with same orientation as the screen, making sure the probe is perpendicular to the tissue being studied.
5. Make sure to utilize acoustic gel.

Choosing your First POCUS Patient

Becoming a competent POCUS user takes time and practice, but there are several examinations that can be a good starting place.

Whenever possible, explain to the patient what is being done and why.

Ocular Scan

Practice setting:

Emergency Room
Urgent Care
Primary Care

Patient scenario: 63-year-old male presents with 1-day history of partial loss of vision in left eye. Denies pain or history of injury.

Contraindications to ocular POCUS**:** retrobulbar hemorrhage, globe rupture, or evidence of trauma.

Clinical questions for POCUS:

- Does this patient have an ocular pathology?
- What is the optic nerve sheath diameter?

Save key images for medical documentation.

Procedure

1. Obtain patient consent
2. Gently apply Tegraderm over the affected, closed eye.
3. Locate the linear probe. Turn the device on and be sure the right probe light is turned on.
4. Apply adequate gel to the entire orbital area.
5. Place the linear probe on the orbital rim and employ a gentle rocking motion.
6. Look for the nerve sheath shadow and obtain a measurement 3 mm posteriorly from the retinal border. A nerve sheath shadow of less than 5 mm diameter is considered normal.
7. Look for the retina: a detached retina will be easier to visualize.
8. Locate the lens to look for dislocation.
9. Take at least one picture to confirm the procedure.
10. Gently remove any remaining gel and Tegraderm from the patient.

11. Turn off the device.
12. Properly clean all equipment.

Soft Tissue

Practice setting:

Emergency Room
Urgent Care
Primary Care

Confirm abnormal findings on examinations, especially if seen in only one view.

Patient scenario: 20-year-old female presents with three-day history of pain, erythema, and swelling to her right posterior calf. No history of injury, but the patient has been camping and sustained multiple pruritic bug bites.

Contraindications for POCUS: patient history and/or physical examination warrants another diagnostic evaluation.

Integrate findings into the context of a patient evaluation.

Clinical questions for POCUS:

- Is there an abscess?
- Are there vascular structures near an abscess?

Procedure

1. Obtain patient consent.
2. Place the patient in a comfortable position for full access of her right posterior calf.

3. Turn the device on and select the linear probe. Be sure the right probe light is turned on. Place a probe cover over the probe.
4. Apply gel to the area of concern.
5. Scan the area of concern; be sure to include an area of greatest fluctuance, if present.
6. An abscess will appear as an anechoic compressible fluid collection.
7. Scan a wider area to evaluate vasculature that could preclude safe incision and drainage.
8. Cobblestoning or cottage cheese curds would suggest cellulitis in the absence of an anechoic collection (black). Air in the soft tissue associated with hyperechoic (white) areas, irregular border, and gray shadow may indicate necrotizing soft-tissue infection.
9. Take at least one picture to confirm the procedure.
10. Gently wipe gel off patient.
11. Turn off the device.
12. Properly clean all equipment.

Renal

Practice setting:

Emergency Room
Urgent Care
Primary Care

Patient scenario: 55-year-old male presents complaining of an inability to urinate even though he has been drinking fluids.

Contraindications for POCUS: patient history and physical examination warrant another diagnostic evaluation.

Clinical questions for POCUS:

- Is the bladder distended?
- Is there evidence of postrenal obstruction?

Procedure

1. Obtain patient consent.
2. Place the patient in a comfortable supine position.
3. Turn on the device and select the curvilinear probe. Make sure the correct probe light is on.
4. Apply gel to the probe surface.
5. Begin by identifying the kidneys. The probe should be placed along the mid-axillary line below the costal margin with the marker toward the patient's head.
6. Move the probe along the costal margin to the iliac crest. It will be necessary to twist and rotate the probe. Once an adequate longitudinal view is obtained, rotate the probe 90 degrees to obtain a transverse view. Be sure to scan the entire kidney. Look for hydro nephrosis, which appears as a black area in the renal pelvis.
7. Repeat the procedure for the left kidney, although the left kidney can be more difficult to scan. Think knuckles on the bed. The patient may have to be repositioned in the right lateral decubitus position.
8. Evaluate the bladder by placing the curvilinear probe above the pubis symphysis. Point it toward to the tailbone.
9. A bladder with urine is an anechoic structure that is usually easily visualized. By measuring bladder dimensions, bladder volume can be estimated.
10. Take at least one picture to confirm the procedure.
11. Gently wipe off any gel from the patient.
12. Turn off the device.
13. Properly clean all equipment.

Gynecologic

Practice setting:

Emergency Room

Urgent Care
Gynecology Care
Primary care

Patient Scenario: A 53-year-old female presents with pelvic pain. She has in intrauterine device (IUD) that was placed 6 years ago, but was due to be removed 1 year ago. She is very concerned as she cannot feel the IUD string and believes the IUD is no longer in the correct location, which is the cause of her pelvic pain.

Contraindications for POCUS: patient history and physical examination warrant another diagnostic evaluation.

Clinical questions for POCUS:

- Is the IUD in the intrauterine cavity?
- If the IUD is in the intrauterine cavity, what is its position?

Procedure

1. Obtain patient consent.
2. Ensure the patient has a full bladder, if possible (aids in visualization).
3. Position the patient in the supine position.
4. Turn the device on and select the curvilinear probe.
5. Apply gel to the suprapubic area.
6. Identify the bladder, which will be used as a window.
7. Rotate the probe to identify the uterus.
8. Once the midline of the uterus has been identified, move the probe bilaterally to evaluate each adnexa, including ovaries.
9. Take a picture bilaterally and centrally.
10. Place the patient in the lithotomy position.
11. Select the endocavitary probe.
12. Apply gel to the transducer and cover with a probe cover.
13. If not already done, perform a bimanual examination to help prepare the patient for the probe.
14. Apply gel to the exterior of the probe cover.

15. Gently insert the probe into the vagina while applying gentle pressure posteriorly.
16. Using the curvilinear probe on the suprapubic area, watch the endocavitary probe being gently advanced taking care not to extend past the anterior cervix.
17. To scan for the presence of an IUD, look for an ~3 mm sharp-edged echogenic image. An IUD should produce shadowing in at least one plane.
18. Take a picture.
19. Rescan the bilateral adnexa including the ovaries.
20. Gently remove the endocavitary probe.
21. Wipe off any excess gel from the patient's suprapubic area.
22. Turn off the device.
23. Remove the used probe cover and properly dispose of it.
24. Clean all the entire device including the endocavitary probe.

Do: Confirm abnormal findings on examinations, especially if seen in one view only.

Pro Tips and Trouble Shooting

- The goal of a clinician is to move the ultrasound probe while watching the screen. It takes time and repetition to develop this psychomotor skill and the associated manual dexterity.
- Adipose tissue poses a challenge. Ultrasound waves travel poorly through adipose tissue. Patients with obesity are often more difficult to image owing to decreased resolution and greater depth of travel. Similarly, lung tissue will obstruct acoustic windows and make imaging of deeper structures difficult. Consequently, in some instances the use of a transesophageal probe may be the best option for imaging thoracic structures.
- If only "static" is visible on the screen, check that the right probe was selected or plugged in.

- If using a sterile probe cover, consider placing nonsterile gel on the probe, then placing the ultrasound cover over the probe, then apply sterile gel onto the sterile cover. This will eliminate potential air pockets, which can impede imaging.
- Remember, the ultrasound view is a very thin slice. If doing a procedure, make sure the tip of the needle is easily visualized on the screen; otherwise, the clinician does not know where it is.
- If an invasive procedure is being performed and the images do not seem to be right, check the probe placement. Slight adjustments of the probe can often help bring a structure into focus.

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CHAPTER 22

Procedural Sedation

Anthony Brenneman

Abstract

The goal of procedural sedation is to minimize patient discomfort while attempting to maintain spontaneous respirations and airway-protective reflexes. To achieve this, it is necessary to understand the indications, contraindications, anatomy and physiology associated with procedural sedation. Identifying materials necessary for the administration of sedating agents are required, as well as discharge criteria.

Keywords

analgesia
anxiolysis
conscious sedation
deep sedation
moderate sedation
procedural sedation

Procedure Goals and Objectives

GOAL: To minimize patient discomfort while attempting to maintain spontaneous respirations and airway-protective reflexes to facilitate appropriate medical care.
OBJECTIVES: The student will be able to:

- Differentiate between conscious sedation and procedural sedation.
- Describe current Joint Commission sedation care standards.
- Identify indications and contraindications for procedural sedation.
- Describe potential complications and techniques that may be used to avoid or to treat problems during sedation.
- Describe the essential anatomy and physiology associated with administration of procedural sedation.

- Identify the materials necessary for the administration of procedural sedation.
- Identify the agents used in procedural sedation, dosing methods, and discharge criteria.

Background and History

Procedural sedation provides one way in which clinicians can perform diagnostic tests and clinical procedures that are sometimes painful or highly anxiety provoking in a manner that prevents or minimizes patient discomfort. Historically, this method has been labeled *conscious sedation*, but this term has now become antiquated and imprecise, because all sedation causes some type of change in consciousness. The current accepted term is *procedural sedation*, which more accurately reflects the goal behind the process. Procedural sedation then refers to the techniques of managing a patient's pain and anxiety to facilitate appropriate medical care in a safe, effective, and humane fashion,[1] with the main goal being to minimize patient discomfort while maintaining spontaneous respiration and airway-protective reflexes. Procedural sedation is currently used in inpatient settings, emergency services, and outpatient settings. Practitioners must be aware of current guidelines and terminology to be able to provide procedural sedation.

Procedural sedation is the accepted term and implies that sedation is on a continuum no matter the amount of sedative used.

The move to procedural sedation intimates that there is a **continuum of sedation** for the patient no matter the amount of sedative used. Objective measures in levels of sedation have been lacking. Based on this, criteria have been established to help define goal levels for procedural sedation. In 2001, the revised Joint Commission on Accreditation of Healthcare Organizations (JCAHO; in 2007, renamed The Joint Commission) sedation care standards replaced the term conscious *sedation* with *moderate sedation/analgesia* and attempted to provide clearer definitions of what this meant. The difficulty remains that this is still a subjective process and that each clinician must always be aware of how the patient is responding to the sedatives and dissociatives that he or she is being given. The JCAHO sedation guidelines provide qualitative goals for each practitioner while conducting procedural sedation, but ultimately safety must be maintained by minimizing risks and ensuring safe discharge.

Understanding that sedation is on a continuum and using correct terminology and descriptors are paramount when documenting procedural sedation.

Definitions

The progression from mild sedation to general anesthesia is a continuum, and definitions of sedation are evolving. Useful definitions include the following:

- Analgesia: Relief of pain without intentionally producing a sedated state. Altered mental status may be a secondary effect of medications administered for analgesia.

- Anxiolysis: A state of decreased apprehension concerning a particular situation; in this state, the level of awareness does not change.

The **continuum of and definition** of levels of sedation/analgesia according to the American Society of Anesthesiologists include the following:

It is important to remember that sedation is on a continuum and using correct terminology and descriptors are paramount when documenting procedural sedation.

- Minimal sedation (anxiolysis): A drug-induced state during which the patient responds normally to verbal commands. Cognitive function and coordination may be impaired, but ventilatory and cardiovascular function are unaffected.
- Moderate sedation/analgesia (conscious sedation): A drug-induced depression of consciousness during which the patient responds purposefully to verbal commands either alone or accompanied by light tactile stimulation. No interventions are required to maintain airway and adequate ventilation. Cardiovascular function is usually maintained.
- Deep sedation/analgesia: A drug-induced depression of consciousness during which the patient cannot be easily aroused but responds purposefully following repeated or painful stimulation. The ability to independently maintain ventilatory function may require assistance in maintaining a patent airway and adequate ventilation. Cardiovascular function is usually maintained.
- General anesthesia: A drug-induced loss of consciousness during which the patient cannot be aroused, even by painful stimulation. The ability to independently maintain ventilatory function is often impaired. The patient often requires assistance to maintain a patent airway, and positive-pressure ventilation may be required because of depressed spontaneous ventilation or drug-induced depression of neuromuscular function. Cardiovascular function may be impaired.[1,2]

Indications

Sedation/analgesia provides two general types of benefit: (1) sedation/analgesia allows patients to tolerate unpleasant procedures by relieving anxiety, discomfort, or pain; and (2) in children and uncooperative adults, sedation/analgesia may expedite the conduct of procedures that are not particularly uncomfortable but that do require that the patient not move.[2] Ultimately, the goals of procedural sedation and analgesia are to alleviate anxiety, minimize physical pain and discomfort, minimize negative psychological responses to treatment, maximize amnesia, control behavior to expedite performance of procedures, maintain safety by minimizing risks, and ensure safe discharge.[3]

Procedural sedation is useful for painful procedures and to relieve anxiety. It also may expedite the procedure with uncooperative or active patients.

Contraindications

Patients should be evaluated before the procedure for their suitability for sedation. From this a decision must be made whether contraindications exist for sedation or anxiolytic medication use. Allergies to possible medications used in the procedure may exclude the patient unless alternative medications may be substituted. Previous reactions to sedation or

general anesthesia should be noted and may contraindicate the use of procedural sedation, depending on the outcomes of prior use. Food ingested within the past 6 hours or clear liquids within the past 2 hours would preclude the patient from sedation unless an emergency situation was involved; then the benefits of the procedure must be weighed against the potential of aspiration.

Absolute **contraindications** are uncommon, but the practitioner should consider comorbid illness or injury and the ability to manage the patient's airway. Patients with significant comorbid cardiac, hemodynamic, or respiratory compromise should be approached with caution, as should patients who may be difficult to intubate or manually ventilate. If the patient is classified as a Class IV or V, as defined by the ASA physical status classification system, a nonanesthesiologist should not provide moderate sedation or anesthesia for that patient, but should refer the patient on to an anesthesiologist, who may recommend general anesthesia or other treatment course (Table 22.1).

Table 22.1

American Society of Anesthesiologists Physical Status Classifications

Patient Classification	Example
ASA 1: A normal, healthy patient	Healthy, nonsmoking, no or minimal alcohol use.
ASA 2: A patient with systemic disease	Mild diseases only without substantive functional limitations. Examples include (but not limited to): current smoker, social alcohol drinker, pregnancy, obesity (BMI 30to 40), well-controlled DM/HTN, mild lung disease.
ASA 3: A patient with severe systemic disease	Substantive functional limitations; one or more moderate to severe diseases. Examples include (but not limited to): poorly controlled DM or HTN, COPD, morbid obesity (BMT > 40), active hepatitis, alcohol dependence or abuse, implanted pacemaker, moderate reduction of ejection fraction, ESRD undergoing regularly scheduled dialysis, premature infant, history of MI, CVA, TIA, or CAD/stents.
ASA 4: A patient with severe systemic disease that is a constant potential threat to life	Examples include (but not limited to): recent (< 3 months) MI, CVA, TIA, or CAD/stents, ongoing cardiac ischemia or severe valve dysfunction, severe reduction of ejection fraction, sepsis, DIC, ARD, or ESRD not undergoing regularly scheduled dialysis.
ASA 5: A moribund patient who is not expected to survive without the operation	Examples include (but not limited to): ruptured abdominal/thoracic aneurysm, massive trauma, intracranial bleed with mass effect, ischemic bowel in the face of significant cardiac pathology, or multiple organ/system dysfunction.
E: Emergency status—added to the ASA designation only if the patient is undergoing an emergency procedure	A healthy patient undergoing sedation for reduction of a displaced fracture, classified ASA 1E

ASA, American Society of Anesthesiologists.

Contraindications for sedation include allergies, previous reactions, ingested food or liquid, comorbid illnesses, level of ability to manage airway, or practitioners knowledge of

medications utilized and compliance within an institution and its guidelines.

Ultimately, the largest contraindication may be the practitioner. If the practitioner does not have an understanding of the medications administered, the ability to monitor the patient's responses to the medications given, or the skills necessary to intervene in managing all potential complications, he or she should be excluded from performing the procedure with procedural sedation or anxiolytics. Practitioners also must be in compliance with the institution's regulations, whether special credentials and privileges are required, or if particular state, professional association, or regulatory body requirements are necessary to perform procedural sedation.

Potential Complications

Complications to procedural sedation include, but are not limited to, vomiting, respiratory depression, hypoxia, hypotension, and cardiac arrest. The most serious complication is respiratory failure from airway obstruction or hypoventilation. Advanced airway management skills are a mandatory prerequisite for performing these techniques. Cardiac depression also may occur and must be rapidly recognized to avoid cardiac arrest or death.

Complications include vomiting, respiratory depression, hypoxemia, hypotension, and cardiac arrest, with the most serious being respiratory arrest or failure. Most occur within 5 to 10 minutes or immediately after the procedure, most often when medications are given in intravenous form.

Complications are most likely to occur within 5 to 10 minutes after administration of intravenous medication and immediately after the procedure when procedural stimuli are removed.[4,5] Thus, monitoring should be especially close during these periods. These complications are less likely to occur when using alternative routes of administration, such as oral, nasal, rectal, or intramuscular, but these routes do not preclude them from occurring.

Intravenous sedative/analgesic drugs should be given in small, incremental doses that are titrated to the desired end points of analgesia and sedation.[2] Sufficient time must elapse between doses to allow the effect of each dose to be assessed before subsequent drug administration. When drugs are administered by nonintravenous routes (e.g., oral, rectal, intramuscular, transmucosal), allowance should be made for the time required for drug absorption before supplementation is considered. Because absorption may be unpredictable, repeat dosing of oral medications to supplement sedation/analgesia is not recommended.

As a practical consideration, unnecessary stimulation, such as inflation of a blood pressure cuff, may hinder the induction of sedation in a young or anxious child or adult. Once a complete set of vital signs has been obtained, deflate the cuff and monitor the patient visually until the drugs have begun to take effect. At this point, monitoring of pulse oximetry and heart rate, at a minimum, should be initiated. This could avoid additional doses of sedatives being given and pushing the patient into a much deeper level of depression than intended when the cuff is deflated or removed.

Hepatic or renal abnormalities may impair drug metabolism and excretion, resulting in increased drug sensitivity and longer duration of drug action. This does not preclude procedural sedation, but the patient should be monitored closely.

Medications that the patient is currently taking may interact with the sedatives and analgesics given. Checking for specific drug interactions before starting the procedural

sedation is recommended. Alcohol or illicit substance abuse may increase a patient's tolerance to sedatives and analgesics. In addition, if the patient has been using these substances before sedation, the addition of sedatives/analgesics may be additive or synergistic and may require intubation earlier than anticipated with normal dosing of medications. Tobacco use can increase the risk for airway irritability, bronchospasm, and coughing during sedation, requiring additional airway monitoring.

Patient Preparation

Identify the patient by armband identification and verbal questioning. Be sure to ask the patient what procedure he or she is there for and confirm that it is the correct procedure. Before giving any anxiolytic or analgesic medication, **obtain consent** for both the procedural sedation and the procedure the patient is to undergo. The patient should be told of any risks involved with either the procedure or the sedation to be used, as well as any postsedation side effects to be expected.

Always identify patient by two forms—armband and verbally; get consent for sedation and the procedure before any medications are given; and always perform a directed history and physical examination before sedation.

Get consent for sedation and the procedure before giving any medications.

A directed history and physical examination should precede sedation.[1,4] Underlying medical problems should be assessed, and information about medication use, allergies, previous adverse experiences with sedation or general anesthesia, and the time and nature of the last oral intake should be obtained.

Auscultation of the heart and lungs should be performed, vital signs taken, and the airway evaluated. Patients who have stridor, significant snoring, sleep apnea, advanced rheumatoid arthritis, dysmorphic facial features, Down syndrome, upper respiratory tract infections, or an abnormal airway examination (including Class III or IV oral examination) should be considered at increased risk for airway obstruction during sedation. These patients potentially have a difficult airway to manage if mask ventilation or intubation becomes necessary.

Essential Anatomy and Physiology

A **normal airway examination** should consist of the following:

Know what a normal airway examination should look like and what the examination requirement needs are.

- Mouth open normally (adults: greater than two fingerwidths or 3 cm)
- Can visualize at least part of the uvula and tonsillar pillars with mouth wide open and tongue out (patient sitting)
- Normal chin length (adults: length of chin is greater than two fingerwidths or 3 cm)
- Normal neck flexion and extension without pain or paresthesias

An abnormal airway examination can consist of the following:

- Small or recessed chin
- Inability to open mouth normally
- Inability to visualize at least part of uvula or tonsils with mouth open and tongue out
- High arched palate
- Tonsillar hypertrophy
- Neck with limited range of motion
- Low-set ears
- Significant obesity of the face and neck
- Class III or IV oral examination (Fig. 22.1)

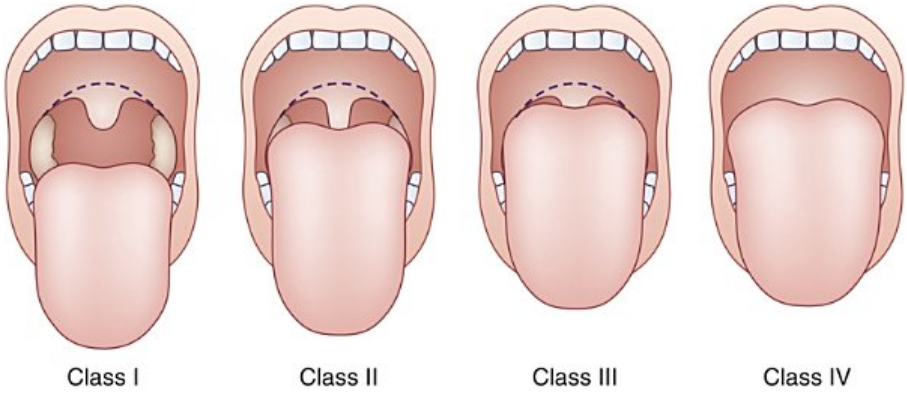

FIGURE 22.1 The progression of diagrams from left to right suggests increased difficulty in airway management during sedation.

Materials

Although rare, procedural sedation and analgesia may result in an allergic reaction, respiratory arrest, or cardiopulmonary arrest.[5] The incidence of complications depends on the drugs used, rate and dose of administration, and patient sensitivities. Although the literature is mixed regarding what specifically needs to be at bedside, clear agreement exists that **pulse oximetry** be performed and consider use of capnography. In addition, if the patient has a history of cardiac disease, ongoing monitoring with electrocardiography should be performed.

At a minimum, all patients must be monitored with continuous pulse oximetry. With a history of cardiac disease, continuous electrocardiography is needed.

Other equipment that must be immediately available includes:

Additional materials to have available include antagonists, appropriately sized airway equipment, suction, and defibrillator.

- Pharmacologic antagonists and appropriately sized equipment for establishing a patent airway and providing positive-pressure ventilation with supplemental oxygen

- Suction, advanced airway equipment, and resuscitation medication, which should be immediately available and in good working order
- A functional defibrillator for whenever deep sedation is administered and when moderate sedation is administered to patients with mild or severe cardiovascular disease

Intravenous access should be maintained when intravenous procedural sedation and analgesia is provided.[1] Intravenous access may not be necessary when procedural sedation and analgesia are provided by other routes.

Monitoring

Monitoring the patient during sedation involves visual observation for ventilatory function, response to verbal commands (unless the patient is unable to respond in a meaningful way [e.g., very young children]), and determination of vital signs at regular intervals. Monitoring of exhaled carbon dioxide should be performed for all patients receiving moderate sedation and for patients whose ventilation cannot be directly observed during any sedation.

At a minimum, all patients must be monitored with continuous pulse oximetry. During the procedure always monitor ventilatory function, verbal command response, and vital signs.

Vital signs should be recorded at specific and regular intervals. At a minimum this should include before starting the procedure, after administration of the drug, when the procedure is complete, during early recovery, and when recovery is completed and the patient is ready for discharge. Capnography, or monitoring of exhaled carbon dioxide, is useful in assessing ventilation during sedation and analgesia. Capnometry is a technique used to monitor end-tidal carbon dioxide and therefore may detect early cases of inadequate ventilation before oxygen desaturation takes place.[1,3,5–8] Capnography has been indicated as useful when ventilatory monitoring is impaired or if the patient is unable to respond to verbal stimuli during the procedure itself.

Sedatives and anxiolytics to be used are practitioner dependent and based on facility constraints.

Agents for Procedural Sedation

The **appropriate choice of agents** and techniques for sedation or analgesia is practitioner dependent and reflects the comfort level and experience that he or she has with administering the particular medication. It also depends on the constraints imposed by the patient, supervising physician, type of procedure, and facility. Once these constraints are identified, the choices of analgesics or sedatives may be more limited. The following are common medications used in sedation and analgesia to achieve minimal to moderate sedation. However, one must keep in mind that all of these drugs have the potential to push the patient into deep sedation, requiring airway management, reversing agents, treatment of cardiac dysfunction, and need for additional airway support. Therefore the practitioner should be able to rescue patients whose level of sedation becomes deeper than initially intended.

All agents for procedural sedation can push patients into deep sedation. Always remember to monitor the patient for signs of distress.

Multiple agents and various combinations of agents can be used to provide sedation and analgesia. **Opioids** are used primarily when analgesia is required. Sedation is often an added benefit for the patient's comfort during the procedure, but it is not the primary indication for administration. **Benzodiazepines** and other sedatives, such as barbiturates and chloral hydrate, are useful medications when achieving anxiolysis and amnesia. They are best given just before a procedure or during the procedure itself. When considering the selection of an agent, it is important to consider the properties of the agent and the type of procedure being performed (painful or nonpainful). This can dictate using only one medication as opposed to multiple medications and possibly drug–drug interaction. However, if the procedure is painful and the patient would benefit from an anxiolytic, it is appropriate to use a combination of opioids and benzodiazepines, recognizing that there is an additive or synergistic effect of these medications and that additional monitoring will be required. These medications are listed in Tables 22.2 and 22.3. The gold standard remains fentanyl and midazolam in combination because of their fast onset, short duration of action, ease in titration, and favorable cardiovascular profile.

Table 22.2

Opioids

Agent	Route	Usual Dosage	Onset/Peak	Duration	Comments
Fentanyl	IV: Adult	1 μg/kg over 2 min	1–2 min/3–5 min	30–40 min	Analgesia, reversible with naloxone
		Titrate 0.25–0.5 μg/kg every 5 min to a maximum of 4–5 μg/kg			Respiratory depression increased with other respiratory depressants; cardiac arrhythmias increased
	IV: Pediatric	Start with 0.5 μg/kg over 2 min			
		Titrate 0.25–0.5 μg/kg every 3–5 min			
Morphine	IV: Adult	Initial dose 0.1 mg/kg over 2 min	10–30 min	4–5 hr	Analgesia, reversible with naloxone
		Titrate 1–2 mg every 5 min			Respiratory depression increased with other respiratory depressants; hypotension possible
	IV: Pediatric	Initial dose 0.05 mg/kg over 2 min			
		Titrate 0.02–0.05 mg/kg every 5–10 min			

CNS, Central nervous system; *IV,* intravenous.

Table 22.3

Benzodiazepines

Agent	Route	Usual Dosage	Onset/Peak	Duration	Comments
Midazolam	IV: Adult	Initial dose 0.05 mg/kg	1–3 min/3–5 min	30–60 min	Requires another agent for analgesia
		Titrate by 0.5 mg every 5 min to a maximum of 5 mg total			Causes respiratory depression, hypertension
					Prolonged sedation may occur in the elderly
	IV: Pediatric	Initial dose 0.05–0.1 mg/kg over 2 min			
		Titrate by 0.025 mg/kg every 5 min, not to exceed a cumulative dose of 0.6 mg/kg			

IV, Intravenous.

Opioids are primarily used for analgesia, and benzodiazepines are primarily used for anxiolysis and amnesia. In combination they have synergistic effects.

The reversing agent for the opioids is naloxone and flumazenil for the benzodiazepines. These are dosed as indicated in Table 22.4. If the patient has received both medications and is in respiratory distress, encouraging deep breathing or bag-mask device assistance may be all that is required. However, if this is inadequate and a reversing agent is indicated, always use naloxone as the first agent of choice.

Table 22.4

Reversing Agents

Agent	Route	Usual Dose	Onset/Peak	Duration	Comments
Naloxone	IV: Adult	0.04–0.1 mg for first dose for partial reversal of opioid-induced respiratory depression. May repeat every 2 min until arousal level is obtained	2 min/5–15 min	Variable; monitor patient closely	May be cleared faster than opioid. Monitor closely for resedation.
		May give up to 0.4–2 mg for first dose if apnea has developed, but with concern for increased side effects (see drug label)			Use with extreme caution in elderly or those with cardiac conditions.

Agent	Route	Usual Dose	Onset/Peak	Duration	Comments
		May repeat every 2–3 min to maximum of 10 mg. *Note:* If patient is on opioids before additional sedation (e.g., for cancer pain), initial dosing should be started at 0.04 mg and instilled every 2 min until arousal occurs to avoid withdrawal syndrome			Acute withdrawal syndrome may also be seen.
	IV: Pediatric	0.01 mg/kg for children <20 kg			
Flumazenil	IV: Adult	0.2 mg over 15 sec	1–2 min/6–10 min	30–90 min, but variable; monitor patient closely	Benzodiazepine reversal use is discouraged; potential for benzodiazepine withdrawal or status epilepticus.
		May repeat every 60 sec with additional 0.2 mg to a maximum of 1 mg			Limited efficacy in reversing respiratory depression.

Agent	Route	Usual Dose	Onset/Peak	Duration	Comments
	IV: Pediatric	0.01 mg/kg for children <20 kg over 15 sec			
		May repeat every 60 sec with additional 0.01 mg/kg to a maximum of 1 mg or 0.05 mg/kg, whichever is lower			

IV, Intravenous.

Reversing agents should be nearby in case they are needed. Their half-life is shorter than the medications they reverse. Monitor the patient continuously, even if the patient arouses and appears back to baseline.

Additional materials that are useful to have nearby include antagonists, appropriately sized airway equipment, suction, and defibrillator. Remember that reversing agent's half-life is shorter than the medications they reverse. Monitor patients continuously, even if they arouse and appear to be back to baseline.

Procedure

Procedural Sedation

1. Confirm patient identity by two methods before procedure or sedation.
2. Obtain consent for the procedure and sedation and discuss with the patient the risks involved with both the procedure and the sedation.
3. Have a family member (or person who will accompany the patient home) present when discussing postprocedure sedation side effects, especially when using amnestic medications.
4. Obtain a thorough history to ascertain any previous allergic reaction to anxiolytics or analgesics. Avoid use of these medications if allergic reaction may be indicated.
5. Perform a physical examination, including the heart, lungs, vital signs, and visualization of the oral airway, before sedation.
6. After the patient has been examined, prepare the room for any need that may arise during the procedure. At a minimum, the patient should be monitored by pulse oximetry and, if he or she has a history of cardiac arrest, with electrocardiography as well.

NOTE: A minimum of two people should be in the room during the administration of sedation and the procedure. This ensures that one person can monitor airway, ventilation function, and responsiveness while the other performs the procedure.

7. Make available a cart containing intubation kits, antagonists, and suctioning equipment in case the patient should develop apnea or slip into deep sedation, requiring intubation. The airway assessment before sedation is of utmost importance in determining which intubation kit to use.
8. Administer the sedative or amnestic as indicated by prior consent. If oral, these typically are given 20 to 30 minutes before the procedure being performed, with someone present to monitor the patient. If given intravenously, these can typically be given 5 to 10 minutes before the procedure, again with physically present monitoring.
9. Monitor during sedation through visual observation for ventilatory function and response to questioning.

NOTE: If the patient is unresponsive to questioning or the observed ventilatory function decreases after the dosing of sedation, monitor oximetry. If oxygen saturations decrease below 92%, initiate oxygen, consider reversing agents and ventilatory support, call for support, and initiate respiratory support as indicated.

10. Record vital signs, at minimum, before starting the procedure, after administering the drug, after the procedure is completed, during early recovery, and immediately before discharge.

NOTE: If at any time during this monitoring the patient appears to need support, start oxygen immediately, call for support, and initiate respiratory support as indicated by the patient's oxygen saturation and responsiveness to questioning.

11. **Monitor the patient** until near-baseline levels are obtained and the patient is no longer at risk for cardiopulmonary depression. Drowsy patients should not be left unattended or in areas in which ventilation cannot be adequately observed.

Monitor the patient until he or she returns to baseline by checking vital signs and pulse oximetry. Provide written instructions at time of discharge and warn patient and family about potential impaired cognition for the following 24 hours.

12. Give aftercare instructions to both the patient and the person accompanying him or her, because it is not unusual for the patient to forget information heard when still partially sedated. Remind both the patient and the other person that after the use of sedative medications the patient should not drive or make legally binding decisions for 24 hours following the procedure.
13. Discharge the patient home with instructions on when to call if side effects or complications develop. Inform the patient and person accompanying him or her that

if nausea or vomiting develops, to change to a clear liquid diet until it resolves.

Discharge Criteria

Patients recovering from procedural sedation must be **monitored** until they are near baseline levels and are no longer at risk for cardiopulmonary depression. Vital signs should be monitored and be stable and at baseline before discharge. This includes checking pulse oximetry until patients are no longer at risk for hypoxemia. Drowsy patients should not be left unattended or in areas of the facility that may not have adequate observation available.

Monitor the patient until he or she returns to baseline by checking vital signs and pulse oximetry.

Before undergoing procedural sedation, the patient and family member should be instructed that when sedation is used, whether it includes amnestics or not, that the patient may have impaired cognitive ability for a prolonged period. They should plan to avoid driving, operating machinery, or making legally binding decisions for at least 24 hours following the procedure.

Written instructions must accompany the patient because of the potential for impaired ability to remember. Postprocedure instructions should include signs and symptoms of potential adverse outcomes and complications. Contact information that includes a 24-hour contact number is advisable in case an emergency does arise. The patient should be instructed to switch to a clear liquid diet until symptoms resolve if he or she develops nausea or vomiting. Generally this is short lived and diet can be advanced as tolerated.

Provide written instructions at time of discharge and warn the patient and the family about the potential for impaired cognition for the following 24 hours.

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CHAPTER 23

Recording an Electrocardiogram

Elias Villarreal, Jr.

Abstract

This chapter briefly addresses the basics of anatomy and physiology as they pertain to the electrocardiogram (ECG). Indications, complications, and a series of steps for administering the ECG are detailed. This chapter addresses the ECG as a procedure itself and does not address the interpretation of any findings.

Keywords

cardiac
cardiology
ECG
electrocardiogram
heart
heart monitoring
heart tracing

Procedure Goals and Objectives

GOAL: To perform an electrocardiogram (ECG) safely and accurately.
OBJECTIVES: The student will be able to:

- Describe the indications, contraindications, and rationale for performing an ECG.
- Identify and describe potential complications associated with performing an ECG.
- Describe the essential anatomy and physiology associated with performing an ECG.
- Identify the materials necessary for performing an ECG and their proper use.
- Identify the proper steps for performing an ECG.

Background and History

In 1790, Salvori demonstrated that stimulation of a charged glass rod attached to a frog's leg muscle causes contraction of the muscle, as if the frog willed it to do so. In 1855, Kollickes and Mueller dissected a frog's heart and attached it to the leg muscle; they noted the frog's leg twitched with each heartbeat. In 1880, Ludig and Waller developed a crude capillary electrometer and recorded the electrical activity of the heart from the skin surface. It was not until 1901 that Einthoven developed a machine that passed light over a moving wire and recorded the PQRSTU waveform (Fig. 23.1). He was the first to develop the first three leads (I, II, and III) that make up the equilateral triangle that today bears his name.[1]

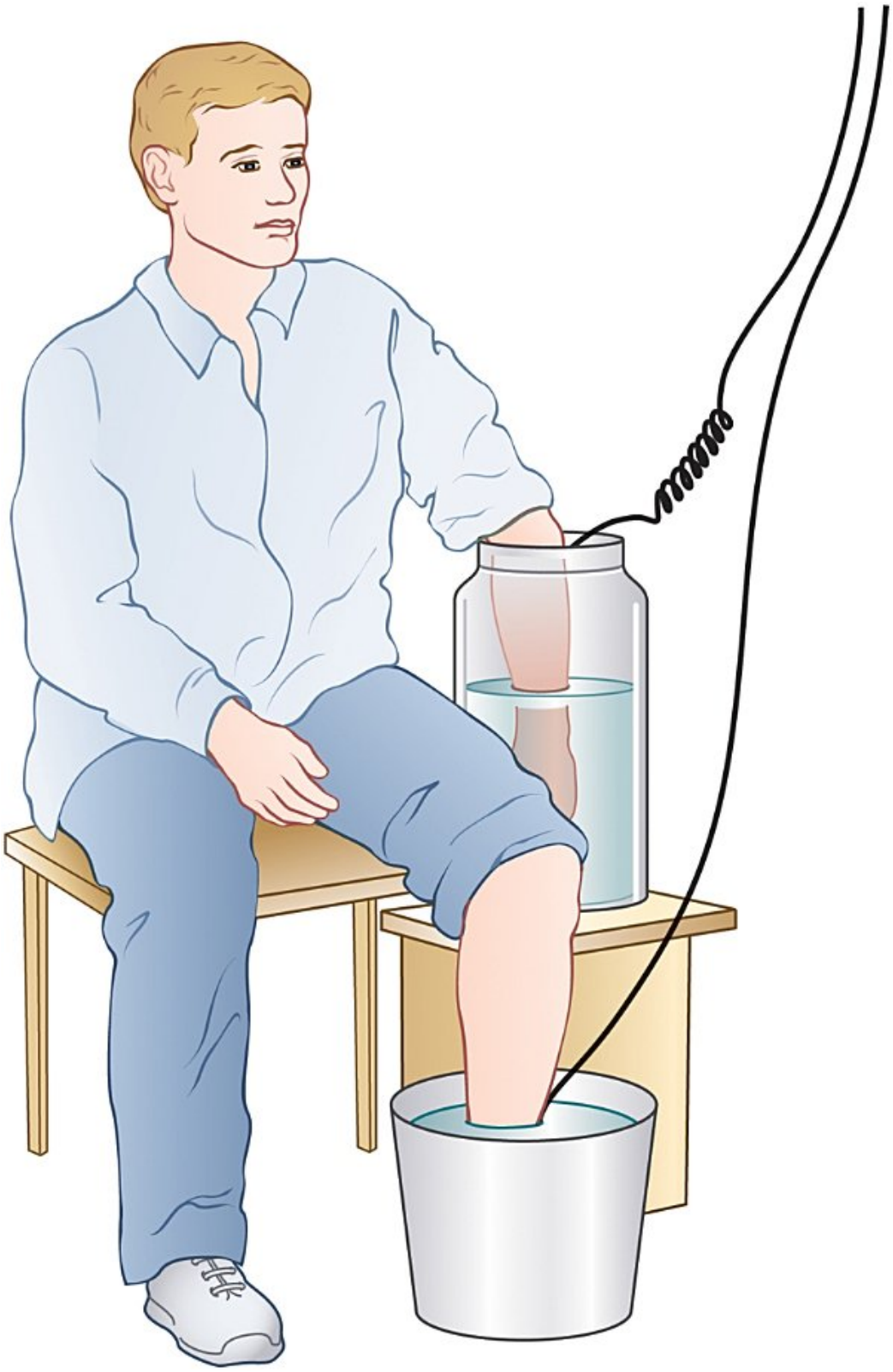

FIGURE 23.1 Electrocardiographic methodology in 1911.
(Redrawn from Rawlings CA.*Electrocardiography*. Redmond, WA:

Spacelabs; 1991, p 26.)

Indications

Numerous technologic advances (e.g., cardiac catheterization, echocardiography, nuclear medicine imaging, and magnetic resonance imaging [MRI]) in the study of heart function notwithstanding, the 12-lead ECG continues to be an effective and inexpensive method to screen for heart disease and monitor patients with acute and chronic heart conditions. The following are some of these conditions[2]:

- Present or impending myocardial infarction
- Previous myocardial infarction
- Heart block
- Electrolyte imbalances
- Abnormality in chamber size or myocardial hypertrophy

The 12-lead ECG plays a critical role in reducing morbidity and mortality in patients with coronary artery disease because it enables the practitioner to detect early danger signs and administer reperfusion medications.

Long-Term ECG Recording

A limitation of the routine 12-lead ECG is that it records the heart's electrical activity for only a very brief period. Some patients have heart rhythm irregularities that occur only periodically. Other recording methods allow these infrequent cardiac rhythm changes to be captured and analyzed. The physician may employ any or all of the following long-term recording methods: (1) the 24-hour Holter monitor, (2) the event (transtelephonic) recorder, and (3) the continuous loop recorder, as follows:

- Holter monitoring is continuous ECG recording for 24 hours while patients go about their usual activities. The patient is

asked to record symptoms (if any) and note the time of their occurrence so that correlation may be made with the symptoms and the ECG tracing at that time.

- The event (transtelephonic) recorder is a small device used when a patient's symptoms, presumed to be related to a rhythm disturbance, occur less frequently than every 24 to 48 hours. When the patient experiences symptoms, he or she attaches the device, usually by putting on a bracelet-like device that attaches to the recorder, or holding the device directly to the chest. An ECG recording, for up to a minute, can be sent over the telephone to the physician's office for interpretation. The event recorder may be loaned to a patient for up to a month.
- The continuous loop recorder (CLR), as its name implies, records an ECG continuously. It records only a few minutes of the ECG, before discarding the "old" information and recording the latest. When the patient experiences symptoms, he or she can immediately "freeze" the recording in the device's memory. Loop recorders may be worn for a long time and are good at capturing very brief episodes that cannot be captured by an event recorder. The CLR also can capture ECG recordings of cardiac rhythm events that can incapacitate the patient, such as syncopy.[3]

Contraindications

The only relative contraindications to performing an ECG are in the case that the equipment may be malfunctioning and if the patient is sensitive to the electrode adhesive.

Potential Complications

Potential complications are as follows:

- The most common complication is misinterpretation of the 12-lead ECG. A tracing can be misinterpreted as being "normal" when it is not (i.e., false-negative). A misdiagnosis

and failure to intervene might lead to harm to the patient and possibly even sudden death.

The lesson is that a "normal ECG" does not always preclude underlying pathology.

- Because electrodes are attached to the patient's skin, either by adhesives or suction, skin damage may result, especially in the elderly or patients with uncontrolled diabetes, potentially leading to infections.
- Although unlikely, it is possible that a patient could receive an electrical shock if there is a short in the wiring. Electrocardiographs today are protected by a third ground wire to prevent such events.

An error in interpretation may be the result of an incorrectly placed lead.

Essential Anatomy and Physiology

A review of the anatomy and physiology of the heart is necessary for proper understanding of the 12-lead ECG. The heart is a complex organ whose primary function is to pump blood through the pulmonary and systemic circulations. Four muscular chambers—right and left atria (collecting chambers) and right and left ventricles (pumping chambers)—comprise the heart (Fig. 23.2). An intricate network of specialized muscle cells coordinates the sequential contractions of the chambers to make it an effective pump.

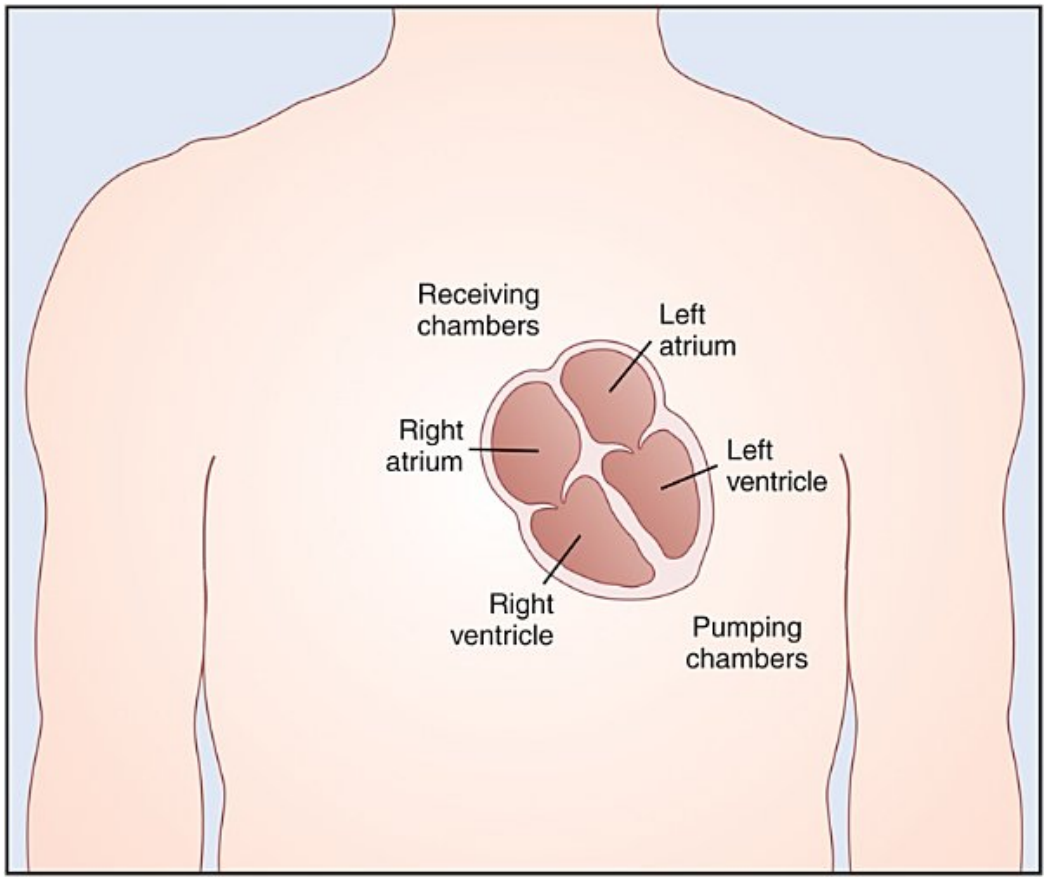

FIGURE 23.2 **Anatomy of the heart.**

The pulmonary artery arises from the right ventricle, whereas the aorta originates from the left ventricle. Each of these large vessels has a valve (i.e., pulmonic and aortic, respectively) that opens to accommodate ejection of blood during systole and closes to prevent backward flow during diastole. Atria and ventricles are separated by valves—the tricuspid between the right atrium and ventricle and the mitral between the left atrium and ventricle. As in the case of the pulmonic and aortic valves, the tricuspid and mitral valves open to accommodate forward flow and close to prevent backward flow. However, unlike the pulmonic and aortic valves, the tricuspid and mitral valves open during diastole and close during systole. The left main and right coronary arteries arise from the root of the aorta. The coronary sinus drains venous blood into the right atrium.

Poorly oxygenated blood returning from the systemic circulation to the right atrium, through the superior and inferior venae cavae, enters the right ventricle in large part (70%) by factors creating

central venous pressure; atrial contraction contributes only 30% to ventricular filling during diastole. The right ventricle pumps blood into the pulmonary artery and the lungs, where it is oxygenated and then returned to the left atrium by the pulmonary veins. As in the case of the right side of the heart, atrial contraction contributes only 30% of the blood that enters the left ventricle during diastole.

The left ventricle pumps blood into the aorta and the systemic circulation, including the coronary arteries, which originate from the base of the aorta and supply the myocardium with oxygen-rich blood mainly during diastole (Fig. 23.3). The larger and thicker-walled left ventricle maintains the pressure necessary to effect forward flow to the systemic circulation. Deoxygenated blood from the myocardium returns to the right atrium via the coronary sinus.

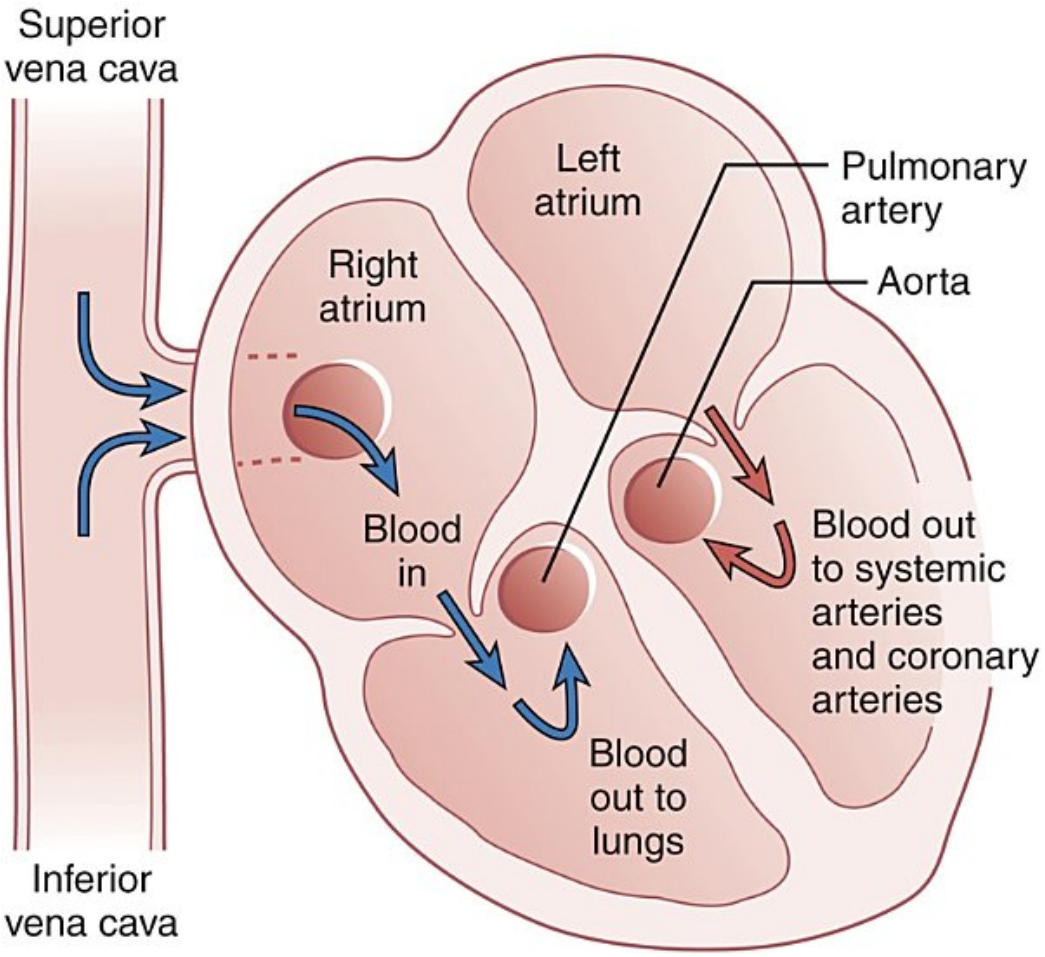

FIGURE 23.3 **The heart box.**

The electrical pathways (or conduction system) (Fig. 23.4) are essential to the coordinated activity of the heart. The sinoatrial (SA) node, located near the junction of the superior vena cava and the right atrium, has an intrinsic (spontaneous) electrical discharge of 60 to 100 cycles per minute, whereas the atrioventricular (AV) node, located between the right atrium and the right ventricle, spontaneously discharges at 40 to 60 cycles per minute. Adjacent to the AV node and traveling through the ventricular septum are specialized fibers—the bundle of His, bundle branches, and Purkinje fibers—that conduct electrical impulses at a high rate of speed.

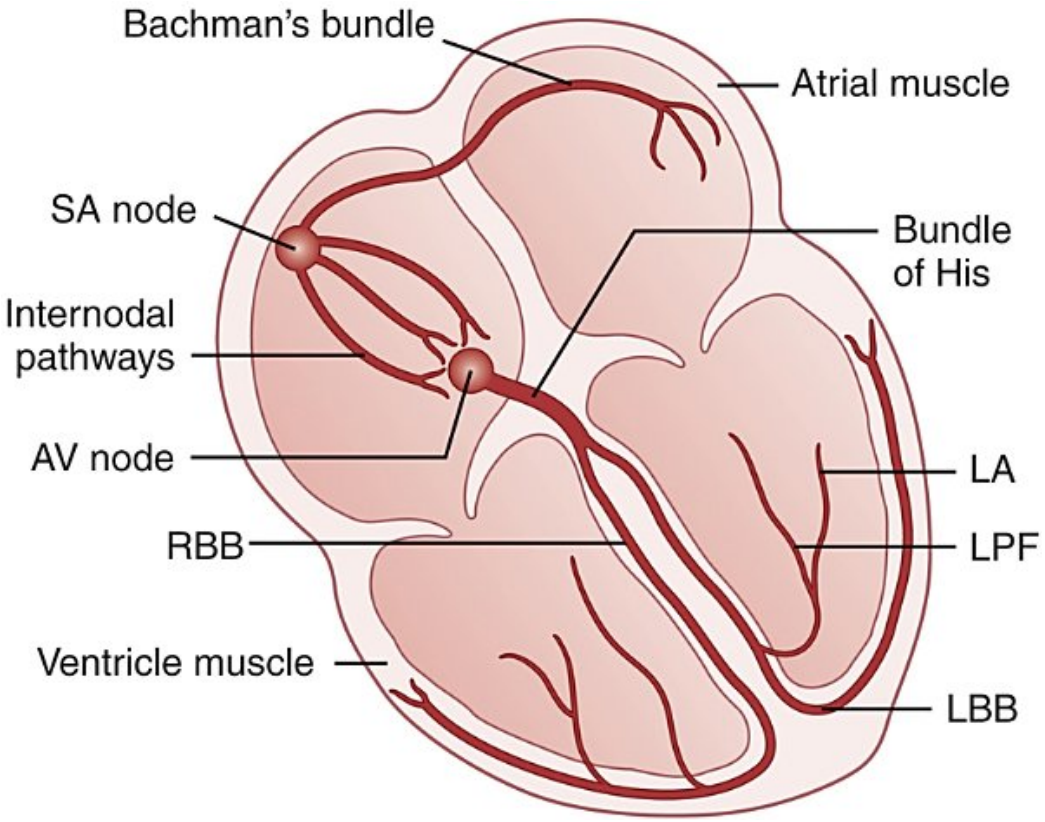

FIGURE 23.4 Electrical pattern of the heart.
AV, Atrioventricular; *LA,* left atrium; *LBB,* left bundle branch; *LPF,* left posterior fascicle; *RBB,* right bundle branch; *SA,* sinoatrial.

Normally, the SA node initiates the electrical impulse, which rapidly spreads through internodal tracts and depolarizes the left and right atria, ultimately reaching the AV node. At this node, conduction slows considerably to allow atrial activity to complete before ventricular activity begins. Following this delay, the impulse moves very rapidly through the bundle of His and its branches (the left has two fascicles) and the Purkinje fibers, resulting in the nearly simultaneous depolarization of the right and left ventricles (Fig. 23.5). The atria and ventricles are separated by a fibrous ring that insulates the chambers from their respective activities and permits spread of electrical activity from atria to ventricles only through the AV node area. The system allows the atria and ventricles to beat synchronously, resulting in effective and efficient pumping activity.

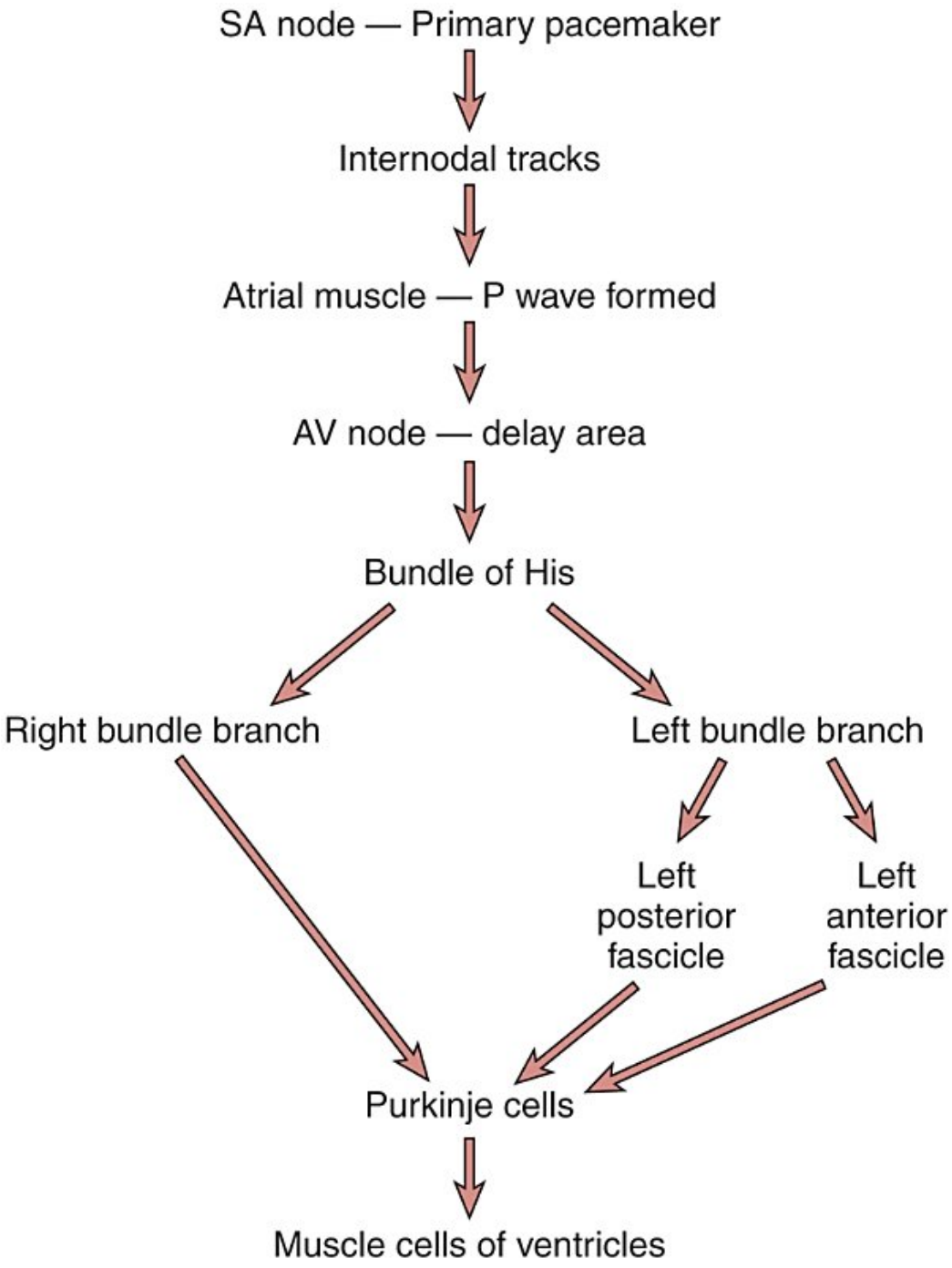

FIGURE 23.5 Electrical sequence of the normal heart.
AV, Atrioventricular; *SA,* sinoatrial.

The electrical activity of the heart can be measured on the surface of the body using an electrocardiograph, thereby producing ECG tracings that consist of repeating waveforms (PQRST) in which the P wave represents depolarization of atrial tissues, the QRS complex

represents depolarization of the ventricles, and the T wave represents repolarization of the ventricles; no waveform is noted that represents atrial repolarization (Fig. 23.6).

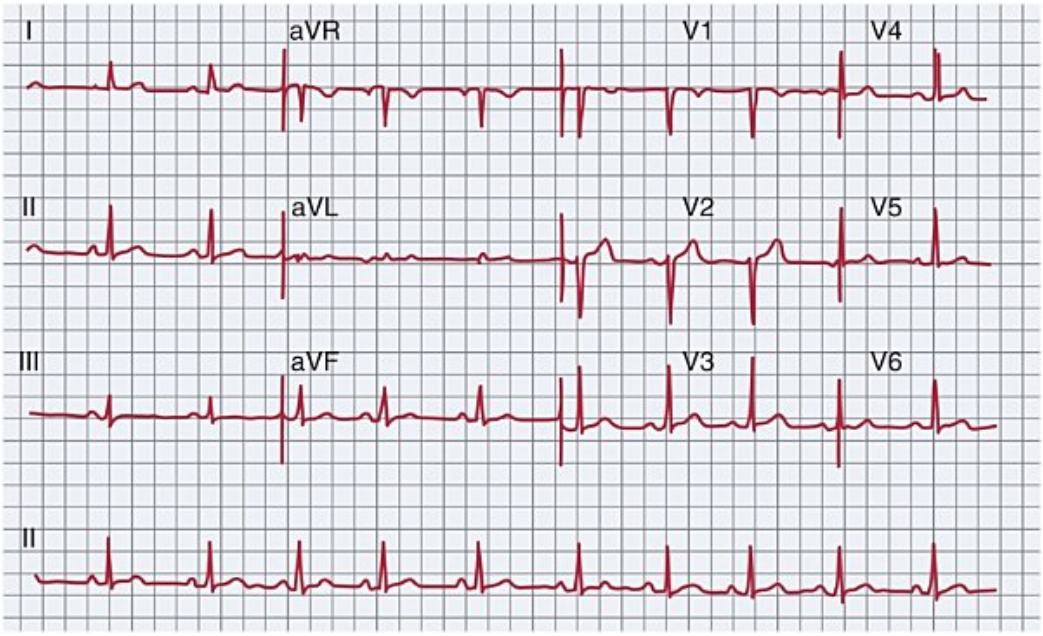

FIGURE 23.6 **Electrocardiographic 12-lead tracing.**

Patient Preparation

Patient preparation is important. Time should be taken to explain to the patient what the procedure entails, inform the patient what he or she should expect, and answer any questions. Preparing the patient's skin helps ensure optimal conditions for recording the ECG. The following steps should be taken to prepare the patient:

- Introduce yourself to the patient.
- Explain the 12-lead electrocardiography procedure and drape the patient's chest.
- Identify the six precordial leads (you may choose to mark them with a felt-tipped pen).
- If necessary, shave the areas where the electrodes are to be placed.

- Use alcohol pads to cleanse the skin and, if necessary, rub with a mild abrasive pad.
- Use alcohol pads again to remove any residue.
- Attach the adhesive pads and connect the electrodes.

Procedure

Obtaining the Electrocardiogram

The following steps are for performing a routine 12-lead ECG at the bedside.

1. Assemble supplies (leads, alcohol, abrasive pads, etc.).
2. Verify the ECG order has been requested for the patient.
3. Verify the patient's identity.
4. Plug in power cord and turn on electrocardiograph.
5. Position the patient in a comfortable supine position and provide a drape or gown to maintain the patient's modesty yet afford adequate access to the patient's chest for lead placement.
6. Wash hands.
7. Cleanse the skin at the six precordial sites.
8. Attach limb and precordial leads (refer to Figs. 23.7 and 23.8 for correct lead placement).
9. Confirm that all leads are connected and secured.
10. Enter patient's information.
11. Ask the patient to lie quietly for 30 seconds.
12. Press the 12-lead (or the record ECG) button to record the tracing.
13. Follow the prompts and/or instructions on the machine to enter the patient's data.
14. Save and print tracings as per the machine's prompts.
15. Results should be filed in either a paper and/or electronic chart.
16. Remove electrodes and adhesive pads.
17. Assist the patient with cleaning up and redressing, as necessary.
18. Properly dispose of used supplies.

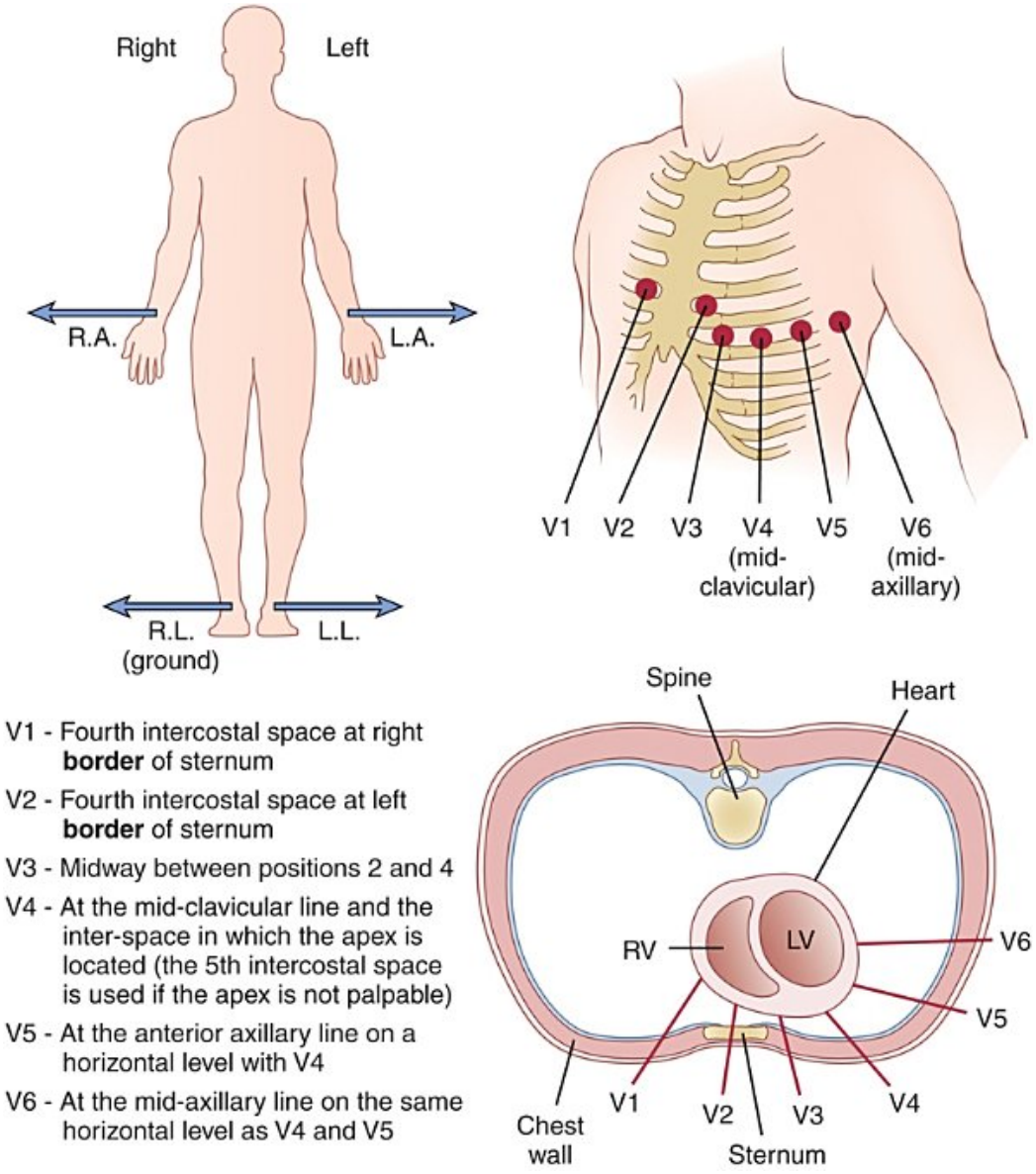

FIGURE 23.7 **Cross-sectional anatomic representation.**

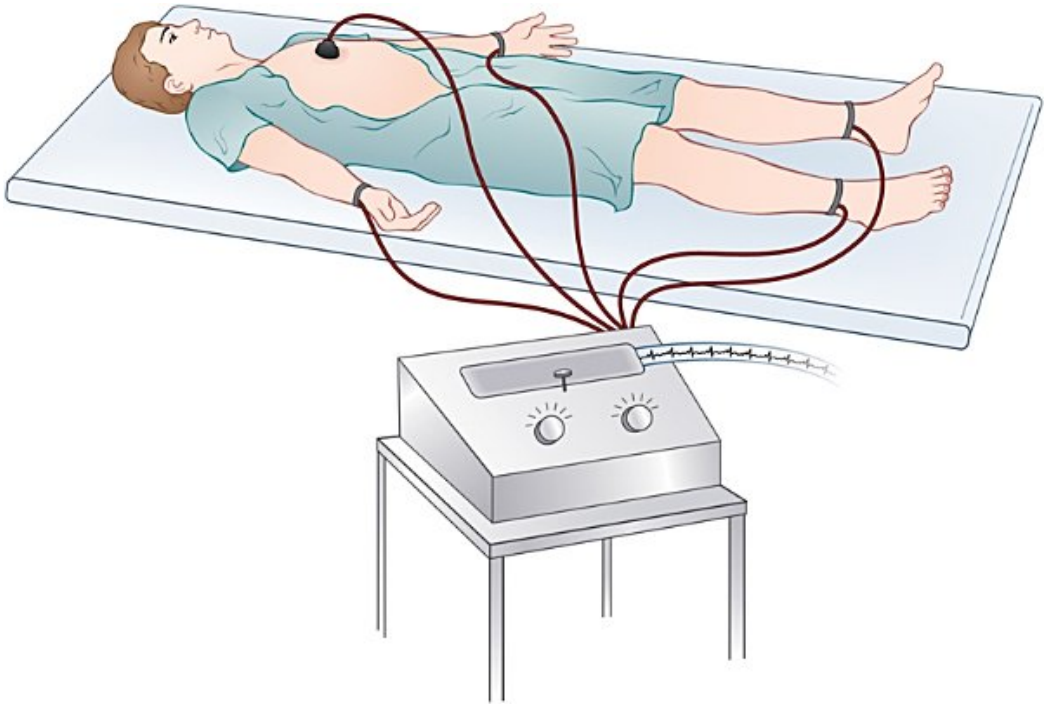

FIGURE 23.8 **Proper lead placement.**

Materials

The machine used to do routine 12-lead ECGs is a standard electrocardiograph mounted on a cart that can be easily wheeled from one location to another. Most systems have a resting electrocardiographic analysis system with quick reference readout.

- Electrodes for the six precordial sites
- Razor to shave hair from a male patient's chest, if necessary
- Alcohol to clean skin surface
- Felt-tip pen to mark site (optional)
- Abrasive pad to remove dead skin at electrode sites and gently remove felt-tip pen marks

Special Considerations

If the patient is unable to remain in one position for 30 seconds because of pain, shortness of breath, or confusion, the operator may need assistance to complete the procedure. Similarly, assistance may

be required if the patient is a child who is anxious about or fearful of the equipment or procedure.

Follow-Up Care and Instructions

No follow-up care is necessary provided the skin has not been damaged by the adhesive pads. Patients should be given an estimate of the time until they are given the results and interpretation of the ECG and who will make the interpretation.

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CHAPTER 24

Reduction of the Shoulder/Finger Subluxations

David Areaux

Abstract

Subluxation, also referred to as dislocation or multidirectional instability, is a temporary, partial dislocation of a joint. A subluxation occurs when the two joint surfaces have lost their usual spatial relation and contact. If the articular surfaces have lost all contact through spatial displacement, this is a dislocation.

Shoulder subluxation or dislocation involves the shoulder joint and occurs when the head of the humerus becomes displaced from the glenoid fossa of the scapula. The shoulder is a ball-and-socket joint, and at any given time, only 25% to 30% of the humeral head is in contact with the glenoid fossa making it an unstable joint.

Finger subluxation or dislocation commonly involves the proximal interphalangeal (PIP) joint or the metacarpophalangeal (MCP) joint. Dislocation of a digit dorsally necessitates failure of the volar plate. Conversely, lateral dislocation violates at least one of the collateral ligaments and produces a partial or complete tear in the volar plate.

Keywords

finger
finger dislocation
finger subluxation

shoulder
shoulder dislocation
shoulder subluxation

Procedure Goals and Objectives

GOAL: To properly reduce a subluxed or dislocated shoulder and finger
OBJECTIVES: The student will be able to:

- Describe the essential anatomy of the shoulder and finger.
- Describe physical findings associated with the shoulder and finger subluxation or dislocation.
- Effectively treat patients who present with a shoulder and finger subluxation or dislocation.

Shoulder Subluxation or Dislocation

Background and History

Subluxation—also referred to as *dislocation* or *multidirectional instability*—is a temporary, partial dislocation of a joint. A subluxation occurs when the two joint surfaces have lost their usual spatial relation and contact. If the articular surfaces have lost all contact through spatial displacement, this is a dislocation.

Shoulder subluxation or dislocation involves the shoulder joint; it occurs when the head of the humerus becomes displaced from the glenoid fossa of the scapula. The shoulder is a ball-and-socket joint, and at any given time, only 25% to 30% of the humeral head is in contact with the glenoid fossa (Fig. 24.1).[1] This minimal articulating

surface coverage allows for an extensive arc of motion but occurs at the cost of a relatively high degree of instability.

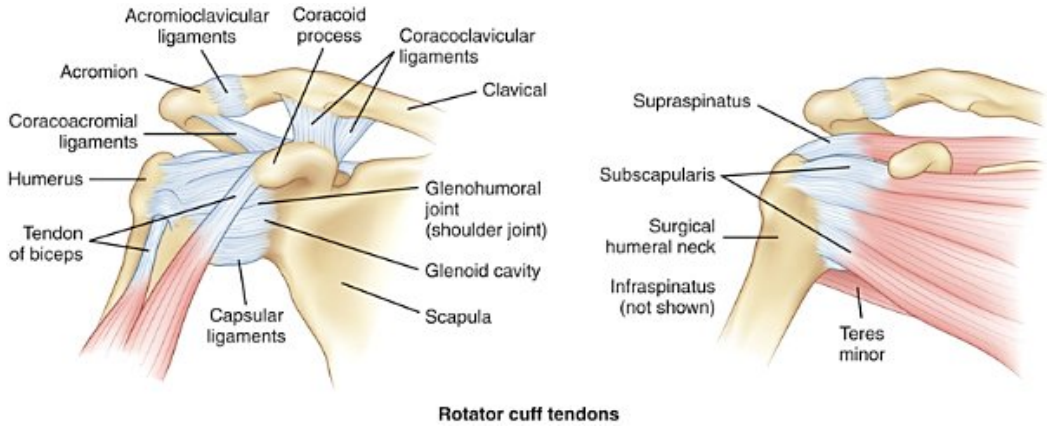

FIGURE 24.1 **Anatomy of shoulder joint and tendons.**

Shoulder subluxation or dislocation involves the shoulder joint where the head of the humerus is displaced from the glenoid fossa of the scapula. Anterior dislocation is more common than posterior dislocation and therefore encountered more often by medical providers.

Depending on the injured structures involved, the direction of instability may be primarily anterior, inferior, posterior, or a combination. The degree of instability may range from mild subluxation to dislocation, with associated damage to surrounding structures.[1] Anterior instability occurs when a shoulder dislocates frequently in the anterior direction. "Dead arm" syndrome is the chronic shoulder subluxation syndrome seen in persons involved in arm-over-head activities, such as baseball pitching or swimming. Posterior dislocation occurs rarely, is often misdiagnosed, and should be considered in patients who experience a loss of external rotation.[2]

Anterior dislocations are most frequently encountered by medical providers. Therefore this discussion will be limited to **anterior subluxation or dislocation** of the shoulder.

Any time a patient presents with a shoulder deformity and mechanism of injury, suspect shoulder subluxation or dislocation.

Indication

Shoulder reduction is indicated when a patient presents with a shoulder deformity and mechanism of injury that suggests shoulder subluxation or dislocation.

Clinical Symptoms

The clinical symptoms of anterior shoulder dislocation:

- Loss of the normal shoulder contour[2]
- Pain with any movement[3]
- Sensation of the shoulder slipping out of the joint when arm is abducted and externally rotated[3]
- Acromion becomes very prominent and the humeral head may be noted in the anterior chest region[2]
- A "hollow" can be appreciated beneath the acromion process, because of the transposed humeral head[2]
- Arm frequently is held in an abducted, externally rotated posture[2]
- Neurologic deficit, most frequently involving the axillary nerve, may be noted[2]
- Ability to dislocate the shoulder voluntarily is frequently associated with multidirectional instability[3]

Diagnosis

Radiographic studies should be considered before attempting to reduce the shoulder. Attempts to reduce a broken humerus can result in a displaced fracture, which creates the possibility that the exposed sharp bone edges will create soft-tissue, nerve, or blood vessel damage. Anteroposterior and axillary radiographs of the shoulder should be obtained. The axillary view may show a bony defect at the anterior edge of the glenoid rim.[3] Some individuals may

require a computed tomography (CT) scan to determine the direction of dislocation or the presence of concomitant fractures.

Radiographic studies should be considered before attempts are made to reduce the shoulder. Anterioposterior and axillary radiographs of the shoulder should be obtained. Some individuals may require a CT scan to determine the direction of the dislocation or the presence of concomitant fractures.

Assessment of a patient believed to have recurrent instability should include the apprehension test for anterior instability, the sulcus sign for inferior laxity, and the jerk test for posterior instability. The patient should be assessed for generalized ligamentous laxity. Ask the patient to touch his or her thumb against the volar surface of the forearm. Bend the fingers back at the metacarpophalangeal joint to determine how far the patient extends past neutral with the fingers and hand in a straight line. Patients with ligamentous laxity are more likely to have multidirectional instability, but other types of instability are still possible.[3]

Materials

- Stretcher
- Weights
- Analgesia
- Muscle relaxants
- Opioids
- Benzodiazepines
- Reversal agents

Potential Complications

The potential complications in a shoulder dislocation are as follows:

- Axillary nerve injury, deltoid dysfunction, and numbness over lateral arm. Test axillary nerve function before and after

shoulder reduction.

- Increased risk for recurrent instability in younger patients and in those with multiple episodes.

Treatment

Most acute shoulder dislocations can be reduced in the **emergency department**. Several techniques may be used by the emergency department staff. The patient is probably best served by the Stimson technique, in which weight loading and time gently reduce the joint.[2]

Most acute shoulder dislocations can be reduced in the emergency department. Several techniques may be used by the emergency department staff. The patient is probably best served by the Stimson technique, in which weight loading and time gently reduce the joint.[2]

Procedure

Reduction of Anterior Shoulder Dislocation

Stimson Technique (Gravity-Assisted Reduction)

1. Perform **neurologic examination** to assess function of the axillary, musculocutaneous, median, radial, and ulnar nerves, with emphasis on evaluating the axillary nerve through voluntary isometric contraction of the deltoid and sensation over the lateral deltoid region.[3]
2. Establish intravenous access; ensure naloxone is available.
3. Apply oxygen (by mask or nasal cannula) and initiate pulse oximetry and cardiac monitoring if opioids are used.
4. Fentanyl 100 µg is given by intravenous push over 1 minute, then repeated every 3 to 5 minutes until adequate sedation is achieved. The usual total dose of fentanyl is 3 µg/kg. Patients with recurrent dislocations may not require anesthesia.

One of the most important and overlooked parts of a dislocation or subluxation physical examination is a neurologic assessment to assess function before and after reduction.

Shoulder Reduction

1. Place the patient prone on a stretcher with the dislocated arm hanging off the edge of the cart.[3]
2. Have an assistant sit on the floor and provide gentle, sustained downward traction, or attach 5 to 15 lb of weight to the patient's arm. The weight should not touch the floor (Fig. 24.2).[3]
3. While traction is being applied, place your left thumb on the patient's acromion and the fingers of your left hand over the front of the humeral head.[3]
4. As the muscles relax, gently push the humeral head caudally until it reduces into the glenoid fossa.[3]
5. Obtain appropriate postreduction radiographs to determine whether adequate reduction of the joint surfaces has been achieved.[2]
6. Immobilize the arm by having the patient hold the limb in internal rotation with adduction against the body using a sling and swath device.

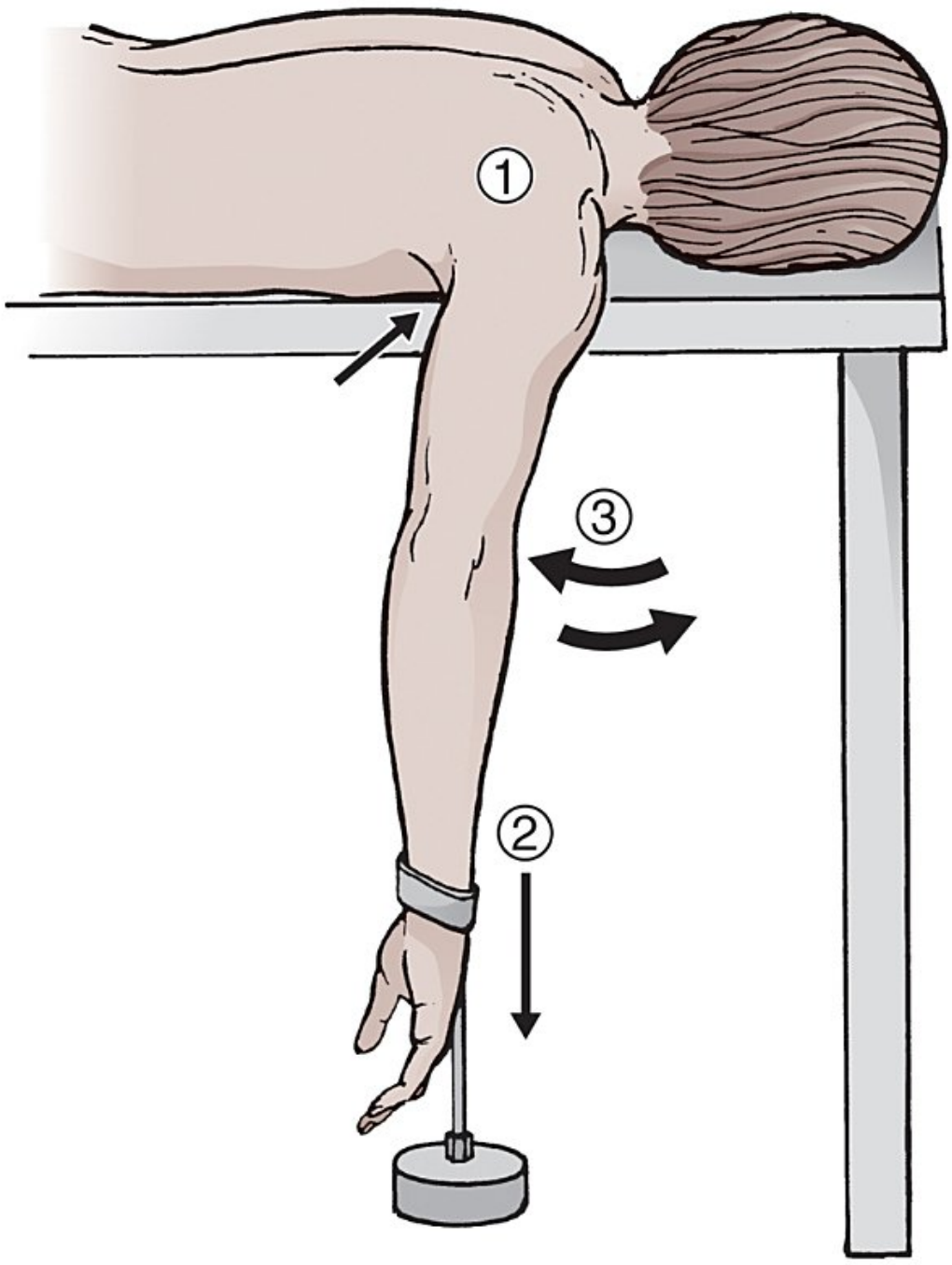

FIGURE 24.2 Stimson technique.
This technique is often tried first because it is the least traumatic if the patient can relax the shoulder muscles. *1.* The patient is lying prone on the edge of the table. One must be careful that the sedated or intoxicated patient does not fall off the table. Belts or sheets can be used to secure the patient to the stretcher. *2.* Five-kilogram weights are attached to the arm, and the patient maintains this position for 20 to 30

minutes, if necessary. *3.* Occasionally, gentle external and internal rotation of the shoulder with manual traction aids reduction. (From DePalma AF: *Management of Fractures and Dislocations: An Atlas.* Philadelphia: WB Saunders; 1970, p 618.)

Follow-Up Care and Instructions

The patient should receive follow-up care and instructions as follows:

- After the designated period of immobilization, the patient can begin strengthening exercises for the subscapularis and infraspinatus muscles at 2 to 3 weeks after reduction in the elderly and as soon as 6 weeks for a younger patient.[2,3]
- Increased shoulder external rotation and flexion can begin at 6 weeks after reduction if the patient is younger than 30 years and at 3 weeks if the patient is older than 30 years.[3]
- Vigorous shoulder motion begins at 6 weeks after reduction if the patient is older than 30 years, but delayed to 3 months for patients younger than 30 years.[3]
- In an athlete, allow return to sports once near-full flexion and rotation of the arm and near-normal strength have returned.[3]

Finger Subluxation or Dislocation

Background and History

Finger subluxation or dislocation commonly involves the proximal interphalangeal (PIP) joint or the metacarpophalangeal (MCP) joint. Each PIP and MCP joint has two collateral ligaments and a volar fibrocartilaginous plate (Fig. 24.3). Joint support is facilitated by these structures as well as the surrounding tendons.[4]

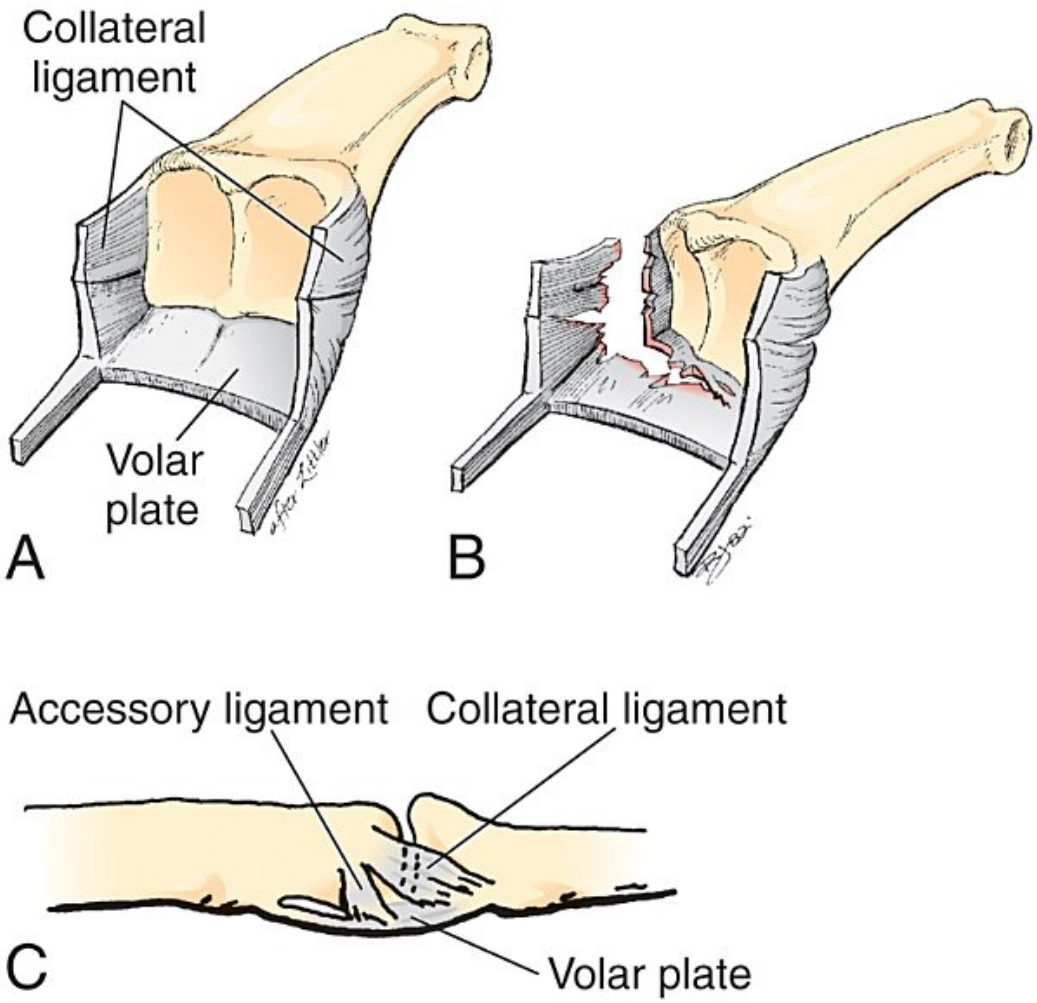

FIGURE 24.3 **A**, **B.** The collateral ligament–volar plate relationship. The metacarpophalangeal and interphalangeal joints derive their strength from a combination of the two collateral ligaments and the volar plate. Dislocations of these joints require tearing of at least two parts of this three-part structure. **C.** Lateral view demonstrates the collateral ligament–volar plate relationship. (**A** and **B.** From Carter P, ed. *Common Hand Injuries and Infections.* Philadelphia: WB Saunders; 1983, p 114. **C.** Redrawn from Eaton RG. *Joint Injuries of the Hand.* Springfield, IL: Charles C. Thomas; 1972.)

Finger subluxation or dislocation commonly involves the proximal interphalangeal (PIP) joint or the metacarpophalangeal (MCP) joint.

Dislocation of a digit dorsally necessitates failure of the volar plate. Conversely, lateral dislocation violates at least one of the collateral ligaments and produces a partial or complete tear in the volar plate.[4] Dorsal dislocations of the MCP joint are considered either simple or complex. Complex dislocations of the MCP joint typically require open reduction.[5]

Indication

Reduction of the finger is indicated when the diagnosis of a dislocated finger is established and the likelihood of a bone fracture is eliminated.

Clinical Symptoms

The clinical symptoms of finger dislocation are as follows:

- History of trauma and acute onset of pain
- Deformity that develops immediately after injury

Diagnosis

- Note obvious deformity and misalignment of the finger.
- **Palpate** both sides of the joint for tenderness over the collateral ligaments for pain and deformity.
- Obtain radiographs to rule out fractures.

Palpate both sides of the joint for tenderness over the collateral ligaments for pain and deformity. Radiographs should be obtained to rule out fractures.

Visual inspection of finger joint will show the following:

- Dislocations are typically obvious on inspection.
- Complete dislocations of the MP joint are characterized by fixed displacement of the distal segment.[5]

- Complex MCP dislocations are characterized by a palmar prominence of the metacarpal head and angulation and dorsal displacement of the proximal phalanx.[4]
- Complete MCP dislocations have limited active flexion.[5]

Potential Complications

- Limited range of motion
- Stiffness
- Chronic pain
- Damage to proximal nerves, blood vessels, ligaments, and tendons
- Swelling
- Chronic hyperextension of the PIP joint or flexion contracture can occur

Treatment

If reduction is performed immediately, **anesthesia** is usually not necessary. However, a digital block typically is required to manage pain effectively if presentation is delayed for more than 1 hour.[6] For a digital block, 1% to 2% lidocaine (Xylocaine) without epinephrine is placed along both sides of the affected digit just distal to the MCP joint. A small-gauge needle (27 to 30 gauge) should be used.[6] If radiography reveals a large fracture fragment or if reduction is unsuccessful, referral to an orthopedic or hand surgeon is necessary.

If reduction is performed immediately, anesthesia is not needed. However, a digital block is usually needed for pain if presentation is delayed for more than 1 hour.[6] If radiography shows a large fracture fragment, or if reduction is unsuccessful, referral to an orthopedic or hand surgeon is necessary.

Proximal interphalangeal joint reduction of a dorsal dislocation of the PIP is usually performed with axial traction and flexion of the proximal phalanx.[5] Buddy tape the affected finger to an adjacent

finger for support and protection. If traction and volarly directed pressure is ineffective, the clinician should hyperextend the distal portion to "unlock" the joint and continue applying traction and volarly directed pressure.[7] Volar dislocation of the PIP joint is rare. This injury may cause a tear in the central slip of the extensor tendon or "buttonholing" of the proximal phalanx through the central slip. The clinician may attempt reduction by hyperflexing the distal segment (middle phalanx) to "unlock" the joint and then applying traction.

Follow-Up Care and Instructions

If successful on the first attempt, the joint should be splinted in full extension for 6 weeks. If reduction is unsuccessful or if avulsion involves more than one-third of the joint, referral to an orthopedic or hand surgeon is needed.[7]

Distal Interphalangeal Joint

Distal interphalangeal (DIP) dislocations are typically dorsal or dorsolateral.[5] Uncomplicated DIP joint dislocations are reduced and treated the same as PIP joint dislocations. With open injuries, suspect an associated tear of the extensor tendon; these injuries will require appropriate debridement and irrigation.[5]

Follow-Up Care and Instructions

After 1 week, a stable joint should be splinted in flexion for 2 to 4 weeks followed by buddy taping and follow-up radiography.[7]

Metacarpophalangeal Joint

The metacarpophalangeal (MCP) joint most commonly dislocated is that of the thumb. Reduction is the same as for PIP and DIP dislocations. Splinting depends on the direction of the dislocation. A reduced dorsal MCP joint dislocation will have injured volar structures, as does a PIP dislocation. Therefore a splint that does not allow full extension is necessary, as it is with a PIP dislocation. The

opposite is true for a volar dislocation. Dorsal structures will be injured, and splinting should be initiated to maintain extension.[7]

Follow-Up Care and Instructions

A dorsal extension-block splint that includes the wrist should be worn for at least 3 weeks; it can be followed by buddy taping for 1 to 3 weeks, if necessary, to provide additional protection and comfort. Active motion within the splint should be started during the first week after reduction.

Referral Decisions

The following should be taken into consideration in determining the need for referral:

- Dislocations that cannot be reduced with anesthesia typically require open reduction.[5]
- Patients with fracture dislocations and open dislocations need further evaluation.[5]
- Open dislocations should undergo surgical debridement and repair for best results.[5]

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CHAPTER 25

Removal of Cerumen and Foreign Bodies From the Ear

Theresa Hegmann

Abstract

Removal of earwax and other foreign bodies from the external auditory canal is a common primary care procedure that can be accomplished using a variety of methods. Performed carefully and correctly, these procedures can result in quick resolution of bothersome symptoms such as decreased hearing, itching, ear pain, or even vertigo. Cerumen removal is particularly important in maintaining quality of life in populations at higher risk for the condition, including the elderly and disabled. However, certain situations are known to greatly increase risk of failure and complications: agitated young children, multiple previous removal attempts, presence of disk batteries or sharp objects, and a history of previous injury or perforation of the tympanic membrane. In these cases, patients should be referred to an otolaryngologist rather than risk potential complications in the primary care setting.

Keywords

cerumen impaction
clinical procedure
ear irrigation
foreign body removal

Procedure Goals and Objectives

GOAL: To remove impacted cerumen or foreign bodies safely from the external auditory canal in a primary care setting.

OBJECTIVES: The student will be able to:

- List indications and contraindications for cerumen removal.
- List contraindications for foreign body removal from the ear in a primary care setting.
- Describe the basic anatomy of the ear and associated implications for removal of foreign bodies and cerumen.
- Identify possible complications of the procedure and strategies for avoiding complications.
- Identify specific situations that require urgent referral of patients to an otolaryngologist.
- List the equipment and basic steps involved in removing cerumen or a foreign body from the external auditory canal.

Background and History

Physician assistants in family practice, pediatrics, internal medicine, urgent care, and emergency room settings commonly encounter patients who need removal of ear wax or foreign bodies from the external auditory canal. Impacted ear wax is more common in **elderly or handicapped patients**. It is worsened by use of hearing aids or the common practice of cleaning the ear canal with cotton-

tipped applicators (Q-tips), both of which can interfere with the normal physiologic processes that tend to move cerumen out of the auditory canal. Cerumen impaction is a common cause of obstructive hearing loss, which can in turn worsen social isolation and depression, so identification and effective treatment of the condition is important in maintaining a good quality of life.[1]

Identification and treatment of cerumen impaction helps maintain quality of life for elderly and handicapped individuals.

Cerumen removal may be accomplished by use of **cerumenolytics** (ear drops), irrigation ("syringing"), manual removal by a clinician, or a combination of these approaches. The 2017 Updated Clinical Practice Guideline from the American Academy of Otolaryngology–Head and Neck Surgery did not find sufficient evidence to recommend one approach above others.[1] Based on weak quality evidence, water-based and oil-based preparations appear to be equally effective in clearing earwax.[2,3]

Home use of earwax dispersants and self-irrigation is a safe and cost-effective option.[3] Oil-based and water-based preparations appear to be equally effective.

Besides hearing loss, both cerumen impaction and foreign bodies can present with symptoms such as ear pain or fullness, itching, infection or drainage, tinnitus, vertigo, or even reflex cough or hiccups.[4,5] Many patients, however, are asymptomatic. In contrast to impacted cerumen, most patients who present with foreign body in the ear canal are young; one 5-year retrospective study reported a mean age of 6.6 years.[6] The type of foreign bodies most commonly encountered varies with the setting, but most authors report beads, plastic toy parts, pebbles, insects, seeds or popcorn kernels, and cotton or paper objects as among the most common.[4,6,7]

Multiple studies of patients presenting to a variety of settings for removal of auditory canal foreign bodies have found that certain

factors are reliably associated with a greater risk for complications and an increased need for removal under general anesthesia by an otolaryngologist. These complicating factors include the presence of **hard round objects or sharp objects**, previous unsuccessful attempts at removal, and patient age younger than 4 years.[4,6–9]

Hard, round objects and sharp objects are the most difficult to remove.

However, soft, irregular, and easily grasped objects often can be removed easily and safely, with success rates nearing 90%.[6,8] Overall success rates in office and emergency department settings are in the 70% range, with the remaining patients requiring specialty referral for removal under anesthesia.[4,9]

It is important that the method chosen to remove an object be appropriate to the type of foreign body present in the ear. Irrigation with warm water may be effective for small objects that are not wedged and will not absorb water and swell; it should be avoided in the case of wooden objects or plant material, which may become harder to remove after absorbing water. Irrigation is also absolutely contraindicated in the case of disk batteries because it can lead to severe injury from tissue necrosis.[10]

Graspable objects can be removed under direct visualization with mosquito, straight, or alligator forceps. Live insects should be killed with 2% lidocaine, alcohol, or mineral or olive oil before removal. Additional less-common approaches to removing foreign objects from the auditory canal that may be useful in specific situations include instillation of acetone to dissolve Styrofoam; use of a drop of cyanoacrylate glue on the end of an applicator stick that is allowed to bond under direct visualization to the foreign body; and instillation of semifluid dental impression material into the auditory canal, which is then removed after it cures.[11,12]

Although removal of impacted cerumen and foreign bodies from the ear is a relatively common procedure handled frequently by primary care clinicians, serious complications are possible. Therefore, it is important in each case to take a careful history and

perform a careful physical examination to assess for risk factors and contraindications. Keys to success include access to appropriate equipment, good lighting and visualization, and, in the case of foreign body removal, a cooperative or carefully restrained patient.

Indications

The presence of virtually any foreign body in the external auditory canal is an indication for removal. **Impacted ear wax** should be removed if it is causing hearing loss, pain, or other symptoms. The need for visualization of the tympanic membrane is another indication for removal of cerumen.

Presence of cerumen in the auditory canal that is asymptomatic and not obstructing the canal does not require any intervention.

Contraindications

Contraindications to *irrigation* of the external auditory canal include:

Presence of a disk battery in the ear canal and suspected perforation of the tympanic membrane are both contraindications to ear irrigation.

- Current or past perforation of the tympanic membrane
- History of prior surgery to the ear or tympanic membrane
- Sudden onset of severe pain or dizziness during the procedure (suggests perforation or other trauma)
- Unilateral deafness (when the side being irrigated is the only hearing ear)[2]
- Presence of a disk battery

Certain situations are known to greatly decrease the likelihood of successful atraumatic removal of an auditory canal foreign body in an outpatient primary care setting. Therefore, immediate referral to

an otolaryngologist should be the rule when a clinician encounters the following[5,6,9]:

Previous removal attempts and young patient age both decrease the likelihood of successful removal of a foreign body in the primary care setting.

- An uncooperative patient who cannot be adequately restrained (sedation or anesthesia may be needed to avoid physical and emotional trauma to the patient)
- Inability to visualize a foreign body, related to difficult anatomy, preexisting infection, or trauma
- Hard, round objects that are against the tympanic membrane
- Hard objects that are wedged in the medial two-thirds of the canal
- **Disk batteries** or sharp foreign bodies, because of the potential for serious complications
- Previous unsuccessful attempts

Disk batteries from watches or hearing aids can cause tissue necrosis in the ear canal and require immediate removal, preferably by a specialist.

Potential Complications[2,6,10]

Potential minor complications include the following:

- Discomfort
- Brief vertigo
- Nausea
- Superficial auditory canal abrasion

More severe complications are possible, including the following:

- Trauma-induced otitis externa
- Perforation of the tympanic membrane

- Alkaline necrosis of the auditory canal wall (in the case of disk batteries)
- Rarely, trauma to the ossicles or round window, which may lead to permanent hearing loss, tinnitus, or vertigo

Essential Anatomy and Physiology

The ear can be thought of as having three basic components—the external ear, composed of the pinna and the external auditory canal; the middle ear, which starts with the tympanic membrane and contains the ossicles and eustachian tube opening; and the inner ear, which includes the cochlea and the semicircular canals (Fig. 25.1). Only the external ear and tympanic membrane can be visualized on physical examination.

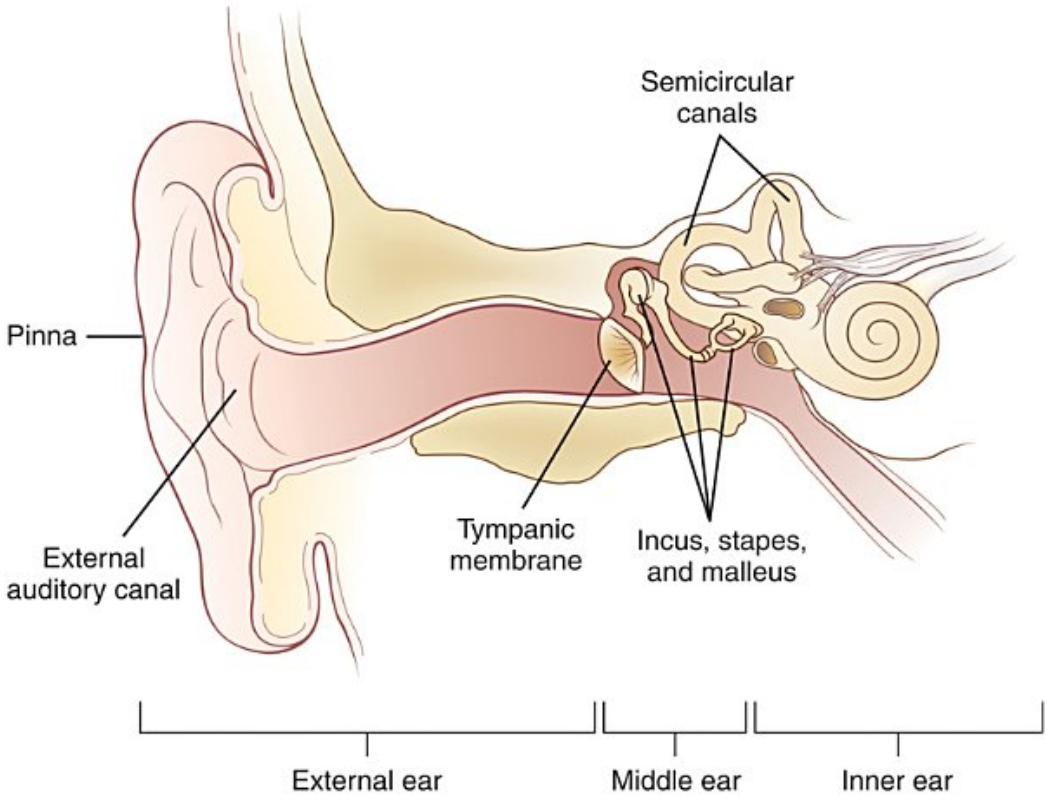

FIGURE 25.1 **Ear anatomy.**

The auditory canal begins as a cartilaginous structure and narrows somewhat at the junction with the bony portion of the canal. This

narrowing can complicate removal of foreign bodies, which may become impacted at this point. The osseous portion of the auditory canal is exquisitely sensitive because there is very little tissue between the periosteum and the skin, which can make attempts at foreign body removal painful. Additionally, trauma or infection that causes swelling of the canal wall may lead to excruciating pain for the patient and more difficult visualization for the clinician.

Standard precautions

Every practitioner should use standard precautions at all times when interacting with patients, especially when performing procedures. Determining the level of precaution necessary requires clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

Patient Preparation

The following should be considered in preparing the patient for cerumen or foreign body extraction:

- Review the proposed procedure, including risks and potential discomforts and complications, with the patient or the patient's parent or guardian and obtain informed consent.
- Place the patient in a comfortable and preferably supported, upright position. Usually it is best not to be working against gravity, but some children may tolerate the procedure better in a supine position. Children may require gentle restraint on a parent's or assistant's lap or can be wrapped in a sheet.[4] It is best to have an additional helper to steady the child's head. An **agitated child** who cannot be adequately restrained is an indication for referral.

Agitated young children who cannot be adequately restrained should be referred to a specialist for foreign body removal.

- Advise the patient to remain as still as possible, and to report pain or dizziness. Notify the patient that mild discomfort or pressure sensation and a loud noise (with irrigation) are possible.

Materials

For cerumen removal, the following equipment should be gathered:

- Otoscope or ear speculum and a bright light or headlamp light source
- Clean water at body temperature
- Towels and a plastic drape, if available
- Syringe: Either the classic metal ear syringe (Fig. 25.2) or a disposable plastic 30- to 60-mL syringe with an 18-gauge plastic intravenous catheter or butterfly catheter tubing attached (remove the needle and butterfly components first)
- Cerumen spoon and/loop, preferably plastic and disposable (Fig. 25.3)

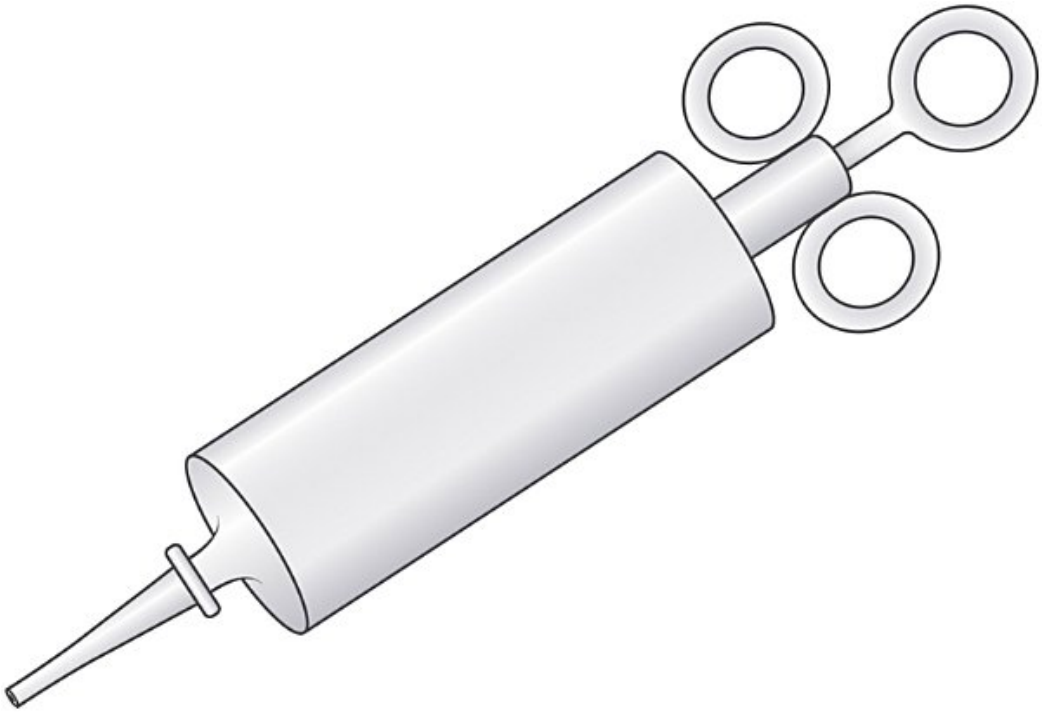

FIGURE 25.2 **Metal ear syringe**
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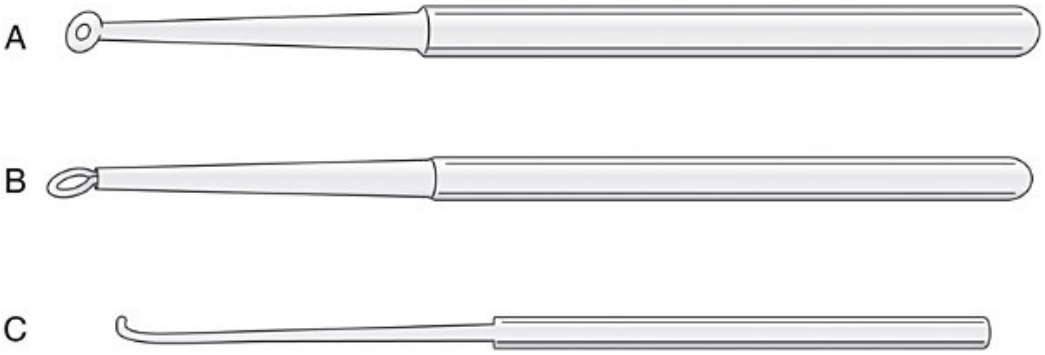

FIGURE 25.3 Cerumen spoon (**A**), cerumen loop (**B**), and right-angle hook (**C**).

For removal of foreign bodies, the following *additional* equipment may be needed, depending on the situation:

- Alligator, straight, or mosquito forceps

- Alcohol, 2% lidocaine, or oil (mineral oil or olive oil) if a live insect is noted in the ear canal
- Applicator stick (wooden or hollow plastic) and cyanoacrylate glue

Procedure

Cerumen and Foreign Body Removal from the External Auditory Canal

Cerumen Removal

1. Take a patient history to identify any contraindications to the procedure and inspect the ear canal.
2. Consider **pretreatment** with water, saline, or an oil-based or water-based commercial earwax preparation for 15 to 30 minutes before office-based irrigation, as it may increase ease of removal.[3,13]

> Pretreatment of impacted cerumen with water or saline in the waiting room for 15 to 30 minutes before irrigation may increase ease of cerumen removal.

3. Position the patient comfortably and use a plastic drape, towel, or absorbent pad to protect the patient from splashing water. Have the patient or an assistant hold a collection basin under the affected ear to collect excess water.
4. Fill the syringe with 37° C (98.6° F) **water**; water that is too warm or too cold can cause acute vertigo.

Water used for flushing the external auditory canal should be at body temperature—no warmer, no colder.

5. Place the tip of the syringe or the intravenous catheter or butterfly tubing into the lateral ear canal. Pull the pinna outward, up, and back, and then **aim the jet of water** toward the superoposterior ear canal. Avoid blocking the canal opening or pushing forcibly on the syringe, because excessive water pressure can damage the tympanic membrane.

When irrigating the auditory canal, aim the jet of water toward the superoposterior canal wall. Do NOT aim at the tympanic membrane.

6. Inspect the ear canal periodically during the procedure. Irrigation may be repeated several times until the impaction is removed.
7. If difficulty is encountered, consider pretreating with water or saline in the ear for 15 minutes, and then trying again.[13] Alternatively, manual removal of the cerumen with a cerumen spoon or loop may be attempted at this point, but must be done with good lighting and direct visualization. **Blind attempts** at manual cerumen removal are likely to result in pain and damage to the ear canal or tympanic membrane.

> Never insert a curette or other tool blindly into the ear canal. Direct visualization with good lighting is necessary to avoid injury.

8. After removal of the cerumen, carefully inspect the auditory canal again and remove excess water from the canal. Inflammation or abrasion to the external auditory canal indicates the need for treatment with an antibiotic otic preparation.
9. Document the history, examination findings, informed consent, and procedure note, including any complications and aftercare instructions, in the patient's medical record.

Foreign Body Removal

1. Take a careful history and physical examination to identify the type of foreign body and any coexisting trauma or infection. If contraindications to office removal are present, proceed with otolaryngology referral (Refer to Contraindications section).
2. Place the patient in a comfortable position, and ensure the patient is able to hold his or her head still. An upright position is usually preferable. As noted previously, pediatric patients may require restraint with the assistance of an experienced staff person.
3. Carefully consider the best removal technique based on the shape and texture of the foreign body. Subsequent attempts at foreign body removal after an initial failure are less likely to succeed and more likely to result in complications.[6,7,9]
    - Soft, graspable items or plant material are best approached with forceps of some sort. Alligator forceps are particularly useful for cotton or paper objects. Irrigation should never be used with absorbent materials.

- Small, round objects that are loose (not wedged) in the canal may be irrigated, *with the notable exception of disk batteries, which must not be allowed to get wet.*
- Live insects should first be killed with alcohol, lidocaine, or oil. Then they can be irrigated or removed with forceps under direct visualization.
- Small beads with a central hole can sometimes be grasped with alligator forceps, cupped forceps, or a right-angle hook.

4. Straighten the auditory canal with gentle upward and outward traction with the nondominant hand. In children, traction directly backward or even downward may straighten the canal.
5. Small tools may be inserted through the otoscope to allow for better visualization. When that is not possible, obtain the assistance of a staff person to hold a bright light to allow the object to be visualized, or use a headlamp. *Never insert instruments blindly into the auditory canal.*
6. Clinicians experienced in the technique can consider use of a drop of cyanoacrylate glue applied to the tip of a wooden or hollow plastic applicator stick. The tip of the applicator is held against the foreign body under direct visualization until the glue dries, and then withdrawn.[11,12]
7. After successful foreign body removal, carefully examine the external auditory canal to make sure the entire object has been removed. If inflammation or epithelial disruption is noted, prescribe antibiotic drops.
8. If the first attempt is unsuccessful, particularly if the patient develops pain, bleeding, or a laceration to the canal wall or tympanic membrane, the procedure should be discontinued, and the patient referred to an otolaryngologist.
9. Document the history, examination findings, informed consent, and procedure note, including any complications and aftercare instructions, in the patient's medical record.

Special Considerations

Special consideration should be given to the following points:

- Dental jet irrigator devices should be avoided, because their use has been associated with tympanic membrane rupture and even trauma to the ossicles. However, commercial devices are available that are specifically intended for ear canal irrigation.
- In a child treated for a foreign body in an ear canal, **always examine the opposite ear and the nostrils**, because other foreign bodies may be present.

After removing a foreign body from a child's ear canal, make sure to check the other ear canal and the nose for additional foreign bodies.

Follow-Up Care and Instructions

The following should be taken into consideration in follow-up care:

- After irrigation, drying the auditory canal by draining excess water and instilling a few drops of isopropyl alcohol may help prevent otitis externa.
- Patients with evidence of inflammation or canal bleeding or laceration after the procedure should be given **antibiotic otic drops** and advised to follow water precautions, with follow-up to ensure healing.
- Patients with tympanic membrane rupture should be evaluated by an otolaryngologist promptly. Provide pain medication and advise water precautions.
- Advise the patient or guardian to report signs of infection or other possible complications immediately. Pain, otorrhea, bleeding, swelling and redness, dizziness or vertigo, or sudden onset of hearing loss or tinnitus after the procedure require prompt reevaluation and appropriate referral to an otolaryngologist.

After removal of cerumen or a foreign body, treat with an antibiotic drop if the canal wall appears inflamed or abraded.

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CHAPTER 26

Ring Removal

Nathaniel Shekem

Jon Van Heukelom

Abstract

Patients may present to primary or acute care settings with a tightly fitting ring that was unable to be removed with simple methods prior to arrival. Multiple techniques for ring removal have been described in the literature and textbooks. These can largely be divided into noncutting and cutting techniques. Although it is not necessary to be an expert in all ring removal methods, clinicians should be proficient in at least one or two techniques within the noncutting and cutting categories. The astute clinician will quickly recognize ring entrapment syndromes with signs and symptoms that suggest ischemia in the involved digit and act promptly to facilitate removal of the ring. It is important to go through every ring entrapment presentation in a systematic manner in order not to miss important findings of ischemia or other significant soft-tissue or bony injuries. The technique that is chosen to remove a ring depends on many factors, including the degree of urgency at which removal must occur, the material of which the ring is composed, the patient's desire to preserve the ring without damages during the procedure, the tools that the clinician has available for ring removal, as well as underlying patient medical conditions.

Keywords

removal
ring
ring entrapment
ring removal
ring removal technique

Procedure Goals and Objectives

GOAL: To effectively identify and manage low and high-risk ring entrapment cases
OBJECTIVES: The student will be able to:

- Identify patients with ring entrapment who have signs and symptoms indicating digital ischemia.
- Describe a variety of ring removal techniques.
- Select an appropriate ring removal technique based on individual patient and ring features.
- Perform ring removal procedures in a manner that ensures clinician and patient safety.

Background and history

Ring entrapment is a clinical scenario familiar to clinicians working in primary and acute care settings in which a patient presents with a constricting ring on a digit, oftentimes metallic jewelry. The reason for the visit is likely that simple techniques employed prior to arrival were unsuccessful and the involved digit is now becoming painful

and swollen. Fingers are most often involved and will be the main focus of this chapter; however, much of the anatomy, techniques, and overall management can be applied to constrictive jewelry on toes and, more rarely, external genitalia.

The causes of ring entrapment might include placing a ring that is too small on a finger, dependent edema, changes in body volume status, soft-tissue infection, trauma, burns, and local or systemic allergic reactions. It is absolutely imperative to quickly assess for the possible presence of neurovascular compromise in the distal involved digit upon the patient's presentation. Impaired blood flow caused by constriction may progress quickly and potentially cause nerve damage, ischemia, and eventually tissue necrosis of the digit.[1]

Important historical features to ask the patient are how long the symptoms have been present, if any traumatic injuries are associated with the entrapment, the techniques that have already been attempted, and the composition of the ring. The hardness of metals is rated on the Mohs ten point scale, with softer metals having lower numbers and harder metals having higher numbers. Gold and silver have a Mohs scale rating of 2.5 to 3.0. Steel has a hardness rating of 4.0 to 4.5, and hardened steel has a rating of 7.0 to 8.0.[2,3] Harder materials, such as titanium, tungsten carbide, and diamond, have Mohs scale ratings of 6.0, 8.5 to 9.0, and 10.0, respectively. When determining which technique to utilize for ring removal, considering the composition of the ring will help in choosing a technique that will maximize the likelihood of success.

By understanding the underlying pathophysiology of ring entrapment, becoming familiar with a number of relatively simple ring removal techniques, and going through each patient encounter in a systematic manner, clinicians will be successful in managing the overwhelming majority of ring entrapment cases.

Indications

Ring removal is indicated in a patient who presents with an inability to remove a ring owing to acute or chronic finger edema.

Contraindications

There are no absolute contraindications for the procedure, particularly in the setting of ischemia.Relative contraindications include associated open wounds, fractures, and dislocations. Additionally, patients must be able to cooperate and tolerate the procedure.

Potential complications

The most significant complication is tissue necrosis related to unsuccessful removal of the ring in a timely fashion. Related to this would be permanent nerve damage from prolonged ischemia.[1] Other considerations are local tissue damage (abrasions, lacerations, burns) from some of the techniques described. There is also the possibility of embedding small fragments or metal filings of the ring into underlying soft tissue during some of the cutting techniques described later in this chapter.[4]

If a digital block is performed for analgesia, be cautious not to further compromise digital perfusion. Use anesthetics that do not contain epinephrine and use only the smallest amount of volume necessary to achieve adequate analgesia for the procedure.[5]

Essential anatomy and physiology

Rings will most often become entrapped between the metacarpophalangeal (MCP) and proximal interphalangeal (PIP) joints. The PIP joint typically has the largest circumference of the digit and poses the most challenging anatomic location over which to pass the ring. Patients with underlying arthritic conditions may have enlarged PIP joints at baseline and can pose a particular challenge when edema develops in the digit.

The digits of the hand are supplied by neurovascular bundles located on both the radial and ulnar sides of the digits.[6] If a laceration is associated with ring entrapment, be particularly cautious of a neurovascular injury if the laceration is present on the lateral portion of the digit.

A simple way to assess for adequate perfusion in the distal digit is to check **capillary refill** time and compare it with the unaffected

hand. Concerning features would be capillary refill longer than three seconds or significant delay compared with the unaffected opposite hand. Box 26.1 has other features suggesting ischemia of the digit.

Box 26.1 Signs and Symptoms of Ischemia

- Prolonged capillary refill
- Severe pain
- Paresthesias or loss of sensation
- Mottling of skin
- Dusky or white discoloration
- Inability to locate distal digital arterial pulses with vascular Doppler

Assess for neurovascular compromise by checking capillary refill and two-point discrimination

Each digit is innervated by four digital nerves, which are located on the radial and ulnar aspects of the digit. One pair, the primary innervation for the majority of each digit, is located on the volar aspect. The second pair is located on the dorsolateral aspect of each digit.[6] **Two-point discrimination** is the recommended test of choice for assessing potential nerve compromise. Inability to discriminate a distance of 5 mm or less on the volar fingertips is a concerning finding.[7]

The pathophysiology of ring entrapment is that the underlying trigger for edema results in decreased venous and lymphatic outward flow from the digit. In a vicious cycle effect, as the edema worsens, the constrictive effect from the ring also increases, leading to progressive external compression on the neurovascular bundles. Digital perfusion is further compromised and ring removal becomes increasingly more difficult.

Patient preparation

As with all procedures, consent should be obtained from the patient after discussing all options and the specific risks and benefits of each. Understand that some rings have high levels of sentimental and monetary value for patients, and efforts should be made to preserve the ring if no true emergency indications are present.

It is important that both the patient and the clinician are in a position of comfort for the procedure. Some techniques described in this chapter require a significant amount of time and patience to be performed successfully.Seat the patient in a chair or on an examination table. The workspace should be clean and well lit. Be familiar with the materials your clinic or hospital has available for ring entrapment and where to locate them. Have all necessary materials to perform your planned procedure in the room and easily accessible to you during the procedure. The success rates for each ring removal procedure vary and it would be wise to have materials available to attempt multiple procedures if necessary. For most of the ring removal procedures described in this chapter, having an assistant available would be helpful.

If the edema and tissue damage is not severe, most procedures can be performed with minimal discomfort in a cooperative patient. In patients who are particularly anxious or apprehensive about manipulating the ring for the procedure, talking them through each step of the procedure is often all that is needed. However, in patients with more advanced edema or soft-tissue damage in whom a high degree of ring manipulation is expected, consideration of medications for analgesia or anxiolysis is warranted. In particular, a digital block can be extremely useful in some clinical scenarios. Techniques for digital blocks include the traditional finger web space block as well as the subcutaneous block on the volar aspect of the hand near the flexor crease of the distal metacarpal and the more advanced transthecal block of the flexor tendon sheath. Although these all report high success rates, the subcutaneous block has the benefit of one injection and may be less painful compared with other techniques.[8-10]

Materials

Each procedure utilizes different materials. Table 26.1 presents a complete list of materials that may be needed for all procedures reviewed in this chapter. Note that not all materials are necessary for each procedure. You should become familiar with and use what is available in your specific institution.

Table 26.1

List of Materials Needed for Ring Removal Procedures

Materials for Ring Removal

Patient preparation

- Sterile or clean water for irrigation, 5 mL syringe with 27-gauge needle and 1% lidocaine without epinephrine (for optional nerve block), water-soluble lubricating jelly, sterile or clean gloves, eye protection, sterile or clean towels, dry gauze sponge

Noncutting techniques

- String, umbilical tape, silk suture (size 0, 2-0 or 3-0), elastic cord from an oxygen face mask, two Penrose drains, flat rubber phlebotomy tourniquet, blood pressure cuff (manual or electronic), hemostats, Kelly clamp

Cutting techniques

- Commercial manual or electric ring cutter, Vise-Grip style locking pliers, Dremel motor saw, dental saw or drill, Steinmann pin cutter, thin metallic safety elevator or hemostat (placed between the skin and the ring), ice water (for cooling)

Procedure

Upon identifying ring entrapment, having the patient elevate the extremity, and applying ice to the digit may help reduce edema while you are preparing for the chosen procedure. Medical textbooks discuss several techniques for ring removal; however, no randomized controlled trials have directly compared different techniques and no formal guidelines exist to help in deciding which technique is most appropriate.[11–14] In general, patients presenting with ring entrapment in the context of signs or symptoms of ischemia, nerve injury, or local trauma should have the ring removed with a cutting technique, because these tend to have shorter times for ring removal. The disadvantage of these cutting techniques is that the ring is damaged or destroyed. Table 26.2 displays options for noncutting and cutting techniques.

Table 26.2

Ring Removal Techniques

Nonnutting Techniques	Cutting Techniques
Winding technique	Manual or electric ring cutter technique
Compression technique	Locking or standard pliers technique
Caterpillar technique	Dremel saw or other diamond-tipped saw or drill
Twin thread technique	Steinmann pin cutter technique
Glove technique	
Kelly clamp technique	

Noncutting Techniques

The noncutting techniques should be utilized if the patient's preference is to preserve the ring and no high-risk features are

present warranting emergent removal. These techniques utilize a two-step process of digital exsanguination and then ring removal. It is recommended that you become familiar and proficient with one or two techniques rather than trying to master all the techniques described. Fig. 26.1 displays various examples of noncutting techniques for ring removal.

The **winding technique** is probably the most familiar technique to clinicians. Multiple variations have been described in textbooks and the literature.[11–17] A lubricated thread, tape, or elastic oxygen mask cord is slipped under the ring with a small portion remaining on the side proximal to the ring. The remaining material is then wrapped around the digit distal to the entrapped ring. The wrapped material should be snug to assist with exsanguination of the digit, but not so tight that arterial compromise occurs. Then the ring is moved distally up the finger by pulling constant distal traction on the portion of material that was proximal to the ring while slowly unwrapping the material around the ring in the same direction that the original wrap occurred. This technique can be repeated because multiple attempts are sometimes necessary.

The **compression technique** has also been described with multiple variations. An older variation describes using a rubber phlebotomy tourniquet to wrap around the affected digit in a distal to proximal direction ending at the distal edge of the ring.[12,17,18] A hemostat can be used to clamp the tourniquet to itself at the proximal aspect to maintain compression. Multiple compressive layers are recommended just distal to the ring where the most significant edema tends to be located. The affected hand is held in an elevated position above the shoulder and a blood pressure cuff is then applied to the forearm at around 250 mm Hg. The rubber tourniquet is removed in 15 minutes while the blood pressure cuff remains inflated to prevent the finger from returning to its edematous state. The ring is then attempted to be removed utilizing lubrication, steady distal pressure, and twisting motions, as needed. This technique can also be repeated, as necessary, because edema tends to lessen with each subsequent attempt. Another variation of this technique is to apply a tightly wound

rubber phlebotomy tourniquet from a distal to proximal direction, running the entire length of the affected finger and stopping proximal to the ring.[19] The tourniquet is then clamped to itself at the proximal aspect with a hemostat. The tourniquet is left on for ten minutes to allow for exsanguination. After removal of the tourniquet, the digit and ring are lubricated and the clinician attempts to quickly remove the ring. The author of this technique reports one failure in over 250 uses.[19] Another variation of these techniques uses two Penrose drains.[14,17,20] One Penrose drain is placed circumferentially around the digit just distal to the PIP with a good amount of compression, which is maintained by clamping the drain to itself with a hemostat. A second compression Penrose drain is then tightly wrapped around the digit beginning at the first Penrose drain and extending proximally to the distal edge of the ring. The second Penrose drain is then removed while leaving the first Penrose clamped, which helps prevent refilling of the edematous tissue between the entrapped ring and the first Penrose drain. Ring removal is then attempted. This technique may also be repeated, as needed. Neurovascular status of the digit should be reassessed in between each attempt with the compression techniques.

The **caterpillar technique** was first described by an anesthesiologist who reported high success rates even when other techniques had failed.[21] A lubricating substance is the only material required for this technique. This technique utilizes small coordinated movements of the ring. After a generous amount of lubrication is applied to the ring and finger, the ring is pushed upward and steady pressure is held in this direction while the dorsal aspect of the ring is rocked distally along the digit. While the dorsal portion of the ring is held in its new position by applying steady downward force, the volar aspect of the ring is then advanced distally. These coordinated movements are repeated until the ring passes the edematous tissue and can be easily removed.[17]

The **twin thread technique** requires two operators. Two pieces (each about 20 inches long) of any thin, strong thread or string material are passed under the ring in a proximal to distal fashion.

The ring and finger should be generously lubricated for this technique as well. Move one piece to the radial aspect of the ring and the other piece to the ulnar aspect of the ring. One operator firmly grips the ends of both pieces of material and pulls constant steady distal traction parallel with the finger. The other operator grips the ring on the volar and dorsal surface with the thumb and index finger and begins alternating movements similar to the caterpillar technique.[17,22]

One study proposed that the **glove technique** will likely have the lowest success rate, but it is safe and easily attempted in lower risk ring entrapment cases.[17] The finger from a sterile or clean examination glove is cut at the base and then the tip of the finger of the glove is cut off. Lubrication is applied to the ring and finger. The now cylindrical tube of the glove is passed over the affected digit toward the base of the finger. The entire proximal aspect of the glove is gently passed under the ring with a hemostat or forceps. This proximal segment of the glove is then turned inside out and pulled back in a distal direction parallel with the finger. Theoretically the ring should slide over the lubricated glove surface.[11] One reported benefit of this technique is that it can be used on digits with wounds, burns, or fractures. However, recall that these types of injuries are at high risk for severe edema and rapid progression to ischemia and therefore cutting techniques should be considered.[23]

The **Kelly clamp technique** is one final option described in the literature.[24] The ring and finger are generously lubricated and the jaws of a Kelly clamp are placed perpendicular across the involved digit. The two surfaces of the Kelly clamp are placed against the proximal ring edge on the dorsal and volar aspects. Slow continuous pressure is applied in a distal direction along with rocking movements of the Kelly clamp from side to side. The original author of this technique reported success in several patients with no complications.

Cutting Techniques

In cases where the above noncutting techniques have failed or when a patient presents with signs and symptoms of an ischemic

digit, cutting the ring is warranted because these techniques typically require less time for ring removal compared with the above techniques. It is imperative that the patient understands that these techniques will damage the ring, but emphasize the importance of timely ring removal and discuss the potential complications if the ring is not removed expeditiously. Fig. 26.2 displays various examples of cutting techniques for ring removal.

The most basic technique in this category is the use of **manual ring cutters**.[11–14] Commercial devices are available that typically utilize a safety lever passed under the ring to protect the skin from the blade, a toothed circular blade that cuts the ring, and a manually operated thumbscrew, which when turned, rotates the circular blade. These will typically have high success rates in cases of softer ring compositions (silver, gold, copper, tin, plastic). Prior to beginning, attempt to position the ring so that you are cutting through the thinnest portion of the ring. A manual ring cutter can also be found on some commercial trauma shears, the Leatherman Raptor being one common specific example. These shears will also cut through soft ring materials well. Once a cut is made through the ring, the ring opening can be further widened by clamping a hemostat on both cut ends and applying gentle lateral force. If the opening does not easily widen, a second cut through the ring can be made one hundred and eighty degrees from the first cut.

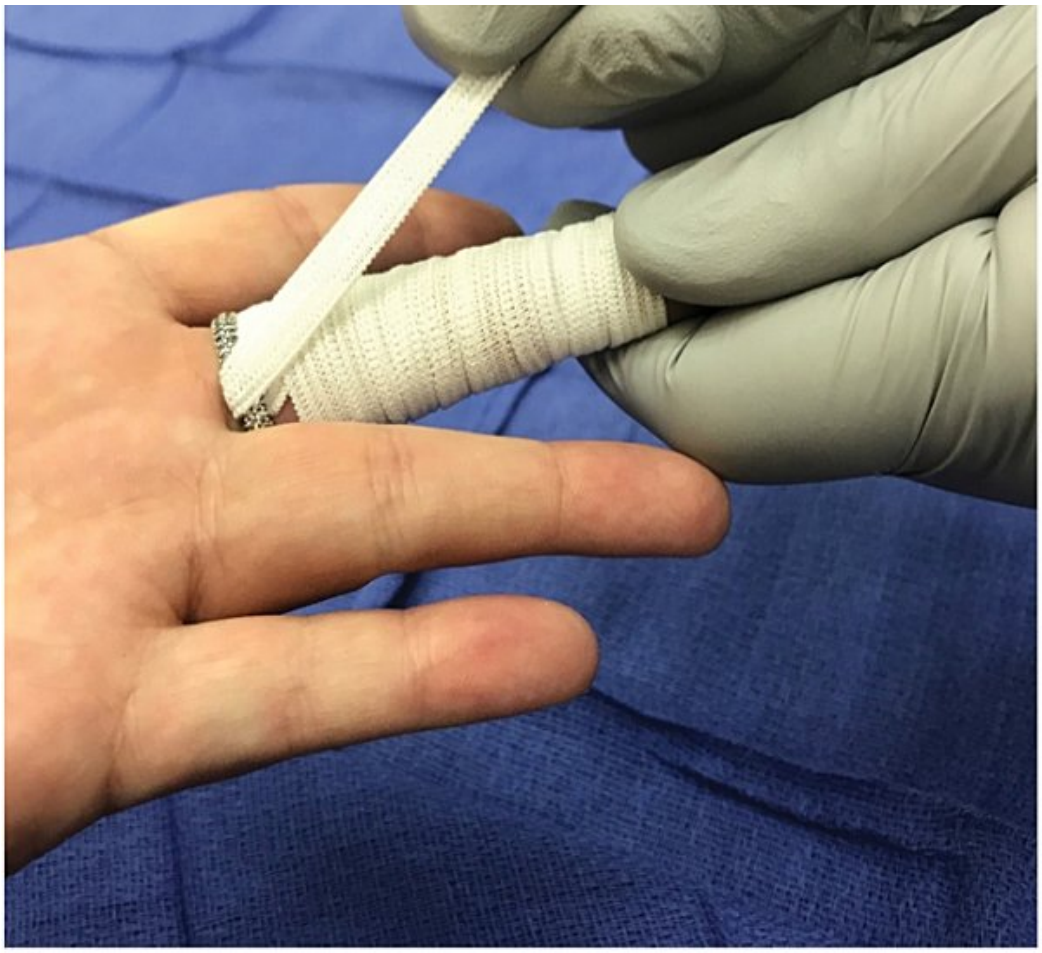
Commercial electric ring cutters are also available with the components being similar to the hand driven manual cutter; however, the major difference being much faster rotation of the toothed blade.[12,13,17] It is important to be aware that any motorized cutters have the potential to cause thermal injuries to the underlying skin, which can be prevented by taking pauses from cutting every 15 to 30 seconds, by placing water-soaked gauze on the tissue surrounding the ring, or by intermittently dripping cold water on the cutting site during the procedure. Be aware that with electric ring cutters exists the potential for formation of sparks while cutting the ring. Therefore, remove any flammable materials from the workspace area where the procedure is taking place. Use of additional specialty devices have been described for ring removal (Dremel saw, diamond-tipped

dental drills and saws, Steinmann pin cutter).[12,13,17] These tools should only be used if the operator is familiar with their use and if the above techniques have failed. Although it is helpful to be aware that these tools exist, the prior techniques should be the main focus of this section.

Rings made of harder materials, such as steel, tungsten carbide, titanium, or ceramic, will have lower success rates with attempts to use the cutting techniques described previously. The matrix of these rings is such that ring removal can be more easily accomplished by application of lateral force to the ring rather than cutting the material.[12–14,17,25,26] This technique leads to the most destruction of the ring because it tends to fracture into multiple pieces. The most commonly described technique is to utilize a pair of locking pliers. Adjust the pliers so that the jaws fit snuggly around the ring. Release the jaws, adjust the pliers a quarter to half turn clockwise, and then clamp down on the ring again. Repeat the quarter to half turn clockwise adjustment, and then clamp down on the ring at different positions until the ring is heard, felt, or seen to fracture. The ring will fall away from the finger in multiple pieces. Be aware that when the ring fractures, small fragments may become airborne projectiles and therefore eye protection is mandatory for this technique.

One study directly compared the locking pliers technique with the winding technique using umbilical tape.[25] Both techniques reported 100% success rates; however, the locking pliers technique was significantly **faster in achieving ring removal**, with a mean time of 23.1 seconds for the locking pliers technique versus 135.4 seconds for the winding technique.

When patients present with evidence of neurovascular compromise, choose a ring removal technique that is likely to accomplish removal in the shortest amount of time possible.

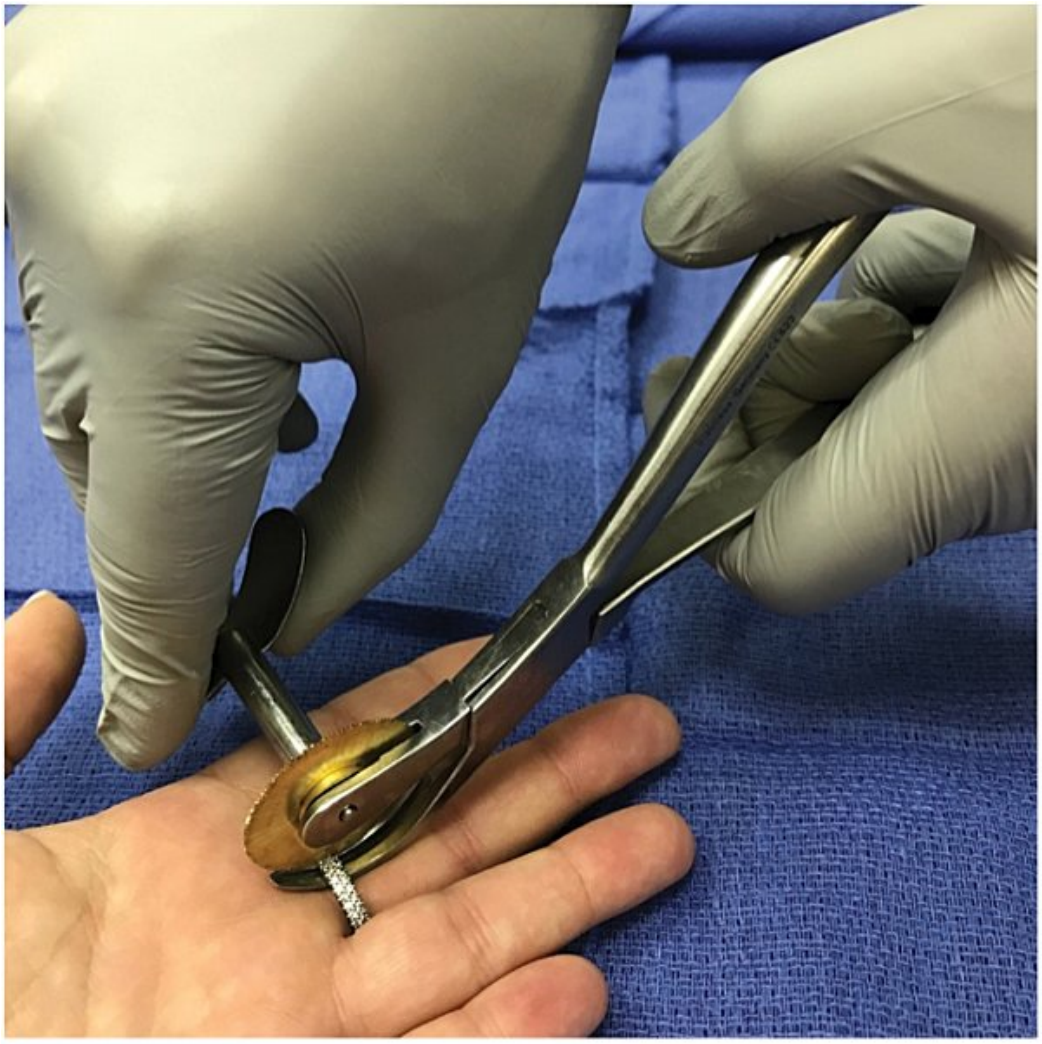


A

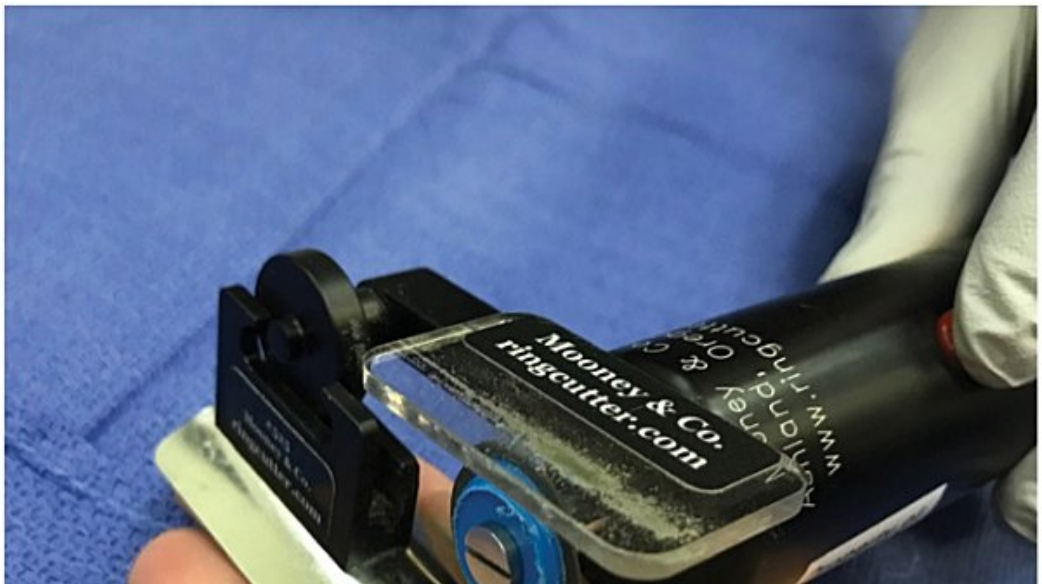
B

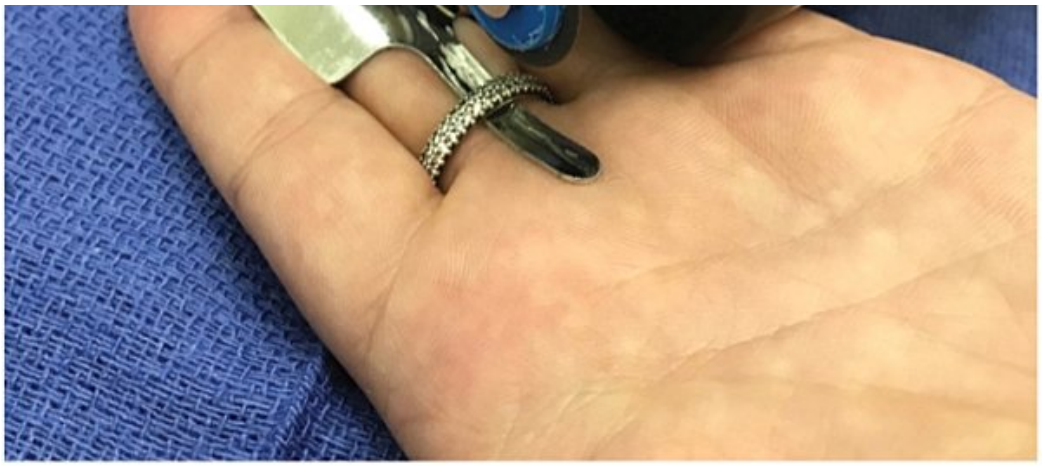
C

FIGURE 26.1 Noncutting techniques.
A. Winding technique using the elastic cord from an oxygen mask. **B**. Compression technique using a rubber phlebotomy tourniquet. **C**. Compression technique using two Penrose drains.

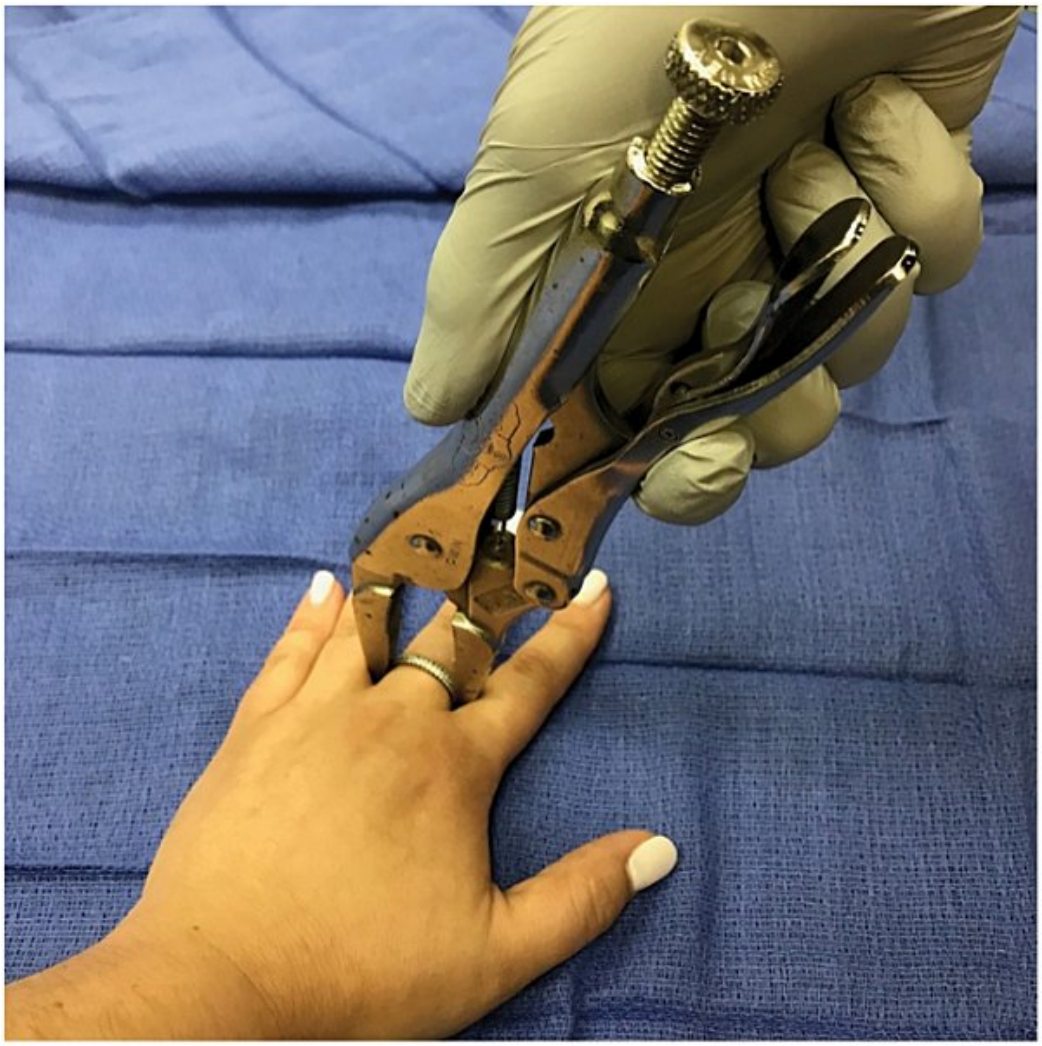


A





B



C

FIGURE 26.2 Cutting techniques.
A. Cutting technique using a manual ring cutter. **B**. Cutting technique using an electric ring cutter. **C**. Cutting technique using a pair of locking pliers. Note that rings will fracture or shatter.

Special considerations

If a ring cannot be removed or if after removal complicating features are identified, consider consultation with a hand specialist. Indications for consultation are persistent signs of ischemia, open fractures, open joint dislocations, unstable fractures, tendon injury, digital nerve injury, or digital arterial injury.

Standard precautions

There is a potential for exposure to patient blood when open wounds are present and therefore adherence to standard body fluid precautions is imperative, including the use of gloves and eye protection at a minimum. Be cautious to avoid sharps' injuries that might occur from needlesticks during digital blocks, sharp edges on the tools used for the procedure, or sharp ring edges after the material is cut or fractured.(Refer to Chapter 35 for more information about Standard Precautions.)

Follow-up care and instructions

After the ring is successfully removed, there are several important tasks to complete prior to deciding on the disposition of the patient. Always reassess and document neurovascular status of the involved digit. Assess for any underlying wounds after ring removal or wounds that may have been caused by the procedure. Irrigate the tissue well with clean or sterile water or saline to remove any particulate matter. Repair any wounds as indicated. With any concern for fractures after ring removal, consider obtaining plain radiographs. This can be considered prior to attempting ring removal with high concern for fracture or dislocation because this may affect your management; however, realize that the ring will

obscure the underlying bone and therefore some fractures may not be identified until after ring removal. If there is any loss of skin integrity on examination, inquire about tetanus status and provide prophylaxis as needed. Patients should receive appropriate antibiotics if there is clinical evidence of associated soft-tissue infection or open fracture or dislocation.

Patients without clinical features of ischemia, normal sensory and motor examination, and reduced edema can be discharged with basic local wound care instructions. Patients should also be instructed not to wear rings on the involved digit until all edema has resolved and any wounds have healed completely.

Disposal of materials

Sharps should be disposed of in accordance with your clinic or hospital protocols.Tools used for the procedure that can be reused should be cleaned or sterilized in accordance with your clinic or hospital protocols. Other nonsharps can be disposed of in a standard waste container.

If the ring is damaged during the procedure, the pieces should be offered to the patient and the patient should be encouraged to visit a jeweler to see if the ring can be repaired.

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CHAPTER 27

The Pelvic Examination and Obtaining a Routine Papanicolaou Smear

L. Gail Curtis

Abstract

Obtaining a female gynecological exam (FGE) and cervical cancer screening as recommended are an essential part of preventive health care for women. This chapter guides the clinician in the understanding female anatomy and physiology, on the recommendations for obtaining FGE & PAP and provides the most UTD guidelines for screening for cervical cancer.

Keywords

PAP smear
Cervical Cancer
Bethesda System
Human Papilloma Virus
HPV
Pelvic exam
gynecologic examination
hymen
cervix

Procedure Goals and Objectives

GOALS: To perform a thorough female gynecologic examination (FGE) in a female patient in a manner that preserves the patient's comfort while maximizing the likelihood of identifying abnormal findings and obtaining a sample for screening for cervical cancer.
OBJECTIVES: The student will be able to:

- Define the indications, contraindications, and rationale for performing a FGE.
- Describe the essential anatomy and physiology associated with the performance of a FGE.
- List the logical order of the steps used to perform a FGE.
- Describe normal and abnormal findings associated with a FGE.
- Describe the recommendations guidelines for cervical cancer
- Describe the recommendations for obtaining a Pap smear (cytology and human papilloma virus [HPV] screening)
- Discuss the updated 2014 Bethesda System for interpretation of abnormal Pap smears.

Background and History

Many women dislike having a FGE performed. The lithotomy position makes some women feel vulnerable. This examination may invoke feelings of anxiety or embarrassment. It is the examiner's responsibility to put the patient at ease while conveying the importance of the examination. The challenge is to make this

experience educational, comfortable, and not to be feared in the future.

The FGE is an extension of the abdominal examination in the female patient. The Pap smear, which is one aspect of the FGE, was developed in the 1920s by Dr. George Nicolas Papanicolaou, an anatomist and cytologist in the United States. Dr. Papanicolaou identified characteristic cellular changes associated with cervical cancer. The original technology allowed for cytologic evaluation of cervical cells exfoliated from the female genital tract. Approximately 20 years elapsed before the technique named for him, the Papanicolaou smear, was accepted as a cancer-screening procedure. The Pap smear was initially used to detect asymptomatic invasive cervical cancer; as time passed, the importance of preinvasive disease was recognized. The Pap smear or test remains a screening test. It does not provide a diagnosis. Current standard of care requires further workup of any abnormality found on a Pap test. This workup typically includes a screening for HPV, a colposcopy, and a biopsy of cervical samples.

Indications

Epidemiologic data have shown Pap test screening to decrease the incidence and mortality rate of **cervical cancer.** In the United States approximately 13,240 new cases of cervical cancer are reported per year, with an annual mortality rate of roughly 4100.[1] American women have a 0.68% chance of developing cervical cancer in their lifetime. Death from cervical cancer has decreased from 3.49 per 100,00 in 1999 to 2.42 per 100,000 in 2007.[2] Accurate sampling with the Pap test is key to this reduction. Most cases of cervical cancer in the United States occur in women who do not get screened.[3]

Cervical cancer is the third most common cancer in females.

Recommendations of the clinical management guidelines for cervical cancer screening were updated in 2012 by the American Society for Colposcopy and Cervical Pathology (ASCCP) and 2016 by the American College of Obstetricians and Gynecologists

(ACOG).[4] These two groups agree on almost every standard for obtaining a Pap test (cervical cytology) and HPV sampling or cotesting, including age to begin screening, frequency of screening, and age to cease screening. Both ACOG and ASCCP recommend Pap screening beginning at age 21, regardless of sexual history, and **sampling frequency is based on age and other factors.**

Yearly Pap smears are no longer recommended for any age group or population.

It is the responsibility of all providers to familiarize themselves with these new recommendations and help patients understand the change from the prior standard yearly Pap screening to which most woman were accustomed. The ACOG and ASCCP recommendations are summarized in Table 27.1.

Table 27.1

Comparison of Screening Recommendation Guidelines for Cervical Cancer

Criteria	ACOG & ASCCP Recommendations
Initial testing	21 years of age
Frequency: age 21–29	Cytology alone every 3 years No screen for HPV
Frequency: age 30–65	Best: Cytology and HPV every 5 years (co-testing) Acceptable: Cytology every 3 years
Age to discontinue screening	At age 65 years with three prior consecutive negative cytology OR two consecutive negative co-testing AND If no H/O CINII or higher
Screening post-hysterectomy	No testing needed if total hysterectomy AND If no H/O CINII or higher
ASC-US positive AND negative HPV screen	ACOG: Cotesting* every 3 years ASCCP: Cotesting* every 5 years
Cytology negative AND HPV positive	If ≥30 years of age: Repeat cotesting in 12 months; if still HPV positive, proceed to colposcopy OR Obtain HPV genotype; if type 16 or 18, proceed to colposcopy; if not type 16 or 18, repeat cotesting in 12 months

Criteria	ACOG & ASCCP Recommendations
Screening after HPV vaccine	No change from age-specific guidelines; same as for unvaccinated

ACOG, American College of Obstetricians and Gynecologists; *ASCCP,* American Society for Colposcopy and Cervical Pathology; *ASC-US*, *CIN,* cervical intraepithelial neoplasia; *HPV,* herpes papillomavirus.

* Cotesting is defined as obtaining a Pap smear for cytology and testing for HPV.

The **presence of or exposure to HPV** is now accepted as the leading risk factor for an abnormal PAP smear and development of cervical cancer. HPV types 16 and 18 are thought to be the most oncogenic.[5]

Infection with specific high-risk strains of HPV is key to the development of cervical cancer.[6]

Contraindications

There are no absolute contraindications to performing the FGE or the Pap test. Permission to perform the examination should be obtained.

Potential Complications

False-negative Pap test results do occur. Common causes of a test being interpreted as normal when the cervical epithelium is abnormal include the following:

- Sampling error because of poor technique or small, peripherally located lesions missed on sampling
- Lesions that do not shed cells well
- Interpretation error

The most publicized error is misinterpretation. Using the proper technique to obtain the Pap test can significantly decrease the incidence of false-negative results because of **sampling error**. New technologies have been developed to decrease the false-negative rate

from errors in interpretation. Most Pap tests in the United States are now processed from a liquid-based medium as opposed to having the cells smeared directly onto a glass slide.[7] Other sources of Pap test screening errors are failure of the clinician to understand or respond appropriately to Pap test results or failure of the patient to follow the clinician's recommendations.

The most common false-negative result is sampling error.

Essential Anatomy and Physiology

External Anatomy

The vulva consists of the mons pubis, the labia majora, the labia minora, the clitoris, and the glandular structures that open into the vagina (Fig. 27.1). The shape, size, and color of the structures vary among individual women and racial groups. Normal hair distribution is in the shape of an inverted triangle centered over the mons pubis.

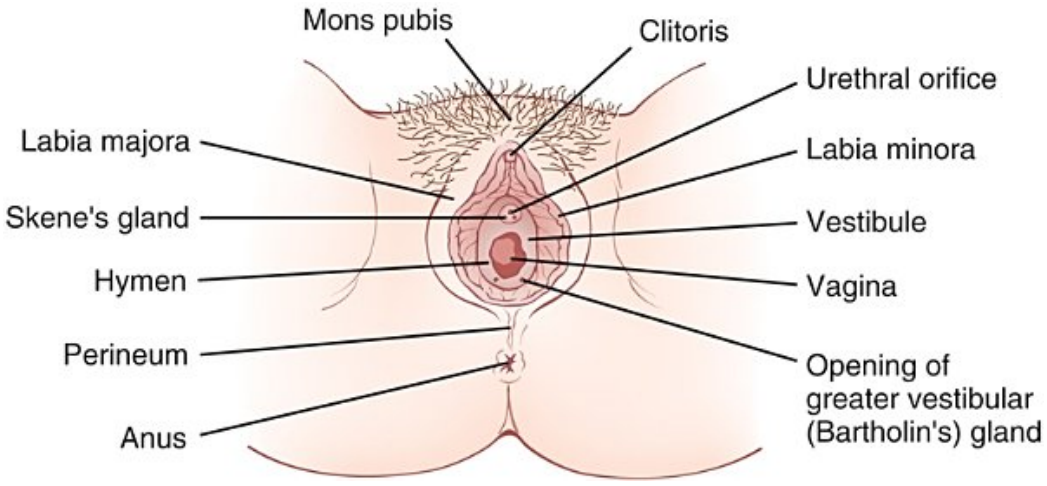

FIGURE 27.1 **External anatomy of the vulva.**

The labia majora are two mound-shaped structures composed primarily of adipose tissue originating at the mons pubis and terminating in the perineum. They form the lateral boundaries of the

vulva. Underlying the skin is a poorly developed muscle layer—the tunica dartos labialis. The labia majora contains numerous sweat glands. The internal and external pudendal arteries and a branch of the perineal artery provide the arterial blood supply to the labia majora. The venous drainage is extensive and provided primarily by the perineal, posterior labial, external pudendal, and saphenous veins. Lymphatic drainage occurs through two systems: one superficial and one deep within the subcutaneous tissue, primarily draining into the inguinal nodes.

The labia minora are two skin folds medial to the labia majora that begin at the base of the clitoris and extend posteriorly to the introitus. The arterial supply is from the superficial perineal artery. The venous drainage is to the perineal and vaginal veins. Lymphatics pass to the superficial and deep subinguinal nodes. The innervation is supplied from branches of the pudendal nerve, which originates from the perineal nerve.

The clitoris is the homologue of the dorsal aspect of the penis. The blood supply is rich, with the dorsal and pudendal arteries supplying arterial blood. Venous drainage consists of a rich plexus draining into the pudendal vein. The lymphatics coincide primarily with those of the labia minora. Innervation to the clitoris is from the terminal branch of the pudendal nerve. Nerve endings in the clitoris vary, from woman to woman, from total absence to a rich supply.

The vestibule is the space bordered by the labia minora and includes the entrance to the vaginal canal, or the introitus. The vaginal opening can be obscured by the hymenal ring or hymen. The hymen is a membrane that partially or wholly occludes the introitus. The shape and opening of the hymen can vary greatly (Fig. 27.2), but only a completely imperforate hymen is pathologic. The arterial supply to the vestibule and hymen is from an extensive capillary plexus from the perineal artery. The venous drainage is also extensive and involves the same areas as the arterial network. The lymphatic drainage terminates in the superficial inguinal nodes and the external iliac chain. The urethra is positioned between the clitoris and the vaginal opening and is not difficult to visualize.

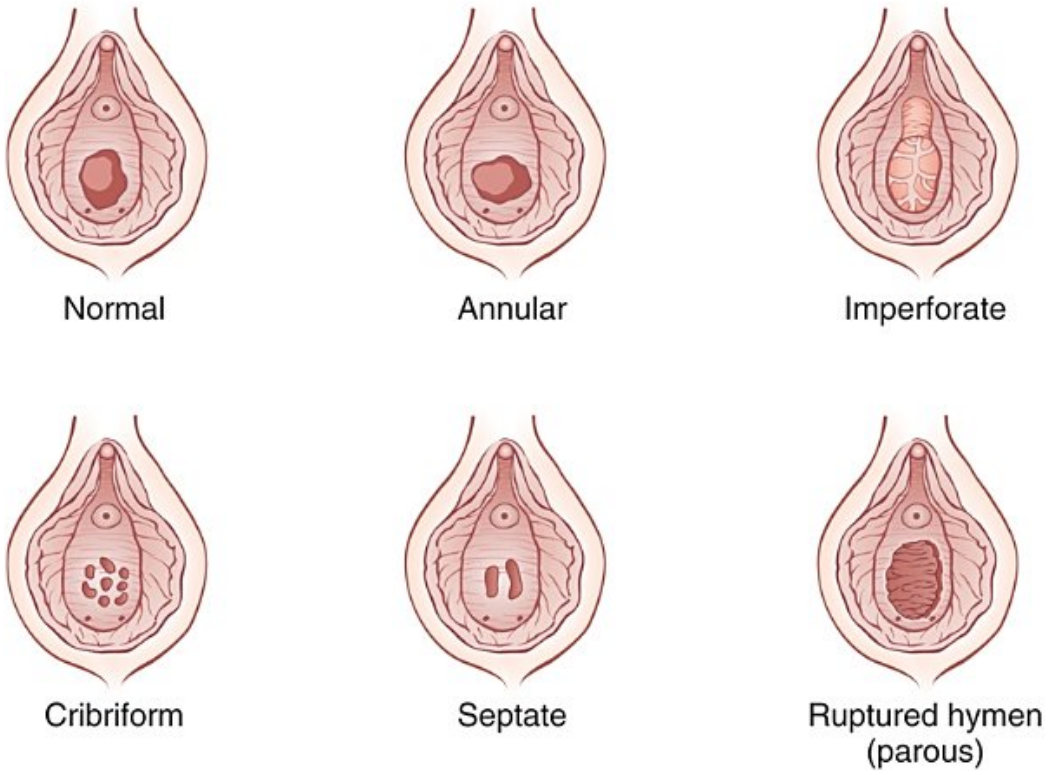

FIGURE 27.2 **Types of hymens.**

The Skene glands are posterior to the urethral orifice and are often difficult to locate. The Bartholin glands lie inferior and lateral to the posterior vestibule, are less superficial, and are usually not visible. The arterial supply and venous drainage is along the pudendal vessels. The lymphatics drain directly via the perineum into the inguinal area. The innervation of the Bartholin glands is a small branch of the perineal nerve.

Internal Anatomy

Fig. 27.3 illustrates the female internal anatomy. The vagina is a muscular canal lined with mucosa or rugae and is approximately 7 cm long, extending from the uterus to the vestibule. It meets the cervix of the uterus at an angle of 45 to 90 degrees. The cervix projects into the upper portion of the anterior vaginal wall, thereby making the anterior vaginal wall slightly shorter than the posterior vaginal wall. The vaginal arterial supply is from the vaginal branch of the uterine artery, and the veins follow the course of the arteries.

The lymphatics drain into the external iliac and inguinal nodes. Both sympathetic and parasympathetic nerves innervate the vagina. The perineum is the tissue between the vaginal opening and the anus.

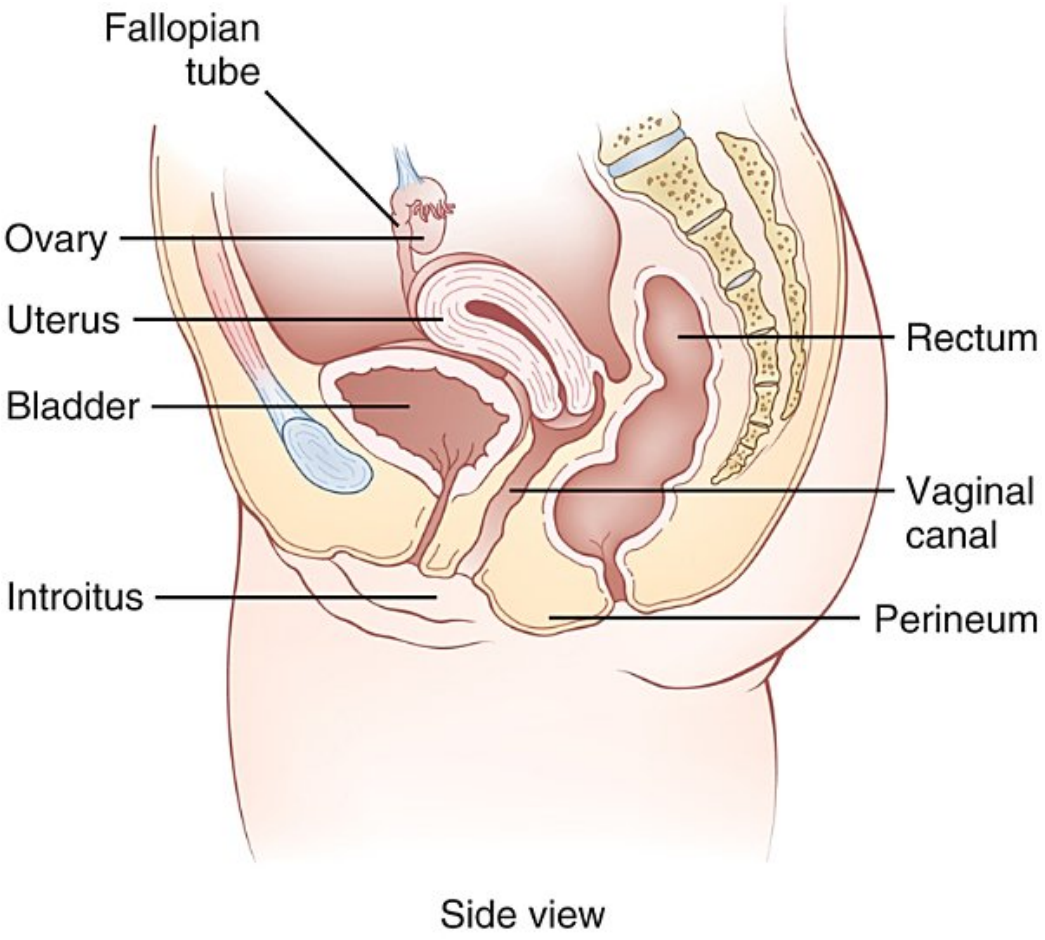

FIGURE 27.3 **Female internal anatomy.**

The uterus is a pear-shaped, thick-walled muscular organ about 7 to 8 cm in length and 4 to 5 cm at its widest in the nonpregnant adult woman. It consists of three parts: the fundus, the body, and the cervix (Fig. 27.4). The uterine cavity opens into the vagina below and into the fallopian tubes above. It is supported by ligamentous attachments to various pelvic structures, including the vagina. The cervix is the portion of the uterus that can be visualized during the FGE and is the structure sampled to obtain the Pap smear. When viewed during the FGE, the cervix appears as a round, bagel-like

mound with a circular or slit type of opening that varies with parity (Fig. 27.5) and leads to the endocervical canal.

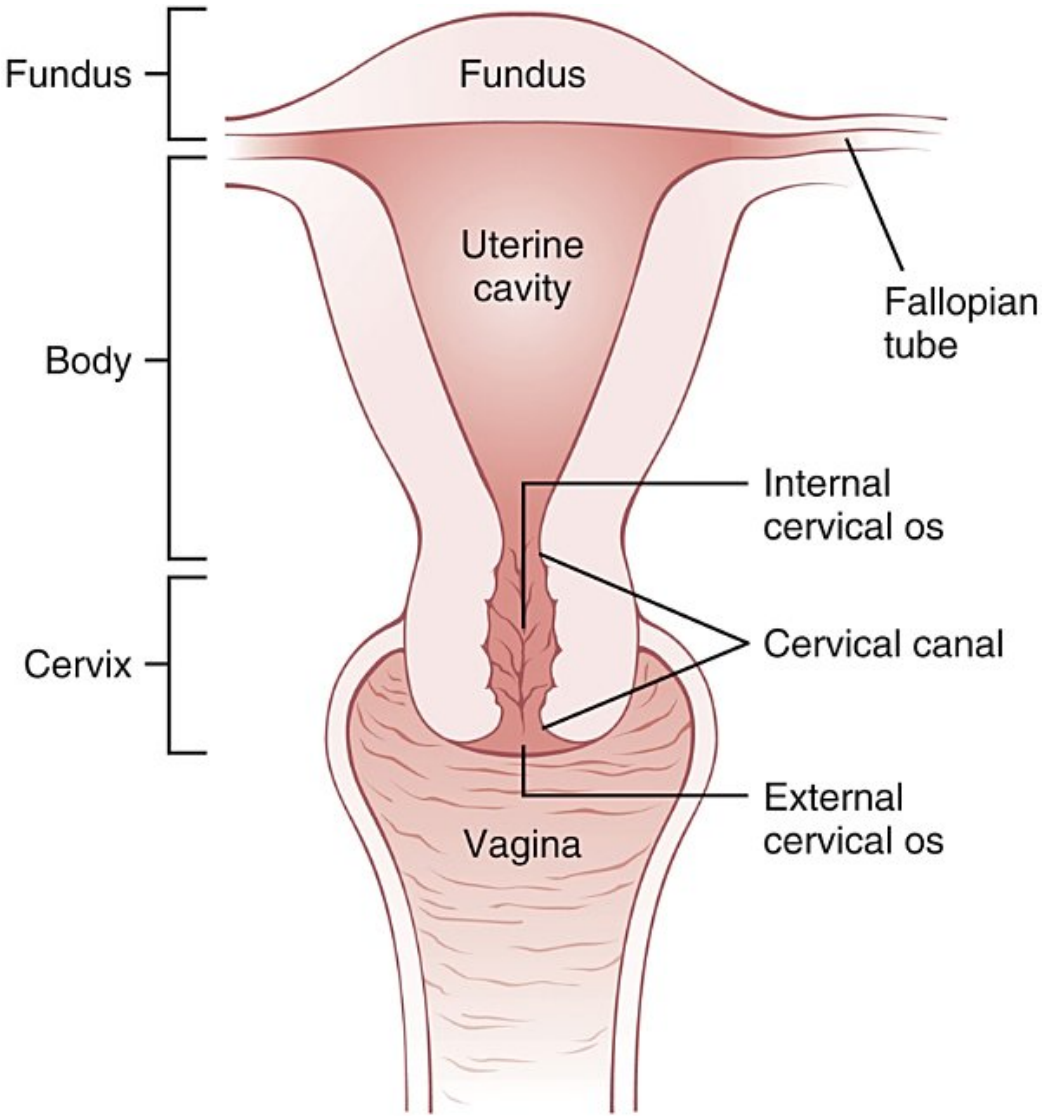

FIGURE 27.4 **The uterus consists of three parts: fundus, body, and cervix.**

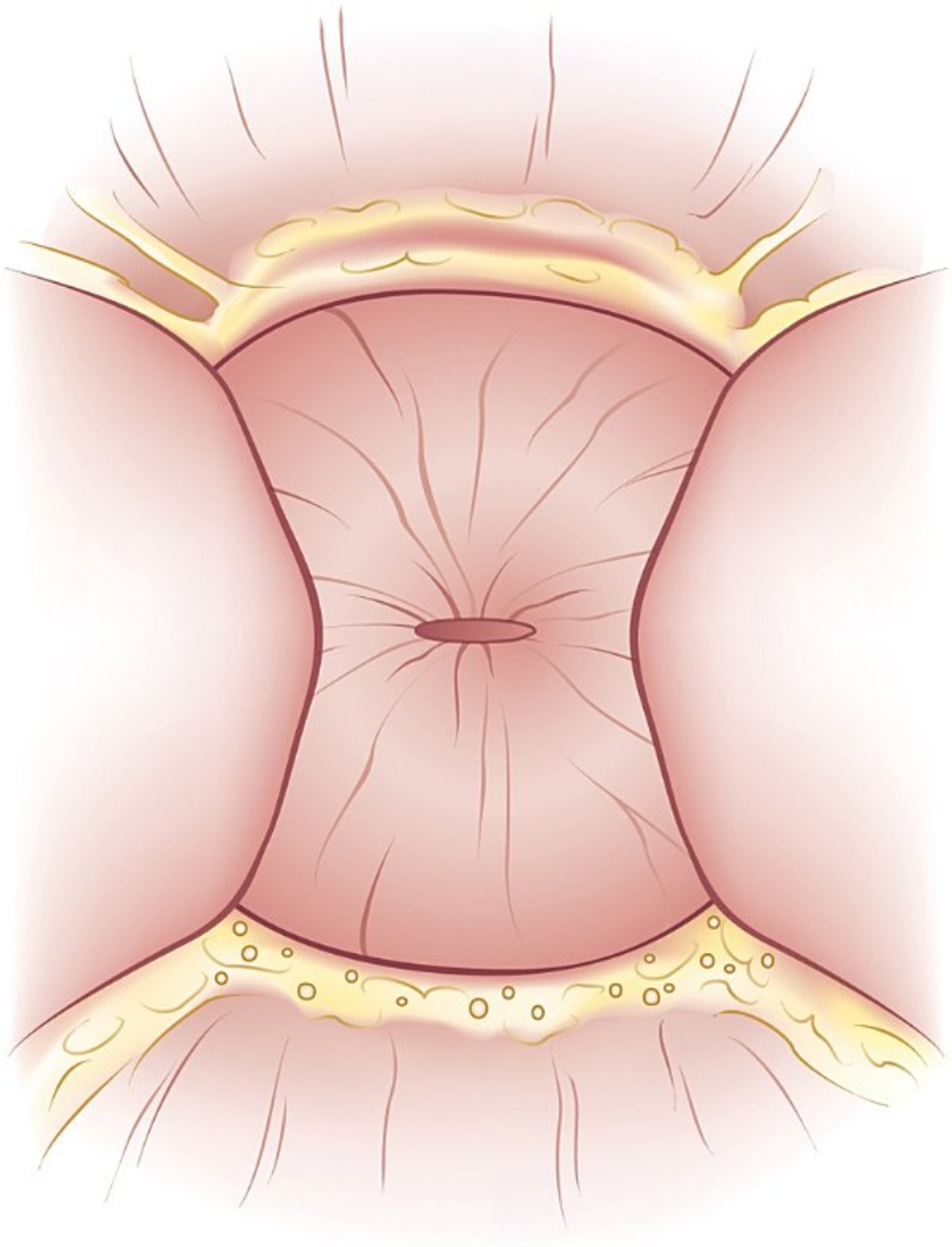

FIGURE 27.5 **The cervix as viewed during pelvic examination.**

The fallopian tubes extend from the lateral portions of the uterine fundus and terminate in a fringed, cone-shaped conduit that arches toward the ovaries (Fig. 27.6). The ovaries are oval organs measuring about 2.5 to 5 cm in length, 1.5 to 3 cm in breadth, and 0.7 to 1.5 cm

in width. The fimbriated ends of the fallopian tubes overhang the upper part of each ovary. The ovarian artery is the chief source of blood for the ovary, and the ovarian veins follow the course of the arteries. Lymphatic channels drain retroperitoneally to the lumbar lymph nodes. The lymphatic channels in the ovaries are extensive and may provide additional fluid to the ovary during periods of preovulatory swelling. The ovaries produce ova and hormones, including estrogen and progesterone.

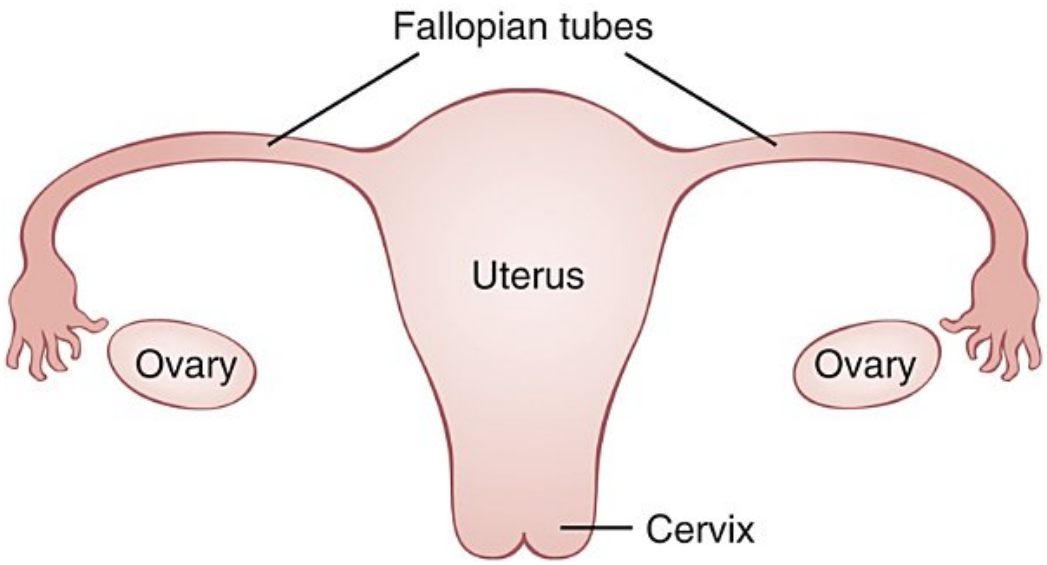

FIGURE 27.6 **The fallopian tubes.**

All the pelvic organs are supported within the lower abdominal cavity by a system of muscles, ligaments, and fascia.

Standard precautions

Practitioners should use standard precautions at all times when interacting with patients. Determining the level of precaution necessary requires the practitioner to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

Patient Preparation

As noted previously, some women may be reluctant to have an FGE and Pap test performed. If a patient has had several previous examinations, she knows what to expect. If this is her first, she has most likely heard about it from others. Your responsibility as the examiner is to explain what is ahead and provide education to decrease anxiety.

First Pelvic Examination Experience

This examination will set the tone for all that follow.

- Schedule enough time to allow a complete explanation of the FGE from beginning to completion, including the Pap test.
- It is helpful to have a diagram or model of the female anatomy to aid the explanation.
- Have the actual equipment to be used on hand to show your patient. Explain all aspects of the FGE and the Pap test.
- Show your patient, using your closed fist to simulate the cervix, how you will sample her cervical cells (Fig. 27.7). Explain that relaxing her pelvic muscles eases the insertion of the speculum (again, demonstrate with your fist; see Fig. 27.7).
- Allow and encourage your patient to ask questions.
- Explain terms she may have heard and been fearful about, such as “blades,” “scraping,” and “stirrups.”
- Educate her about the lithotomy position: why it is necessary and how it allows visualization of the cervix.
- Offer opportunities that empower the patient, such as the semisitting position and a handheld mirror if she desires to observe the examination and visualize her own anatomy while the examination is in progress.
- Assure your patient that this examination is indicated and that the FGE and Pap test should not be painful. Tell her you will be gentle, and that if she wants you to stop at any time during the examination, you will.

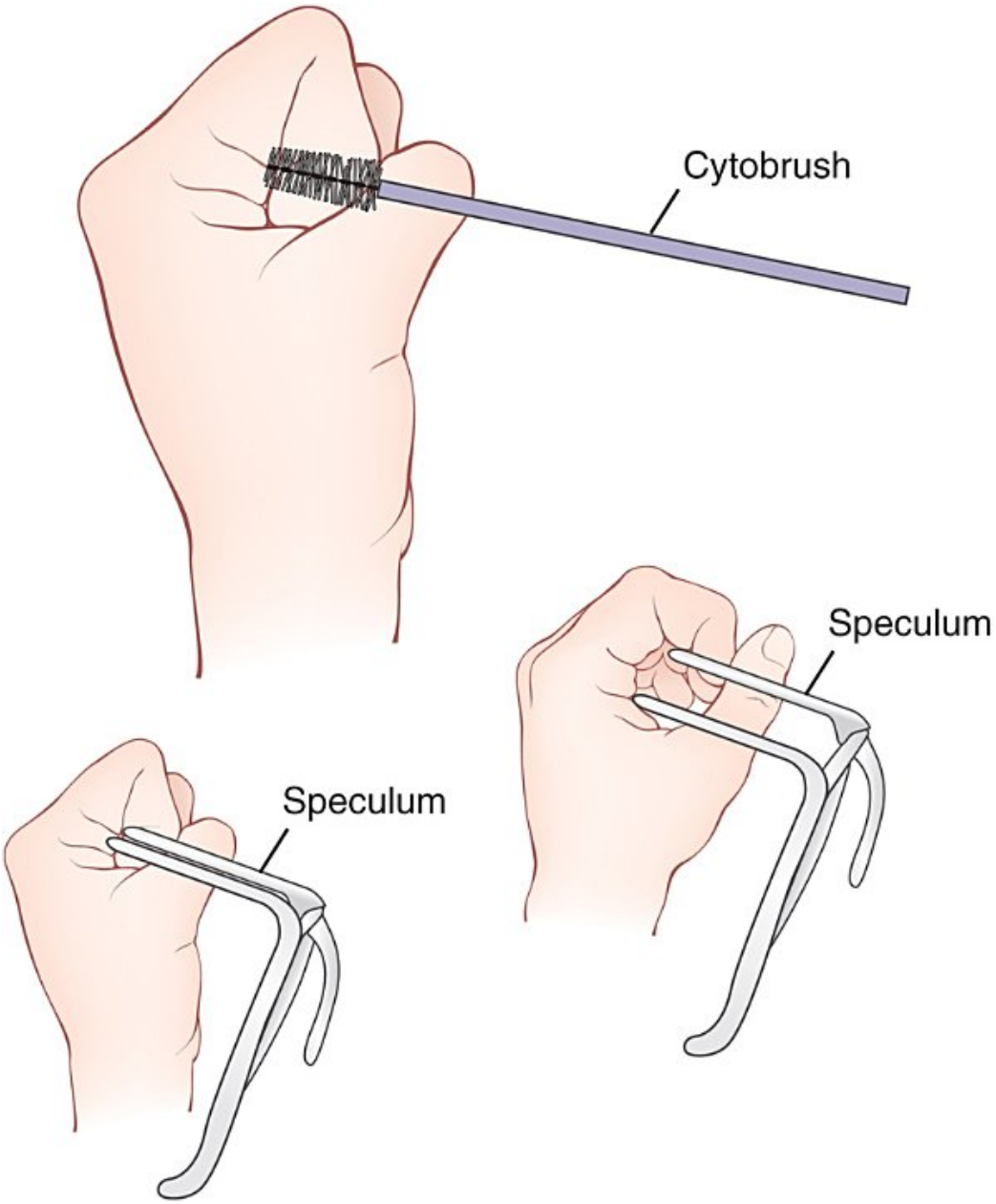

FIGURE 27.7 *Top,* Closed fist, simulating the cervix. *Bottom,* Closed fist simulating the vaginal opening for speculum insertion in tensed position *(left)* and relaxed position *(right).*

The Returning Patient

- Always ask the patient if she has any particular concerns about this examination.

- Reassure her that you will be gentle and that there should be no pain associated with the examination.
- Assure her that she can ask questions at any time during the examination.
- Tell her to alert you immediately if she experiences any discomfort and you will stop and redirect your attempt.
- Explain every step of the examination as it unfolds.

Chaperone in Attendance for All Patients

Having a **chaperone** in attendance is mandatory for this examination. This is required even if the examiner is female. In addition to providing assistance with the examination, the presence of another member of the staff helps reduce the likelihood of a patient filing an unfounded accusation regarding inappropriate conduct of the clinician during the examination. Explain that the chaperone is in attendance to assist with any needs during the examination. Avoid statements such as "she (or he) is here to watch and observe."

Having a chaperone in attendance is mandatory for this examination.

Materials

The Vaginal Speculum

Several types of speculums are available (Fig. 27.8):

- Pedersen speculum, metal and reusable: This type of speculum comes in short and long sizes.

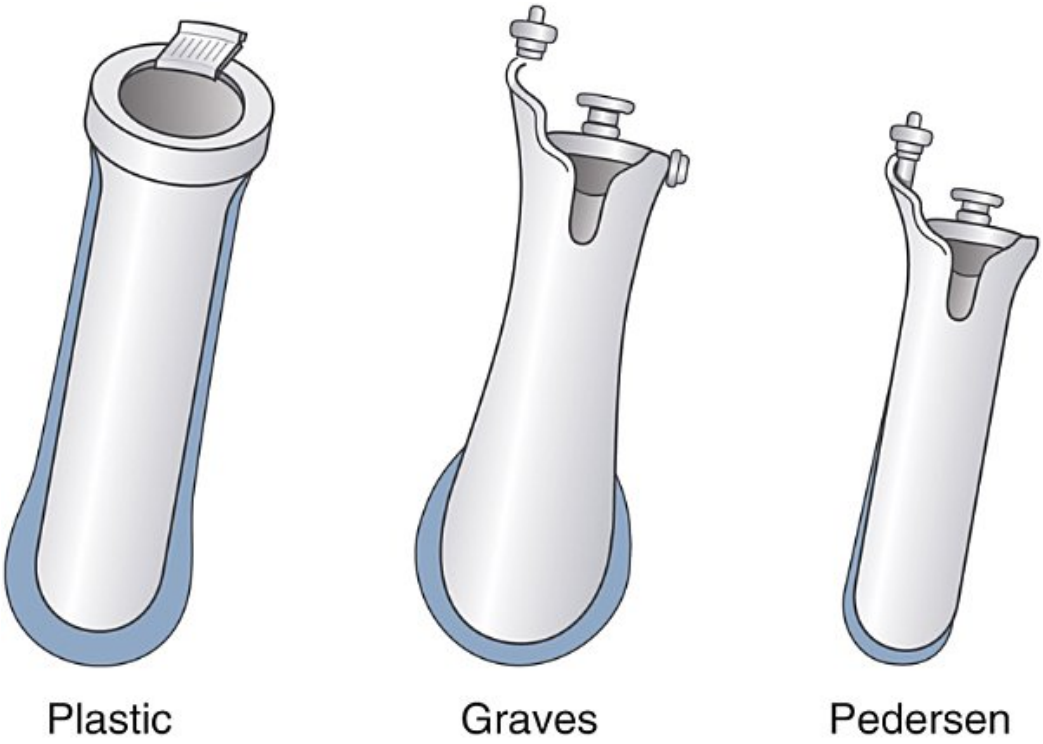

FIGURE 27.8 **Types of vaginal speculums.**

The Pederson speculum should be used if at all possible because it is narrow and is more comfortable for most women.

- Graves speculum, metal and reusable: This speculum also comes in short and long sizes. The Graves has a duckbill shape and is a better choice for viewing the cervix if the patient is significantly overweight, has a lot of redundant skin surrounding the introitus, or has a severely retroverted uterus.
- Disposable speculum: This type of speculum is made of hard, clear plastic, usually similar in shape to the Graves-type speculum. It makes a loud click when locked into place. Warn patients about the upcoming click and use great care not to pinch the patient's surrounding skin on insertion.
- Pediatric speculum: This speculum is useful for children and virginal or geriatric women. This speculum is also preferable when explaining a first FGE to a patient. Its small size

reduces undue anxiety and fear of pain about the pending examination.

NOTE: It is all right to switch speculums during the examination if there is trouble viewing the cervix. Avoid comments such as "I have to get a bigger speculum." Women may feel sensitive to implications that their anatomy is too large. Rather state, "I am having difficulty visualizing your cervix and I don't want you to experience any discomfort, so I am going to change speculums to make this examination more comfortable for you."

Whichever speculum is chosen, be sure that you understand how to open it, insert it, and secure it into place before you begin.

Other equipment needed to complete the examination may include the following:

- Plastic broom (Fig. 27.9)
- Cytobrush (see Fig. 27.9)
- Wooden spatula (see Fig. 27.9)
- Container of liquid-based medium or Pap smear slide (most Paps are now liquid based)
- Good light source
- Water-soluble lubricating jelly
- **Gloves**

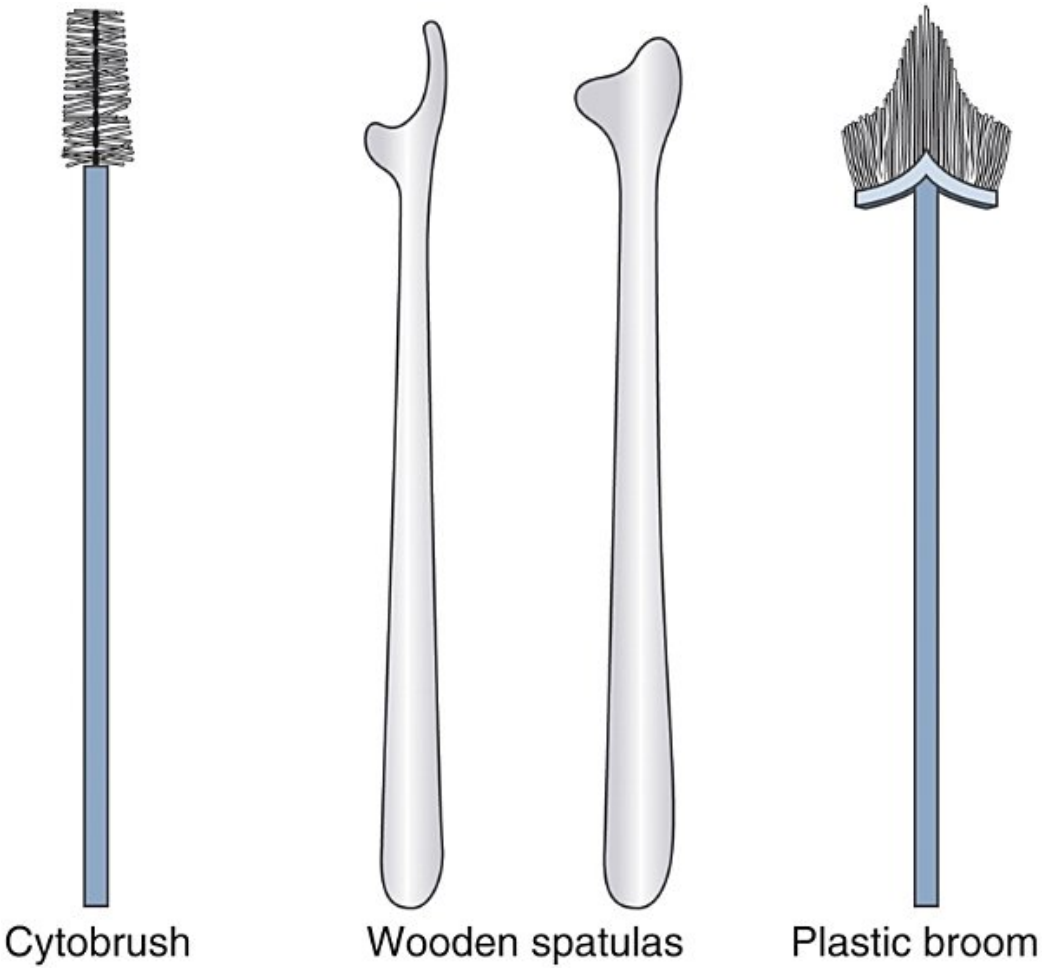

FIGURE 27.9 Instruments used for gathering cervical cells.

Be sure to ask your patient about latex allergy; most institutions now use only latex-free products, but be sure to inquire at your institution or office if this is the case. If all products are not latex-free, have nonlatex gloves available.

NOTE: The choice of a wooden spatula, a cytobrush, or a plastic broom to collect samples is dictated by the sampling system available. The plastic broom is preferred for liquid-based preparation of the specimen. The spatula or cytobrush is typically used with fixation of the specimen on a slide.

Procedure

Female Gynocologic Examination and Obtaining Cervical Cells

The examination itself is divided into three parts: inspection of the external genitalia; the internal examination, which includes obtaining the Pap test and other samplings; and the bimanual examination.

1. Before beginning the examination, have all your equipment ready and your chaperone in the room.
2. Extend the foot stirrups. Keep in mind, the stirrups are often cold and uncomfortable. If possible, have the stirrups covered with a soft, warm material or allow the patient to keep her socks on. When prepared, ask the patient to lie back in the lithotomy position (hips flexed and abducted, feet in stirrups, and buttocks slightly beyond the edge of the examining table). Place a sheet as a drape over her. Most women will indicate if they prefer to be fully draped with the sheet to their knees blocking their view of the examination or if they prefer to be able to see you throughout the examination.

NOTE: Although most examiners have patients lie flat on the examining table, some women prefer to be in a semisitting position (Fig. 27.10). The semisitting position works just as well for the examiner and makes some women feel more comfortable.

Be prepared to explain each step to the patient as it is being performed. Encourage her to ask any questions she may have. Continue to talk to her and monitor her status throughout the examination. If she tenses her abdomen or buttocks, ask her to relax them. Once the patient is as comfortable as possible, begin the examination of the external genitalia.

External Examination

3. Put gloves on a rolling stool at the table end, adjust the light source, and begin inspecting the external genitalia.

4. First examine the mons pubis, labia, and perineum. Note the pubic hair for its pattern, any lice or nits, infected hair follicles, or any other abnormality, and then inspect for any lesions, erythema, swelling, nodules, or discharge on the skin.
5. **Expose the clitoris,** urethral orifice, and the vaginal opening by gently retracting the labia minora. Inspect for any cysts or other lesions. Inspect the area of the Bartholin glands. Normal Bartholin glands cannot be seen or felt.

> Take care during the external examination to avoid unnecessary contact with the clitoris by separating the labia minora during examination of this area.

6. If enlargement or redness is noted, or if indicated by symptoms, examine the Bartholin glands by inserting your index finger into the vagina and your thumb outside (Fig. 27.11) and palpate the tissue between the internal and external fingers. Check for any discharge from the duct. If discharge is noted, a culture should be obtained using the appropriate medium.
7. Next, ask your patient to perform the Valsalva maneuver or bear down while you check for cystocele, rectocele, or uterine prolapse.

Internal Examination

8. Warm the previously selected vaginal speculum under running water. Water warms the instrument and acts as a lubricant to ease insertion. Other lubricants may interfere with the cytologic studies.
9. A digital examination performed by inserting a finger into the vaginal canal helps locate the cervix (it has a consistency

similar to the end of the nose). Insertion of the speculum can then be directed toward the cervix for easy visualization and patient comfort. This technique eliminates the need to "search" for the cervix with the speculum, a maneuver that can be uncomfortable for the patient (Fig. 27.12A).

10. Once the speculum is fully inserted, rotate to the appropriate angle and open to allow visualization of the cervix (see Fig. 27.12B). Avoid pressure on the more sensitive anterior wall, urethral orifice, or clitoris.
11. If there is still a problem locating the cervix, withdraw the speculum and reposition it (usually more posteriorly). Apply gentle pressure to the posterior vaginal wall and try again.
12. Avoid excessive movements of the speculum while searching for the cervix, because this can be uncomfortable.
13. Once the cervix is visualized, secure the speculum in place. Your hands are now free to obtain the Pap test and any other needed cultures or samples.
14. Collecting the Pap smear sample—plastic broom:
    - Insert the long central bristles into the cervical os until the lateral bristles bend against the ectocervix. Rotate the broom three to five times in both directions.
    - Transfer the material onto a slide with a stroke of both sides of the broom, placing the second stroke exactly over the first.
    - Or, if using a vial of preservative solution, place the entire broom tip into the solution and stir vigorously to transfer material.[8] Then remove tip and discard broom, or leave in solution, based on laboratory preference.
    - Collecting the Pap test—spatula: A wooden spatula can be used to obtain cells from the cervix and the vaginal wall (Fig. 27.13).
    - Use the pointed or longer end of the spatula and insert it into the external cervical os.
    - Apply mild pressure while turning the spatula 360 degrees to obtain cells from the squamous–columnar junction or the transformation zone.

- Use the opposite, rounded end of the spatula to sample cells from the vaginal wall.
- Apply the obtained cells to a slide by gently dragging the spatula with the samples from the external cervix and the vaginal wall down the slide.

15. Collecting the Pap smear sample—cytobrush: The cytobrush (see Fig. 27.13) is used to obtain cells from the endocervical canal.
    - Insert this brush into the cervical os until the bristles are no longer seen and turn two full revolutions.
16. Transfer cells collected from the Pap test quickly to the appropriate transport medium:
    - When using a slide, thin out large clumps of material as much as possible, while avoiding excessive manipulation, which can damage cells (Fig. 27.14).
    - Transfer material from both sampling instruments to the slide within a few seconds.
    - Immediately fix the specimen by either immersing the slide in 95% ethanol or coating the slide with a surface fixative.
    - Label the vial of liquid-based medium or slide with the patient's information.

Be sure to obtain an adequate sample to avoid having to repeat the examination and to reduce the false-negative rate. In a woman with a uterus, endocervical cells must be obtained. If the cytologic report comes back stating "no endocervical cells seen," inadequate sampling is indicated, and the patient will need to have the examination repeated to obtain an adequate sample. Therefore it is important to sample adequately the first time.

NOTE: If a wet mount or cultures are to be obtained, do so only after the Pap test cells have been obtained.

17. After collecting the sample or samples, unsecure the speculum and slowly withdraw the instrument while inspecting the vaginal wall for any abnormalities. Allow the speculum to close naturally as withdrawn.

18. Once the speculum is removed and the samples are preserved, proceed to the bimanual examination.

Bimanual Examination

19. Inform the patient that you are going to examine her uterus and ovaries. Tell her this includes a digital rectal examination.

Lubricant can be used during this portion of the examination, because the cytologic samples have been procured. This lubricant makes this portion of the FGE more comfortable for your patient.

Lubricant can be used during this portion of the examination, because the cytologic samples have been procured.

20. Push upward on the cervix with your internal fingers while pushing downward on the uterine area of the abdomen with the external hand. Palpate the uterine fundus as it rises toward your external fingers.
21. Then palpate the ovaries by moving the internal fingers to the right and left of the cervix while sweeping down on either side of the uterus with the external hand.

NOTE: Ovaries should be palpable in women until menopause. A palpable ovary in a postmenopausal woman needs further workup. Most women can tell when you palpate their ovaries and can offer feedback.

22. The rectovaginal examination is the final step in the FGE. Insert your index finger in the vagina and your middle finger

in the rectum and repeat the maneuvers of the bimanual examination.

NOTE: This approach allows assessment of the retroverted uterus and the region behind the cervix.

23. The examination is complete. Remind your patient to push back on the table before trying to sit up. Provide your patient with a towelette to remove any excess lubricant used during the examination.

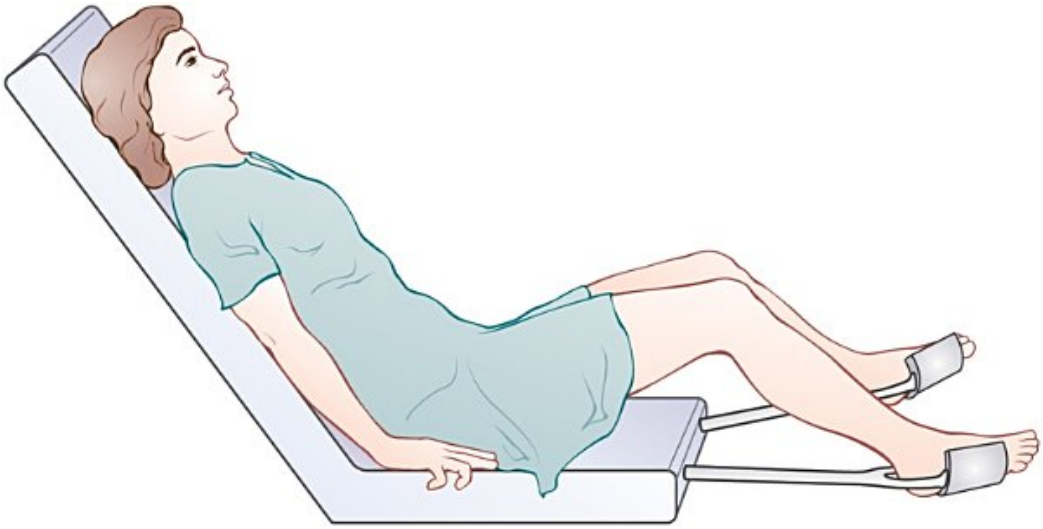

FIGURE 27.10 Semisitting position for the pelvic examination and obtaining cervical cells.

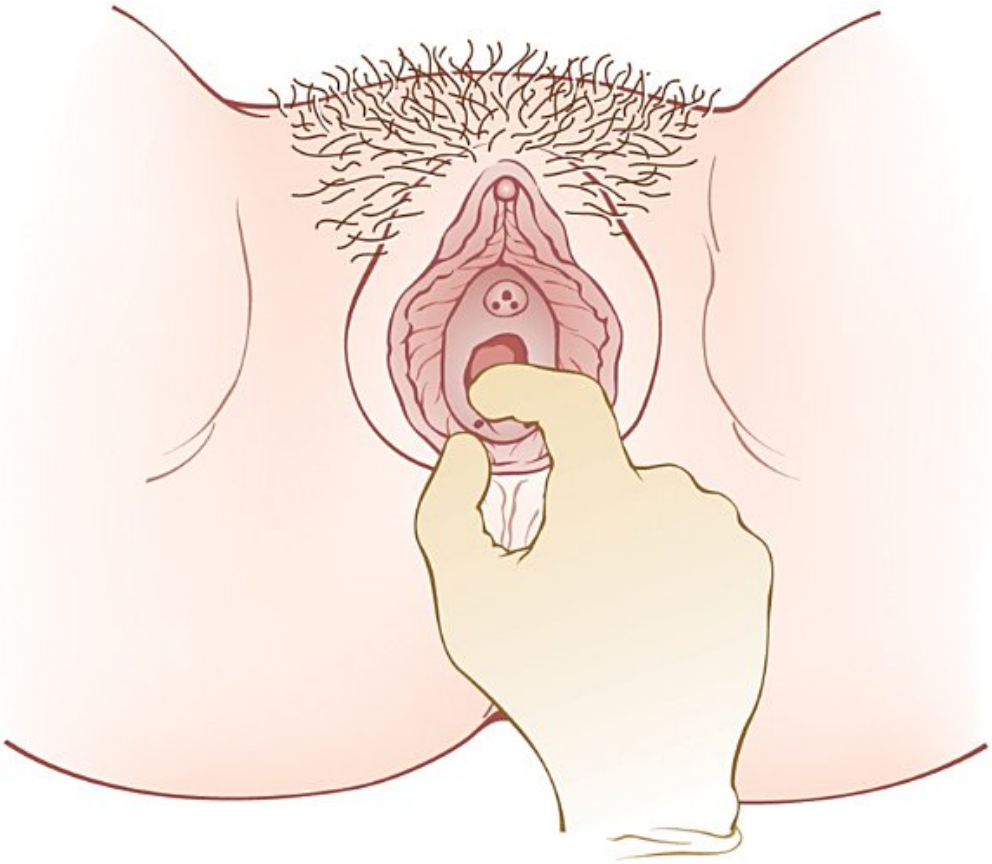

FIGURE 27.11 **External and internal examination.**

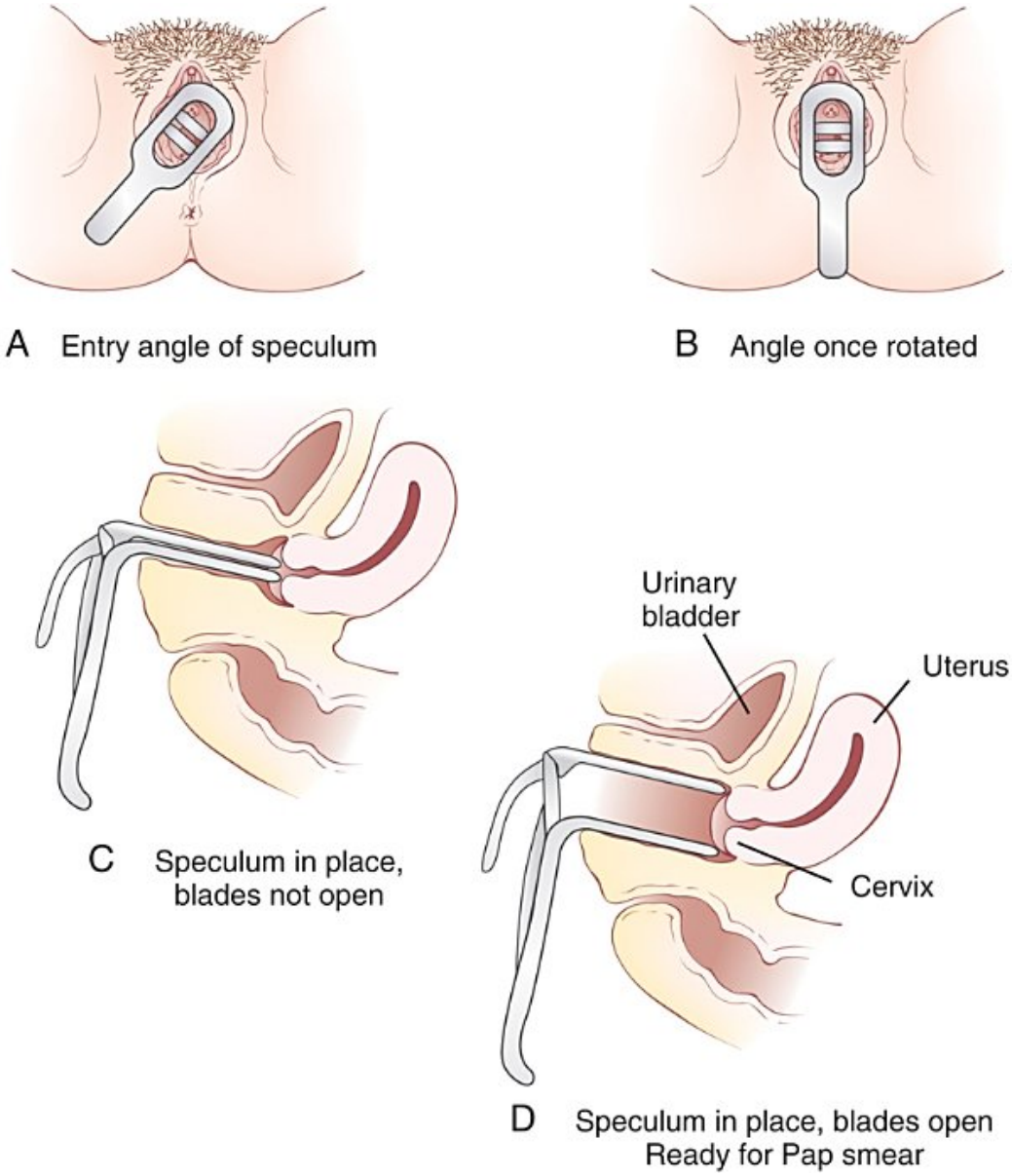

FIGURE 27.12 **Insertion of the vaginal speculum.**

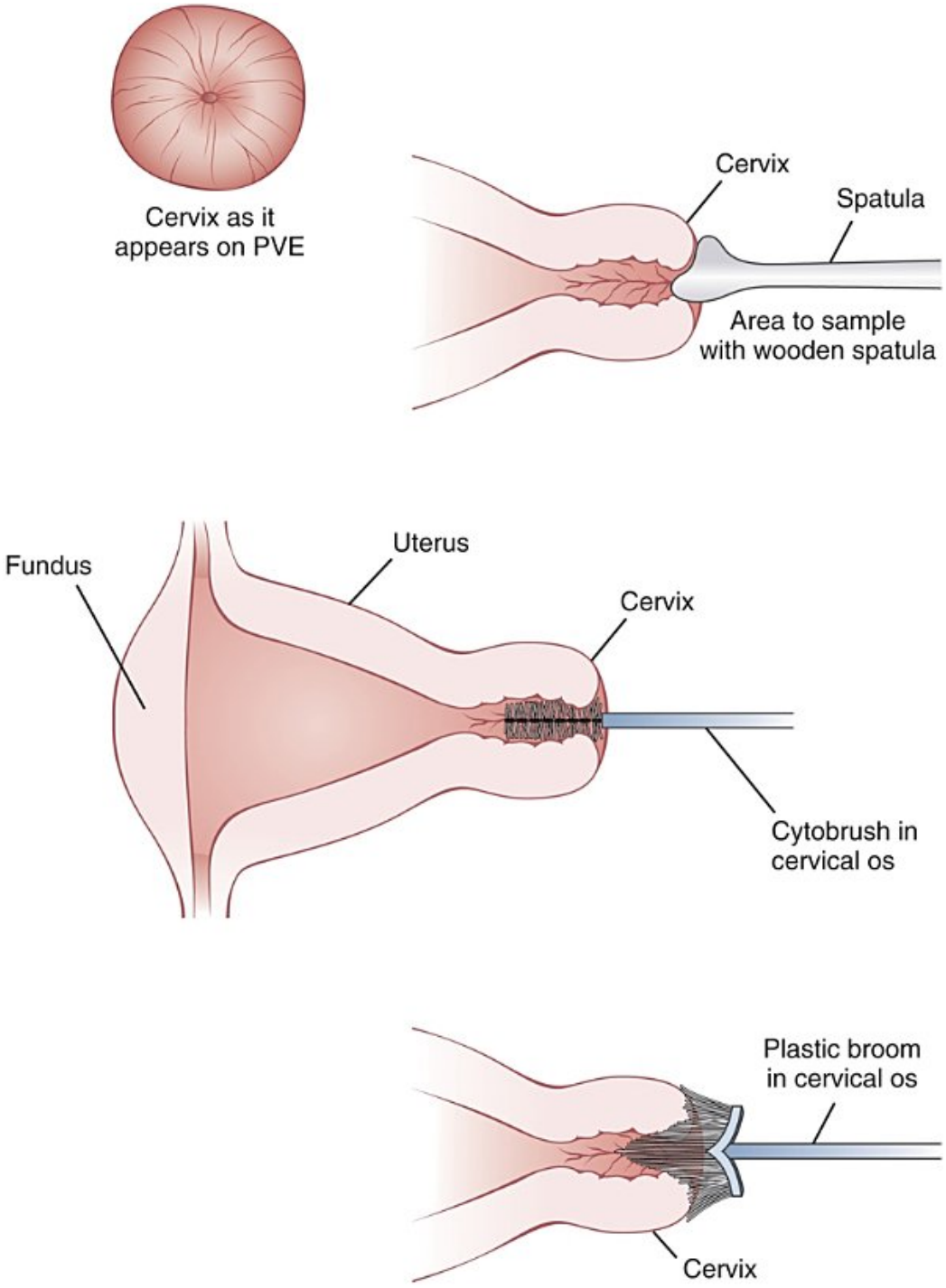

FIGURE 27.13 **Obtaining the cervical sample.**

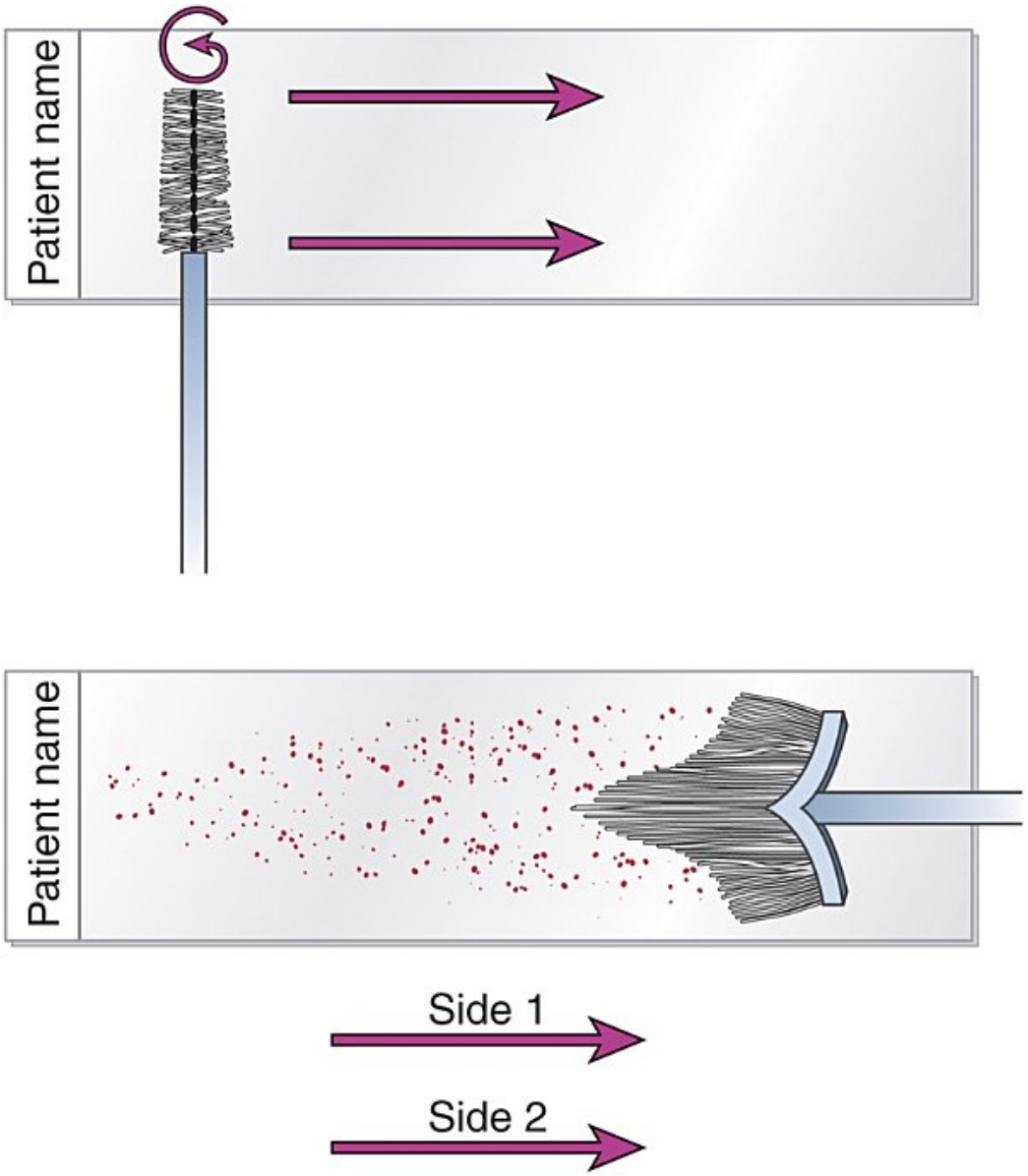

FIGURE 27.14 **Preparation of the cervical sample.**

Special Considerations

Pediatric genital examinations, when necessary, often can be performed using the "frog leg" position (see Fig. 27.15). Special attention must be given to semantics and patient education when examining children. Keep in mind that most children have been taught not to allow anyone to touch their genitals.

FIGURE 27.15 **Pediatric “frog leg” position.**

In the geriatric population, frequency of FGE can often be decreased. Any posthysterectomy patient can receive less-frequent examinations, varying from every 3 to 5 years, and no Pap smear is necessary after age 65 unless there is a history of prior disease (see Table 27.1). Some practitioners cease doing examinations altogether unless circumstance dictates. If the ovaries are still present, bimanual examination can still be important. Postmenopausal women often have dryer, atrophic vaginas. This can make the FGE uncomfortable or painful. Care should be taken to use the smallest possible speculum and not tear the thin tissue.

Follow-Up Care and Instructions

The patient should receive follow-up care and instructions as follows:

- Inform the patient of the results of the examination, taking care not to imply that everything is completely normal until all test results are received.
- Educate her about when to return for her next screening examination. If anything was noted on examination, explain the possibilities and what follow-up may be necessary.
- Let her know what correspondence to expect from your office and the time period within which to expect it. Specifically tell her how she will receive her Pap test results (e.g., letter, phone call, report).
- Ask her to call the office requesting her results if she has not heard anything within the specified period.
- Patient education handouts explaining Pap test results are helpful and should be sent home with the patient. These handouts may increase the patient's understanding of female gynecologic examination and increase compliance with the recommendations made based on the Pap smear results.

The FGE and screening for cervical cancer, including obtaining a Pap test and sampling for HPV, are important parts of providing comprehensive well-woman care. Patient education and examiner sensitivity and competence increase compliance of the female patient in regard to this life-saving examination. For all examiners, competence and sensitivity toward the patient help make this examination repeatable for the patient and the next provider.

Interpretation of the Pap Test

The Bethesda System introduced in 1988 and updated in 2001 and 2014 is used to interpret Pap test cytology.[9,10] This system includes information on the following:

- Specimen type (conventional smear of liquid-based preparation)
- Whether the specimen is an adequate sample
- Incidental findings, such as evidence of infection
- Evidence of **lesions:** Squamous cells: Atypical squamous cells of undetermined significance (ASC-US), low-grade squamous intraepithelial lesion (LSIL), high-grade squamous intraepithelial lesion (HSIL), atypical glandular cells (Box 27.1)

Invasive cervical cancer most often occurs from lack of or inadequate cervical cancer screening.

Box 27.1 Bethesda System Classification Terms (2014 Update) [11]

Squamous Cell

Atypical squamous cells (ASC)

- Undetermined significance (ASC-US):
- Cannot exclude HSIL (ASC-H)

Low-grade squamous intraepithelial lesion (LSIL)

- Cellular change associated with HPV
- Mild (slight) dysplasia/CIN I

High-grade squamous intraepithelial lesion (HSIL)

- Moderate dysplasia/CIN II
- Severe dysplasia/CIN III
- Carcinoma in situ/CIS

Glandular Cell

Atypical glandular cells of uncertain significance (AGC-US)

- AGC is broken down into favoring endocervical, endometrial, or not otherwise specified origin or endocervical adenocarcinoma in situ
- Unspecified (AGC-US) (ASC-US)
- Atypical glandular cells, favor neoplastic (AGC-H)

CIN,cervical intraepithelial neoplasia; *HPV*, human papillomavirus. *CIS*, carcinoma in situ

This Bethesda system provides that the:

- Pap test analysis is considered a medical consult.
- Pathologist is responsible for diagnosis and recommendations regarding follow-up.
- Referring health care provider provides history.
- Report must have a statement of adequacy.

Providers performing the FGE and obtaining Pap test, HPV testing or co-testing must understand how to interpret the results to avoid errors in interpretation from failure of the clinician to understand or respond appropriately to cervical cancer screening results.

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CHAPTER 28

Trauma-Oriented Ocular Examination, Corneal Abrasion, and Ocular Foreign Body Removal

Brent Norris

Abstract

Ocular trauma is a commonly encountered condition in the primary care setting. Evaluation of the patient to rule out life-threatening injuries should be performed prior to pursuing a more detailed examination of the eye. A rapid and systematic approach to eye examination in the patient with ocular trauma enables the clinician to delineate accurately the type, location, and degree of ocular impairment.

Caution should be exercised when examining traumatic eye injuries in which globe rupture is suspected. Eye examination should be delayed in the case of caustic splash exposures to the eye so as not to delay treatment with flushing. Eyelid lacerations that do not penetrate the tarsal plate, cross the eyelid margin, or affect the lacrimal system may be safely repaired in the primary care setting. Other conditions, such as orbital fracture, retinal detachment, hyphema, penetrating foreign bodies, and large subconjunctival hemorrhages, should also be referred to ophthalmology.

Most corneal abrasions and superficial corneal foreign bodies are easily treated in primary and acute care settings. Many foreign bodies will be found on the surface of the cornea whereas others

might be stuck on the inner portion of the eyelid. Several methods exist for removal, including moistened cotton swab, corneal spud, or a small-gauge needle. The material of the foreign body holds special considerations for imaging, removal, and follow-up care. Corneal abrasions generally heal quickly. They may require analgesia, tetanus update, and prophylactic antibiotics, depending on the various circumstances of the injury.

Keywords

antibiotics
corneal abrasion
eye
eyelid
foreign body
fracture
globe rupture
hyphema
imaging laceration
orbit
tetanus
trauma

Procedure Goals and Objectives

GOAL: To perform a trauma-oriented ocular examination, treat corneal abrasion or ulceration, and perform ocular foreign body removal safely with minimal risk to the patient.
OBJECTIVES: The student will be able to:

- Describe the indications, contraindications, and rationale for performing a trauma-oriented ocular examination.
- Identify the common precautions and potential complications associated with the performance of a trauma-oriented ocular examination.
- Describe the essential anatomy and physiology associated with a trauma-oriented ocular examination.
- Identify the materials necessary for performing a trauma-oriented ocular examination.
- Demonstrate the steps necessary to perform a trauma-oriented ocular examination, identify corneal injury, and remove an ocular foreign body.
- Identify the aspects of post-procedure patient care.

Background and History

Ocular trauma is a commonly encountered condition in the primary care setting. Ocular trauma can occur as part of work, recreation, or leisure activities, and usually is caused by accident. It is estimated that each year in emergency departments in the United States almost 900,000 patients are treated for eye injuries. The rate of eye injuries is approximately 3.15 per 1000 population (95% confidence interval [CI], 2.66 to 3.63), with the injury rate among males being 4.52 per 1000 (95% CI, 3.77 to 5.20).[1–4]

The majority of eye-related injuries occur at home (40%), with sports injury and work-related injury both causing 13% of injuries. Of those injured, 78% were not wearing any eye protection, 5% were wearing regular glasses, and only 2% were wearing safety glasses, indicating that eyewear use significantly reduces the rate of eye injury. The majority of those injured are men (95%) and under the age of 30 years (57%). Most eye injuries are from blunt trauma (31%), followed by sharp objects (18%), motor vehicle crashes (9%), or BB

gun or pellet gun (6%), with 5% each for nails, hammer on metal, fireworks, and guns.[1,2,4]

In the primary care setting a rapid and systematic approach to examination of the patient with ocular trauma enables the clinician to delineate accurately the type, location, and degree of ocular impairment. This examination is frequently performed in primary care and acute care settings.[4–6]

Once the clinician has accurately assessed the eye injury, an appropriate treatment plan can be developed. Many uncomplicated corneal abrasions and superficial corneal foreign bodies are easily treated in the primary and acute care settings. Primary care clinicians should be able to perform basic care for the most common eye injuries. They should also know when the patient's condition is beyond their scope of practice and when to refer the patient to an optometrist or an ophthalmologist.[4–7]

Indications

A trauma-oriented eye examination is indicated for any potential eye injury, including blunt force, suspected abrasion, suspected foreign body, or any acute visual disturbance.[4,5] Properly performed, the examination adds little additional risk to the patient's vision.[4] Symptoms of a corneal abrasion include foreign body sensation, tearing, pain, and photophobia. Symptoms range from mild foreign body sensation to severe pain. The degree of pain appears to be strongly associated with the degree of damage to the cornea. Symptoms typically begin instantly after the injury and can last from minutes to days. Conjunctival injection and eyelid swelling may be present.[4–6]

Contraindications

The contraindications discussed in the following section should be referred to an ophthalmologist for emergent treatment.

Ruptured Globe

With a high level of suspicion for a ruptured globe, globe laceration, or intraocular foreign body, do not examine the patient further and immediately refer that patient to an ophthalmologist. Suspect a penetrated globe if the patient was in a situation in which the particle may have had a high velocity (e.g., grinding metal). Do not rely on clinical examination in this setting, but rather focus on the mechanism of injury when deciding to consult a specialist.[1–6]

If the globe is ruptured, do not use topical agents on the eye. Make the patient comfortable as soon as possible. Cover both eyes with a Fox shield (Fig. 28.1) to reduce movement of the injured eye.[4] An actively draining globe laceration often demonstrates ocular hypotony (intraocular pressure <5 mm Hg). Although a trained ophthalmologist or optometrist may roughly estimate hypotony resulting from a draining globe by having the patient close his or her eyes and gently applying light pressure with the thumbs to feel the eyes, this is not recommended. The injured eye may feel "softer" than the noninjured eye. Some authors question the benefit of checking intraocular pressure in the setting of an obvious globe injury because it may increase the risk for infection or extension of the injury (Fig. 28.2).[4,5]

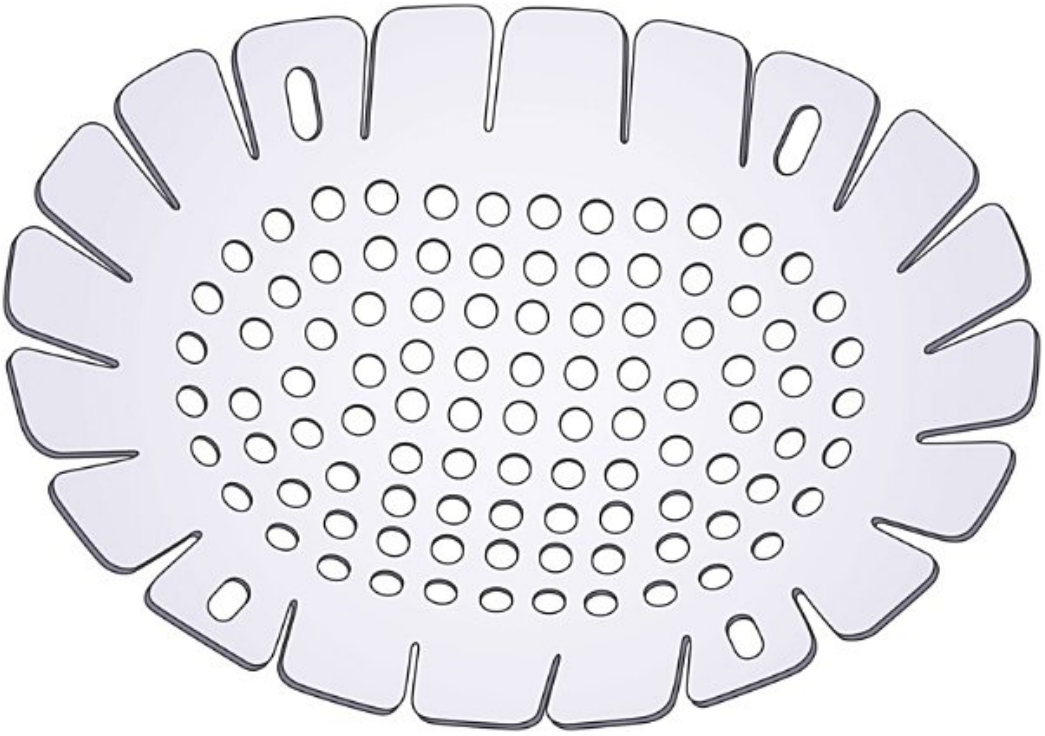

FIGURE 28.1 **Fox shield.**

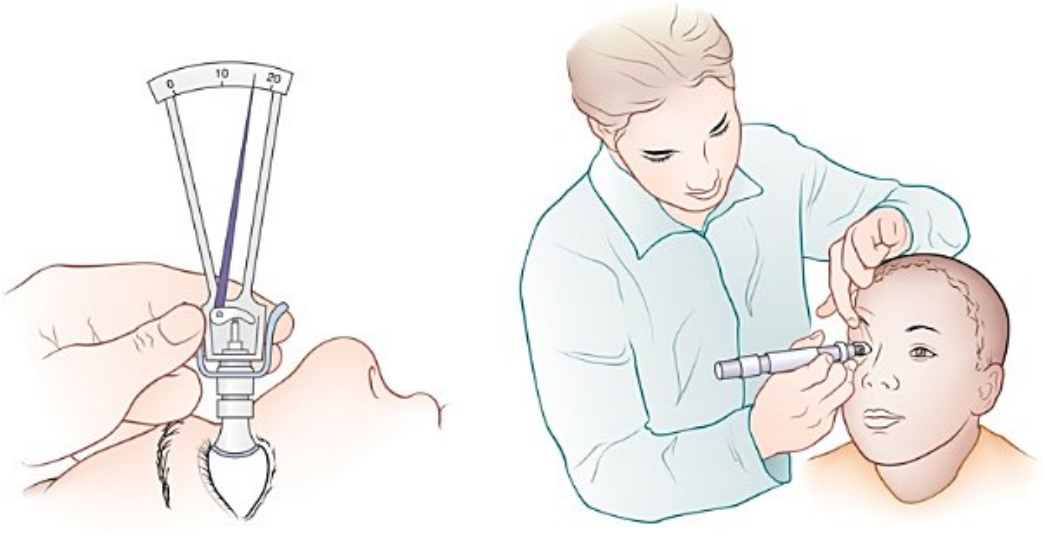

FIGURE 28.2 Measuring intraocular pressure with a Schiøtz manometer (**A**) and Tonopen (**B**).

If the penetrated globe is leaking aqueous humor, application of fluorescein may demonstrate a dark blue stream of fluid leaking from the site of the injury, through the pool of fluorescein (Seidel sign).[4,5] An eye with a laceration to the globe without an active aqueous humor leak may have a positive Seidel sign if the eye is gently pressed after the fluorescein has been applied.

Eyelid Laceration

Any eyelid laceration that causes concern pertaining to structural damage to the eye, loss of adnexal eye functions, or cosmesis should be referred for immediate evaluation and treatment by an ophthalmologist (Fig. 28.3). Vertically oriented lacerations, especially those occurring in the medial portion of the lower eyelid, are of particular concern because they may involve the tear ducts. These repairs are best left to an ophthalmologist.[3,5] If necessary, you can evaluate a laceration for lacrimal gland involvement by instilling fluorescein stain over the cornea and then checking for fluorescein in the wound under a Wood's lamp. Superficial horizontally oriented (parallel to the eyelid) lacerations that do not penetrate the tarsal plate, cross the eyelid margin, or affect the lacrimal system may be repaired safely in the primary care setting. These wounds generally close easily and heal with minimal scarring owing to their favorable orientation along Langer's lines. If you have concerns about injuring the eye while suturing, a Morgan lens can be placed to reduce the risk of iatrogenic globe puncture.[9]

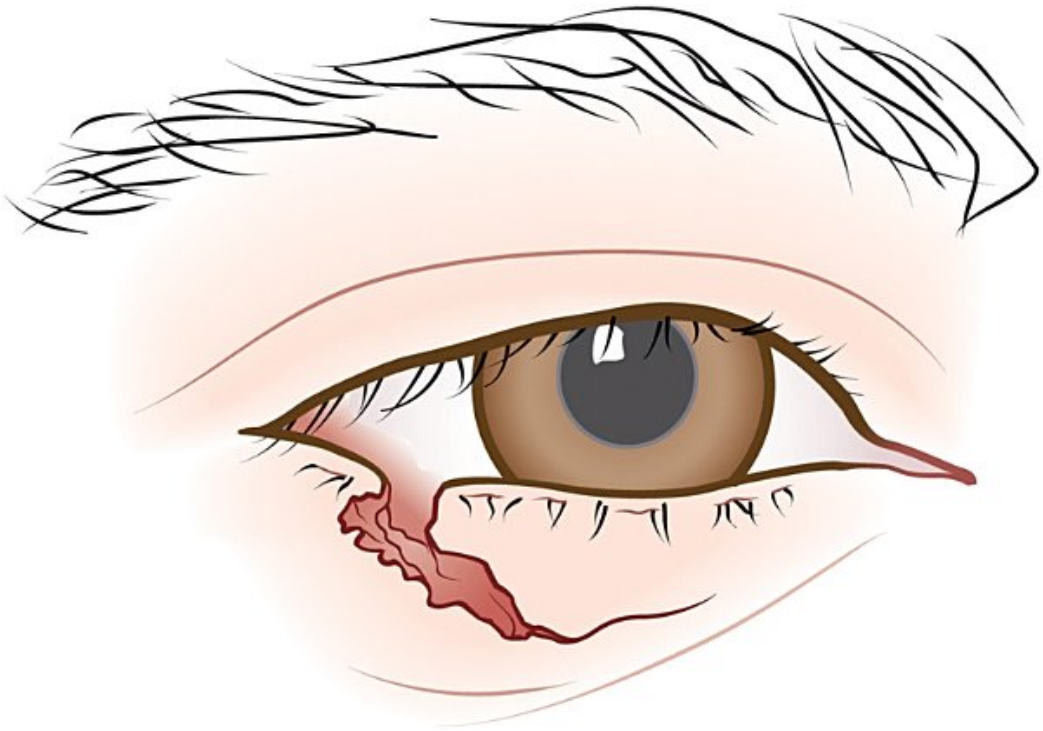

FIGURE 28.3 **Eyelid laceration.**

Caustic Splash Exposure

Caustic or other serious splash injuries require rapid dilution of the offending chemical. The clinician should treat the condition first and then assess the patient after the eye has been adequately flushed. Flushing should begin as soon as possible and the lids should be held open during the flushing, either manually or with a Morgan lens (Fig. 28.4). The wash should be at least 5 minutes for a mild irritant, 20 minutes minimum for most other irritants, and 60 minutes for penetrating corrosives such as acids and alkalis. Flushing of the eye may require 10 or more liters of fluid in some instances. Consideration should be given to minimize excessive wetting of the patient's clothing and preventing the collection of fluid on the floor. The clinician should have the flush performed first; then confirm adequacy with a pH indicator for the eye. Allow 5 minutes after flushing for the eye fluid to equilibrate before measuring the pH. A test done sooner than this may yield a false-negative result.[3,6,10]

Always test visual acuity BEFORE any other examination is performed; the only exception is with caustic splash injuries, which are always irrigated first to reduce delay in treatment (see Fig. 28.4).[4,5]

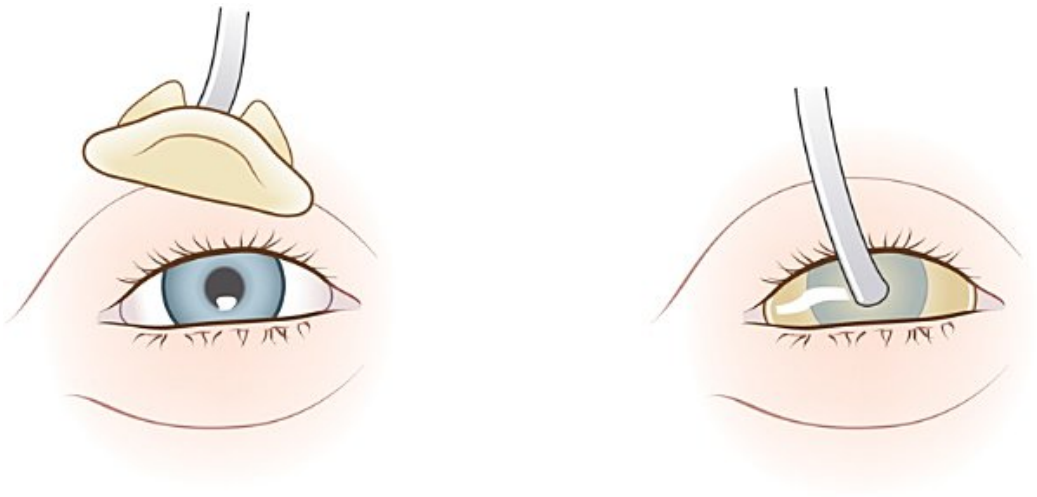

FIGURE 28.4 **Use of the Morgan lens to flush the eye.**

Cautions and Considerations

The clinician should follow standard infection control precautions in order to avoid complicating the injury. Patients who have received a direct blow to the eye may present with pupillary abnormalities, which may be misinterpreted as a sign of intracranial pathology.[4] Evaluate the patient to rule out life-threatening pathologies prior to pursuing a more detailed examination of the eye.[9] Patients with prior corneal flap surgical procedures (i.e., LASIK) may have dislodgement of this flap with trauma (e.g., finger in eye) (Fig. 28.5). This should be carefully examined and cleaned judiciously and the flap made to lie back in its normal position. Refer the patient to the on-call ophthalmologist before discharge.

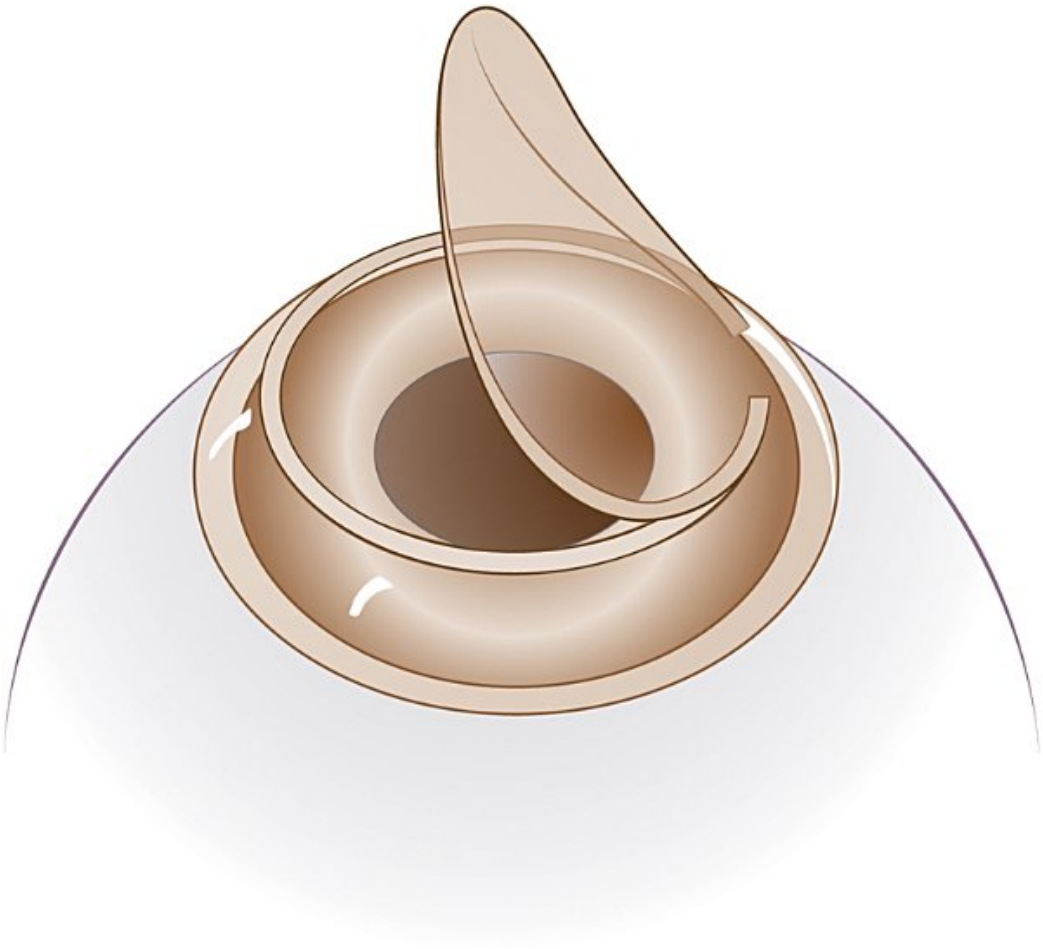

FIGURE 28.5 Dislodgement of corneal flap following surgical procedure.

Contact lens wearers presenting with a corneal ulceration are at risk for *pseudomonas* infection. A *pseudomonas* infection of the cornea can cause permanent vision disability in a short period of time.[2,4,11] Patients with exposure to organic debris in the eye are at increased risk for infection. A broad-spectrum topical antibiotic should be prescribed.[2,11]

When considering imaging the eye, a logical stepwise approach is best. Initial evaluation with plain film x-rays can evaluate for orbital fractures and most radioopaque foreign bodies. Computed tomography scans are the diagnostic study of choice for most ocular injuries owing to their ability to identify intraocular injuries. Ultrasound can serve as a useful adjunct that can aid in the assessment of intraocular injuries that might otherwise be masked to

visual inspection by intraocular blood. It can be performed at bedside by trained providers, but is contraindicated if globe rupture is suspected. Magnetic resonance imaging (MRI) provides excellent visualization of injuries to the soft tissues of the eye and can be used to identify wooden foreign bodies that might be missed with other imaging studies. It should be used with caution because it may inadvertently move a metallic foreign body into or around in the eye, causing further damage.[12,13]

Cooperation with this procedure is essential. The inebriated patient, confused elderly, young children, and others who may be unable to control their responses during a recommended procedure may need sedation.

Complications

The patient may experience increased eye pain, photophobia, nausea, or vomiting as a result of the eye examination. This is primarily owing to how the body responds to the intraocular injury. Judicious use of topical anesthetics, oral antimetics, and darkening the room, can be useful to reduce patient discomfort.[4,6] Antiemetics can reduce further eye injury by preventing vomiting, which increases intraocular pressure.[6]

Essential Anatomy and Physiology

The eye is a complex organ, with six extraocular muscles and four cranial nerves that work in tandem. These extraocular muscles can become entrapped following an orbital blowout fracture, which generally affects the floor of the orbit, thus producing the restricted vertical eye movement and diplopia sometimes associated with orbital blowout fractures. Other muscles in and around the eye allow for blinking to prevent desiccation adjustment of near and far vision and pupillary response to light stimulus. Together the eyes produce images at the occipital lobe of the brain. Bilateral visual input is essential for proper visual cortex data interpretation. The overlapping of both left and right visual fields compensates for visual field losses, enabling adequate visual function in a person

who has experienced significant visual field loss. The eye possesses several features that protect it from innocuous conditions, such as dry eyes, to a "blowout" injury:

- The ability to produce tears, to heal the surface of the eye rapidly
- The ability to adjust intraocular pressure
- Accommodating for direct injury with the ability for the orbit to give in or "blow out" and the eye to change shape to absorb impact forces

It is important to know and understand terms related to the anatomy of the eye (Fig. 28.6). This knowledge is useful when examining the patient, documenting the findings, and discussing the case with other clinicians. The anterior chamber, the area bounded in front by the cornea and in back by the iris, is filled with aqueous fluid. The aqueous fluid is a clear, watery solution in the anterior and posterior chambers. The canal of Schlemm is the passageway for the aqueous fluid to exit the eye to maintain normal intraocular pressures. Blunt trauma to the eye can result in a hyphema (blood in the anterior chamber of the eye) usually by disrupting the blood vessels within the iris or ciliary body. This can cause increased intraocular pressures owing to occlusion of the trabecular meshwork and the canal of Schlemm in approximately one-third of hymphemacases.[14] The choroid, which carries blood vessels, is the inner coat between the sclera and the retina. Its main function is to deliver nutrients and remove waste products. The conjunctiva is a clear membrane covering the white of the eye (sclera) and is continuous with the inside of the eyelids. It functions as protection from external injury. Subconjunctival hemorrhages can occur owing to trauma or infection, and even arise spontaneously. The bleeding accumulates above the sclera and below the conjunctiva, but should not cross the limbus or spread onto the iris owing to the anatomic separation of these structures.

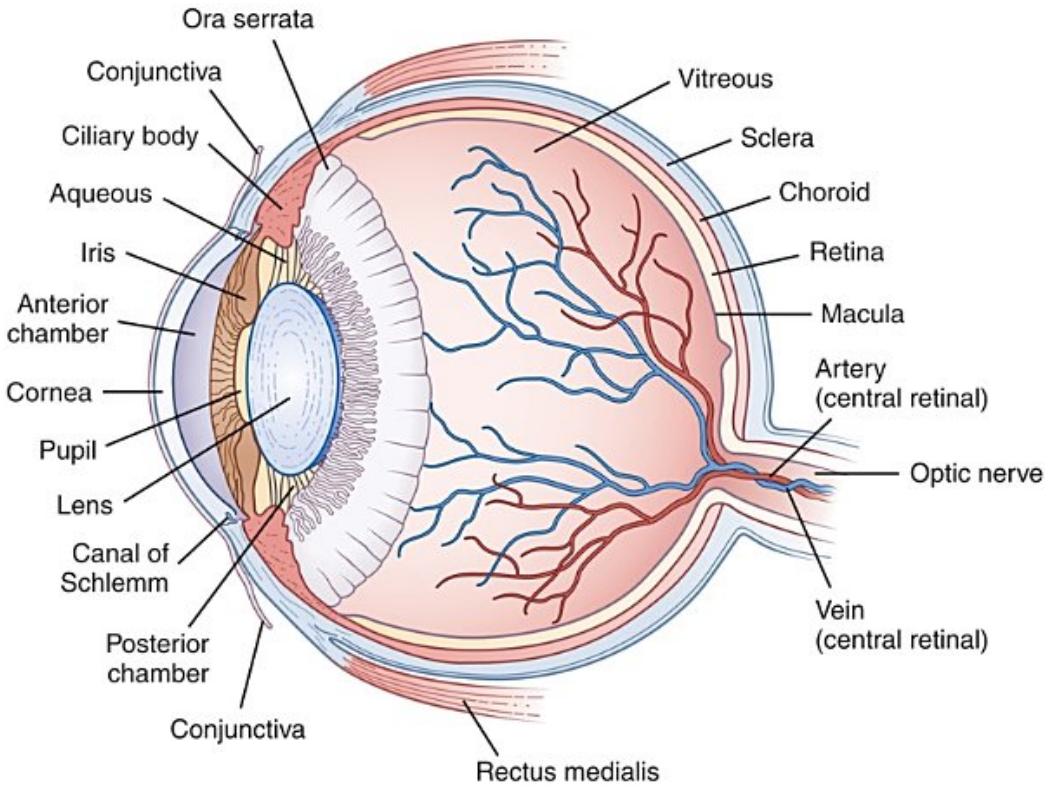

FIGURE 28.6 **Anatomy of the eye.**

The cornea is a clear transparent portion of the outer coat of the eyeball through which light passes to the lens, modulating light refraction and providing further protection. The corneal epithelium of the eye heals from most injuries in 1 or 2 days without any further consequences. The clinician must realize that the cornea is an avascular structure; oral medication will be delivered to it indirectly, primarily through the tears. Thus topical medications are the drug of choice for most eye injuries, providing the medicine is directly applied to the site where it is needed. The iris gives the eyes color; it functions like the aperture on a camera, enlarging in dim light and contracting in bright light. The aperture itself is known as the pupil. The lens helps to focus light on the retina.

The macula is a small area in the retina that provides the most central acute vision. The optic nerve conducts visual impulses to the brain from the retina. The posterior chamber is the area behind the iris, but in front of the lens, that is filled with aqueous. The pupil is the opening, or aperture, of the iris. The retina is the innermost coat of the back of the eye, formed of light-sensitive nerve endings that

carry the visual impulse to the optic nerve. Trauma to the eye can result in retinal detachment, which will result in some degree of visual field loss. The sclera is the white of the eye; it provides support and strength to the eye. The vitreous is a transparent, colorless mass of soft, gelatinous material filling the eyeball behind the lens, providing structural support.

Standard precautions

Every practitioner should use standard precautions at all times when interacting with patients, especially when performing procedures. Determining the level of precaution necessary requires the practitioner to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

Patient Preparation

The patient is often seated at the edge of an examination table, but could also be placed in a recumbent position to facilitate the examination.The following should be taken into consideration when preparing the patient for procedures involving in the eye:

- Darkening the room reduces photophobia.
- The patient should be made aware that the anesthetic drops may initially burn.
- The fluorescein may cause the patient's vision to turn yellow or orange.
- The patient should be educated that some topical antibiotics burn slightly when applied and that this does not represent an allergic reaction to the medication.[6]

Materials

- Vision chart (near point, distance)
- Anesthetic drops (e.g., proparacaine [Alcaine])
- Fluorescein strips

- Black light or cobalt blue light
- Magnifier (slit lamp, ophthalmoscope, or other magnification source)
- Cotton-tipped swabs
- Corneal spud, or small-gauge needle on 1- to 3-mL syringe
- Corneal burr
- Normal saline or equivalent for eye rinse
- Tissue or washcloth
- Fox shield
- Universal precautions: gloves, hand soap
- Emesis basin
- Eye occluder
- **Pinhole occluder**

Use a **pinhole occluder** to rapidly determine whether a person's loss of visual acuity is from a refraction problem or damage to optic nerve.

Procedure

Examination of an Injured Eye[4,7]

1. Obtain a history of the injury, detailing how and when the injury occurred, what agents were involved (e.g., chemical, blunt or sharp instrument), and what, if anything, has been applied to the injured eye. This will help you decide what type of injury or foreign body may be present.
2. Identify medication allergies, especially to anesthetics, fluorescein, and topical antibiotics.
3. A distance and/or near point vision examination is useful to demonstrate visual acuity. Record whether the examination was performed with or without corrective lens(es). Perform this examination before any additional procedures, to demonstrate existing vision deficits. Record findings of right eye (OD), left eye (OS), and both eyes (OU). Check visual acuity using the injured eye first, then the contralateral eye,

then both. This reduces the chance the patient may "learn" the vision chart and inadvertently have a better visual acuity in the injured eye.[6]

NOTE: Patients with significant visual disturbance (e.g., native refractive disorder, blood in anterior chamber, or other changes in the vitreous) may find their visual acuity improved when looking through a pinhole occluder. Patients in whom visual acuity fails to improve with a pinhole occluder may have more significant defects in the retina, macula, or optic nerve.

4. Place the patient for examination in a sitting or semirecumbent position. Ultimately, the best position is the position in which the patient is most comfortable and the clinician has the best access to perform the visual examination.
5. Explain the procedure to the patient using nonmedical terms at the patient's level of understanding.
6. Examine the eye for deformity, pupil reaction, extraocular movements, fundus abnormality, and obvious foreign body. This examination can be performed with a slit lamp, ophthalmoscope, or magnifying lens.

NOTE: Many foreign bodies will be found on the surface of the cornea, others might be stuck on the inner portion of the eyelid, and still others might be found penetrated into the cornea. The minority will have penetrated the globe. If a superficial foreign body is identified, decide which method you will use to remove the foreign body (see Procedure: Foreign Body Removal from the Eye).

7. Apply 1 or 2 anesthetic drops into the affected eye.
8. Moisten fluorescein strip with anesthetic drop or normal saline.
9. Instruct the patient to hold his or her head straight and to gaze upward nasally. Gently hold the lower eyelid down.

Apply strip to lower part of conjunctiva just above the lower (Fig. 28.7).

10. Ask the patient to blink the affected eye.
11. Visualize the cornea with black light or cobalt blue light. As the patient's tears break up or dilute the fluorescein, you may need the patient to blink to redistribute the fluorescein over the cornea.
12. Instruct the patient to hold his or her head straight and gaze upward, nasally and temporally, while you evert the lower lid to increase the visual field.
13. To evert the upper eyelid, have the patient look downward but not close the eyes (Fig. 28.8). Apply a cotton-tipped applicator against the mid-portion of the lid, parallel to the surface. Gently grasp the eyelashes, lift upward, and flip the lid back over the cotton applicator. This should enable an increased visual field for the cornea as well as expose the undersurface of the upper lid. Instruct the patient to hold his or her head straight and to gaze downward nasally and temporally to allow you to view the upper portion of the cornea.

Findings

If several scratches (often linear and vertical) are found on the cornea, be careful to inspect the inner surface of the eyelids (usually superior lid) for a foreign body (Fig. 28.9). If a corneal abrasion is identified without an offending foreign body, the foreign body or mechanism that caused the injury may no longer be present in the eye or may have floated into the fornices (corners) of the orbit. If a foreign body is suspected, but not visualized, carefully swab the fornices using a saline-moistened, cotton-tipped swab (Fig. 28.10). Estimate the depth and length of the abrasion. Report the abrasion location relative to normal eye landmarks, such as nasal, temporal, pupil, or as points on a watch face (e.g., 3-mm superficial corneal abrasion located at 3 o'clock on the right eye medial to the border of the iris).

Some patients with prior corneal damage develop recurrent corneal ulcerations. A typical presentation involves the reporting

of eye symptoms on arising in the morning with no recent history of trauma. The erosion will be in the same location as the initial eye injury and have an appearance similar to that of a typical corneal abrasion. The cause of post–eye-trauma ulcer formation is failure of the ocular basement membrane to adhere properly. The patient should receive standard treatment for corneal abrasion. Some authors suggest nighttime use of ointments to help moisten the eye. One controlled study revealed long-term treatment actually increased the likelihood of recurrent corneal ulceration.[6] If a pattern of **recurrent ulceration** is suspected, refer the patient to an optometrist or ophthalmologist to identify the cause. Causes of recurrent corneal ulceration include granulation tissue abnormalities, subclinical infection, or residual tissue overgrowth requiring debridement.[24]

> Repeated corneal abrasions in the same eye in the same spot suggests a poorly epithelized abrasion and should be referred to an optometric clinician.

If the appearance of the lesion on the surface of the cornea resembles a stellate or an irregular branching pattern, the patient may have a viral infection. A fluorescein examination might reveal dendritic keratitis, which is characteristic of ocular viral infections (Fig. 28.11). The treatment includes preparations (topical, systemic) with good antiviral activity. Lack of good response to topical antibiotics should cause the clinician to reflect on the accuracy of the previous diagnosis and consider whether this finding was missed initially.

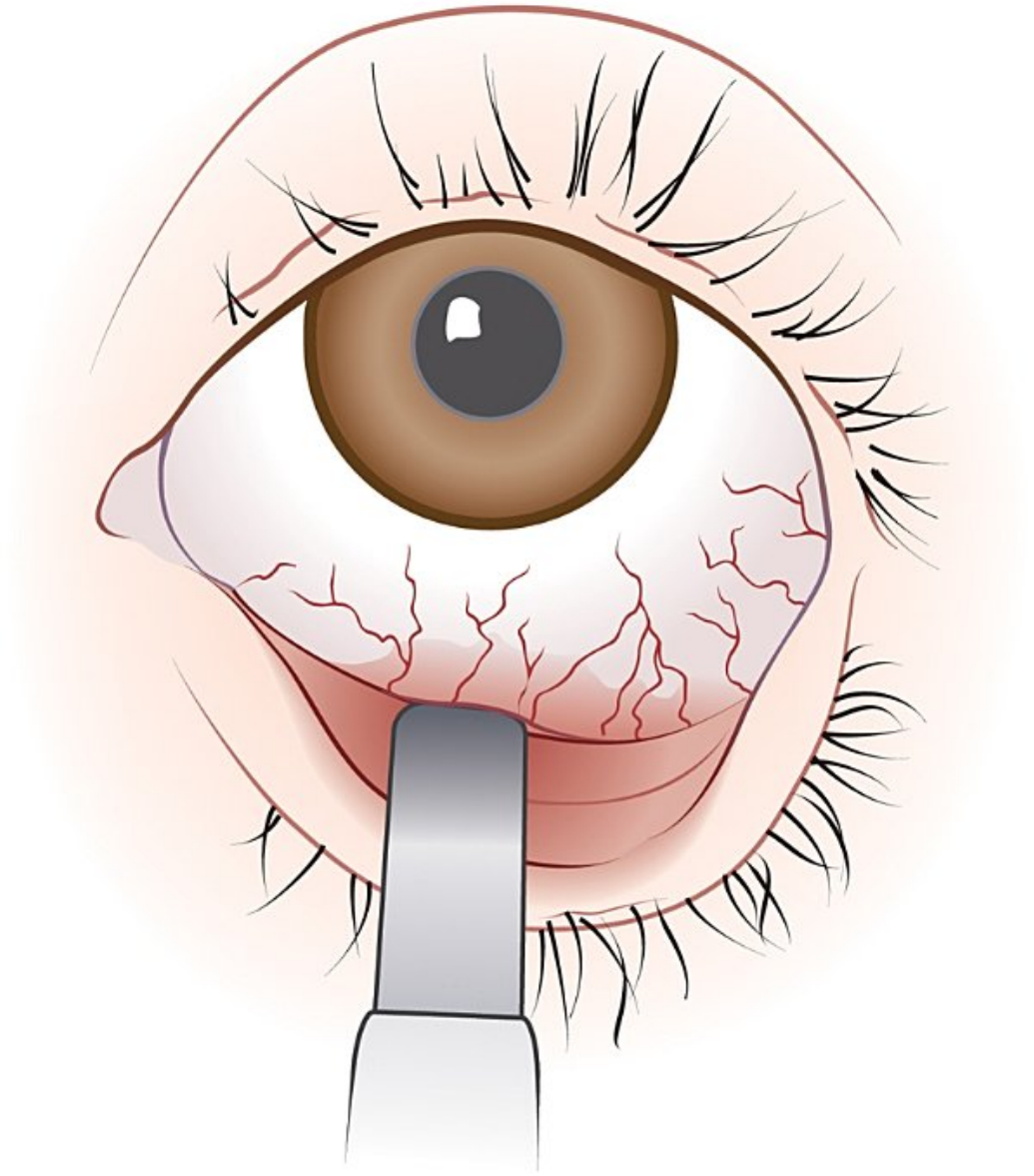

FIGURE 28.7 **Application of fluorescein to the eye using fluorescein strip.**

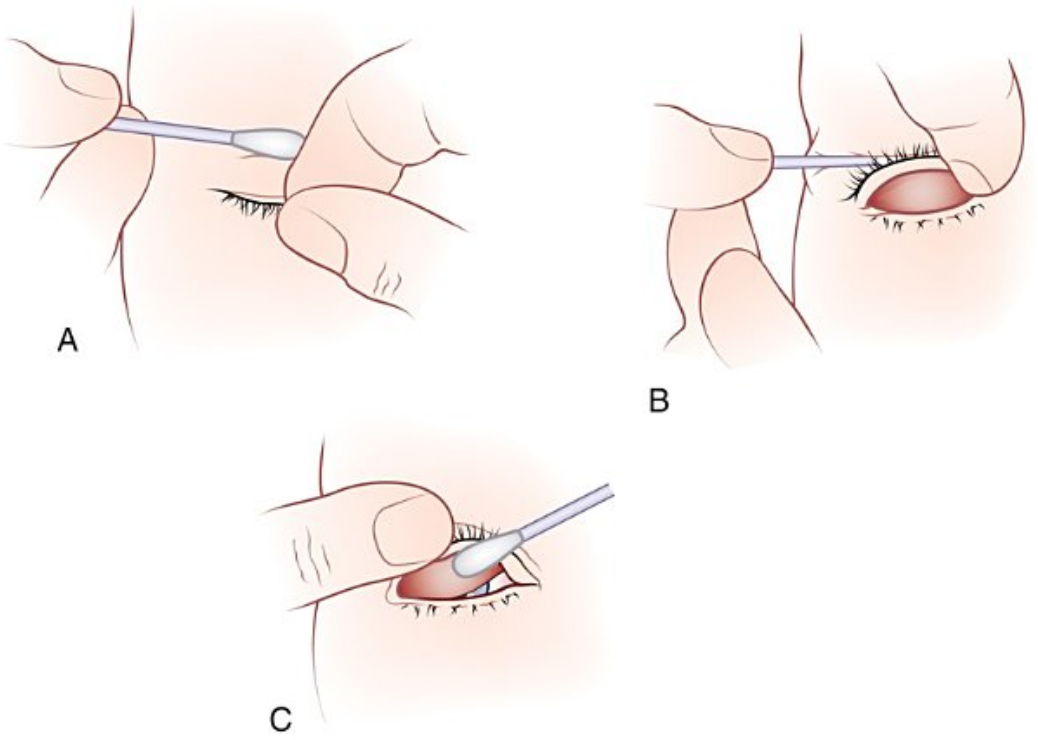

FIGURE 28.8 **Everting the eyelid (see text).**

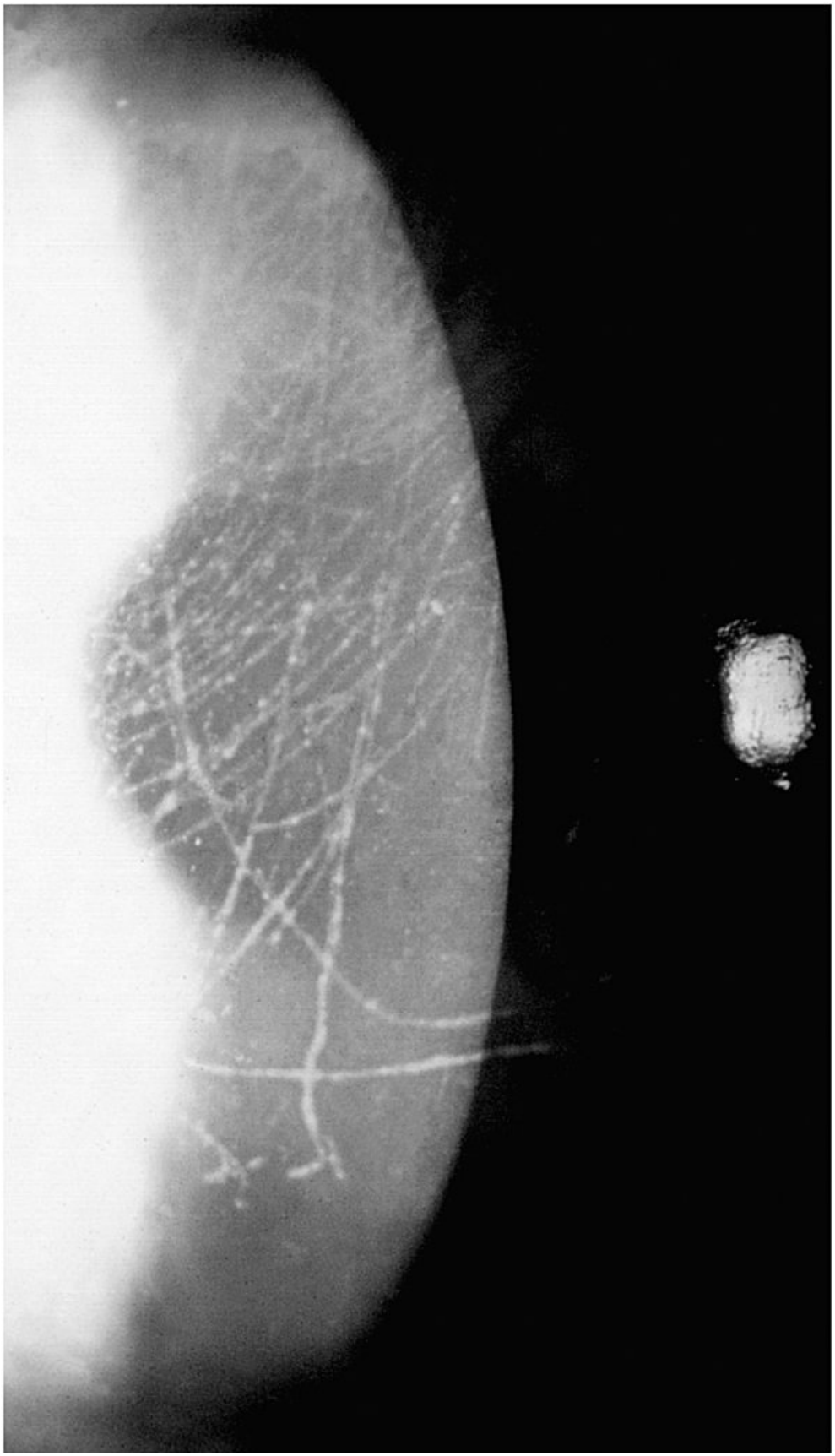

FIGURE 28.9 **Corneal scratches.**

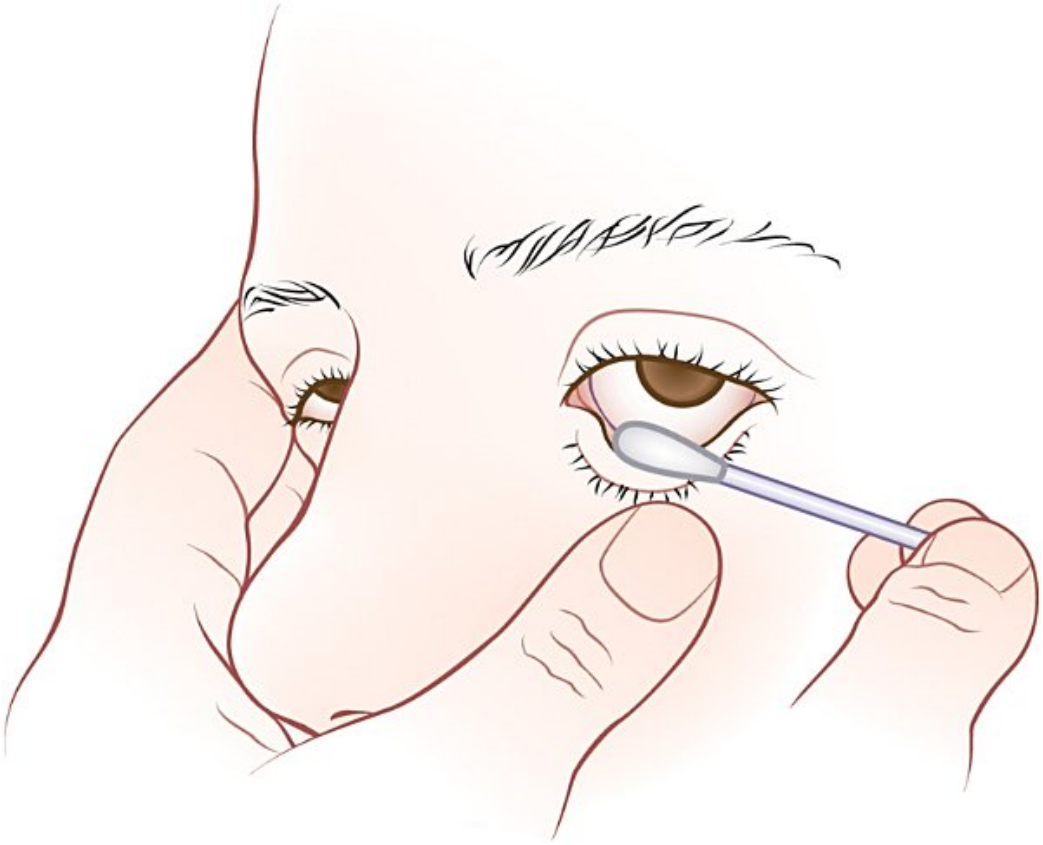

FIGURE 28.10 **Swabbing the fornices using a saline-moistened, cotton-tipped applicator.**

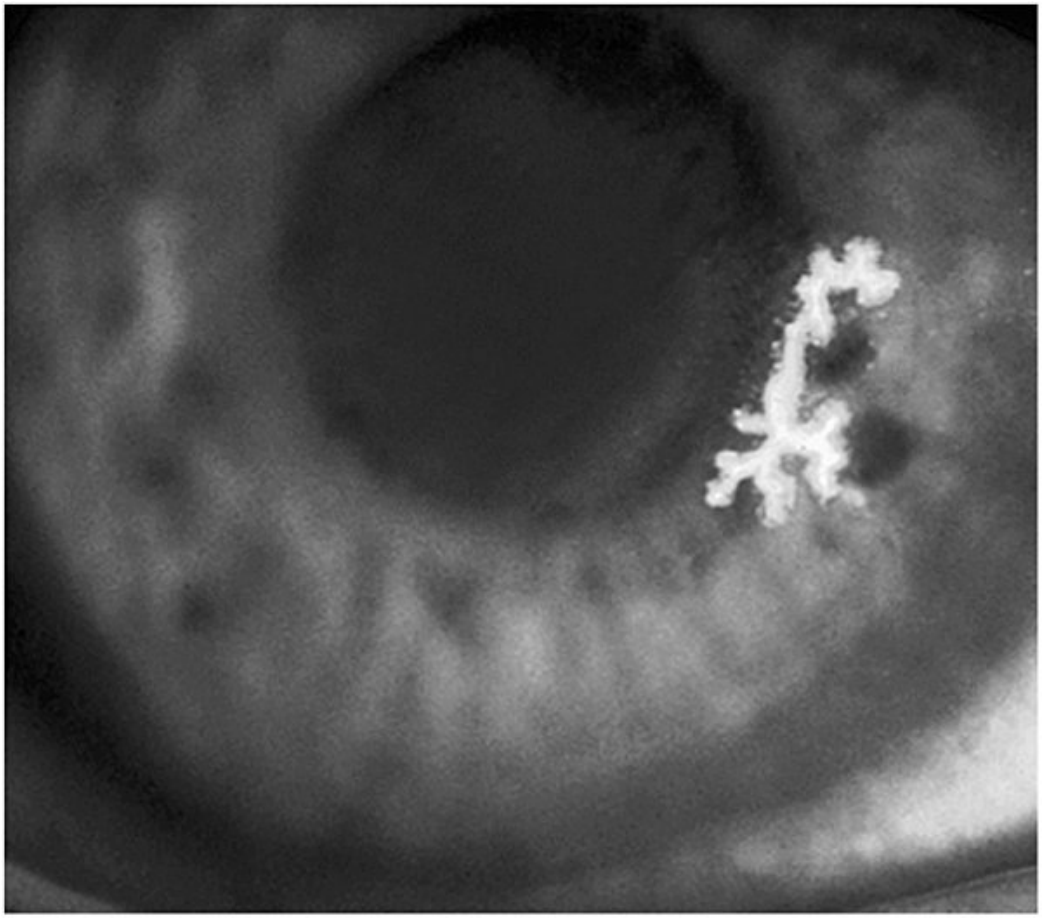

FIGURE 28.11 **Dendritic keratitis.**

Procedure

Foreign Body Removal From the Eye

1. Foreign body removal may be as simple as flushing the eye; however, if more than a simple flushing is required, the eye should be anesthetized before using any device to remove the foreign body.
2. Surface foreign bodies may be removed easily with a moistened cotton swab.
3. Superficial metallic foreign bodies may be removed using either a small-gauge needle (e.g., 25-gauge needle on a 1-mL syringe) (Fig. 28.12) or a corneal spud, which is specially designed to remove corneal foreign objects (Fig. 28.13).

4. The patient's gaze should be directed so that the foreign body is clearly visible. Approaching the patient's eye from the side and inferiorly distracts the patient from the procedure and minimizes anxiety and blinking reflexes.
5. The needle should be held with the bevel up and approach the cornea at a flat angle. Some providers find it helpful to bend the needle slightly in order to facilitate better access while maintaining the proper angle of approach for the needle. The needle tip should scoop the foreign body while removing little or none of the surrounding corneal tissue.
6. Metallic foreign bodies often leave a rust ring in the cornea that should be removed, either immediately or within a few days, using a device called a corneal burr (see Fig. 28.13). Not removing the rust ring may cause a disturbance in the patient's vision and may delay healing of the corneal tissue (Fig. 28.14). The rust actually causes the cornea to soften a bit in that area, so the burr procedure may be somewhat easier to perform at the time of reexamination.

Concluding the Examination

Rinse the eye generously with normal saline or equivalent to remove the fluorescein dye and also flush out any offending debris. Instruct the patient that the fluorescein dye will drain through the tear ducts into the nose and may be present in the nasal discharge for the next few hours and that it may stain white clothing.

It is recommended the clinician recheck the visual acuity to demonstrate that the examination has not extended the injury to the eye.

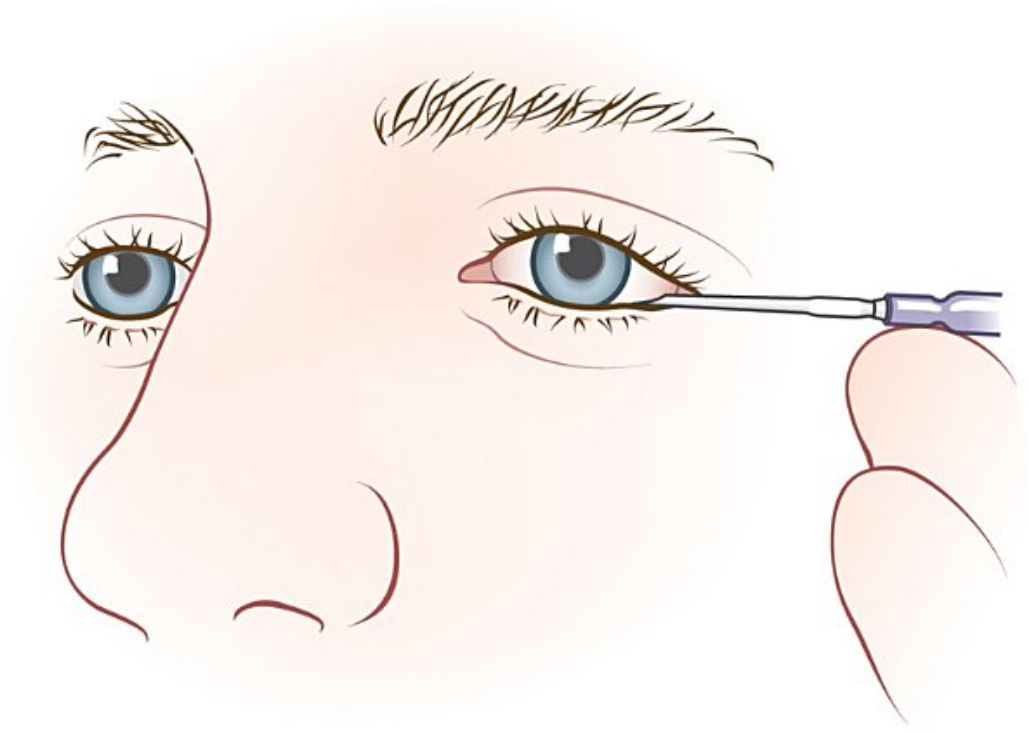

FIGURE 28.12 **Removal of superficial metallic foreign body using a small-gauge needle.**

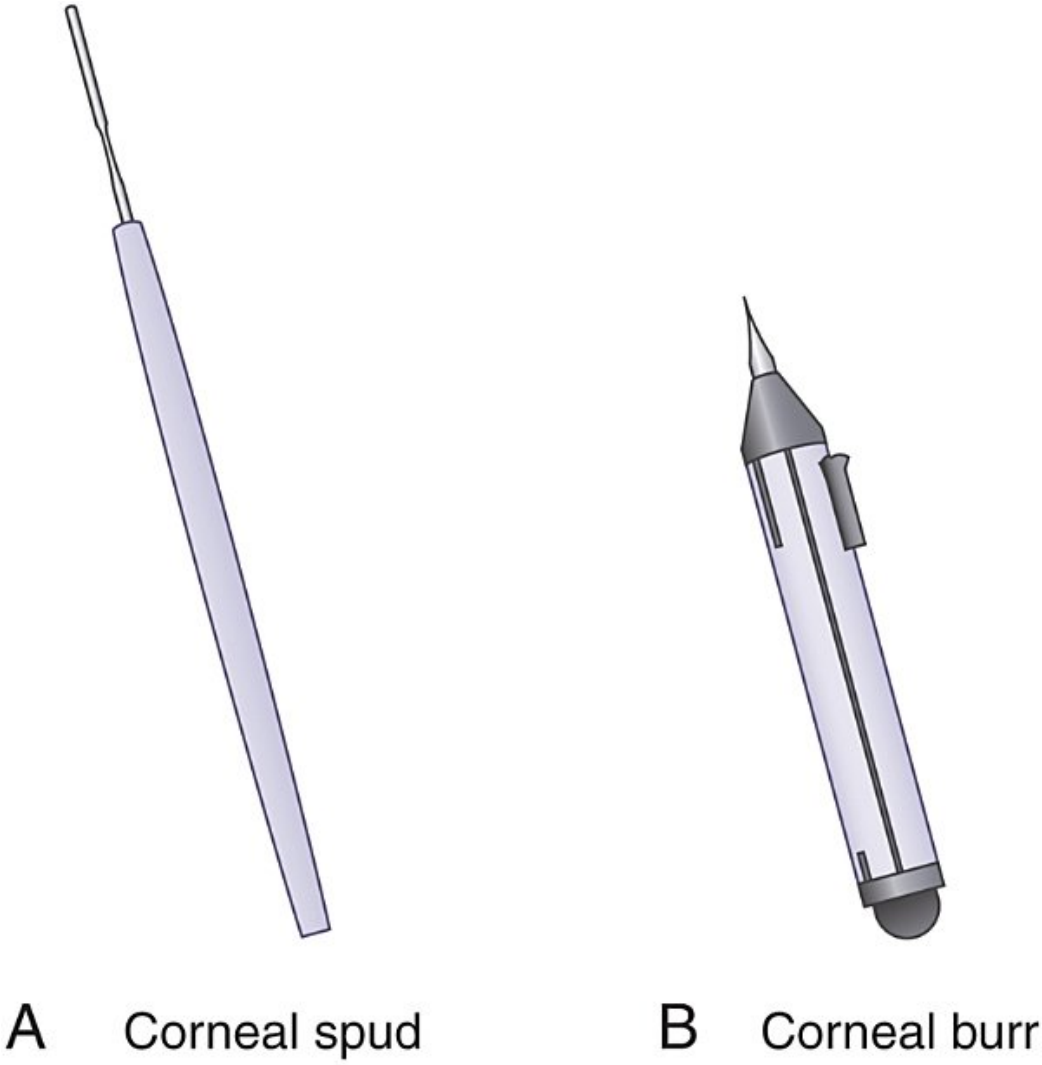

FIGURE 28.13 Corneal spud (A) and corneal burr (B).

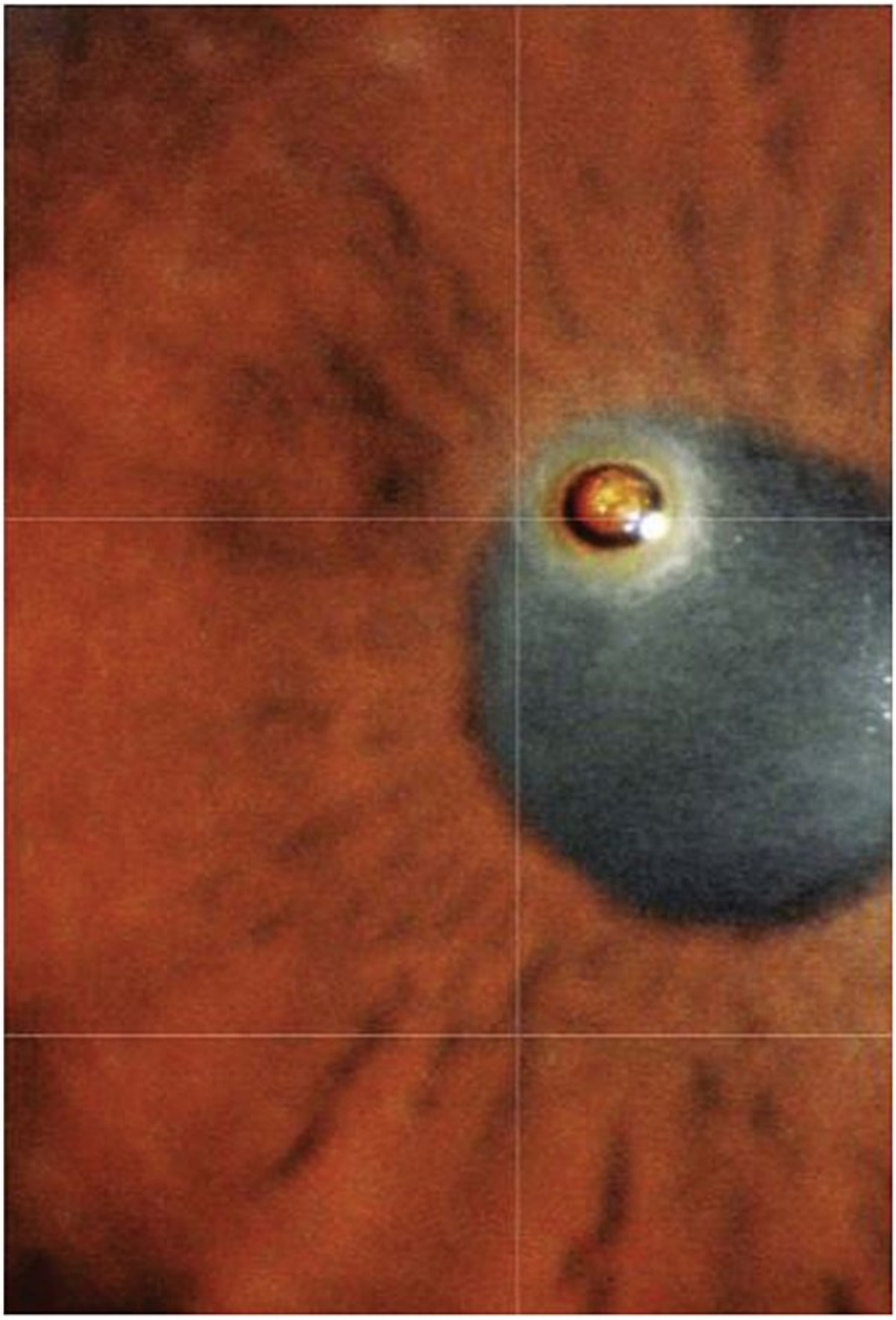

FIGURE 28.14 Rust ring in the cornea created by metallic foreign body. Reproduced with permission from Krachmer JH, Palay DA.*Cornea Atlas* ed 3. Philadelphia: Elsevier; 2014.

Special Considerations

Update tetanus immunization if the patient's last tetanus was given more than 10 years ago or no record of the last immunization exists. Corneal injuries caused by organic matter or dirt, as well as those associated with penetrating injuries, are more susceptible to tetanus and should prompt updating the patient's tetanus immunization if it has been more than 5 years from the patient's last booster.[15]

Use precaution not to leave anesthetic drops unattended. Patients might ask to take extra anesthetics with them for pain control. It is important to educate your patients that even short-term repeated use of the drops can cause the cornea to soften and slough off.[2,4] If a rust ring from the metallic foreign body cannot be removed completely, refer the patient to an eye care practitioner for definitive care.

It is important to emphasize the need to practice eye injury prevention strategies. Patients who may be at greater risk for potential eye injuries need to know the possible long-term consequences, such as recurrent, nonhealing ulcer. Children are at high risk for ocular reinjury; therefore, it is essential that parents understand and implement the use of eye-protecting sports gear. Clinicians should have information available to share with their patients regarding the distribution of **protective eyewear**.[1,17]

The majority of eye injuries can be prevented through use of safety glasses. Reinforce use of safety glasses at each encounter involving eye injury.

Cycloplegic drops are sometimes prescribed to help reduce pain by limiting the constriction and dilation movement of the ciliary muscle in the pupil; however, continued use of some of these medications may contribute to the development of hallucinations. Ask the patient to call for advice if this occurs. Typically advise the patient to stop the cycloplegic drops, and follow up in the next few days. The hallucinations usually stop after several hours, but may take up to a day.

Follow-Up Care and Instructions

The four main goals in the treatment of corneal abrasions are controlling pain, reducing risk for secondary infections, promoting corneal reepithelization, and risk avoidance to reduce reoccurrence.[2]

Pain Control

The anesthetic will wear off after a short period, so eye pain will return. Topical nonsteroidal antiinflammatory drugs are often prescribed for pain reduction and appear to be effective. The potential downside is that these medicines theoretically may delay healing.[11,25,27] Patching the eye is no longer largely recommended because of studies showing no benefit to pain control and possibly increased rates of infection. Advising the patient to wear sunglasses may improve overall vision comfort during healing.[2,3,16,17,23,26] Bandage contact lenses are usually prescribed by the optometrist or ophthalmologist if the condition is severe enough to have considered patching to prevent lid and epithelium interaction. Deep corneal abrasions may require a prescription of opioid analgesics for pain control. Oral analgesics are typically less expensive than topical, and because the eye heals quickly, only short-term use is indicated. However, the use of oral opioids for pain control should be very limited, to avoid masking a worsening condition and to reduce the chance for secondary gain in patients who may be demonstrating opioid-seeking behavior.[18]

Reduce Secondary Infection

Often a topical antibiotic drop or ointment is prescribed to reduce the chance for a secondary infection from an eye injury.[2,11,18] Patients who develop a corneal ulcer from contact lens use often grow *pseudomonas* species; therefore **patching is contraindicated**.

Never patch an eye injury that may have been exposed to contaminated organic matter.

Patching an eye with a pseudomonal ulcer will create the ideal *pseudomonas* breeding environment. In a short time (24 to 48 hours) a patient may develop permanent visual impairment or blindness as a result of the *pseudomonas* bacteria burrowing deeper into the eye. Ideally, these patients should be treated with a broad-spectrum antibiotic that is effective against a wide variety of bacteria, including *pseudomonas* species. A follow-up examination the next day with the ophthalmologist or optometrist is essential.[11,18–22] Patients with deep corneal abrasions, abrasion from contaminated organic material, or corneal abrasion from contact lens use need to be seen in the clinic or by an optometrist or ophthalmologist as soon as possible to ensure proper healing.

Reepithelization

A follow-up visit for a patient with a superficial corneal abrasion or uncomplicated foreign body is usually not necessary. Educate the patient that the symptoms will resolve in 1 or 2 days. Larger abrasions may take up to a week to heal fully. If in doubt, the patient should return to the primary care clinic daily; if more seriously injured, the patient should be followed daily by optometry or ophthalmology.[7,19] Contact lens wearers should refrain from using their contact lens(es) until the eye has healed, plus another 5 to 7 days to let the eye "rest." This will avoid the risk for reaction in the eye, which would cause the patient to be unable to wear contact lenses in the future. This is another reason why contact lens wearers should have a current prescription for their glasses. Before prescribing topical steroids, consult with an eye care practitioner about the use of this medicine in any situation.[19]

Reduce Reoccurrence

Avoidance of reoccurrence via the use of appropriate eye protection, such as safety guards on equipment and safety glasses or goggles (e.g., American National Standards Institute [ANSI] certified lens for paintball, carpentry work, and racquetball), should be reinforced.[17–19]

Patient Discharge Instructions for Corneal Abrasion

Inform the patient that most eye injuries heal fully over a few days. The patient should also be given the following instructions:

- Use ice compresses and oral painkillers to relieve pain.
- Use ointment or eye drops exactly as prescribed.
- Return in 1 day for reexamination of the eye (if the patient is unable to return, make arrangements to communicate with the patient).
- Avoid touching or rubbing the eye, especially when waking up.
- Do not wear contact lenses until the eye has healed and all ointments or drops have been finished for at least 1 day, preferably as long as a week, to allow the eye to "rest."
- Follow up with an eye care practitioner before resuming contact lens wear.
- Avoid exposure to bright light. Sunglasses or a hat with a brim may be helpful to avoid glare.
- To avoid future injury, wear appropriate eye protection, such as safety goggles, when working near materials that could become airborne and cause eye damage, or sports glasses when playing sports.[7]
- Call for advice or return for a recheck if he or she experiences increasing pain that does not respond to medications prescribed, a change in vision or change in vision tolerance (e.g., bright lights, increased eye watering or tearing), new discharge from the eye, or failure of the eye to improve or completely heal in 1 or 2 days.

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CHAPTER 29

Treating Ingrown Toenails

Sue M. Nyberg

Ronda J. Hanneman

Abstract

Managment of an ingrown toenail (onychocryptosis) is a common procedure in primary care. Local trauma to the periungual tissue from improper nail trimming or ill-fitting shoes is a frequent cause of inflammation and secondary infection. Conservative measures may be sufficient in mild to moderate cases; partial or total removal of the nails remains the definitive treatment in more severe or recurrent cases.

Keywords

ingrown
onychocryptosis
paronychia
periungual
toenail

Procedure Goals and Objectives

GOAL: To treat problems associated with an ingrown toenail by removing all or part of the affected nail.
OBJECTIVES: The student will be able to:

- Describe the indications, contraindications, and rationale for removing an ingrown toenail.
- Identify and describe common complications associated with removing an ingrown toenail.
- Describe the decision process used to determine when to remove an ingrown toenail.
- Describe the essential anatomy and physiology associated with removal of an ingrown toenail.
- Identify the materials necessary for performing removal of an ingrown toenail and their proper use.
- Identify the important aspects of postprocedure care after removal of an ingrown toenail.

Background and History

The management of an ingrown toenail is one of the most common procedures that the primary care practitioner is asked to perform. The ingrown toenail can be painful, causing limitation in function and mobility in many patients. Typically, only the great toe is affected, and either the medial or lateral border may be involved. In their protective role, nails bear the brunt of daily activities. Walking, running, wearing shoes, and participating in sports are just a few of the stresses that feet must endure. The most frequent underlying cause of an ingrown toenail is improper trimming of the nail, resulting in impingement, inflammation, and even infection in the surrounding and overlying skin of the nail fold. Improperly fitted shoes (e.g., high-heeled, narrow-toe) that compress the toes together are also a significant contributing factor to the development of

ingrown toenails. Other injuries to the nail bed that change the shape of the nail or a congenitally increased curvature of the lateral edges of the nail plate also may result in an ingrown nail.[1]

Patients report pain along the margin of the toenail that is aggravated by any type of pressure, especially when wearing shoes. Erythema and swelling are usually present and, if infection has occurred, pustular drainage may be noted. Conservative measures, such as elevation of the nail plate with a small cotton wick, frequent soaking, wearing loose-fitting shoes, and selective trimming of the nail, may be attempted; however, either partial or total removal of the nail remains the definitive treatment.[2,3]

Conservative care for ingrown nails should include basic foot care and footwear advice. Removal of part or all of affected nails is considered the treatment of choice for painful swelling, inflammation, and infection.

Indications

The most common indication for the removal of a nail is onychocryptosis (ingrown nail).[3] Other indications include the following:

- Onychomycosis (fungal infection of the nail)
- Chronic, recurrent paronychia (inflammation of the nail fold)
- Onychogryposis (deformed, curved nail)[2]

Contraindications

Relatively few contraindications to the procedure exist, but do include a bleeding diathesis or an allergy to local anesthesia. Patients with diabetes mellitus or peripheral vascular disease should be considered on a case-by-case basis.[2] In these situations, conservative measures should be attempted first, with consideration of referral to a specialist if operative treatment is still indicated. Pregnant patients should not have phenol ablation.[2]

Potential Complications

Infection is a possible complication; however, it should be easily treatable with appropriate antibiotics and frequent soaks. If the nail bed is not cauterized (ablated), the nail will regrow and symptoms may return. If the nail bed is cauterized, potential still exists for regrowth and return of symptoms (approximately 10% with phenol ablation). A systematic review concluded that nail avulsion combined with phenol is probably more effective in preventing recurrence and regrowth on the ingrowing toenail.[4]

Essential Anatomy and Physiology

Nails are derived by keratinization of cells from the nail matrix, which is located at the proximal end of the nail plate (Fig. 29.1). The nail plate consists of the nail root embedded in the posterior nail fold, a fixed middle portion, and a distal free edge. The whitish nail matrix of proliferating epithelial cells grows in a semilunar pattern. It extends outward past the posterior nail fold and is called the *lunula*.[5] Sensory supply to the great toe is through the digital nerves that have an extensor and plantar branch on both the medial and lateral aspects of the toe.

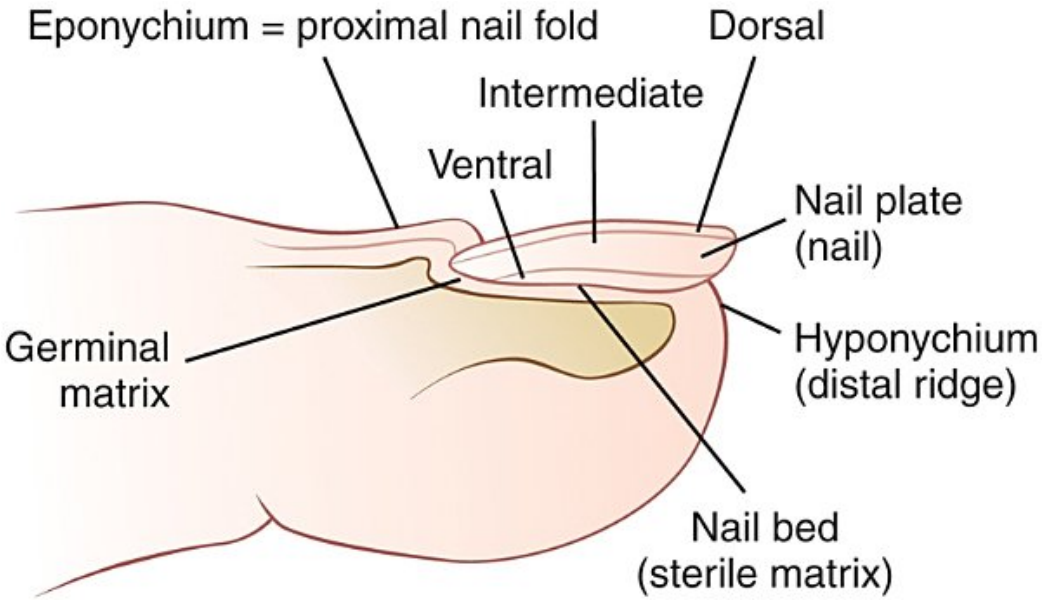

FIGURE 29.1 Anatomy of the nail and nail bed. (From Pfenninger JF, Fowler GC. *Procedures for Primary Care.* Philadelphia: Mosby Elsevier; 2011, p 200.)

Standard precautions

Every practitioner should use standard precautions at all times when interacting with patients, especially when performing procedures. Determining the level of precaution necessary requires the practitioner to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

Patient Preparation

The following should be considered in preparing the patient for removal of an ingrown toenail.

- Explain the procedure to the patient to help alleviate as much anxiety as possible.
- Reassure the patient that the procedure is generally not painful except for the initial injection.

- Indicate the need for the patient's cooperation in keeping the foot still.

Materials

- Local anesthetic without epinephrine (vasoconstricting agents are generally avoided when anesthetizing a digit[2,6])
- 5-mL syringe with a 1- to 1½-inch, 25- to 27-gauge needle
- Povidone-iodine (Betadine) swabs
- Sterile drape
- Rubber band or small Penrose drain
- Straight hemostats
- Sterile straight scissors
- Sterile periosteal elevator
- Sterile gauze pads
- Sterile cotton-tipped applicators
- Silver nitrate sticks (optional)
- Phenol solution (88%) if permanent ablation of nail bed is desired
- Isopropyl alcohol
- Antibiotic ointment
- Rolled or tubular gauze dressing

Procedure

Removing an Ingrown Toenail

1. Place the patient in the supine position.
2. Scrub the digit with povidone-iodine and drape the toe in a sterile fashion. Alternatively, the toe may be soaked in an antibacterial solution for 5 minutes.

Anesthesia (see Chapter 16)

3. Withdraw approximately 5 mL of local anesthetic (without epinephrine) into a syringe.

4. Inject the anesthetic in a ring fashion around the toe. The initial injection should be proximal to the edges of the medial nail fold on the dorsal surface of the toe. Four digital nerves should be anesthetized: both extensor and plantar branches of the medial and lateral nerves.
5. Inject approximately 1 mL of anesthetic around each nerve site, starting dorsally and directing the needle gently in a plantar direction, injecting around the plantar digital nerve.
6. Repeat the procedure on the lateral side of the toe.
7. After the toe is anesthetized (approximately 5 to 10 minutes), apply a tourniquet to the base of the toe (either a rubber band or small Penrose drain clamped with a hemostat).

Toenail Removal

8. For partial nail removal, first cut the nail lengthwise with sterile scissors or nail cutters, 4 to 5 mm from the affected nail fold (Fig. 29.2).

NOTE: If the entire nail is to be removed, cutting the nail in half in a lengthwise manner facilitates easier removal.

9. Loosen and lift the nail with a narrow periosteal elevator, flat edge of the scissors, or any similar instrument. If the entire nail is to be removed, the nail can first be cut in half with sterile scissors or nail cutters.
10. Gradually separate the nail from the underlying nail bed by applying gentle upward pressure, taking care to minimize trauma to the underlying nail bed. It is important to ensure that the proximal nail underneath the cuticle is fully loosened.
11. Silver nitrate may be applied to the nail bed to control bleeding.[2]

Ablation of the Nail Matrix

12. If permanent removal of the nail is desired to prevent recurrent problems, the matrix of the nail bed must be ablated.

> Ablation of the underlying nail matrix following nail removal may lower the rate of recurrence.

13. Dry the nail bed with sterile gauze and apply an 88% phenol solution to the nail matrix with a sterile cotton-tipped applicator for approximately 3 minutes.

> **CAUTION:** Care must be taken not to expose surrounding tissue to the phenol solution.

14. Neutralize the area with isopropyl alcohol.
15. Remove the tourniquet.

Postprocedure Care

16. Apply antibiotic ointment to the nail bed and apply a sterile, nonadherant gauze pad to the site.
17. Wrap the toe with rolled or tubular gauze.
18. Recommend wearing a hard-soled, postoperative shoe for several days following the procedure.

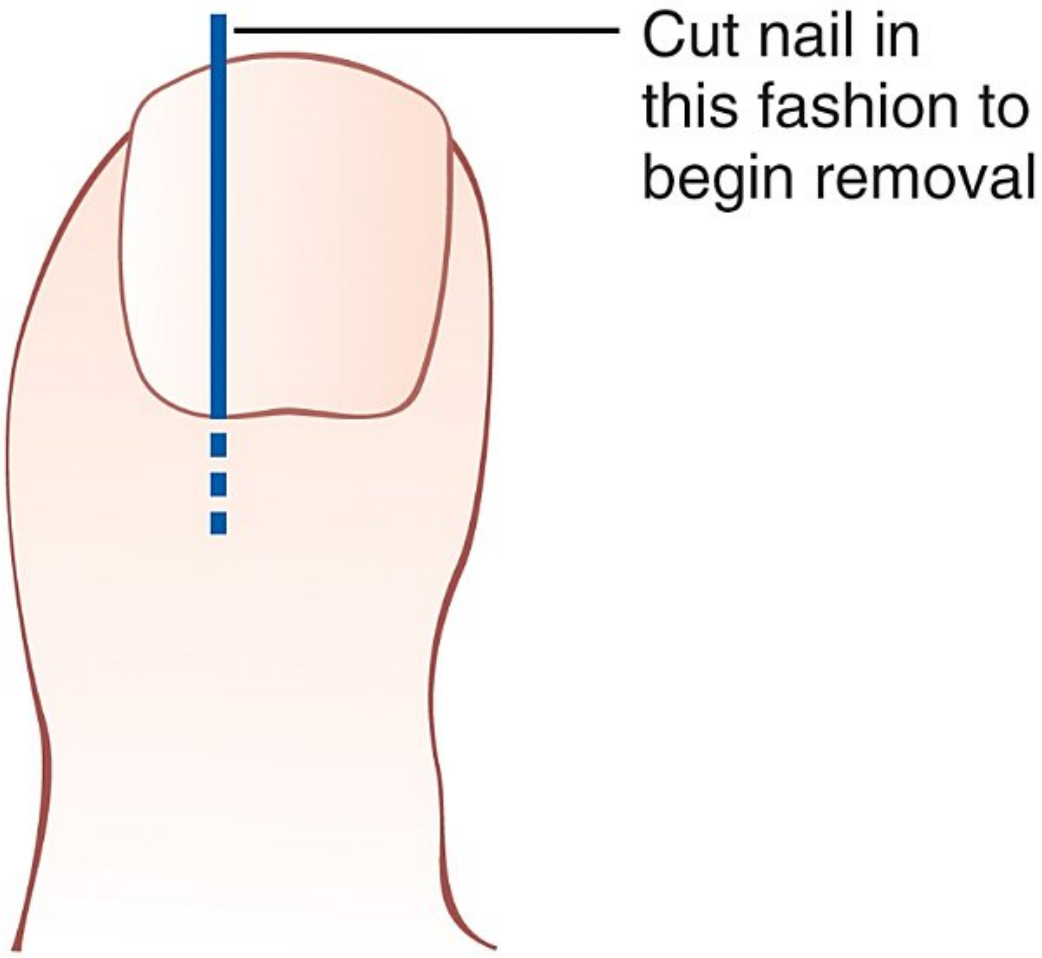

FIGURE 29.2 **Toenail removal.**

Follow-Up Care and Instructions

The following should be considered when providing follow-up care after toenail removal:

- Instruct the patient to keep the foot elevated for 24 to 36 hours, with gradual return to ambulation.
- Over-the-counter analgesics are generally sufficient for pain relief.
- Advise the patient to change the dressing in approximately 24 hours and to soak the toe in warm water twice per day for several days.

- Instruct the patient to report back to the office with any signs of infection (fever, increasing swelling or erythema, pustular drainage).
- To prevent recurrence of the ingrown nail, advise the patient to wear low-heeled shoes with adequate room for the forefoot and toes.
- Instruct the patient not to trim the nails too short and to trim in a flat, straight-across fashion.

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CHAPTER 30

Urinary Bladder Catheterization

Daniel T. Vetrosky

Abstract

This chapter covers the background and history, indications, contraindications, potential complications, anatomy and physiology, patient preparation, materials, procedure, special considerations, precautions, and follow-up care and instructions for urinary bladder catheterization. The objectives of this chapter will allow the student/practitioner to:

- Describe the indications, contraindications, and rationale for performing urinary bladder catheterization.
- Identify and describe common complications associated with performing urinary bladder catheterization.
- Describe the essential anatomy and physiology associated with the performance of urinary bladder catheterization.
- Identify the materials necessary for performing urinary bladder catheterization and their proper use.

Keywords

bladder irrigation
catheter
female catheterization
false passage
French sizes

indwelling catheter
infection
male catheterization
obstruction
sterile urine sample
types of catheters

Procedure Goals and Objectives

GOAL: To perform urinary bladder catheterization on a patient safely and accurately.
OBJECTIVES: The student will be able to:

- Explain the indications, contraindications, and rationale for performing urinary bladder catheterization.
- Discuss and describe common complications associated with performing urinary bladder catheterization.
- Describe the essential anatomy and physiology associated with the performance of urinary bladder catheterization.
- Identify the materials necessary for performing urinary bladder catheterization and their proper use.
- Demonstrate the proper technique for urinary bladder catheterization.

Background and History

Disease processes that require urinary bladder catheterization have existed since ancient times. Urethral strictures, bladder stones, and prostate hypertrophy are among the first diseases that necessitated urinary bladder decompression by catheterization. The approach to urinary catheterization remains the same today as it was in ancient times. It is the technique of passing a hollow tube through the urethra into the urinary bladder for purposes of circumventing an obstructed urinary bladder or obtaining a sample of urine for analysis, or both.

The first known urologic instruments would be considered somewhat barbaric by today's standards. Ancient and medieval "urologists-lithotomists" used perineal incision and metal and glass tubes to circumvent urinary obstruction. Today's approach often uses a local anesthetic and urethral catheters made of rubber, latex, polytetrafluoroethylene (Teflon), or silicone polymers. Urethral catheterization is currently used to relieve bladder outlet obstruction or when measurement of urinary output must be precise (e.g., in multiple trauma, surgery, intensive care, renal failure).

Indications

Reasons for passing a catheter into the urinary bladder are many. The most common uses of bladder catheterization are the following:

- To obtain a sterile urine sample, especially in the female patient
- To monitor urinary output closely in critically ill patients
- To facilitate urinary drainage in patients who are incapacitated (e.g., stroke, advanced Alzheimer disease, spinal transection)
- To bypass obstructive processes in the urethra, prostate, or bladder neck caused by disease or trauma until surgical repair can be performed
- To hold urethral skin grafts in place after urethral stricture repair
- To act as a traction device to control bleeding after prostate surgery

- Specialized three-way Foley catheters are used after bladder or prostate surgery to allow continuous bladder irrigation. Continuous irrigation and drainage help prevent the formation of blood clots, which can occlude a catheter and cause bladder obstruction. Three-way Foley catheters also allow easier evacuation of formed blood clots (Fig. 30.1).

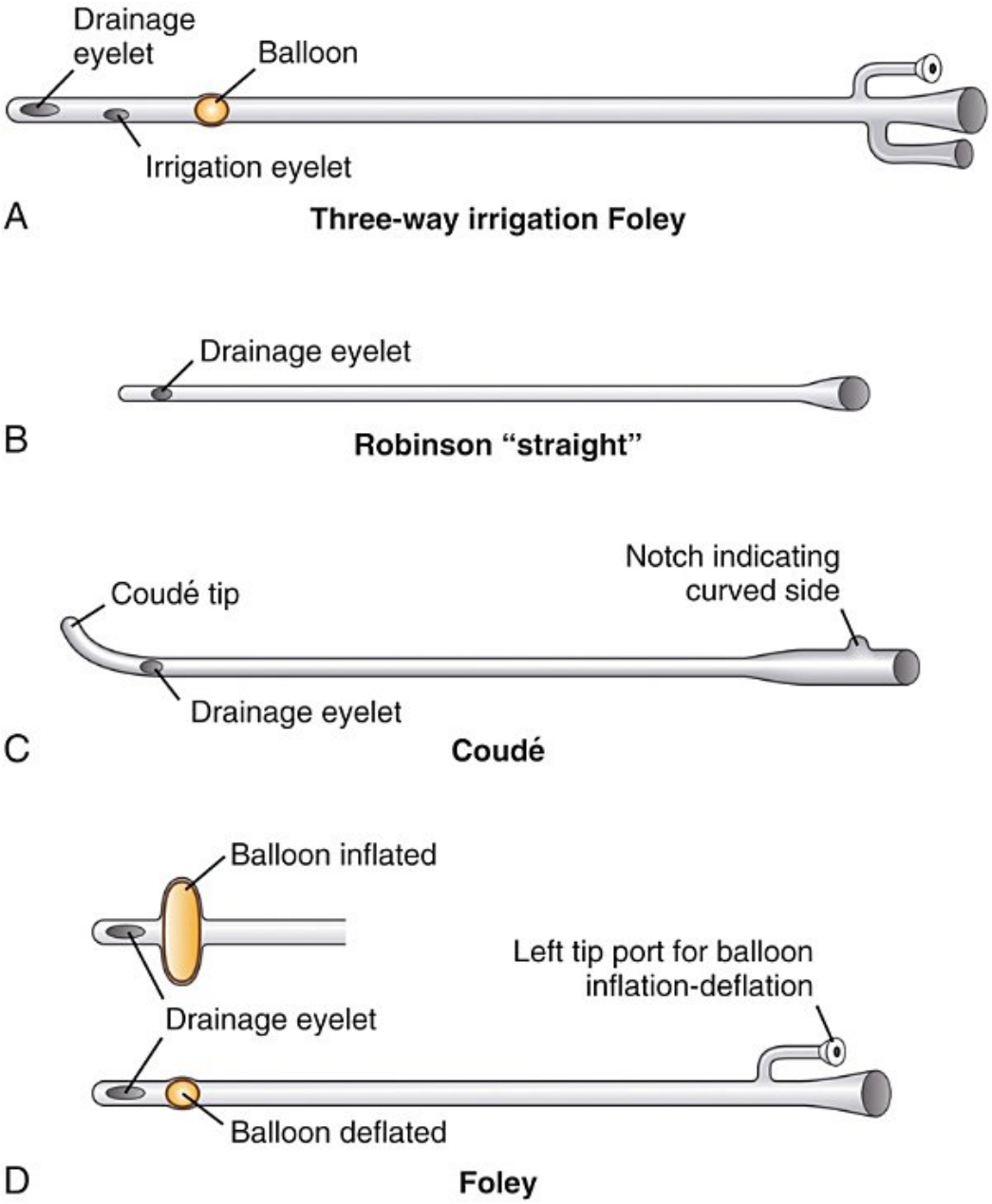

FIGURE 30.1 **A.** Three-way Foley-irrigation Foley catheter. **B.** Robinson, or straight, catheter. **C.** Coudé catheter. **D.** Foley catheter.

The main reasons for using the one-time, straight, or Robinson catheter are as follows:

- To obtain a sterile urine sample or to decompress a distended bladder caused by an acute obstructive process

- As a protocol of intermittent catheterization in persons with neurogenic bladder: Catheterizing patients with neurogenic bladder at regular intervals with the Robinson catheter facilitates complete bladder emptying, routine urine sampling, and bladder training. After a time, some of these patients may be able to decrease the frequency of their catheterization, regain complete bladder control, or both.
- To deliver topical antineoplastic medication to the bladder in patients who have bladder cancer or deliver other topical medication to patients who suffer from interstitial cystitis
- Assess postvoid residual urine through catheterization; however, this is being replaced by postvoid ultrasound of the bladder

Contraindications

The only contraindication to inserting a catheter (either Robinson or Foley) is the appearance of blood at the urethral meatus in a patient who has sustained pelvic trauma. This finding can be an indication that the urethra has been partially or totally transected. Attempting to pass a catheter in this situation could cause a partial urethral transection to become total. A urologist should be consulted when blood at the urethral meatus is present in a patient with pelvic trauma. Allergy to materials used in the procedure, such as latex, rubber, tape, and lubricants, is also a contraindication.

Potential Complications

Most of the complications with catheterization are seen in the male patient. Female patients rarely have urethral strictures, caused by traumatic catheterization. Because the female urethra is comparatively short, false passages are rarely created. Complications can include the following:

- Urethral dilation resulting from placement of a long-term indwelling Foley catheter in women. Leaking can occur because of bladder spasm. Instead of treating the spasm,

progressively larger diameter catheters are placed, causing urethral dilation and continuation of leaking.

- Urinary structural trauma may occur as a result of catheterization.
- Urinary tract infection may occur as a result of organisms on the catheter or transmitted during the procedure.
- Inflammation of the urinary tract may occur secondary to the procedure.
- Catheterizing a male patient with urethral stricture disease, bladder neck contracture, or an enlarged prostate; this may present some technical difficulties for the unsuspecting health care provider
- Passage of a Robinson or Foley catheter in a patient with urethral stricture disease or an enlarged prostate. This increases the danger of creating false passages in the urethra if excessive force is applied when resistance is met during the catheterization. The mechanism of injury occurs when the obstructive process deflects the catheter into the sidewall of the urethra. If the clinician meets these types of obstructive processes and continues to apply excessive pressure in an attempt to bypass the blockage, the catheter can act like a drill and undermine the lining of the urethra, thus creating a false passage. The worst scenario in this situation would be pushing the catheter completely through the urethra into the surrounding tissue. This results in copious bleeding from the urethra and creates the possibility of urine and blood extravasation into the surrounding tissues.
- Having the catheter double back or make a U-turn at the site of obstruction. It is not uncommon to have the catheter tip reappear at the urethral meatus when a significant obstruction or bladder neck spasm is present.
- Improper securing or taping of the Foley catheter.
- Patient-caused trauma. Patients who are confused can pull out a fully inflated Foley catheter.

Essential Anatomy and Physiology

Urine is produced by the kidneys and transported to the bladder by the ureters, where it is stored for transport through the urethra during urination. Bladder catheterization involves the passage of a mechanical device into the bladder through the urethra. To accomplish this without damage requires an understanding of the anatomy of the lower urinary tract. Fig. 30.2 illustrates the anatomy in relation to the location at which a urinary catheter would be placed for males and females.

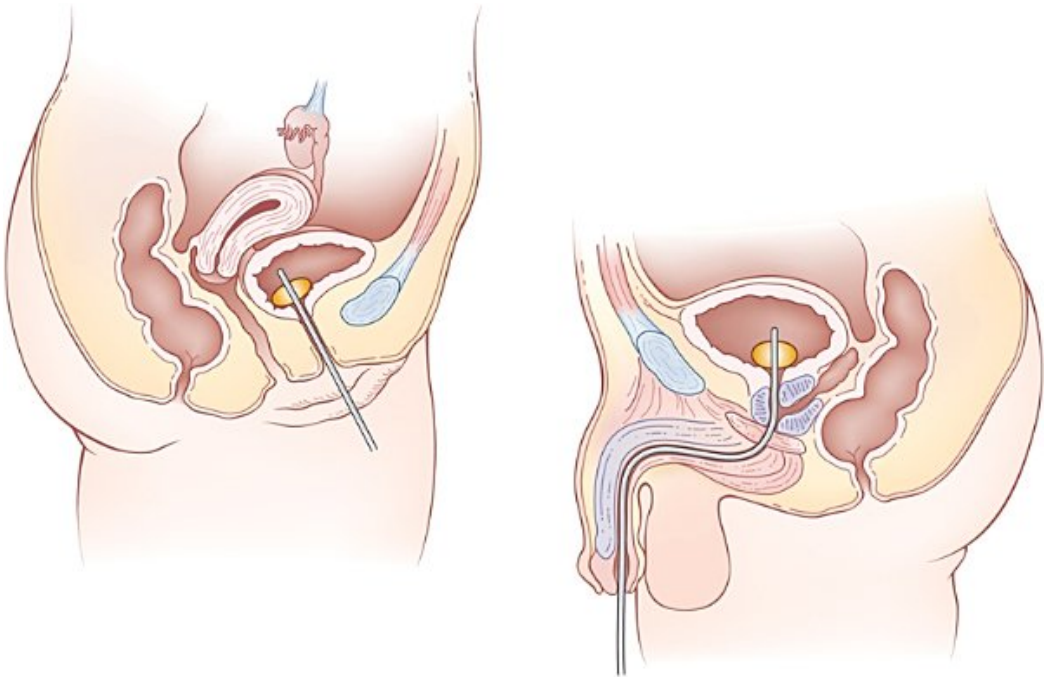

FIGURE 30.2 Anatomy of the female *(left)* and male *(right)* lower urinary tracts with catheters in place. (Redrawn from Potter PA, Perry AG. *Fundamentals of Nursing*, ed 4. St. Louis: Mosby; 1997, p 1324.)

In females, the distance from the distal end of the urethra to the bladder is relatively short (1.5 to 2 inches), and the course through the urethra is relatively unobstructed. Because of this, bladder catheterization in the female patient is typically accomplished faster and with less discomfort than it is in the male patient.

In males, the distance from the distal tip of the urethra to the bladder is longer (typically 6 to 7 inches); however, it can vary

considerably and is more circuitous than in females, thus making catheter insertion potentially more difficult. In males, the path to the bladder typically includes curves that may be encountered while traversing the penis as well as a sharp bend through the prostate. Occasionally, prostatic hypertrophy can make catheter insertion difficult because the pressure of the hypertrophic prostate can add a curvature to the urethra as well as produce urethral obstruction.

Standard precautions

Practitioners should use standard precautions at all times when interacting with patients. Determining the level of precaution necessary requires the practitioner to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion see Chapter 35).

Patient Preparation

The following must be considered in preparing the patient for bladder catheterization:

- Before the procedure, inform the patient how the catheterization will be performed and what he or she might expect to feel during the procedure. This will help secure the patient's trust and cooperation. Do not tell the patient that he or she will not feel anything, because this would be untruthful and counterproductive during the procedure. Inform the patient that the passage of the catheter may feel as though he or she must urinate and that it will be slightly uncomfortable.
- Patient comfort must be a primary consideration if a sterile, atraumatic catheterization is to be accomplished.
- Explain to the patient the importance of being reasonably still and not touching your gloved hands or sterile implements.

- Typically, the patient is positioned in the supine position. Drapes should be placed to cover all but the genitalia. The female patient will need to abduct the legs laterally to allow easy access to the urethra.

Materials

- Sterile tray or working area
- Vessel for collecting urine (sometimes included with tray)
- Sterile gloves
- Sterile lubricant or anesthetic jelly lubricant
- Antiseptic cleansing solution (typically povidone-iodine [Betadine])
- Sterile gauze or cotton balls for cleansing the external exit of the urethra and the surrounding skin
- Sterile forceps
- Syringe filled with sterile water for catheter balloon, 5 to 30 mL, depending on the balloon capacity of the catheter selected
- Urine collection tubing, bags, hardware, and specimen collection containers
- Sterile drapes to protect the sterile field and nonsterile drapes to maintain patient modesty
- Catheter
- Catheterization kits containing the following:
  - Sterile lubricant
  - Sterile drapes
  - Sterile gloves
  - Sterile cotton swabs
  - Povidone-iodine
  - Forceps to grasp the cotton swabs
  - Sterile specimen container for urinalysis and culture
  - Container to catch the urine
  - Robinson or Foley catheter, 14, 16, or 18 Fr. If a Foley catheter is used, the kit will also contain a prefilled 10-mL Luer-tipped syringe to inflate the Foley balloon and can contain a preattached drainage bag (attached to the

Foley catheter). The advantage of a preattached drainage bag is that once in place, the Foley catheter and the drainage bag are considered a sterile "closed system." The disadvantage is the inability to obtain a specimen or irrigate the bladder without "breaking the seal" and making what was once a sterile closed system a "contaminated" open system.

Types of Catheters

Urinary catheters (Robinson, coudé, and Foley types) are made of various materials and are soft and flexible (see Fig. 30.1). The most common, the Robinson or straight type, catheter is made of rubber. Catheters can be made of pure rubber, rubber with synthetic coatings such as latex, or pure latex. Pure silicone and silicone-coated catheters are also manufactured, although they are much more expensive than rubber or latex catheters. These coated catheters are more commonly seen in indwelling or Foley catheter lines. The coatings are touted to resist encrustation when left in the bladder for prolonged periods. Patients with latex allergies should not be catheterized with rubber or latex catheters. In such cases, catheters made of pure silicone are an acceptable alternative.

Robinson Catheter

The Robinson catheter is also known as the straight catheter and is sterile if the package seal is not broken. It has a soft, rounded tip and one or two drainage eyelets on the tip side walls. The catheter is hollow, and the distal end is flared to facilitate urinary drainage. These catheters are designed for one-time use, hence the term *in-and-out catheter* (see Fig. 30.1).

Coudé Catheter

Coudé catheters have a bend at the distal tip that causes the catheter to follow the anterior surface of the male urethra. This bent tip facilitates the insertion of the catheter in patients with false passages, which typically occur on the posterior surface of the urethra.

Foley Catheter

The Foley catheter is designed to remain in place in the bladder. It also is sterile, and its appearance is similar to that of the Robinson catheter, with a few exceptions. At the tip, behind the drainage eyelets, is an inflatable balloon. The balloon is inflated after the catheter is properly placed in the bladder to help keep the catheter seated in the bladder. The flared end of the catheter is located at the distal end and can be attached to a drainage bag. Also at the distal end is an elbow with a Luer-Lok cap attached. This elbow is the end of an extremely small lumen, which traverses the length of the catheter and ends in the balloon at the tip. The Luer-Lok cap allows the balloon to be inflated once the catheter is in place and deflated once the catheter must be removed. The balloon is typically inflated with sterile water. Use of saline is discouraged because of the possibility of crystal formation along the balloon's lumen. Should this occur, the balloon might not deflate when the catheter must be removed.

The two sizes of Foley catheter balloons are 5 and 30 mL. The most commonly used is 5 mL; it is typically inflated with 10 mL of sterile water, which accounts for the lumen volume and the balloon volume; 30-mL balloons are used to ensure that the Foley catheter does not migrate into the prostatic fossa or out of the urinary bladder altogether. In addition, the 30-mL balloon can be inflated with 50 mL of sterile water and used as a traction stent after certain urologic procedures (e.g., radical prostatectomy, transurethral prostatectomy).

Catheter Size Requirements

Urinary catheters come in various sizes and are measured according to the Charriére French scale (0.33 mm equals 1 Fr). A 3-Fr catheter is 1 mm in diameter; a 30-Fr catheter is 10 mm in diameter. The French size of the catheter depends on the patient and the catheter's purpose. For example, pediatric boys will need a French size between 5 and 12 Fr. Adult men should be catheterized with a 16- or 18-Fr catheter. These sizes are slightly stiffer and will follow the anatomic curvature of the male urethra easier and better than

smaller French catheters (14 Fr or smaller). Smaller French catheters have a tendency to turn around in the male urethra if the slightest resistance is met (especially at the bladder neck). The adult woman should also be catheterized with 16- or 18-Fr catheters, although a 14 Fr should be used most of the time to facilitate comfort. Larger French catheters (20 to 30 Fr) are used to evacuate blood clots in postoperative prostate surgery patients or in patients who are bleeding from the kidney or bladder.

Procedure

Urinary Bladder Catheterization in a Male Patient

Male patients are more susceptible to sustaining damage to the urethra during the catheterization procedure. Improper lubrication and excessive force used to overcome an obstruction are the most common offending factors causing urethral trauma. The steps outlined in the following list will help reduce the chances for inflicting excessive pain, causing urethral damage, or introducing infection.

1. Obtain the Robinson or Foley catheter appropriate for the procedure or purpose, ensuring it is sterile (packaging must be intact).
2. Obtain the appropriate catheterization kit or supplies.
3. Follow aseptic techniques and standard precautions by washing hands and putting on sterile gloves.
4. Open the kit in a sterile manner.
5. Prepare the patient by draping him in sterile drapes (found in the kit) and exposing the genital area, making sure to allow for the patient's privacy and comfort.
6. Open the catheter, if not contained in the kit, and place on the sterile drape using sterile technique.
7. Even if a package of sterile lubricant is contained in the kit, it is best to obtain a sterile 15- to 20-mL syringe and place it on the sterile drape.
8. Once the operator is gloved, an assistant is needed to squirt lubricant into the syringe. Water-soluble lubricant can be

substituted for sterile anesthetic jelly (lidocaine [Xylocaine] *jelly*, not ointment, or Anestacon [a prepackaged anesthetic jelly]).

9. Open the package of povidone-iodine and pour it onto the cotton swabs.
10. Inform the patient that you are going to hold his penis and clean it with the povidone-iodine. Assure him that it will not stain the skin permanently. Swab the head of the penis, making sure to clean the meatal opening first and wiping out to the glans with the povidone-iodine–soaked cotton swabs. (Use your nondominant hand to hold the penis.) Use all of the cotton swabs.
    - If the patient is uncircumcised, the foreskin will need to be drawn back before beginning the cleaning and catheter insertion process.
11. Once the penis is clean, do not let go; position the penis at a 90-degree angle from the abdomen and instill the lubricant or anesthetic agent into the urethra. Gently occlude the urethra so the lubricant or anesthetic agent will not come back out the urethra. If using anesthetic jelly, wait for approximately 1 minute before proceeding so that the anesthetic jelly has time to work.
12. Position the urine container near the patient's leg or between the patient's legs, as appropriate.
13. Grasp the catheter with your dominant hand about three-quarters of the way toward the catheter tip. Inform the patient that you are now going to insert the catheter. Gently begin inserting the catheter into the urethral meatus and continue the insertion without stopping (Fig. 30.3). When the sphincter is encountered, you will feel slight resistance. Ask the patient to take a deep breath, which might assist in relaxing him somewhat, but continue to insert the catheter, applying gentle pressure, if necessary.

NOTE: When a stricture or obstruction is encountered during catheterization, the clinician has some techniques and tools that may facilitate atraumatic bladder catheterization. The first

technique is to make sure the urethra is well lubricated by instilling sterile, water-soluble lubricating jelly or topical anesthetic jelly into the urethra. Once this is accomplished, a 16- or 18-F coudé-tipped catheter (see Fig. 30.1) can be used to facilitate bypassing false passages or bladder neck obstruction. The coudé tip is fashioned to follow the normal curve of the urethra and should be passed with the tip facing the anterior portion of the patient's urethra. If the clinician continues to meet obstruction and is unsuccessful using the coudé catheter and the techniques outlined, a urologist should be called. The urologist will most likely try using a filiforme bougie and followers to bypass and dilate urethral structures or bladder neck contractures. If these techniques or tools are not successful, a flexible cystoscope or suprapubic catheterization may be used.

14. Once the sphincter is passed, continue to pass the catheter until almost to the hub of the catheter. Urine should begin to flow, although it may take some time for the lubricant, which will be in the catheter after you pass it into the bladder, to "melt." Place the end of the catheter into the urine container and empty the bladder.
15. Obtain a specimen at this point, if needed.
16. Once the bladder is empty, remove the catheter in one continuous motion, making sure to pinch off the distal end so that the column of urine left in the catheter does not pour onto the patient.

Make sure to measure the amount of urine obtained and record it.

Having the patient void immediately before catheterization allows measurement of residual urine in the bladder. The amount voided must be measured, and then the postvoid residual left in the bladder can be measured after catheterization. In many practices, ultrasound measurement of postvoid residual urine in the bladder is replacing the in-and-out catheterization.

17. If this is a Foley catheter placement, once the catheter is in the bladder and urine begins to flow, get the prefilled syringe (with sterile water) and inflate the Foley balloon.

Make sure the Foley catheter is **inserted almost to the hub.**

> This ensures that the balloon is not inflated in the prostate, bladder neck, or urethra.

18. Once the balloon is inflated, pull the Foley catheter out gently until it stops. The Foley catheter is now in the proper position.
19. Attach the drainage bag if it is not already in place.
20. **Tape** the Foley catheter to the abdomen.

> Taping the Foley catheter in this manner prevents it from eroding through the urethra by eliminating the first curve of the S formed by the male urethra. Maintenance of the Foley catheter includes daily cleaning, retaping in the proper position, when necessary, and appropriate meatal care.

CAUTION: Taping the Foley catheter is an important step. The penis should be pointing toward the umbilicus and the catheter taped just below the hub.

Apply bacitracin ointment to the urethral meatus one to three times per day, as needed. This helps keep the catheter

from irritating the meatus excessively and prevents infection.

If the patient is uncircumcised, the foreskin will need to be placed back into its original position.

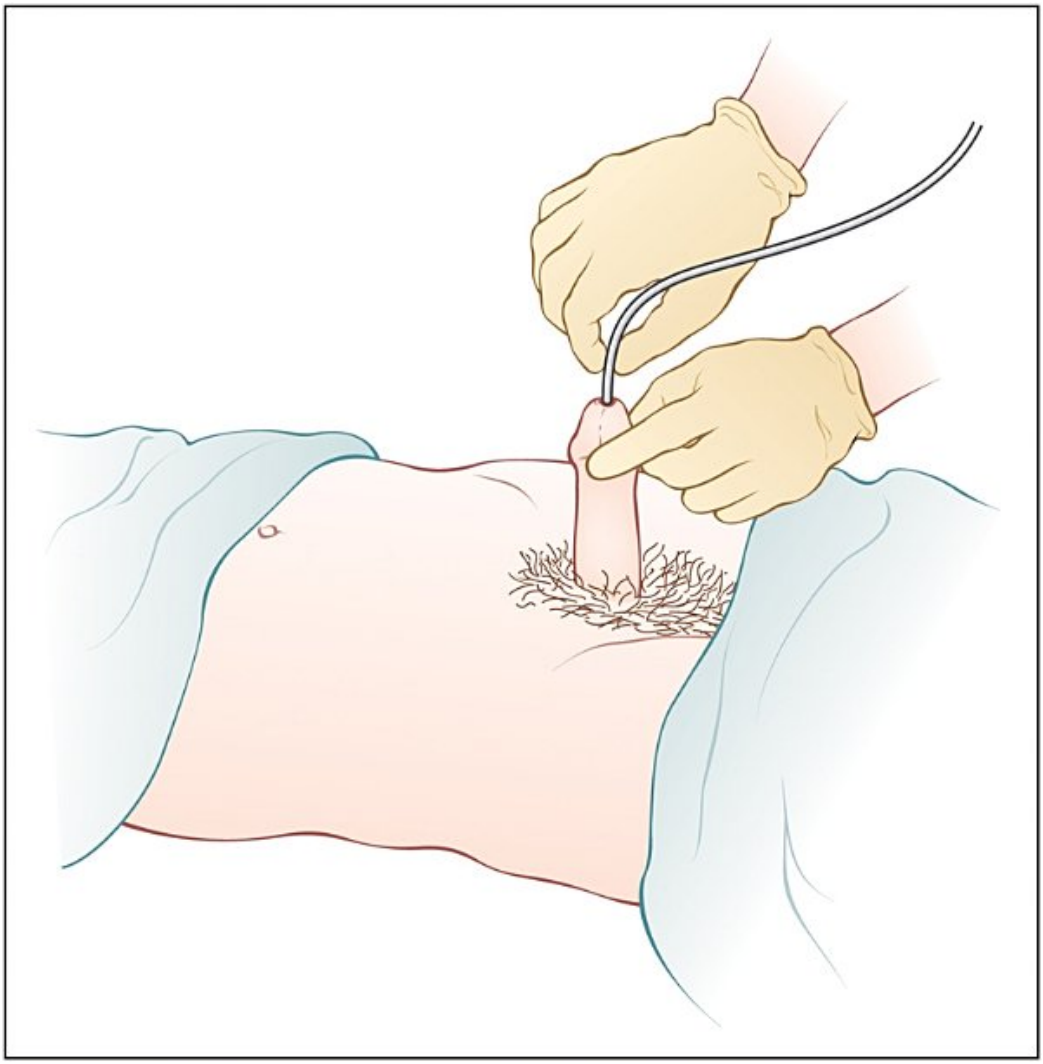

FIGURE 30.3 **Catheter insertion in the male patient.**
(Modified from Potter PA, Perry AG. *Fundamentals of Nursing*, ed 4. St. Louis: Mosby–Year Book; 1997, p 1323.)

Procedure

Urinary Bladder Catheterization in a Female Patient

Females can be difficult to catheterize because of the placement of the urethral meatus. If the female patient has a normal anatomy and is not excessively obese, the urethral meatus should be superior to the vaginal introitus and inferior to the clitoris. Some women's urethral meatus is located just inside the superior aspect

of the vaginal introitus. This can make catheterization difficult, because the urethral orifice can be obscured by vaginal tissue.

1. Obtain the Robinson or Foley catheter appropriate for the procedure or purpose, ensuring it is sterile (packaging must be intact).
2. Obtain the appropriate catheterization kit or supplies.
3. Follow aseptic techniques and standard precautions by washing hands and putting on sterile gloves.
4. Open the kit in a sterile manner.
5. Prepare the patient by draping her in sterile drapes (found in the kit) and exposing the genital area, making sure to allow for the patient's privacy and comfort.
6. Open the catheter, if not contained in the kit, and place it on the sterile drape using sterile technique.
7. Instead of instilling lubricant into the female urethra, lubricate the catheter well, about one-third of the way from the tip of the catheter up.
8. Open the package of povidone-iodine and pour it onto the cotton swabs.
9. Inform the patient that you are going to swab the urethral opening with povidone-iodine once you separate the labia majora and labia minora. Using the nondominant hand, spread the patient's labia. Wipe the urethral opening with the cotton swabs from an anterior to a posterior direction. If the urethral opening is at or in the vaginal opening, the vaginal opening must be swabbed as well.
10. At this point, anesthetize the urethra, if desired. To do this, apply lidocaine jelly or aqueous cocaine to a cotton-tipped swab and gently insert it into the urethra. Leave it in place for approximately 1 to 2 minutes before placing the catheter.
11. Place the urine container between the patient's legs.
12. Grasp the catheter with your dominant hand, making sure that the catheter is still well lubricated, and gently **insert the tip of the catheter** into the urethral opening until urine starts to flow or approximately one-third of the catheter has been inserted into the bladder (Fig. 30.4).

If you have missed the urethral opening or inserted the catheter into the vagina, you must obtain a new catheter and try again. A helpful technique is to leave the first catheter temporarily in place. (This helps identify where *not* to place the new catheter.)

14. Once the bladder is empty (and you have obtained your specimen), remove the catheter in one continuous motion, making sure to pinch off the distal end of the catheter so that the column of urine left in it does not pour onto the patient.
15. If this is a Foley catheter placement, once the catheter is in the bladder and urine begins to flow, get the prefilled syringe (with sterile water) and inflate the Foley balloon.
16. Make sure the Foley catheter is inserted at least **one-third of the way into the bladder**.

This ensures that you do not inflate the balloon in the bladder neck or urethra.

17. Once the balloon is inflated, pull the Foley catheter out gently until it stops. The catheter is now in the proper position.
18. Attach the drainage bag if it is not already in place.

CAUTION: Taping the Foley catheter is an important step.

Tape the Foley catheter to the inner thigh. Leave some slack so it is not taut and pulling against the bladder neck. This can cause bladder spasms. Tape just below the hub.

Maintenance of the Foley catheter includes daily cleaning, retaping in the proper position when necessary, and appropriate meatal care. Typically, povidone-iodine ointment is applied to the urethral meatus one to three times per day, as needed. This helps keep the catheter from irritating the meatus excessively and helps prevent infection.

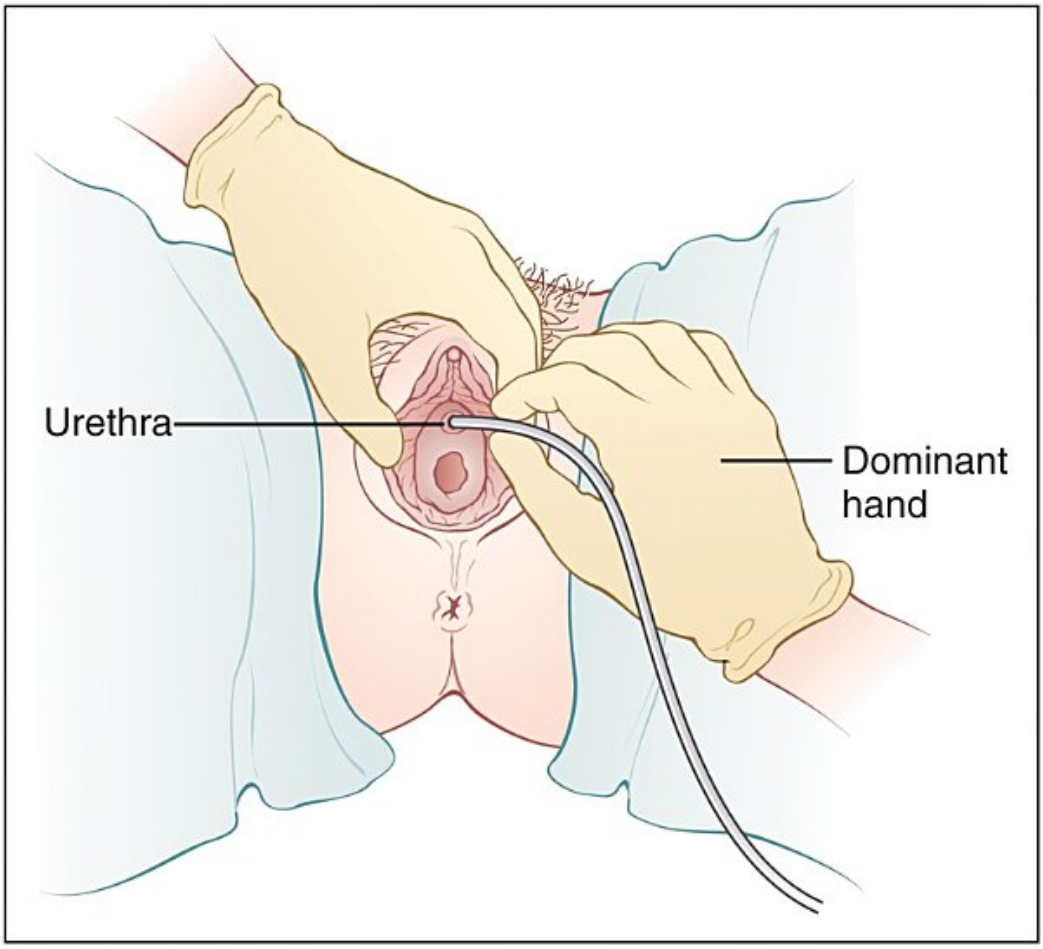

FIGURE 30.4 Catheter insertion in the female patient.
(Redrawn from Potter PA, Perry AG. *Fundamentals of Nursing*, ed 4. St. Louis: Mosby–Year Book; 1997, p 1323.)

Follow-Up Care and Instructions

Short-Term Catheterization or In-and-Out Catheterization

Aftercare for the short-term and in-and-out catheterization procedures are as follows:

- Complications are unlikely.
- The most common complications include irritation of the urinary tract and infection.

- Patients will most likely experience a burning sensation the first few times they urinate after catheterization. Reassurance is usually all that is needed.
- Instruct the patient to monitor urination for continuous dysuria, urinary frequency, hematuria, and pyuria, as well as for systemic signs of urinary tract infection such as fever or back pain.

Indwelling Catheterization

Aftercare instructions for the indwelling catheterization procedure are as follows:

- The two major risks associated with an indwelling urinary catheter are trauma and infection. After successful catheter placement, trauma is typically a result of not protecting the catheter properly.
- Instruct the patient that the catheter should be secured with tape at all times and that care should be taken not to snag the tubing on clothing or furniture in a way that would pull on the catheter.

Infection prevention measures include the following:

- Advise the patient to always position the drainage bag below the bladder to prevent urine flowing back into the bladder.
- Instruct the patient to be careful to avoid kinks in the tubing system.
- Instruct the patient to monitor the bag often to ensure it is emptied before it becomes completely full.
- Caution the patient to be careful when emptying the bag or manipulating the drainage system, to avoid introducing contaminants.
- Instruct the patient to wash hands frequently and use latex gloves (if not allergic; if allergic to latex, indicate which type of gloves to obtain).

- Be careful not to have the drainage system come into contact with contaminated objects such as toilet bowls.
- Caution the patient to be aware of signs of infection, such as changes in the appearance of the urine or symptoms of a urinary tract infection, and to call the office if any appear.

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CHAPTER 31

Venipuncture

Jennifer Feirstein

Abstract

This chapter provides a descriptive account of the steps involved with performing venipuncture utilizing both a Vacutainer system and a syringe. Indications, contraindications, and potential complications associated with venipuncture are discussed in a comprehensive manner. Techniques for optimal safety are emphasized as are methods to minimize patient discomfort. A thorough summary of postprocedure care and patient follow-up instructions are also provided.

Keywords

butterfly
diagnostic tests
evacuation tubes
laboratory tests
phlebitis
phlebotomy
phlebitis
syringe
Vacutainer
vasovagal syncope

venipuncture
venous blood

Procedure Goals and Objectives

GOAL: To obtain a sample of venous blood while observing standard precautions and minimizing the degree of risk to the patient.
OBJECTIVES: The student will be able to:

- Describe the indications and contraindications for performing venipuncture.
- Identify and describe the potential complications associated with venipuncture.
- Describe the essential anatomy and physiology associated with the performance of venipuncture.
- Identify the necessary materials and their proper use for performing venipuncture.
- Demonstrate the appropriate technique and sequence for performing venipuncture utilizing both a vacutainer system and a syringe.
- Identify strategies for handling unsuccessful attempts at venipuncture.
- Communicate important aspects of venipuncture postprocedure care.

Background and History

Since ancient times, numerous medical principles and procedures have been developed and have evolved from humans' appreciation

for the association between blood and life itself. Hippocrates (460–377 BC) stated that disease was the result of excess substances within the body, such as blood, phlegm, black bile, and yellow bile. It was believed that removal of these excess substances would restore balance to the body.[1] From this belief arose the practice of bloodletting—the first form of phlebotomy.

Phlebotomy, from the Greek words "veins" and "cutting," is defined as the incision of a vein for the purpose of bloodletting or collection. By the seventeenth and eighteenth centuries, phlebotomy had advanced as a major therapy for those practicing the healing arts. Venipuncture evolved from the practice of phlebotomy, and the methods and procedures incorporated today have dramatically improved. The primary purpose of phlebotomy is to obtain a sample of blood for diagnostic testing, and only rarely is phlebotomy utilized as a therapeutic modality (e.g., for patients with polycythemia). The procedures in this chapter describe techniques for obtaining blood samples through venipuncture methods using both Vacutainer systems and syringes.

Indications

Venipuncture is an extremely common procedure indicated for the evaluation and management of many different disease processes. This procedure is required to obtain a venous blood specimen for the purpose of laboratory tests when the quantity required for testing is larger than can be obtained by puncturing the skin with a lancing device.

Contraindications

Venipuncture is a relatively low-risk procedure when the proper techniques and standard precautions are followed. The benefits universally outweigh the associated risks of the procedure when performed for an appropriate indication. Contraindications are a function of specific concerns related to a local site for venipuncture; therefore, these should be viewed as relative contraindications, since another location may be selected for the procedure without concern for increased risk of complications. Contraindications to performing

venipuncture at a specific location on the body include the following:

- Skin infection, skin rash, or a newly tattooed area
- Extensive scarring from burns, surgery, injuries, repeated venipuncture, or trauma
- Phlebitis or sclerosed veins
- Lymphedema: The upper extremity on the ipsilateral side of a mastectomy should be avoided owing to the frequent presence of lymphedema occurring after dissection and removal of the lymphatic system.
- Hematoma
- An intravenous infusion catheter distal to the proposed site of venipuncture
- An arm with a cannula in place
- An arm with a vascular anomaly, such as an arteriovenous fistula

Potential Complications

The risk of **complications from venipuncture** is rare when implementing standard precautions and following the appropriate techniques; however, as with any medical intervention, some potential complications exist. Complications during the procedure may include pain and discomfort to the patient. Vasovagal syncope, or fainting, is another possible complication, especially in patients highly anxious about the procedure or in patients with prior episodes of syncope related to venipuncture. As a result of puncturing the skin and vein, cellulitis and/or phlebitis may occur. Other possible complications include thrombosis, bruising, laceration of the vein, and hemorrhage or hematoma at the puncture site.

Before performing venipuncture it is important to understand the contraindications and complications associated with the procedure.

Patients with coagulopathies, such as diffuse intravascular coagulation, hyperfibrinolysis, thrombocytopenia, or qualitative platelet disorders, characteristically experience prolonged bleeding after venipuncture. Although patients with these disorders do not have a contraindication to having venipuncture performed, the clinician should be aware of the increased risk of a bleeding complication occurring, and thus, should be appropriately prepared for a prolonged time to hemostasis.

The *Procedure* section of this chapter will include techniques for minimizing the likelihood of the above complications occurring.

Essential Anatomy and Physiology

Blood constitutes 6% to 8% of the total body weight and consists of blood cells suspended in fluid called *plasma. Serum* refers to the substrate remaining when the fibrinogen has been removed from the plasma. The three main types of blood cells are red blood cells, called *erythrocytes;* white blood cells, called *leukocytes;* and platelets, known as *thrombocytes.* The primary function of blood is to transport oxygen via hemoglobin molecules within the erythrocytes. In addition, blood transports nutrients, waste products, hormones, and other specialized materials throughout the body while also playing a critical role in the constant regulation of body temperature, regulation of fluids, and acid–base equilibrium. Leukocytes and other cellular components transported in blood play a critical role in the immune system response mechanisms. Finally, thrombocytes are responsible for preventing blood loss from hemorrhage and have their primary influence on the blood vessel walls.

Veins serve as conduits for channeling deoxygenated blood back to the heart and, eventually, to the lungs. Muscles within the vein walls facilitate the movement of blood within the vein, and one-way valves in the vein prevent the backward flow of blood.

The cubital fossa is a triangular area on the anterior aspect of the elbow; because of the prominence and accessibility of the superficial veins in the cubital fossa, it is the site most frequently utilized for venipuncture. The boundaries include an imaginary line connecting

the medial and lateral epicondyles superiorly, the pronator teres medially, and the brachioradialis laterally.

In the cubital fossa region, the cephalic and basilic veins are often most prominent. Considerable variations can occur in the connection of the basilic and cephalic veins. The median cubital vein crosses the bicipital aponeurosis, which separates it from the underlying brachial artery and median nerve. The median cubital vein often receives the median antebrachial vein and can bifurcate to form a median cephalic vein and a median basilic vein (Fig. 31.1). These veins may be embedded in subcutaneous tissue, making them difficult to visualize; however, utilization of a tourniquet occludes the venous return, distending the veins and making them palpable and, in most instances, also visible.

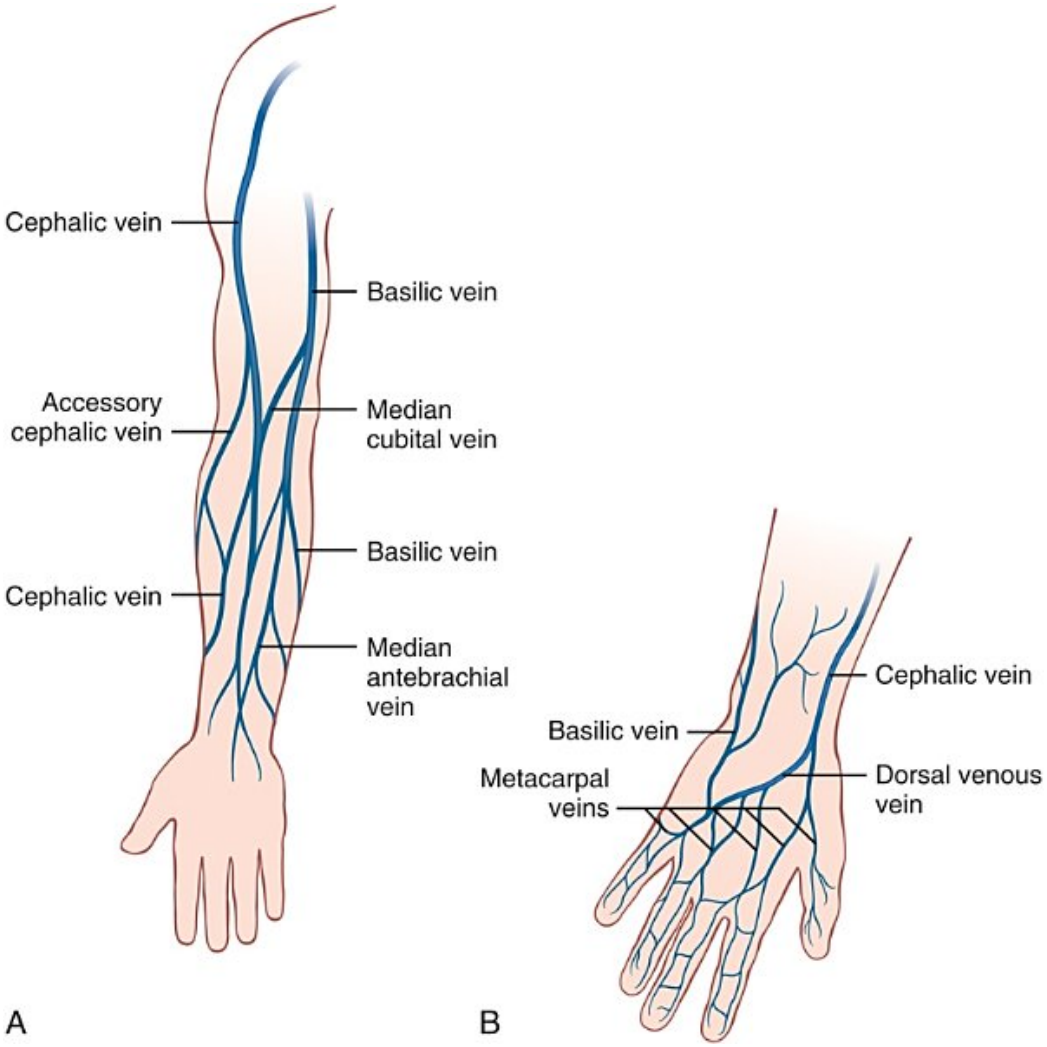

FIGURE 31.1 **Superficial veins.**
A. Inner aspect of forearm. **B.,** Dorsal aspect of hand and wrist.

Patient Preparation

Patient preparation is important and can be a key factor in ensuring a successful procedure that minimizes discomfort to the patient. Patient preparation should occur when a clinician orders diagnostic tests that require venipuncture, and additional preparation should occur immediately prior to performing the procedure. When the clinician orders tests requiring venipuncture, the rationale and possible complications associated with the procedure should be discussed. Additionally, the patient should be provided with any

specific instructions that must be followed prior to venipuncture (e.g., fasting before a blood glucose or lipid profile, or instructions regarding medications that must be withheld or taken prior to the procedure). Immediately prior to performing venipuncture, follow these steps:

- Review the rationale for the procedure, as well as the technique and possible complications.
- Ask the patient about prior experiences with venipuncture to identify any potential difficulties with the procedure (e.g., anxiety, fainting, vomiting).
- Ask the patient about prior surgeries (e.g., mastectomy), or other recent procedures (e.g., venous cutdown, dialysis shunt) to identify locations for which venipuncture would be contraindicated.
- Ask the patient about use of anticoagulants in order to anticipate the possibility of prolonged bleeding after the procedure.
- Inform the patient of the possibility of an initial stinging pain and bruising, while continuing to stress the importance of the patient's cooperation for a successful procedure. Explain that discomfort can be minimized by patient cooperation.
- Instruct the patient to remain as still as possible while the procedure is being performed.
- Answer any and all questions the patient may have before beginning the procedure.

Materials

The following materials should be readily available prior to initiating venipuncture:

- Gloves: At least two pairs of nonsterile gloves (in case one set becomes contaminated). Be sure to use non-latex gloves in patients with a latex allergy.
- Tourniquet: ¾ or 1 inch for adults and ⅛ inch for children. Single-use tourniquets are preferred. Be sure to use non-latex

tourniquets in patients with latex allergy. An adult or pediatric blood pressure cuff may be utilized in place of a tourniquet. This is especially helpful in elderly patients to prevent excessive stress on the vein. When utilizing a blood pressure cuff, be sure to maintain pressure greater than the patient's diastolic blood pressure.

- Gauze pads: 2 × 2 inch or 4 × 4 inch
- Isopropyl alcohol pads, 70%
- Povidone-iodine: Used for cleansing venipuncture sites for blood culture specimens.
- Evacuated tubes for blood collection. Ensure the appropriate color test tube is utilized based on the diagnostic test ordered (Table 31.1). Always have spare tubes readily available to avoid having to repeat the venipuncture procedure in the case of a tube with insufficient vacuum.
- Labels for evacuated tubes. Prepare the labels with patient name and other pertinent information for each tube prior to starting the procedure.
- Adhesive strips, nylon tape, or paper tape. Be sure to inquire about allergies to adhesive tape prior to starting the procedure.
- Sharps disposal container
- Biohazard waste container

Table 31.1

Blood Collection Tubes and Corresponding Diagnostic Tests

Collection Tube	Types of Laboratory Tests	Special Collection Instructions
Red top	Chemistry Immunology Serology panels Blood bank	Not applicable
Gold top	Chemistry Immunology Serology panels	Not applicable
Light blue top	Coagulation tests (thrombin and prothrombin times)	Requires a full draw of sample
Green or Lavender top	Hematology Blood bank	Requires a full draw of sample Invert slowly at least eight times to prevent clotting and platelet clumping
Gray top	Lithium level Sodium heparin level Glucose	Requires a full draw to prevent hemolysis
Syringe	Blood cultures	Performed with a syringe using only iodine as the skin preparation

Venipuncture performed utilizing a syringe requires the following materials:

- Single draw needle (18 to 23 gauge) or butterfly infusion set (21, 23, or 25 gauge)
- Syringe: 1, 3, 5, and 10 mL, or larger (plastic or glass)
- Vacutainer blood transfer device

Venipuncture performed utilizing a Vacutainer requires the following materials:

- Multisample needles (18 to 23 gauge) or **butterfly** infusion set (21, 23, or 25 gauge). Multisample needles have a rubber sheath on the opposite end of the needle.

Butterfly needles are particularly useful for performing venipuncture on children because they prevent excessive suction on the vein.

- Vacutainer holder/barrel

Procedure

When performing venipuncture, proper **planning and preparation** are essential for obtaining good results and ensuring a good outcome for your patient. Developing a routine, sequential plan for the procedure helps ensure effective and efficient results with the least amount of discomfort for the patient.

> All needed equipment and material should be collected and organized prior to beginning the procedure.

General Preparation

1. Check patient identification to ensure the correct patient is having the procedure.
2. Check the test ordered twice, even if ordered by you.
3. Identify which specific samples need to be collected for the laboratory studies requested and anticipate the materials and proper sequence for collecting the needed samples.
    - For each laboratory study to be performed, identify the additive, additive function, volume, and specimen considerations to be followed; be sure to use the appropriately color-coded tube for the specified tests (see Table 31.1). This helps to ensure the best outcome for each sample of blood and corresponding laboratory test.
    - Assemble the equipment by preparing the needle/and or syringe, preparing the tubes in the correct order with labels, and making site cleansing and postprocedure supplies readily accessible.

NOTE: In some instances, the equipment needed depends on the patient, the medical condition, the site to be used for the procedure, the number of samples required, and the type of setting (hospital, outpatient, pediatric ward, nursery, emergency room) where the procedure will be performed.

4. Wash hands with warm water and bacteriostatic soap. Always observe standard precautions.

Patient Preparation

See the *Patient Preparation* section earlier in this chapter for the initial steps that should be followed when interacting with the patient.

1. Position the patient properly. The patient should be positioned in a manner that is both proper for the procedure and comfortable for the patient. If possible, position the patient in a supine or recumbent position. This assists the

patient in relaxing and carries the least likelihood for injury if the patient experiences vasovagal syncope. If the patient is sitting upright, extend his or her arm straight down from shoulder to waist.

2. Observe the patient for any of the previously mentioned contraindications.
3. Choose a location for the venipuncture site. The cubital fossa is the most common site for venipuncture; however, be sure to check bilaterally, distally, and proximally to the antecubital fossa. Inspect the patient's surface anatomy and venous system prior to applying the tourniquet. The selection of a good site should include a vein that is easily palpated, is large and well anchored, and does not roll when palpated.

NOTE: The best veins for venipuncture, listed by order of preference, are as follows:

- Median cubital vein, which is easily palpated, well anchored, least painful, least likely to bruise, and usually the largest vein in the antecubital space
- Cephalic vein, which is a large vein that is easily palpated, but poorly anchored; venipuncture here can be painful to the patient
- Basilic vein, which is easy to palpate, not well anchored, and very close to the brachial artery and the median nerve

NOTE: To augment the ability to identify the best site for venipuncture, palpation skills and the sense of touch should be refined by using the palmar aspects of gloved finger pads. Do not rely totally on vision. This can be practiced on oneself or on volunteers until the location of a vein can be identified confidently with eyes closed.

NOTE: Heavily pigmented skin and overlying adipose tissue can make veins difficult to visualize. In particular, difficulty with venipuncture can occur in patients who have had repetitive blood

draws or in patients who are using intravenous drugs. In these instances, selecting an adequate site may be difficult. Patients who frequently undergo venipuncture may be able to direct you to sites with the highest likelihood of success.

NOTE: For finding difficult veins:

- Have the patient keep the extremity below the level of the heart for a few minutes.
- Apply a warm towel to the extremity to promote vasodilation from the heat—the towel should be less than 42° C (107.6° F) and left on for no longer than 2 minutes.
- Use a blood pressure cuff inflated to a point between the systolic and diastolic pressures as a tourniquet to allow for greater control and less discomfort to the patient.
- Carefully rub or tap the vein over the potential puncture site to promote vasodilation (this should be completed before the site is cleansed).

NOTE: Remember that it is a contraindication to perform venipuncture proximal to an intravenous infusion site. If the opposite arm cannot be utilized, venipuncture may be performed at a site distal to the IV site (see additional recommendations in the *Special Considerations* section).

4. Firmly place the tourniquet about 3 to 4 inches above the venipuncture site without causing obstruction of arterial blood flow or patient discomfort. Use a wide tube band tied with easily removable bow ties pointing up and away from the site, allowing for easy removal (Fig. 31.2).
5. Ask patient to make a fist with their hand.

CAUTION: Never leave the tourniquet on for more than two minutes. The vein may collapse if the tourniquet is too close to the puncture site. After applying the tourniquet, begin palpation of the identified site to locate a desirable vein.

NOTE: If the vein being palpated feels tight and has no flexibility, it may be a tendon or may overlie a tendon. If it has a palpable pulse, it is an artery. Be certain of the underlying anatomy before performing the procedure.

6. Put on gloves and ensure that all tubes and equipment are within easy reach in the order that they will be used.
7. Open several alcohol or povidone-iodine pads. Before cleansing the area, secure the site by anchoring the vein distal to the venipuncture site, using a finger to apply pressure over the top of the vein (useful with large veins) and thus holding the vein still.
8. Clean the procedure area, beginning at the venipuncture site and circling outward to a 2-inch diameter. Allow the area to air dry thoroughly. This is especially true when using povidone-iodine.

NOTE: Alcohol lyses red blood cells and can cause intense stinging. To avoid unnecessary patient discomfort, be sure the site is dry prior to proceeding.

Needle Insertion

After the patient has been properly prepared and the venipuncture site cleansed, the needle can be inserted in order to collect the blood specimen.

1. Visualize what you are going to do and begin by stretching the skin downward below the anticipated venipuncture site with the nondominant hand to anchor the vein and limit vein movement.
2. Maintaining needle sterility, insert the needle into the straightest section of the vein, puncturing the skin with the bevel facing up at a 15- to 30-degree angle directly over and parallel to the vein. Enter the vein or a point immediately adjacent to the vein and penetrate the needle halfway into the vessel (Fig. 31.3). When the needle has entered the skin, lower the needle until it is almost parallel with the skin.

NOTE: Inserting the needle at greater than a 15- to 30-degree angle may allow the needle to puncture through the far wall of the vein.

NOTE: Slower insertion of the needle and the correct angle of insertion help prevent the occurrence of hemorrhage or hematoma at the puncture site. If a hematoma does develop, remove the tourniquet, remove the needle, and maintain pressure on the site for at least 10 minutes (a minimum of 15 minutes in patients taking medication with an anticoagulant effect).

Special Instructions for Blood Collection with a Vacutainer System

1. Prior to needle insertion, the Vacutainer collection system should be prepared. Remove the protective covering from the threaded hub and screw the needle into the Vacutainer barrel. Place the Vacutainer tube inside the barrel without puncturing the top of the tube with the needle (Fig. 31.4). Be sure to have additional tubes close at hand in the right order of draw.

NOTE: Use caution when using a Vacutainer because it can exert excessive vacuum, causing the vein to collapse.

2. After needle insertion, hold the needle steady. Move the Vacutainer tube down into the barrel so that the tube is punctured. A drop of blood will be visible at the top of the inside needle when it is in the vein. Let the tube fill three-fourths full. Avoid rotating the needle because this may result in excessive damage to the vessel wall.

NOTE: The existing vacuum gently draws blood into the tubes. Most Vacutainer tubes are not sterile and have additives. The tube will cease drawing blood when its vacuum is expired (i.e., when the tube is appropriately filled).

NOTE: Remember that multiple tubes of blood can be drawn at this one venipuncture site without having to puncture the patient

again.

NOTE: Determine the correct order of drawing the samples in the tube, depending on the laboratory, the tests required, or both (Table 31.2). This prevents interference by carryover of additives between tubes.

Table 31.2

Order of Blood Collection by Method of Venipuncture

Vacutainer System Venipuncture	Syringe Venipuncture
Blood cultures	Blood cultures
Red top	Light blue top
Gold top	Lavender top
Light blue top	Green top
Green or lavender top	Gray top
Gray top	Red top

3. When removing the filled tube and inserting the next tube, grasp the barrel holder securely in the nondominant hand and anchor it by holding it against the extremity to avoid inadvertently removing the needle from the lumen of the vein.

NOTE: If multiple tubes are drawn, carefully invert tubes and mix as required for each specific tube. Do not shake the tubes vigorously because disruption of the cell membranes may result, thus altering the concentrations of intracellular and extracellular components.

4. After blood finishes flowing into the last Vacutainer tube, release the tourniquet and ask the patient to relax his or her hand.

NOTE: Be sure to remove the Vacutainer tube from the holder before removing the needle.

Special Instructions for Blood Collection With a Syringe

Syringes may be used for venipuncture when the patient's veins are small or fragile and Vacutainer tubes may cause the veins to collapse. Using a syringe with a 20- or 21-gauge needle or butterfly needle allows for greater control. The procedure for using a syringe follows the same steps as those for using the Vacutainer collection system except it differs in the order of samples drawn, the aspiration of blood into the syringe, and the transfer of blood into the vacuum tubes. Self-capping needles are extremely useful when using a syringe. Once the needle is in the vein, keep the needle steady and still, and then pull back gently on the syringe plunger while holding the syringe securely to keep the needle in the vein.

1. When using a syringe, watch for a backflow of blood after needle insertion. If backflow is not present with a syringe, carefully advance the needle slightly further into the vein.
2. Using the syringe to brace against you, pull back on the plunger and fill the syringe with the desired amount of blood (usually three-quarters full) needed for the tubes and diagnostic tests.
3. Release the tourniquet and complete the dressing procedure using the technique described later in the *Procedure Completion* section.
4. Transfer blood from the syringe to the tubes. Engage the needle safety device and discard the needle in the sharps container. Attach a Vacutainer blood transfer device to the syringe and proceed to engage and fill the evacuated tubes in the correct order (see Table 31.2). Allow the tubes to fill by using the pressure of the vacuum tube.

CAUTION: Do not use the plunger to fill the tubes. The temptation is to push the blood sample into the vacuum tube using the syringe plunger, which will affect the integrity of the sample.

Special Instructions for Blood Collection with an Infusion Set

A butterfly infusion set can be used for venipuncture when you are drawing from a hand, foot, or a very small or difficult vein. The procedures for cleansing the area and site selection are the same as for the syringe and Vacutainer procedures; however, with the infusion set, the hand and the foot may be included as new collection sites.

1. Insert the needle at a lesser angle than for either of the other methods.

CAUTION: It is important to take great care with the needle so as not to miss the vein.

NOTE: Infusion sets come in different needle sizes, and the appropriate size for the adult, child, or difficult vein should be selected carefully.

2. Attach a syringe or a vacuum collection system to the set. If using a syringe, be careful not to use excessive suction from the syringe; draw the blood slowly and carefully.

NOTE: The infusion set has plastic "wings" that are attached to a short length of flexible plastic tubing, which is then attached to either a syringe or Vacutainer system.

NOTE: As soon as the needle is in the vein, blood will be visible in the tubing, and this will allow easy access by the syringe.

3. When using a safety infusion set, after completion of the blood draw, slide the safety cover over the needle and discard the entire set. To prevent an accidental needlestick with the infusion set needle, hold the base of the needle or the wings as you remove the needle, and do not let go of the needle base until it is being placed in the biohazard sharps container.

Procedure Completion

The venipuncture procedure is concluded once all collection tubes have been filled. The needle is removed, the puncture site is appropriately bandaged, and postprocedure instructions are provided to the patient.

1. Have sterile gauze ready. Carefully remove the needle from the skin. Cover puncture site with alcohol pad or sterile gauze.
2. Once the needle is removed completely, apply firm pressure for hemostasis by holding sterile gauze over the site while the arm is outstretched or raised overhead. Avoid bending the arm. Pressure should be applied for at least 3 to 4 minutes, until the bleeding stops, or for 5 minutes or more if the patient has been taking anticoagulant medication.
3. Dress the site with gauze using multicolored sponge tape or an adhesive strip (ask about allergies before applying dressing).
4. Discard the needle in a puncture-resistant sharps container.
5. Clean any blood spillage with appropriate cleaning agent.
6. Label all Vacutainer tubes according to facility procedure (Fig. 31.5).
7. Properly dispose of all contaminated materials in the appropriate biohazardous waste container.
8. Talk with the patient, recheck the venipuncture site, and assess the site dressing.
9. Make sure the patient is stable without signs of vertigo, lightheadedness, or discomfort before leaving.
10. Remove gloves and wash your hands.

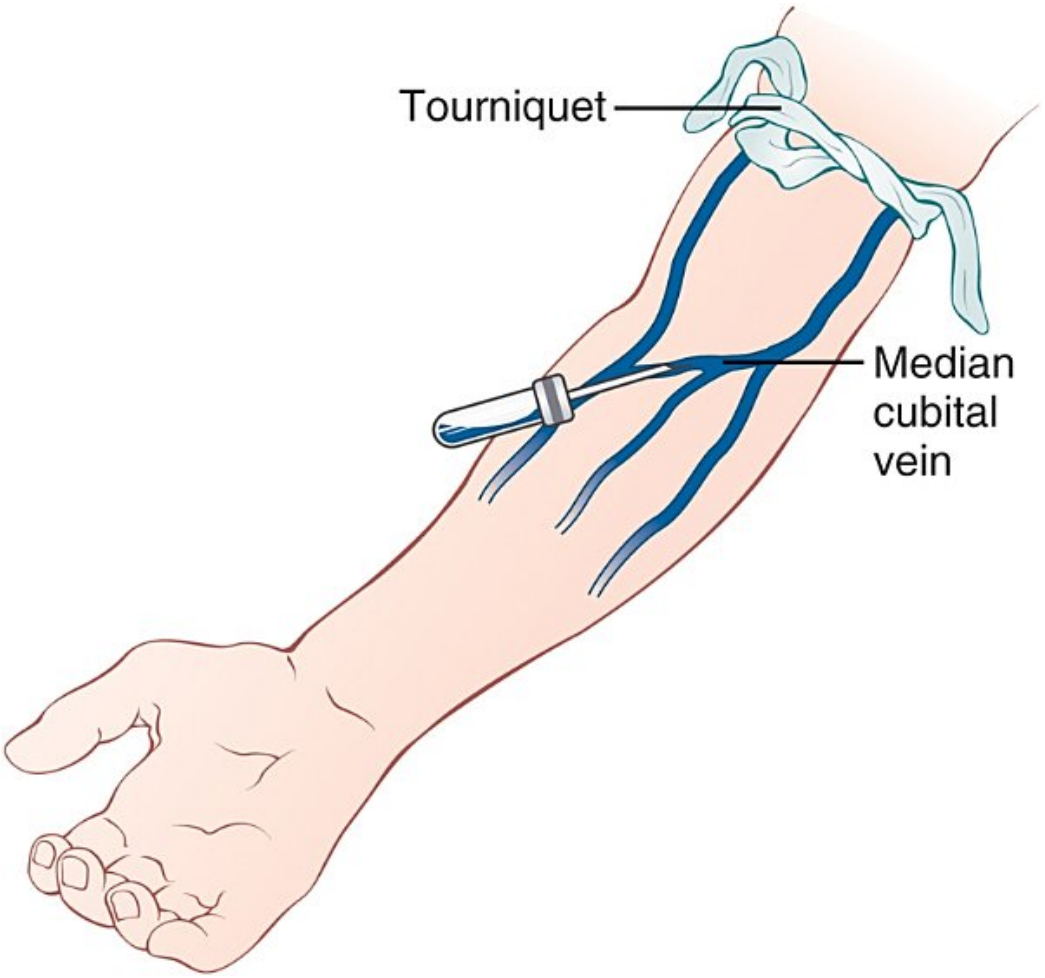

FIGURE 31.2 **Tourniquet placement.**

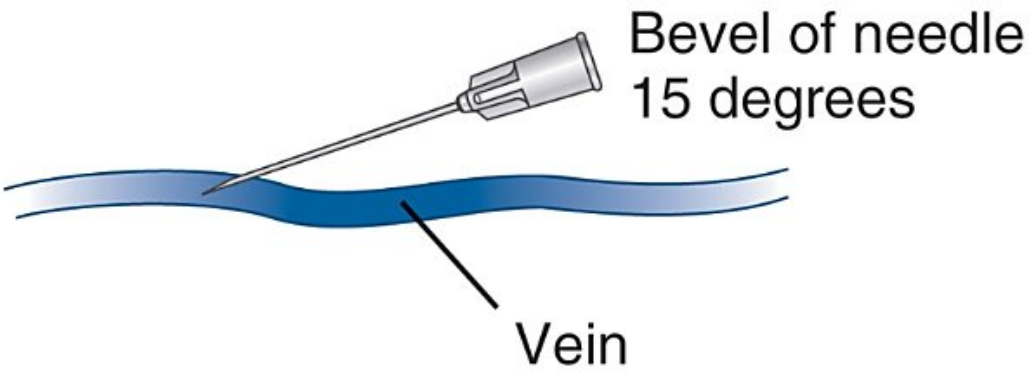

FIGURE 31.3 **Placement for needle insertion.**

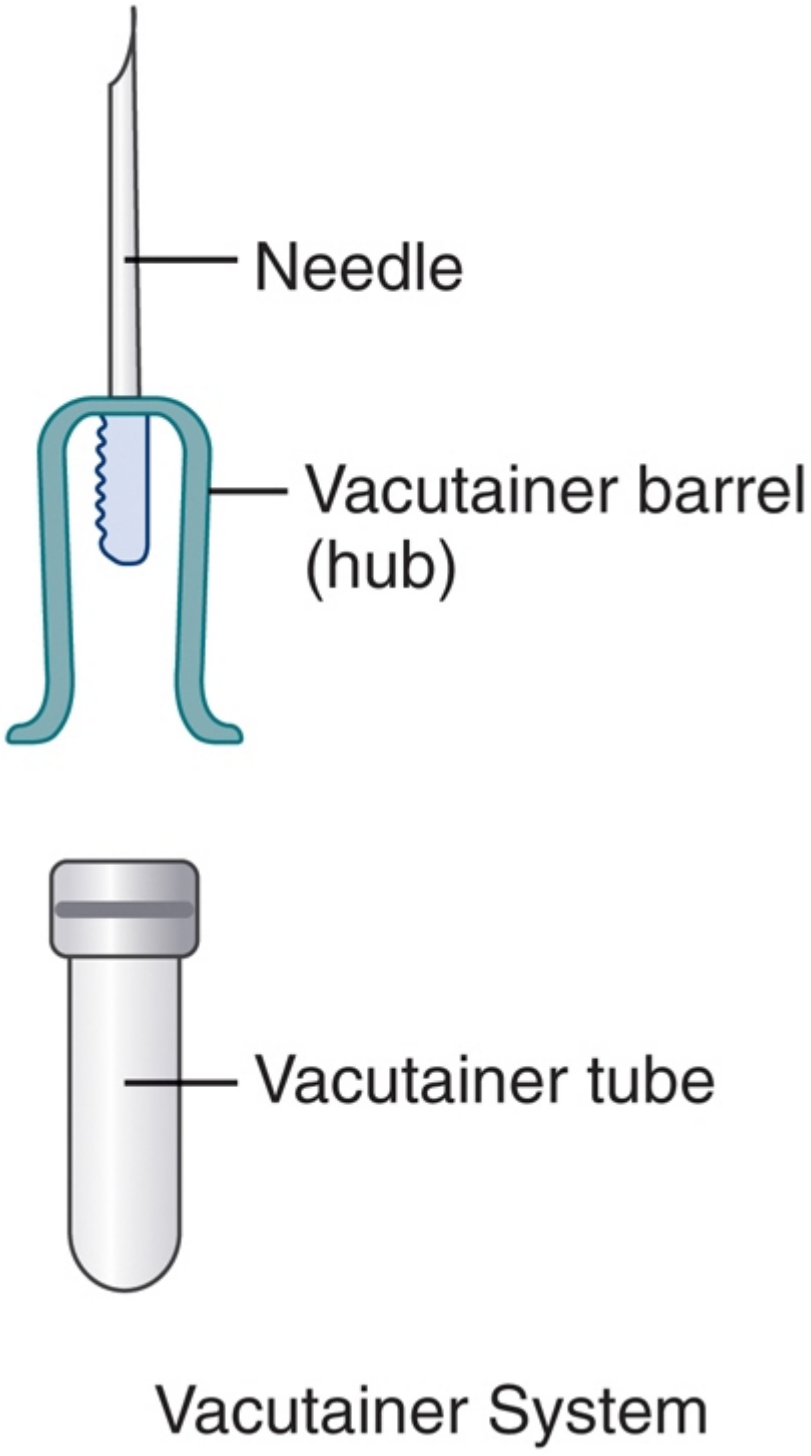

FIGURE 31.4 **Vacutainer system.**

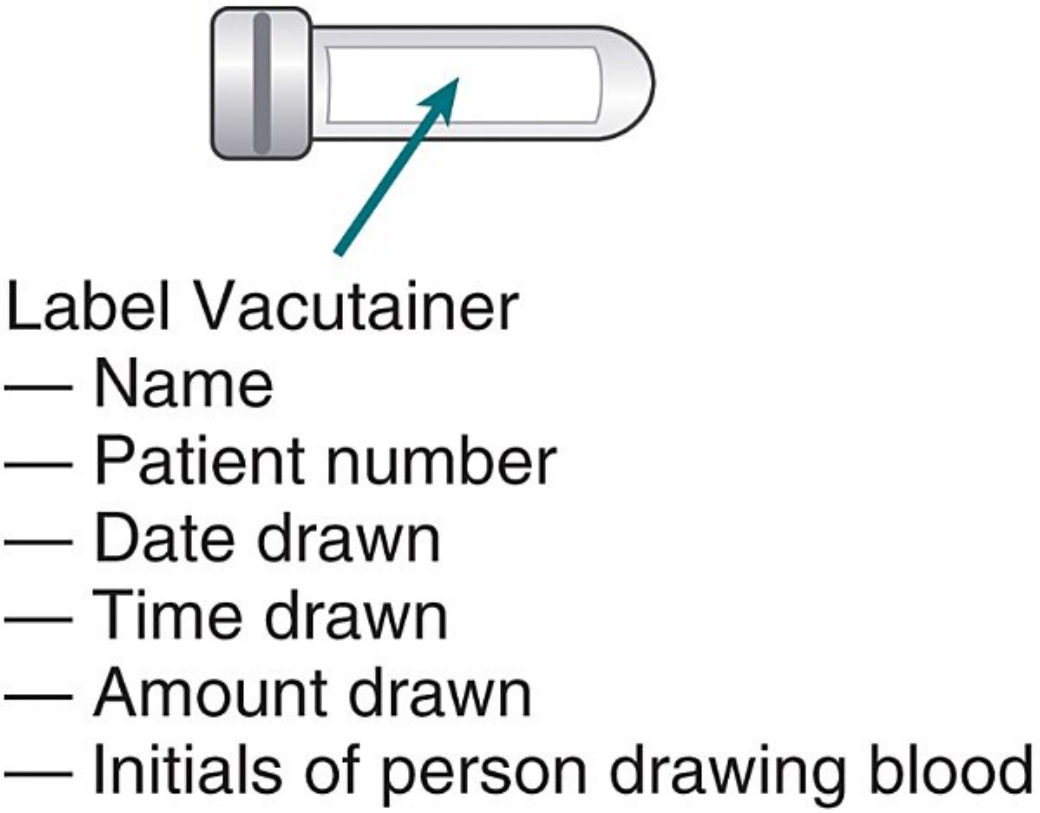

FIGURE 31.5 **Sample label for blood collection tube.**

Special Considerations

Special considerations in venipuncture methods are as follows:

- Never draw from a thrombosed or scarred vein. Thrombosed veins lack resilience, feel cordlike, and roll easily.
- Never draw over scars or new tattoo sites. It is difficult to puncture the scar tissue, and the needle and the tourniquet should not come in contact with the inflamed tattoo site. Edematous extremities with swollen tissue alter test results.
- Never attempt venipuncture in an artery. Arteries pulsate, are very elastic, and have a thick wall. If you see bright red blood, be cautious. Remove the tourniquet, carefully remove the needle, and apply a firm steady pressure for at least 10 minutes.

- Never draw proximal to an IV site because the fluid may dilute the specimen. It is preferential to collect the sample from the opposite arm. However, if the ipsilateral arm to the IV site must be used, be sure to select a location distal to the IV site and complete the following steps:
  - Turn off the IV line for at least 2 minutes, if possible.
  - Draw the blood from a vein other than the one being utilized for the IV.
  - Discard the first 5 mL of blood that is drawn.
  - Draw the samples for testing.

NOTE: Blood specimens drawn for glucose levels from the same extremity as the IV infusion may be inaccurate, even when obtained from a point distal to the IV site.

- Do not use alcohol for skin cleansing when drawing a blood alcohol sample.
- Make sure the venipuncture site is dry.
- If the patient experiences vasovagal syncope during the procedure, remove the tourniquet, remove the needle, apply pressure to the site, and fix with tape. Carefully lay the patient down and apply appropriate measures to wake the patient.
- If no blood is obtained, change the position of the needle carefully. Move it forward or backward, and consider adjusting the angle of the needle. Monitor for hematoma formation, stopping the procedure if this occurs.
- If blood stops flowing into the evacuated tube, the vein may have collapsed. Resecure the tourniquet to increase venous filling. If this does not result in the resumption of blood flow, remove the needle, take care of the puncture site, and redraw.
- Avoid leaving a tourniquet on for more than 2 minutes. This can cause hemoconcentration of nonfilterable elements. The hydrostatic pressure causes some water and filterable elements to leave the extracellular space.

- When using a syringe, avoid drawing the plunger back too forcefully.
- If the venipuncture procedure is unsuccessful, do not attempt to repeat it at the same site until healing has occurred. After three unsuccessful attempts, stop and ask for assistance.

Standard precautions

Practitioners should use standard precautions at all times when interacting with patients. Determining the level of precaution necessary requires that the practitioner exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

Follow-Up Care and Instructions

The patient should be advised that minor discomfort and discoloration at the procedure site may be experienced for 48 to 72 hours after **venipuncture**. The patient should be instructed to keep the site clean and dry to reduce the likelihood of infection. Educate the patient about signs of infection and phlebitis and advise the patient to **call or return to the office** if such signs are seen.

Complications from venipuncture are rare, but in the event a complication occurs, early recognition and intervention are critical to minimizing adverse outcomes.

Disposal of Materials

Standard precautions should be followed in the disposal of all material related to venipuncture. All needles, Vacutainer barrels, and infusion sets must be discarded in a puncture-resistant sharps container. All contaminated material must be discarded in an appropriately labeled biohazardous waste container.

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CHAPTER 32

Wound Closure

Karen A. Newell

Abstract

Wound management begins with a thorough evaluation of the wound. Once it is determined that a wound requires closure knowing the various closure options as well as the technical steps involved is necessary to minimize complications. Additionally, providers should be able to convey post-procedure information to the patient including proper wound care and follow-up instructions.

Keywords

suture
suturing
wound
wound closure
wound management
wound care
skin stapling
wound adhesives

Procedure Goals and Objectives

GOAL: To reapproximate wound edges with sutures, staples, or skin adhesive successfully to facilitate wound healing and reduce the likelihood of infection.
OBJECTIVES: The student will be able to:

- Describe the indications, contraindications, and rationale for performing wound closure.
- Identify and describe common complications associated with wound closure.

- Describe the essential anatomy and physiology of the skin associated with the performance of wound closure.
- Identify the materials and tools necessary for performing wound closure and their proper use.
- Identify the important aspects of postprocedure care after wound closure.
- Demonstrate proper technique for wound closure.

Background and History

Wound closure has been in existence for many years in the practice of medicine. Although wound closure typically is associated with suturing the wound, many materials have been used over time. The word *suture* describes any strand of material used to ligate (tie) blood vessels or approximate (sew) tissues. The first written description of sutures used in operative procedures is recorded in the Edwin Smith Papyrus, the oldest known surgical document. This document has Egyptian origins and dates back to the 16th century BC. Dating as far back as 2000 BC, written references have been found describing the use of strings and animal sinews for suturing.

Rhazes of Arabia was credited in 900 AD with first using kit gut to suture abdominal wounds. The Arabic word *kit* means a dancing master's fiddle. In those days the musical strings of fiddles, called *kit strings*, were made of sheep intestines. It has been speculated that Rhazes used these to suture. The term *catgut* is thought to have evolved from these origins.

Through the centuries, a wide variety of materials—silk, linen, cotton, horsehair, animal tendons and intestines, and wire made of precious metals—has been used in operative procedures. Some of these materials are still in use today. The evolution of suturing material has brought us to a point of refinement that includes sutures designed for specific surgical procedures. They not only eliminate some of the difficulties the surgeon may have previously encountered during closure, but they decrease the potential for infection postoperatively. Despite the sophistication of today's suture materials and surgical techniques, closing a wound still involves the same basic procedure used by physicians to the Roman emperors.[1]

Indications

Most superficial wounds heal without intervention. However, a superficial skin laceration extending into the subcutaneous tissues should be considered for closure to avoid undesirable outcomes. Suture, staple, or skin adhesive closure of wounds may be warranted for the following reasons:

- To decrease the time required for the wound to heal
- To reduce the likelihood of infection
- To decrease the amount of scar tissue likely to form
- To repair the loss of structure, function, or both of the tissue
- To improve cosmetic appearance

Contraindications

Before any wound or laceration repair is initiated, a thorough evaluation of the patient must be carried out. Remember that all wounds, no matter how minor they may appear, can be the result of serious injury to underlying structures. The basic history, general physical examination, and wound examination help define the repair strategy and identify more serious problems that may necessitate specialized care.

Contraindications to suture closure of wounds relate largely to the risk for infection and disruption of underlying structures, such as nerves, arteries, and tendons. Wounds that have the following characteristics should be left unclosed, or at least very careful consideration should be given (weighing the pros and cons of closure) before electing to suture the wound:

- **Wounds that require suturing** to minimize infection and scar potential should be closed within 8 hours of the injury. Some wounds can be closed up to 24 hours after injury if the anatomic location is highly vascular (e.g., face, neck, and scalp), and the cosmetic appearance is an important consideration.

Wounds that have a high likelihood of contamination should not be closed with sutures. Doing so may mask a developing underlying infection, thus delaying appropriate treatment. This delayed treatment may result in spread of infection to underlying and surrounding structures, which has the potential to cause considerable morbidity.

- The presence of foreign bodies in the underlying tissues is a consideration. Foreign bodies may remain a source of repeated infections if not thoroughly removed through irrigation, exploration, and extraction or debridement of devitalized and contaminated tissue.
- Extensive wounds involving tendons, nerves, or arteries should be carefully considered before closure.

Classification of the wound helps the clinician to make an informed decision about the appropriateness of closing the wound (see discussion of essential anatomy and physiology).

Potential Complications

The primary complications associated with wound closure include the following:

- Infection
- Scarring, including keloid formation
- Loss of function and structure (e.g., scarring of an eyelid repair, resulting in incomplete closure of the eyelids)
- Loss of a cosmetically desirable appearance
- Wound dehiscence (wound margins separate and wound reopens)
- Tetanus

Essential Anatomy and Physiology

Anatomy of the Skin and Fascia

The epidermis is a thin layer of squamous epithelial cells located on the outermost surface of the skin. This layer is void of blood vessels or nerve endings. The epidermis provides an excellent protective barrier when healthy and intact. The stratum germinativum, or basal layer, is the parent layer for new cells. This layer provides the cells for new epidermis formation during wound healing (Fig. 32.1).

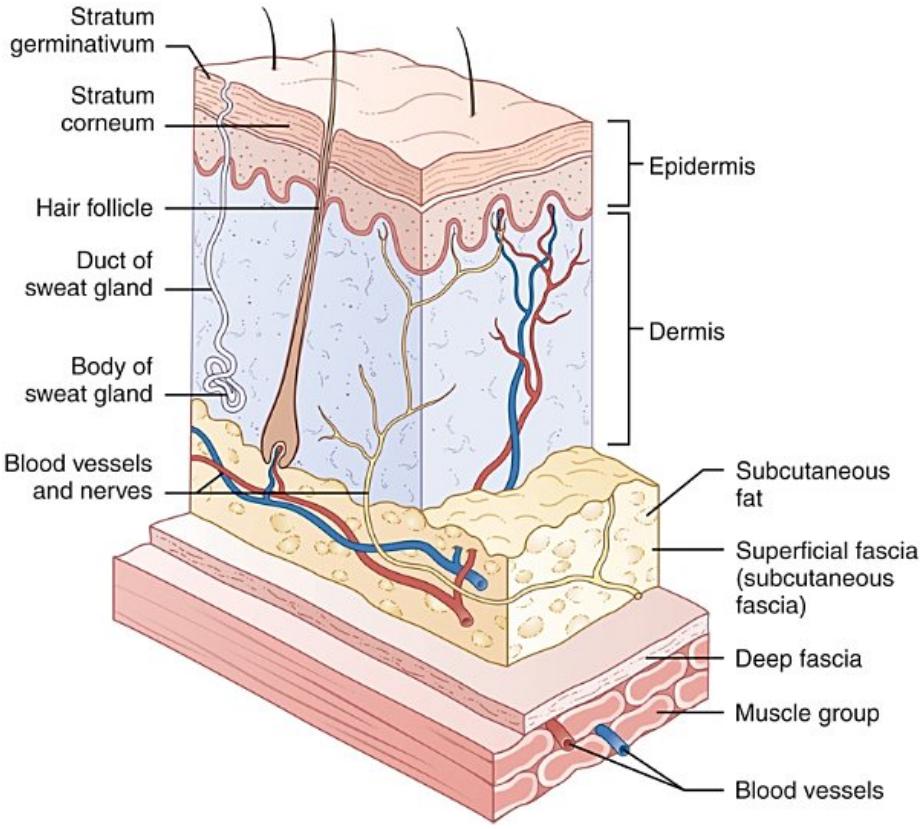

FIGURE 32.1 Anatomy of the skin, illustrating structures pertinent to wound repair. (Modified from Trott AT. *Wounds and Lacerations: Emergency Care and Closure*, ed 2. St. Louis: Mosby–Year Book; 1997, p 13.)

The dermis is much thicker than the epidermis. It is composed largely of connective tissue, such as fibroblasts; macrophages, lymphocytes, and mast cells are also present. Some small blood vessels and nerve fiber endings are present at this level.

Deep to the dermis is a layer of loose connective tissue that comprises the superficial fascia or subcutaneous tissue. Many blood vessels and nerve endings are located at this level. Subcutaneous fat is present here, and the quantity varies depending on the region of the body. Sensory nerve branches to the skin travel in the superficial fascia just deep to the dermis, which makes it ideal for injecting local anesthetic because the anesthetic spreads easily along this plane and abolishes sensation in the overlying skin (see Chapter 16, Local Anesthesia).

The deep fascia is a relatively thick, dense, and discrete fibrous tissue layer. It lies just above muscle, tendon, or bone. If disrupted by the injury, it should be repaired to

reestablish the supportive function of this layer. Failure to do so may result in disfiguration of the surrounding area.

Skin Tension Lines (Langer Lines)

Skin tension lines, also known as *Langer lines* or *lines of cleavage,* are linear clefts in the skin that indicate the direction of orientation of the underlying collagen fibers. If the skin is disrupted parallel to the long axis of the fibers, the wound tends to reapproximate. However, if the wound crosses the long axis of the fibers perpendicularly, they are disrupted in a manner that causes the wound to gape open; therefore, greater tension is required to close the wound. Lacerations that run parallel to these lines naturally reapproximate the skin edges. Lacerations that run at right angles to the tension lines tend to gape apart.Fig. 32.2 illustrates the typical orientation of Langer lines throughout the body.

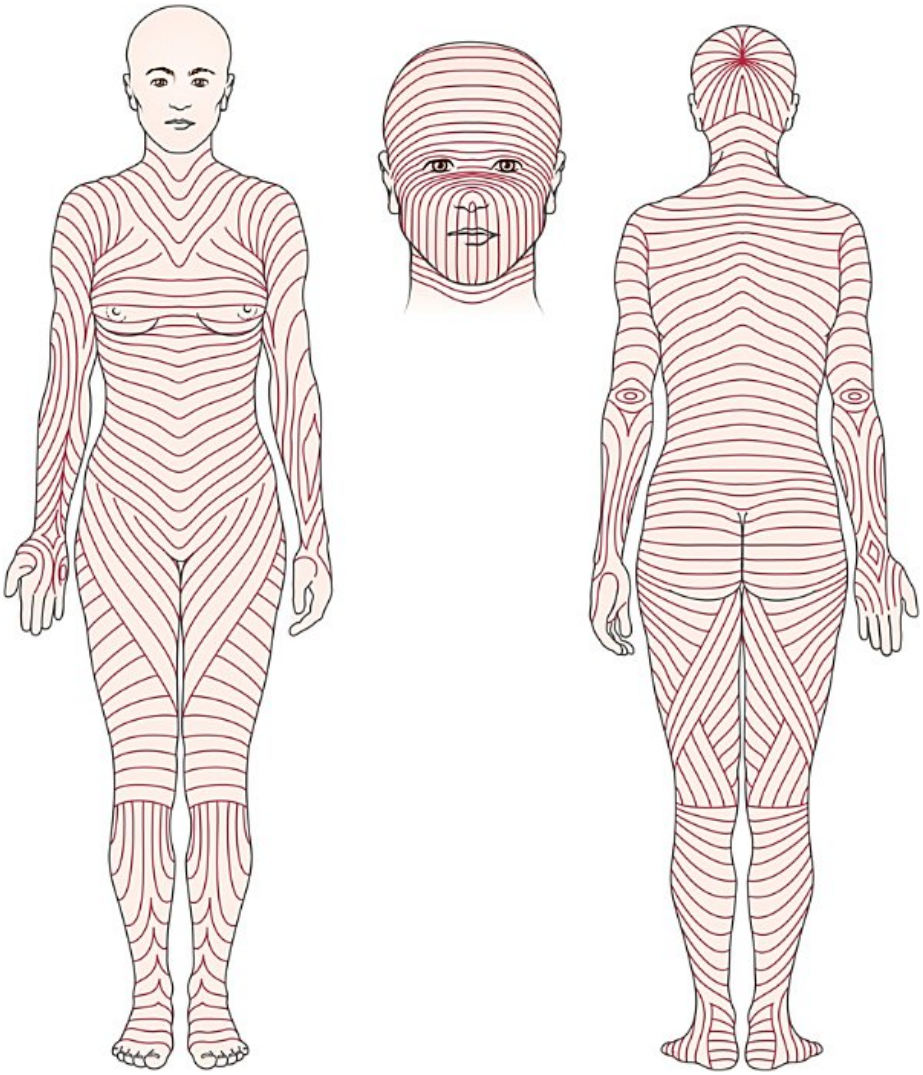

FIGURE 32.2 Skin tension lines of the body surface. (Modified from Trott AT. *Wounds and Lacerations: Emergency Care and Closure.* 2nd ed. St. Louis: Mosby–Year Book; 1997, p. 16-17.)

Wounds should be classified based on their degree of contamination with bacteria, foreign matter, or both. Timing of the closure is also important to consider. The chance of wound infection developing increases each hour that wound closure is delayed. General agreement is that wounds less than 6 to 8 hours old that are considered clean are eligible for primary closure with sutures. Highly vascular areas, such as the face and scalp, can be considered for primary closure with sutures up to 24 hours after the injury. In each case, the clinician must consider the degree of contamination and evaluate each wound individually.

Classification of Wounds

- *Clean:* Incisions made during a surgical procedure in which aseptic techniques were followed, without involvement of the gastrointestinal, respiratory, or

genitourinary tract; likelihood of infection is less than 2% and warrants routine primary closure.
- *Clean-contaminated:* Similar to clean wounds, except that the gastrointestinal, respiratory, or genitourinary tract is involved.
- *Contaminated:* Similar to clean and clean-contaminated, except there is gross spillage (e.g., bile, stool); traumatic wounds fall into this category.
- *Infected:* Established infection before wound is made (e.g., incision and drainage of an abscess) or heavily contaminated wounds (e.g., gross spillage of stool)

Wound Closure Classification

- *Primary intention:* All layers are closed.
  - Best chance for minimal scarring
  - Usually performed in clean and clean-contaminated wounds
- *Secondary intention:* The deep layers are closed, whereas superficial layers are left open to granulate on their own from the inside out.
  - Often leaves a wide scar and requires frequent wound care, consisting of irrigation and assorted types of packing and dressings
  - Prolonged process
  - Reasons for use include excessive tissue loss and infection
- *Third intention or delayed primary intention:* The deep layers may be closed primarily, whereas the superficial layers are left open until reassessment on day 4 or 5 after initial closure, at which time the wound is inspected for signs of infection.
  - If it looks clean and has begun to granulate, it is irrigated and closed.
  - If it looks as if it may be infected, it is left open to heal by secondary intention.
  - These wounds often arise initially from contaminated wounds.

Standard precautions

Every practitioner should use standard precautions at all times when interacting with patients, especially when performing procedures. Determining the level of precaution necessary requires the practitioner to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

Patient Preparation

The following should be considered when preparing the patient for the procedure:

- Take the patient's history to denote when, where, and how the injury occurred. Other pertinent information in the history may include handedness, tetanus status, other past or concurrent medical problems (e.g., diabetes mellitus, peripheral vascular diseases, immune status), smoking history, occupation, hobbies, family history, medications, and allergies.
- Begin the physical examination with a meticulous inspection detailing the type of wound, anatomic location, extent of injury, and level of contamination. Bleeding usually can be controlled with direct manual pressure applied to the site with a

clean bandage. A careful sensory and motor examination should precede any wound exploration or anesthetic infiltration.
- Prepare the patient for the initial treatment of the wound. This involves irrigating the wound, which is the major step in reducing the likelihood of infection. Some advocate cleansing the wound with 1% povidone-iodine and then, with the patient properly anesthetized, suturing the wound (see Chapter 16, Local Anesthesia).
- Immunize the patient against tetanus, if necessary.

A discussion regarding tetanus status and potential risk is warranted in any patient with a wound. Tetanus is a preventable endotoxin-mediated disease caused by *Clostridium tetani.* When present, it may cause trismus, neck rigidity, dysphagia, and severe, uncontrolled reflex spasms. Populations at particular risk are the elderly and those who have immigrated to the United States and have inadequate immunization, those who are immunocompromised, and those who inject drugs regularly and have frequent skin abscesses, impaired immune status, and reluctance to seek health care.

It is therefore important to determine when the patient last received a tetanus immunization and to classify the wound as either tetanus prone or not tetanus prone. Tetanus-prone wounds have the following characteristics:

- Greater than 6 hours old
- Greater than 1 cm deep
- Stellate or have an avulsion configuration
- Associated with devitalized tissue
- Contaminated with soil, feces, or saliva
- From a missile (e.g., gunshot wound)
- From a puncture or crush
- Associated with a burn or frostbite

All other wounds can be considered not tetanus prone. To determine the appropriate treatment, see http://www.cdc.gov/tetanus for the most current recommendations. However, Table 32.1 and the following guidelines may also be helpful as a general rule:

- A non–tetanus-prone wound in an adult (aged 19 to 64) patient with up-to-date immunization requires immunization with the vaccine for tetanus, diphtheria, and pertussis (Tdap) or for tetanus and diphtheria (Td) if it has been 10 years since the last immunization. Tdap is recommended once in a lifetime. If the patient has already received Tdap, Td should be given. If the patient is older than 64 years of age, Td should be given.
- A tetanus-prone wound in a patient with up-to-date immunization requires immunization with either Tdap or Td if it has been more than 5 years since the last immunization. Tdap is recommended once in a lifetime. If the patient has already received Tdap, Td should be given.
- Tetanus-prone wounds in adult patients with inadequate immunization require both passive immunity with tetanus immunoglobulin (TIG) and active immunity with Tdap. When giving either Tdap or Td and TIG, place them in different syringes and deliver them at separate anatomic locations.
- Adults with an unknown history should receive the three-dose regimen and therefore will require follow-up. The initial dose of Tdap is given at the time of

wound closure; 4 to 8 weeks later, a second dose of Td toxoid is administered. The last dose is given 6 to 12 weeks after the second dose. Booster doses of Td toxoid should then be given every 10 years to maintain an adequate tetanus status.

- Diphtheria, tetanus toxoid, and acellular pertussis (DTaP) or (DT) is used instead in children. Please consult the Centers for Disease Control and Prevention regarding current vaccination recommendations for the pediatric patient as well as vaccination recommendations during pregnancy.

Table 32.1

Summary Guide to Tetanus Prophylaxis in Routine Wound Management

History of Tetanus Immunization (Doses)	Clean, Minor Wounds		All Other Wounds	
	Tdap or Td*	TIG	Tdap or Td*	TIG†
Uncertain or <3 doses	Yes	No	Yes	Yes
≥3 doses	No, unless >10 years since last dose	No	No, unless >5 years since last dose	No

DT, Diphtheria and tetanus; *DTaP,* diphtheria, tetanus toxoid, and acellular pertussis; *Td,* tetanus and diphtheria; *Tdap,* tetanus, diphtheria, and pertussis; *TIG,* tetanus immunoglobulin.

* For children aged <7 years, DTaP (DT, if pertussis vaccine contraindicated) is preferred to tetanus toxoid alone. For children aged 7 to 10 years who are not fully vaccinated against pertussis and for whom no contraindication to pertussis vaccine exists, a single dose of Tdap should be given to provide protection against pertussis. If additional doses of tetanus and diphtheria toxoid-containing vaccines are needed, then children aged 7 to 10 years should be vaccinated according to catch-up guidance, with Tdap preferred as the first dose. For adolescents and adults aged 10 to 64 years, a single dose of Tdap should be provided in place of one Td booster if the patient has not previously been vaccinated with Tdap. Adults aged ≥65 years who have or who anticipate having close contact with an infant aged <12 months and who have not previously received Tdap should receive a single dose of Tdap to protect against pertussis and reduce the likelihood of transmission.

† Passive immunization with ≥250 international units of TIG intramuscularly (or 1500 to 5000 international units of antitoxin of animal origin, if globulin is not available), regardless of the patient's age, is indicated for patients with other than clean, minor wounds and a history of no, unknown, or <3 previous tetanus toxoid doses. When tetanus toxoid and TIG or antitoxin are given concurrently, separate syringes and separate sites must be used. More frequent boosters are not needed and can accentuate side effects.

Modified from https://www.cdc.gov/tetanus/clinicians.html.

Materials Used for Performing Irrigation, Cleansing, and Debridement

- Gloves and goggles

Irrigation

- 60-mL syringe with splash guard or similar device

- 21-gauge plastic intravenous catheter or irrigation needle with blunted end for fluid irrigation
- Several liters of saline solution

Cleansing

- A cleansing agent (Table 32.2) may be considered, but because of tissue toxicity and lack of supportive evidence, it cannot be routinely recommended.
- Sterile, fenestrated drape
- Several sterile square or rectangular drapes

Table 32.2

Wound Cleansing Agents

Skin Cleanser	Antibacterial Activity	Tissue Toxicity	Systemic Toxicity	Potential Uses
Povidone-iodine surgical scrub	Strongly bacteriocidal against gram-positive and gram-negative bacteria	Detergent can be toxic to wound tissues	Painful to open wounds Other reactions extremely rare	Hand cleanser
Povidone-iodine solution	Strongly bactericidal against gram-positive and gram-negative bacteria	Minimally toxic to wound tissues	Extremely rare	Wound periphery cleanser
Chlorhexidine	Strongly bactericidal against gram-positive organisms, less strong against gram-negative bacteria	Detergent can be toxic to wound tissues	Extremely rare	Hand cleanser Alternative wound periphery cleanser
Poloxamer 188	No antibacterial activity	None known	None known	Wound cleanser (particularly useful on face)

Skin Cleanser	Antibacterial Activity	Tissue Toxicity	Systemic Toxicity	Potential Uses
Hexachlorophene	Bacteriostatic against gram-positive bacteria; poor activity against gram-negative bacteria	Detergent can be toxic to wound tissues	Teratogenic with repeated use	Alternative hand cleanser
Hydrogen peroxide	Very weak antibacterial agent	Toxic to red cells	Extremely rare	Wound cleanser adjunct

Modified from Trott AT. *Wounds and Lacerations: Emergency Care and Closure,* ed 2. St. Louis: Mosby–Year Book; 1997, p 91.

Debridement

- Scalpel or sharp tissue scissors

Procedure

Irrigating and Cleansing the Wound

1. Don gloves and goggles to avoid exposure to blood-borne pathogens.
2. Using a 60-mL syringe with a splash guard and a 21-gauge plastic intravenous catheter or similar device designed for **irrigation,** repeatedly squirt normal saline into the site in short bursts to dislodge remaining particulate matter. Minimally, 250 to 500 mL of irrigation solution should be used. Several liters may be necessary for large wounds that are heavily contaminated.

> Adequate and efficient irrigation of the wound is perhaps the most important step in wound closure. Irrigate, irrigate, irrigate, and when you think you have irrigated enough, irrigate some more.

3. Apply a cleansing agent (see Table 32.2) to the wound edges and surrounding skin using a bull's-eye or circular motion from the inside moving outward and repeat three times. Avoid allowing the agent to enter the wound.

NOTE: One example of a cleansing agent might include three sterile diluted povidone-iodine (1%)-soaked 4 × 4-inch pads. Please be advised that standard povidone-iodine solution is 10% and the scrub is even more concentrated.

4. Place a sterile fenestrated drape over the wound site and several sterile square or rectangular drapes around the site to create a sterile field.

NOTE: If the wound is on a limb, a sterile drape should be placed under the extremity before the other drapes are applied. Drapes are often found in prepackaged suture kits or on a laceration tray and are placed after the clinician dons sterile gloves.

5. If debridement is necessary to remove dead or devitalized tissue, use a scalpel or sharp tissue scissors.

NOTE: Care should be taken to preserve tissue, yet conversion of a jagged laceration to a surgical one may be required for optimal closure to occur. Sometimes the subcutaneous tissue may need to be undermined to allow for adequate closure of tight wound edges.

Materials Used to Perform Suturing

- Sterile gloves

Suture Selection

Once it is determined that a wound should be closed primarily, suture selection begins. The first item to consider is whether to use absorbable or nonabsorbable suture based on anatomic location and healing potential.

- Absorbable suture is used in mucosal areas such as the oral cavity and tongue and disintegrates by one of two methods—enzymatic breakdown of organic material (e.g., surgical gut—plain or chromic) or by hydrolysis of synthetic material (e.g., polyglactin 910 [Vicryl]).
- Nonabsorbable suture (i.e., silk, stainless steel, nylon, polypropylene, polyester fiber) can be further classified into monofilament (single strand) or multifilament (several strands, which are often braided).

NOTE: One advantage of a monofilament suture is that it passes through tissue more easily than does braided suture. However, a disadvantage is that it has less tensile strength than a multifilament suture. An advantage of a multifilament suture is better flexibility, whereas a disadvantage would be that it may harbor organisms more easily within the braid. It is also important to recognize that loss of either tensile strength or absorption is a separate process (i.e., suture may lose tensile strength rapidly but absorb slowly or vice versa).

Refer to Table 32.3 as a guide for suggested **suture size** based on anatomic location.

Table 32.3

Suggested Guidelines for Suture Material and Size for Body Region

Body Region	Percutaneous (Skin)	Deep (Dermal)
Scalp	5-0/4-0 monofilament*	4-0 absorbable†
Ear	6-0 monofilament	—
Eyelid	7-0/6-0 monofilament	—
Eyebrow	6-0/5-0 monofilament	5-0 absorbable
Nose	6-0 monofilament	5-0 absorbable
Lip	6-0 monofilament	5-0 absorbable
Oral mucosa	—	5-0 absorbable‡
Other parts of face/forehead	6-0 monofilament	5-0 absorbable
Trunk	5-0/4-0 monofilament	3-0 absorbable
Extremities	5-0/4-0 monofilament	4-0 absorbable
Hand	5-0 monofilament	5-0 absorbable
Extensor tendon	4-0 monofilament	—
Foot/sole	4-0/3-0 monofilament	4-0 absorbable
Vagina	—	4-0 absorbable
Scrotum	—	5-0 absorbable‡
Penis	5-0 monofilament	—

* Nonabsorbable monofilaments include nylon (Ethilon, Dermalon), polypropylene (Prolene), and polybutester (Novafil).

† Absorbable materials for dermal and fascial closures include polyglycolic acid (Dexon, Dexon Plus), polyglactin 910 (Vicryl), polydioxanone (PDS [monofilament absorbable]), and polyglyconate (Maxon [monofilament absorbable]).

‡ Absorbable materials for mucosal and scrotal closure include chromic gut and polyglactin 910 (Vicryl).

Modified from Trott AT. *Wounds and Lacerations: Emergency Care and Closure*. 2nd ed. St. Louis, MO: Mosby–Year Book; 1997, p 179.

Suture size is denoted by the number of zeros, and increases in number as the diameter of suture decreases; for example, 7-0 is smaller than 1-0.

- Needles

NOTE: The final consideration for proper suture selection is based on needle characteristics and includes the following:

- The type and shape of needle should be considered:
  - A conventional cutting needle is often used for skin and has three cutting edges (two lateral and one on the inner concave curve).
  - A reverse cutting needle is often used for tough tissue, such as ligament, and also has three cutting edges (two lateral and one on the outer concave curve).
  - A taper needle is circumferentially rounded, with a point, and is useful intraoperatively on delicate tissue, such as peritoneum. Fig. 32.3 illustrates the various parts of a needle.

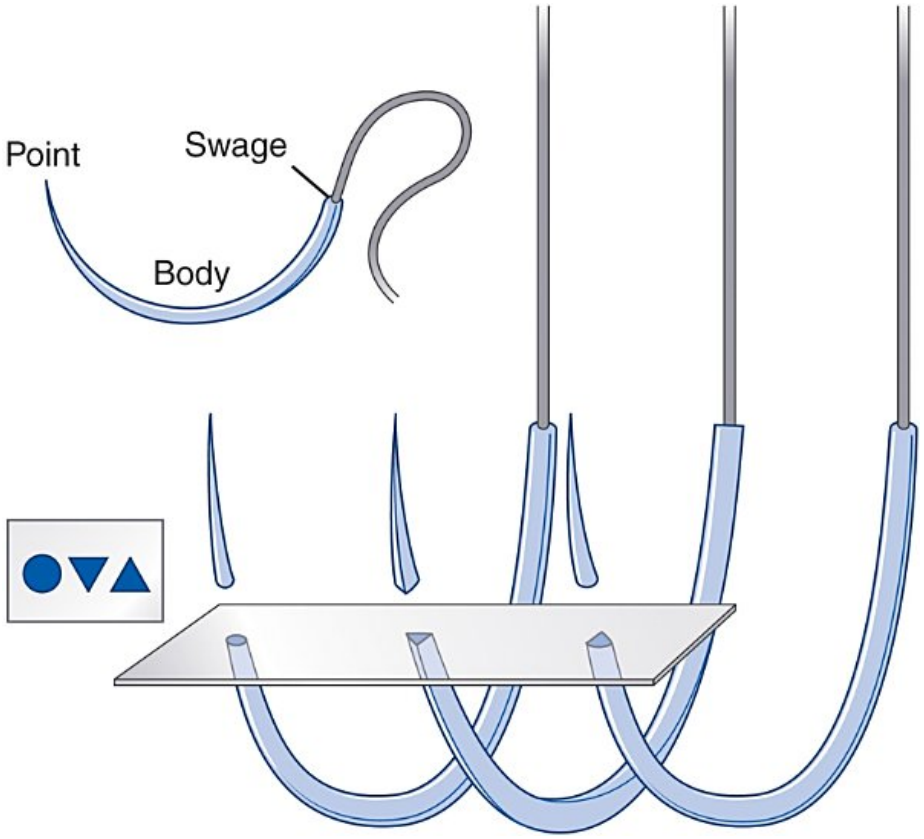

FIGURE 32.3 The parts of taper, reverse, and conventional cutting needles are shown (*left to right*). (Modified from Trott AT. *Wounds and Lacerations: Emergency Care and Closure,* ed 2. St. Louis: Mosby–Year Book; 1997, p 113.)

Other Instruments

- Needle driver or holder, appropriate for the size of needle and suturing material being used
- Skin forceps
- Suture scissors

Procedure

Performing Suture Techniques (General Information)

CAUTION: Proper instrument technique is paramount.

Needle Driver-Holder

1. Using sterile gloves, hold the needle driver with the dominant hand while the nondominant hand holds the forceps.

NOTE: The tripod grip (as viewed from below) is an excellent method when using both the needle driver and scissors because it maximizes hand control (Fig. 32.4). This may include the distal phalanx of the thumb and fourth digit inserted into the rings of the needle driver but never allowing the digits to move into rings more proximal than the distal interphalangeal joint. Clinicians with larger hands can hold smaller instruments on the outside of the rings.

2. Grasp the needle at the tip of the needle driver and load so that the needle is perpendicular to the needle driver, as shown in Fig. 32.5.

NOTE: The needle concavity will be furthest from the clinician and the point of the needle will be pointing to the nondominant shoulder as the clinician views the needle.

3. Grasp the needle at the junction of its proximal and middle third. It can be moved more distal (toward the point) for smaller bites.

NOTE: The tip of the needle should never be grasped because it can become dull.

> To minimize needlestick injuries, needles should never be touched with the fingers; they can be loaded easily from the packet they come in or from any flat surface.

Forceps

1. For maximal control, hold the forceps like a pencil, as shown in Fig. 32.4.

NOTE: If the forceps have teeth, avoid a tight tissue grasp to eliminate skin trauma ("teeth marks").

2. One method lifts the tissue rather than grasping it by placing one tooth of the forceps into the wound edge and lifting gently without closing the other toothed face to the skin surface.

Scissors

1. Cut with the tips of the scissors using the tripod grip at a 45-degree angle to the suture.

NOTE: Scissors are manufactured to cut most accurately with the tips.
NOTE: The technique of cutting at a 45-degree angle helps eliminate the possibility of accidentally cutting out the knots when no tail is left intraoperatively.

> Never attempt to cut a suture without full visualization of the distal scissor tips to avoid cutting tissue inadvertently.

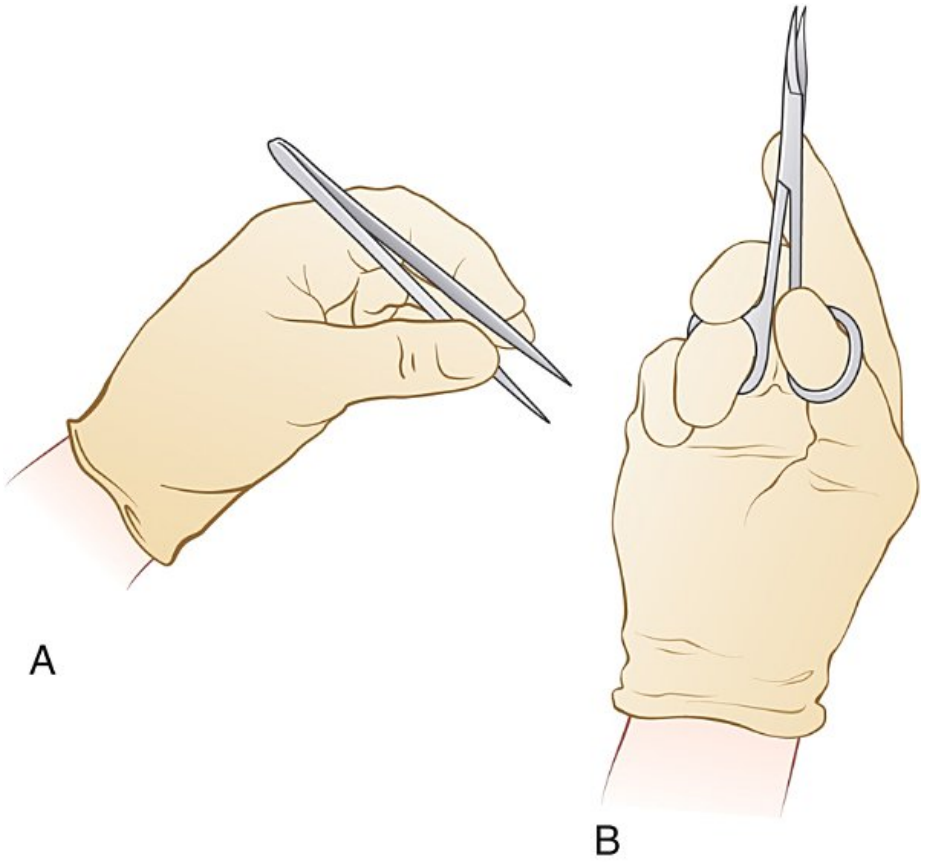

FIGURE 32.4 Proper Instrument Technique. (Modified from Trott AT. *Wounds and Lacerations: Emergency Care and Closure,* ed 2. St. Louis: Mosby–Year Book; 1997, p 108, 110.)

Procedure

Suture Placement

1. Introduce the suture needle into the tissue at a 90-degree angle or less (toward the wound) (see Fig. 32.5); try to approximate this angle as closely as possible. This can be maximized with full wrist pronation.

NOTE: Entering the tissue at 90 degrees helps is to promote skin eversion or a slight tenting of the wound edge at closure to minimize the ultimate scar visibility. With time, a normal scar contracts and flattens and appears flush, casting no shadow. Conversely, a wound that initially is closed flush often later "sinks in" and creates a shadow of light that highlights and draws attention to the scar.

NOTE: The depth of needle penetration is determined by the wound depth. Sometimes a bite can be completed by one pass through the tissue (skin surface, wound edge, wound edge, skin surface); other times the needle should be reloaded halfway through or after it passes from skin surface through the first wound edge. This allows for specific placement of the wound edge to the adjacent wound edge to ensure a side-to-side match and is necessary for larger bites in a deep wound. Typically, the total stitch length should be as wide as the wound is deep, as shown in Fig. 32.6.

NOTE: If a needle begins to bend, excessive pressure has been placed on it by either poor technique or attempting too large a bite. Taking a bite deeper than the wound may cause important structures to be traumatized from blind needle placement. Conversely, taking too superficial a bite may leave dead space below the closure, inviting blood accumulation, bacterial growth, and infection.

2. Place the needle bite just superficial to the wound depth.

NOTE: This allows complete visualization of structures penetrated and adequately closes the wound.

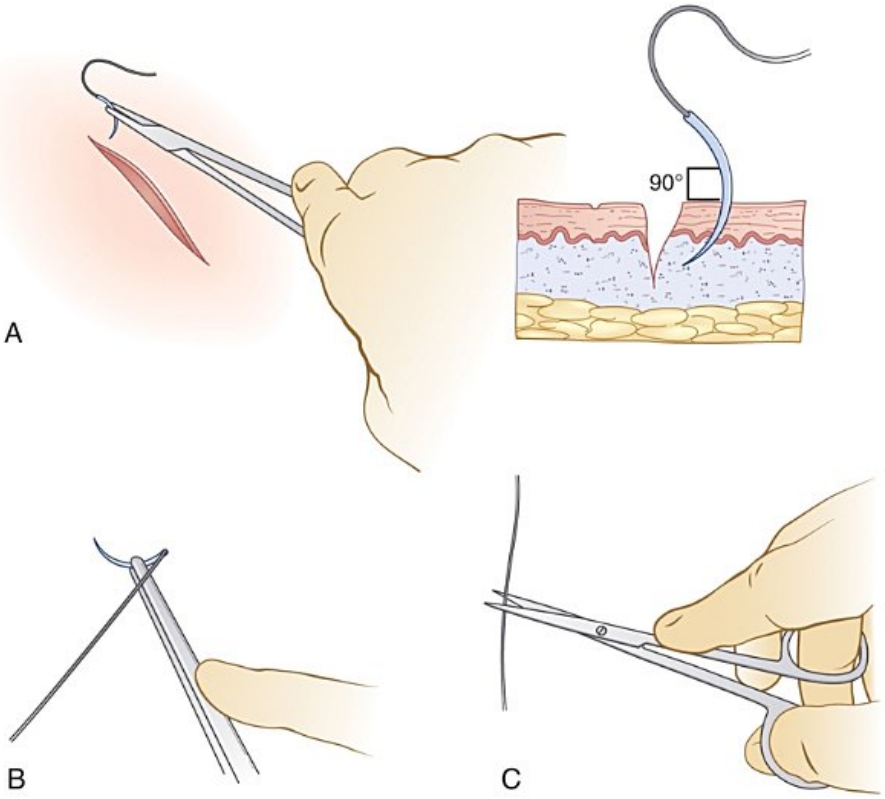

FIGURE 32.5 A = proper tissue entry, B = proper position of the needle in the needle driver, C = proper scissor cutting technique. (Modified from Trott AT. *Wounds and Lacerations: Emergency Care and Closure,* ed 2. St. Louis: Mosby–Year Book; 1997, pages 105, 110, and 145.)

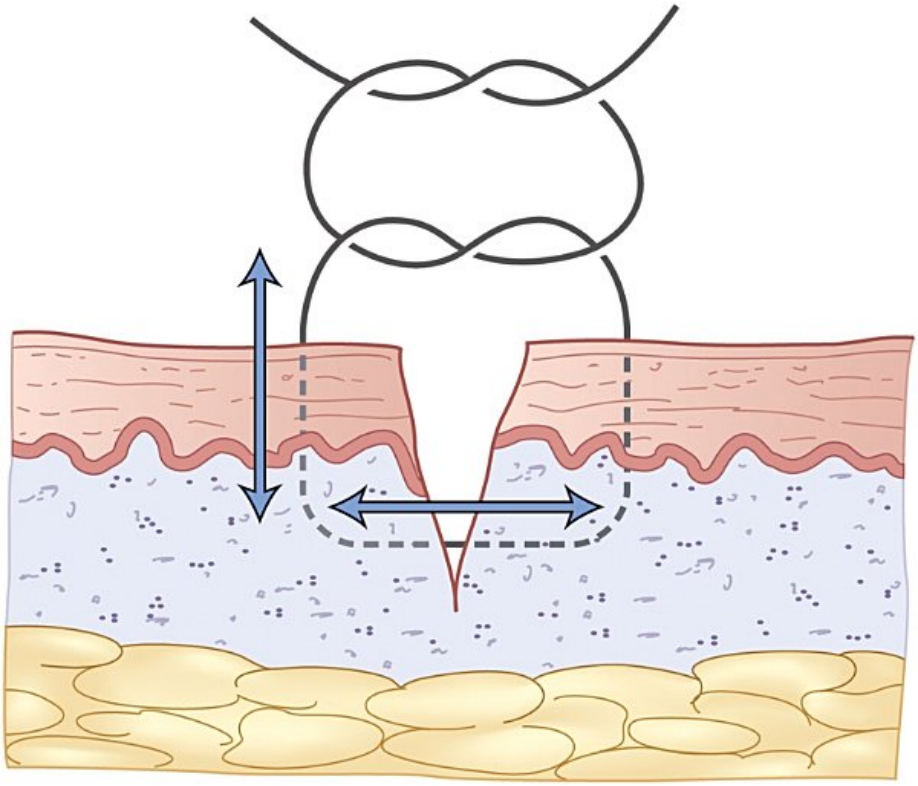

FIGURE 32.6 Surgeon's Knot. (Modified from Trott AT. *Wounds and Lacerations: Emergency Care and Closure,* ed 2. St. Louis: Mosby–Year Book; 1997, p 137.)

Procedure

Performing the Instrument Tie

1. Place the needle driver between the suture ends and, with the nondominant hand, wrap the suture with the needle attached over the instrument twice on the first throw of the first knot only (surgeon's knot, used to prevent slippage) (Fig,. 32.7, A and B).
2. Grasp the short end of the suture with the needle driver, and the short and long suture ends switch sides (see Fig. 32.7*C*).

NOTE: This is considered one throw. Two throws makes one knot. Next, the needle driver is placed between the two suture ends, and one wrap of the long suture over the instrument is used (Fig. 32.7*D*).

3. Again, grasp the short suture end with the needle driver. The long and short suture ends again switch sides (see Fig. 32.7*E*).

NOTE: A circle should be seen as the suture comes down to the skin surface. This suture circle should be placed at 90 degrees to the wound length for simple interrupted and vertical mattress sutures (horizontal mattress sutures will be parallel with the wound) (see Fig. 32.7*F*).

4. Repeat these steps with only one wrap over the needle driver on every successive throw until the suture is cut.

NOTE: Remember, the only throw that gets two wraps is the first throw of the first knot in a series. Therefore, an even number of throws ensures completion of all knots. Compare the diagrams of the first wrap of a typical knot (see Fig. 32.6) with a surgeon's knot (see Fig. 32.7*G*).

NOTE: The **number of knots** depends on the anatomic location (below the skin surface requires fewer knots; above the skin surface requires more knots) and suture material (those with "memory" often require more knots). Usually three or four knots on the skin surface are sufficient. The needle remains connected throughout these steps and usually poses no problem to the clinician or patient, because it remains stationary lying on the sterile field. There is no need to remember where you are in a sequence with this method, as in the "over-under technique."

After an adequate number of knots are secured, pull the suture knot to one side to avoid knot placement directly over the wound to minimize debris collection and potential infection.

NOTE: The suture is now ready for cutting. The "suture tail" or "suture tag" will be used during suture removal.

NOTE: Two helpful rules can be used to estimate this length: (1) The tail length should be equal to the distance from the wound edge to the suture border. (2) The tail length should be slightly less than the distance between adjacent knots. Use the previously described scissor technique to cut the suture.

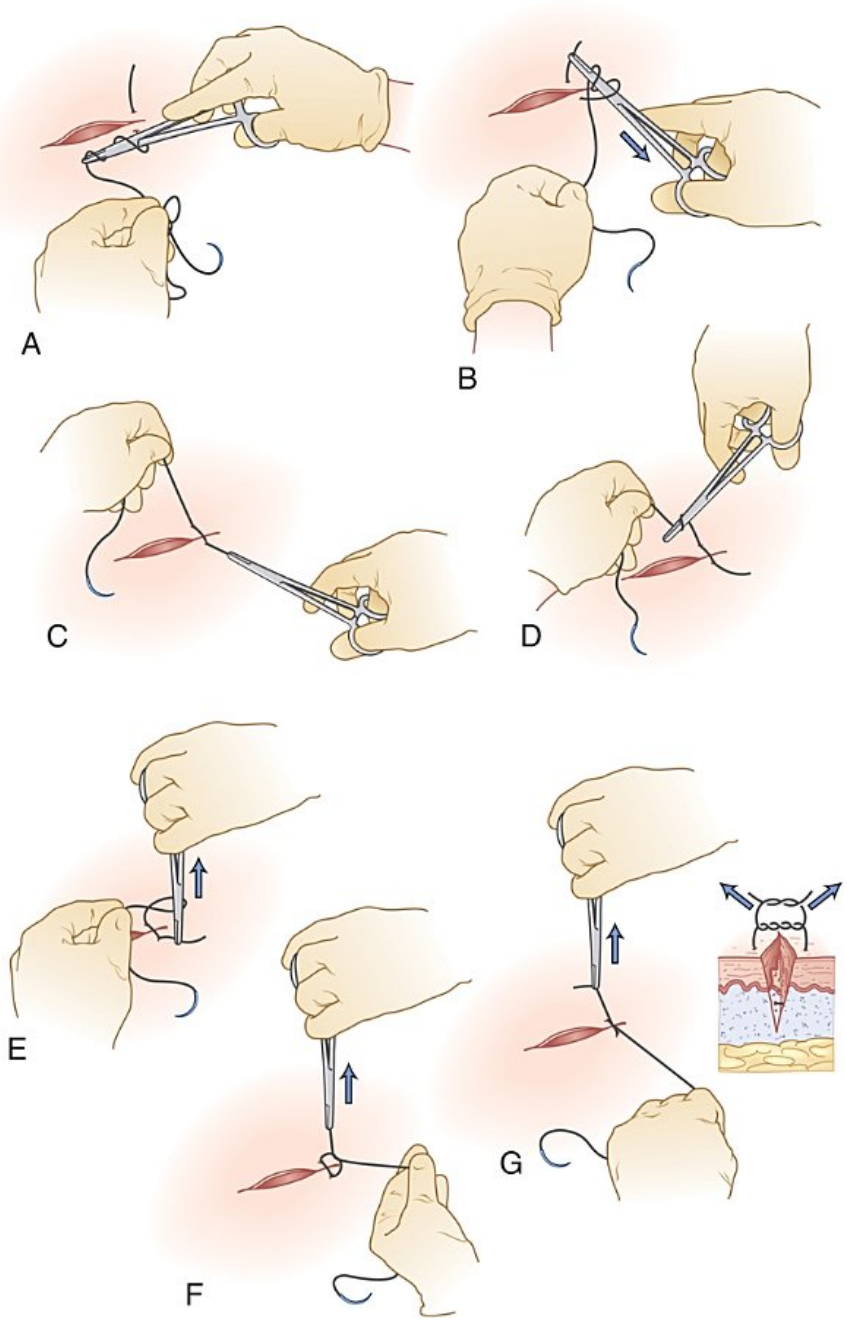

FIGURE 32.7 Steps for an Instrument Tie. (Modified from Trott AT. *Wounds and Lacerations: Emergency Care and Closure*, ed 2. St. Louis: Mosby–Year Book; 1997, pp 134-137.)

Procedure

Performing the Simple Interrupted Stitch

It is important to estimate carefully the number and size of sutures necessary to close the wound adequately without placing too many stitches and stiches that are too small, too few, or too large. Most simple interrupted stitches should measure between 3 and 10

mm in length and should be about this same distance apart. The method described in the instrument tie section is consistent with the simple interrupted stitch, which is frequently used to close most lacerations.

1. One method of closure includes closure by halves. Place the first stitch at the halfway point along the length of the wound.
2. Place the next stitches at the halfway point between the first stitch and each end of the wound.
3. Place the next stitches between each of the previous stitches until the wound is approximated.

NOTE: An alternative method involves beginning at one end of the wound and placing evenly spaced sutures along the length until you reach the opposite end of the wound. Be careful to place the sutures evenly on both sides of the wound; failure to do so may result in an asymmetric end to the wound known as a *dog ear,* in which one side of the wound appears to be longer than the other side, creating a redundant "ear" of tissue.

Procedure

Correcting Dog Ear Deformity

If a dog ear develops, the sutures should be removed and the closure reattempted. If it appears that correction cannot be achieved by reapproximation, the following method illustrates an acceptable procedure for correction.

1. Make an incision 45 degrees at the end of the redundant side.

NOTE: This tissue is undermined to create a small flap, which, when gentle traction is applied, can be excised as shown.

2. Close the wound in the usual fashion, creating a "hockey-stick" appearance (Fig. 32.8).

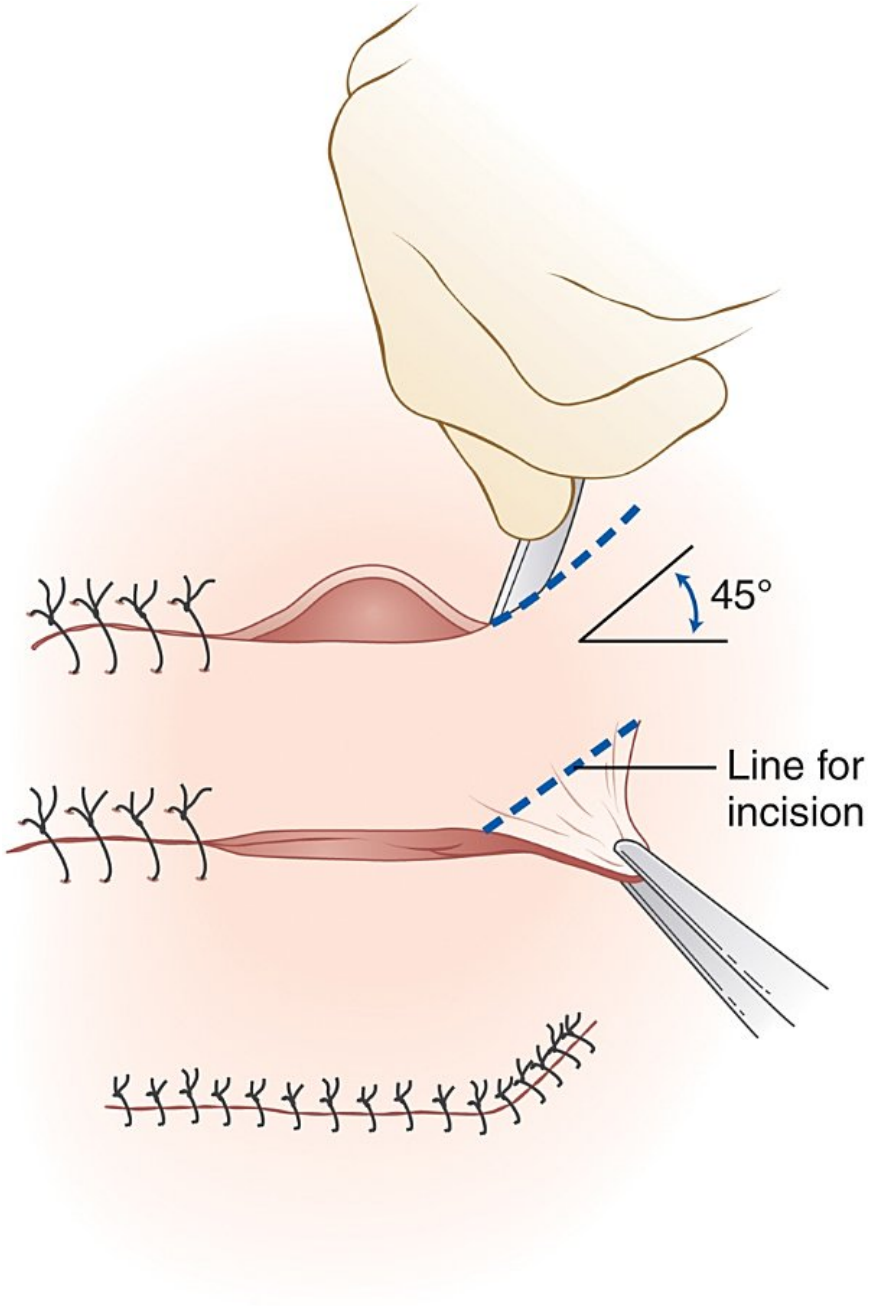

FIGURE 32.8 **Dog Ear Repair.** (Modified from Trott AT. *Wounds and Lacerations: Emergency Care and Closure,* ed 2. St. Louis: Mosby–Year Book; 1997, p 173.)

Procedure

Performing the Vertical Mattress ("Far-Far/Near-Near") Stitch

The next most commonly performed stitch is the vertical mattress stitch. This stitch is so named because the stitch lies in a plane perpendicular (vertical) to the skin. It is useful for closing deeper wounds (e.g., those of the scalp) in which the closure occurs at two levels (superficial and deep), eliminating dead space.

1. To perform the vertical mattress stitch, introduce the needle "far" and exit "far" from the wound edge, diving deep, but just superficial to the wound depth (Fig. 32.9).

NOTE: Fig. 32.9 illustrates a wound with first stitch traversing the lower wound margin. Most wounds will have the first stitch traverse within the lower portion of the wound margin, as illustrated in Fig. 32.6.

2. Next, starting on the same side as the first exit point, load the needle backhand (needle points to dominant shoulder while all other criteria remain unchanged) and enter "near" the wound edge and exit on the original side "near" the wound edge, both at a level more superficial than the original deep first pass.
3. The remainder of the instrument tying steps is the same (see Fig. 32.7).

NOTE: Performing the second step first, or a "near-near/far-far" stitch, should be avoided to eliminate "blind" needle placement and creating inadvertent trauma to unseen structures.

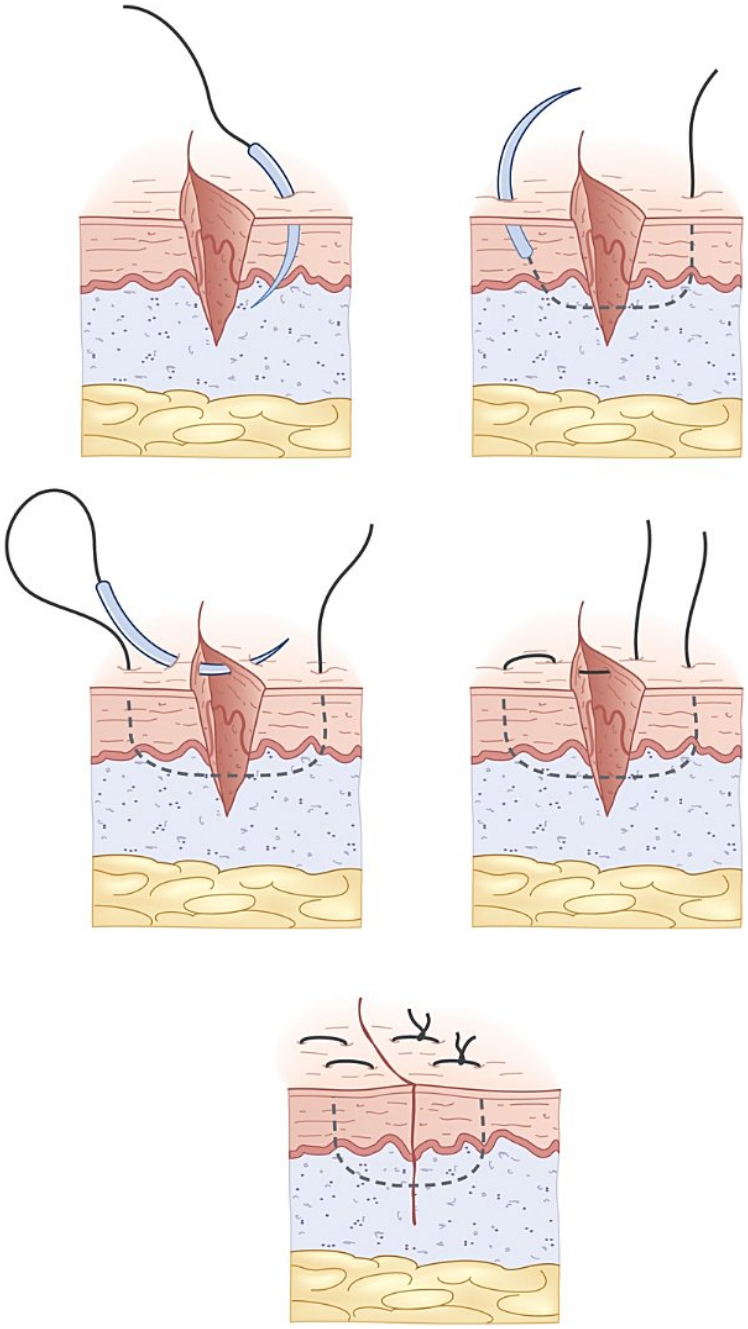

FIGURE 32.9 Vertical Mattress Stitch, Right Handed Clinician's View, Everything would be reversed for a Left Handed Clinician. (Modified from Trott AT. *Wounds and Lacerations: Emergency Care and Closure,* ed 2. St. Louis: Mosby–Year Book; 1997, p 146.)

Procedure

Performing the Horizontal Mattress Stitch

The **horizontal mattress stitch** lies in a plane parallel to the skin.

The horizontal mattress stitch is useful when there is a flap of tissue or when the tension of the stitch is to be predominantly on one side (the knotted side). For example, this method works well in a wound with a vascular side and a relatively avascular side, as the avascular area is pulled toward the vascular side, with most of the tension being on the vascular side. In other stitch types, the tension is shared equally by each side.

1. To perform the horizontal mattress stitch, start on the vascular side and exit on the relatively avascular side, such as what might be found in a flap or avulsed wound.
2. Reenter backhanded on this avascular side parallel to the wound edge and adjacent to the original exit site; the final exit is on the original vascular side.

NOTE: The stitch should look like a box. All knot tying steps are performed as previously discussed except that the stitch is brought down parallel (not perpendicular) to the wound line (Figure 32-10).

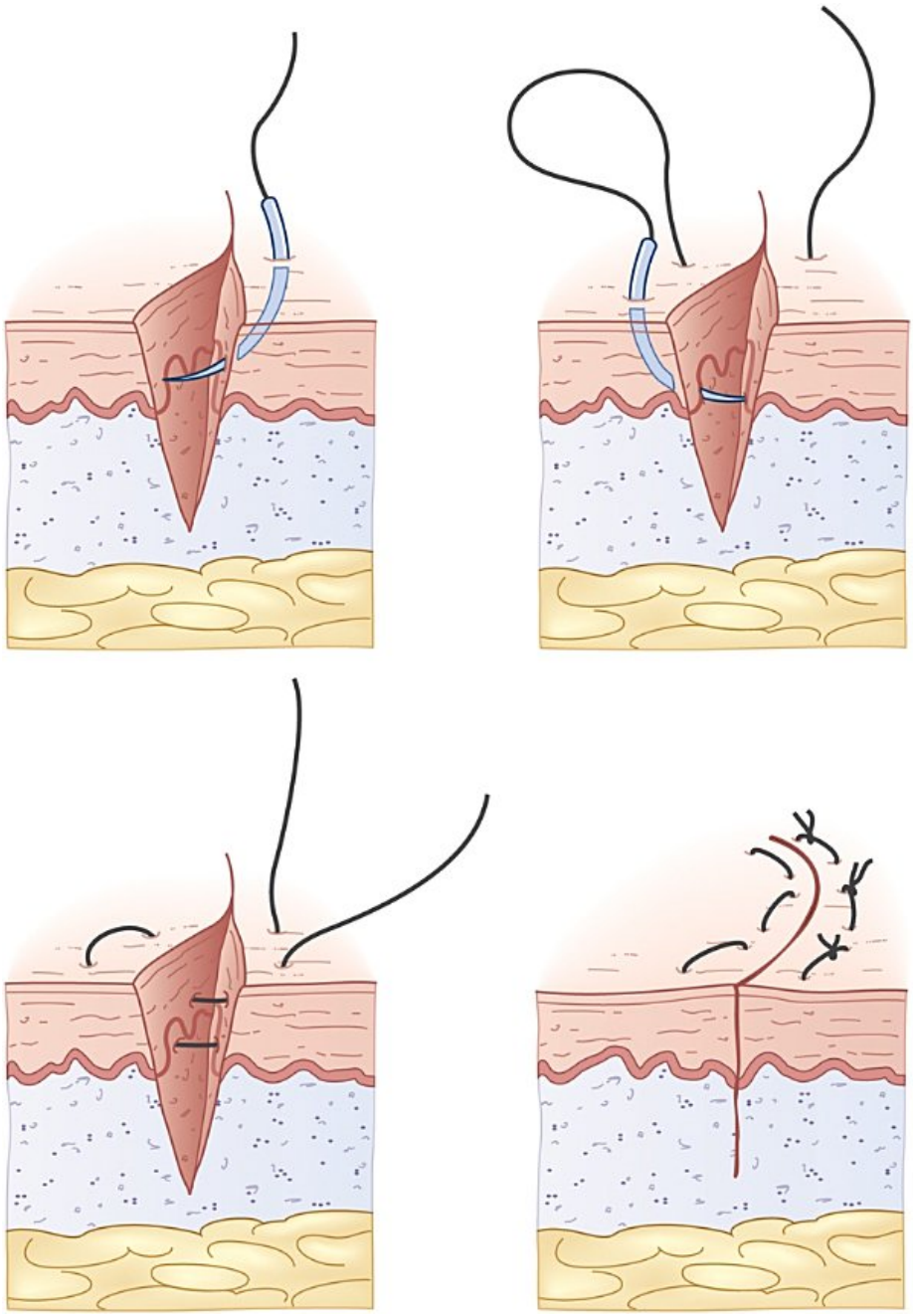

FIGURE 32.10 Horizontal Mattress Stitch, Right Handed Clinician's View, Everything would be reversed for a Left Handed Clinician. (Modified from Trott AT. *Wounds and Lacerations: Emergency Care and Closure,* ed 2. St. Louis: Mosby–Year Book; 1997, p 147.)

Procedure

Performing the Continuous-Running-Baseball Stitch

The advantages of the continuous stitch is that it can be performed quickly and can be applied tightly if "locked." The disadvantages are as follows:

- If one loop is broken, the entire wound may open.
- It cannot be partially removed as can other stitch types (e.g., every other or a wound segment) to allow for drainage when managing an early wound infection.
- It may leave a cosmetically suboptimal scar with a "railroad tracks" appearance.

The continuous suture is performed as follows:

1. Place a suture at the end of the wound in the same fashion as that outlined for a simple interrupted suture (only cut suture on nonneedle side after knot is tied).
2. Using the initial suture as an anchor, additional sutures are placed (throws) in a continuous fashion until the entire wound is reapproximated. Enter next to knot and exit on opposite side skin surface at a 45-degree angle to the wound and reenter through skin surface directly across and repeat (Fig. 32.11).
3. When the end of the wound is reached, the final suture is tied in the same manner as that outlined for the simple interrupted suture, but the needle side is tied to the last loop before it has been pulled taut. When cut, it will yield three tails.

NOTE: The method illustrated demonstrates the "nonlocking" method. To "lock" the suture, bring the needle up through the previous loop before it has been pulled taut, creating a tight seal; this can be particularly useful intraoperatively.

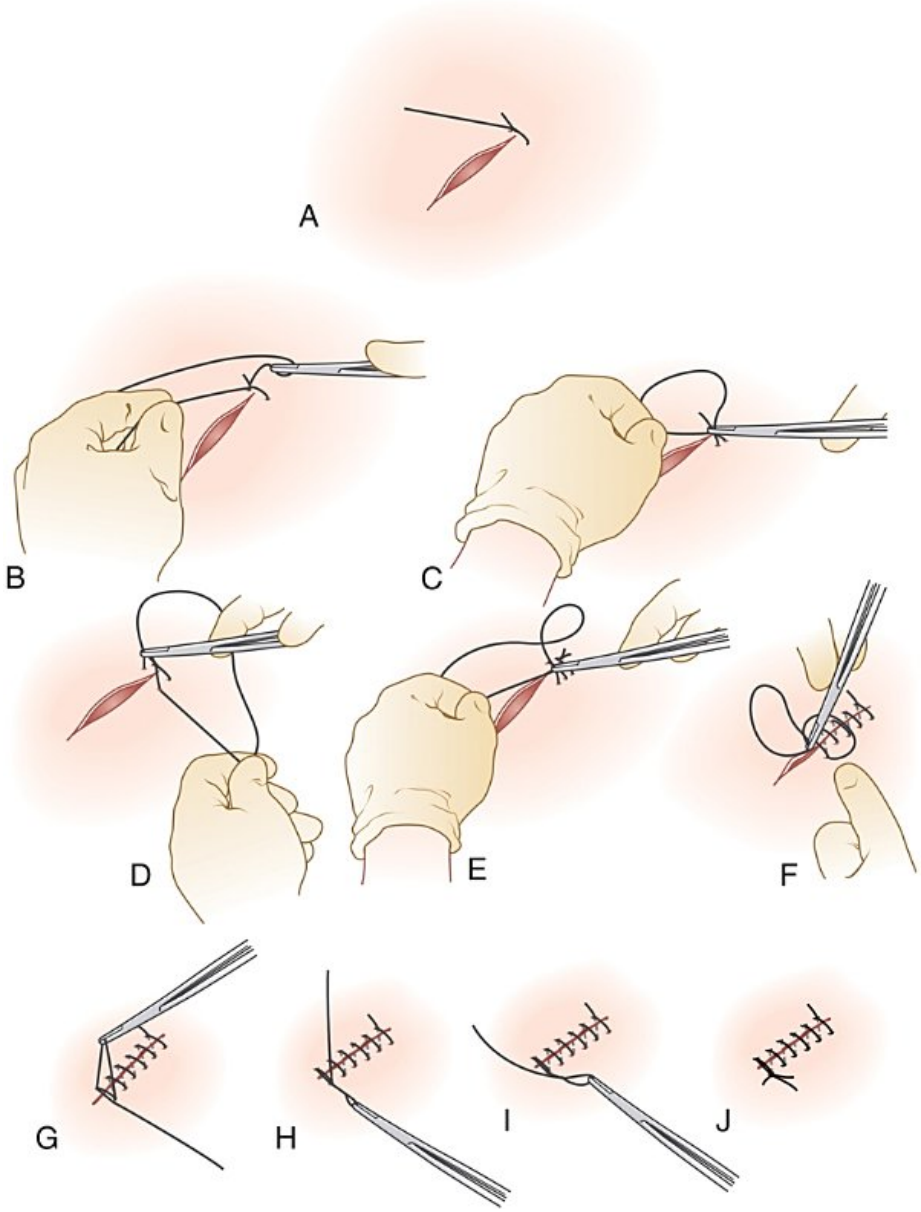

FIGURE 32.11 **Continuous-Running-Baseball Stitch.** (Modified from Trott AT: Wounds and Lacerations: Emergency Care and Closure, ed 2. St. Louis, Mosby–Year Book, 1997, pp 155-157.)

Procedure

Performing the Subcuticular Stitch (also known as Sub-Q or Subcutaneous)

The subcuticular stitch is often used to close a surgical incision or a very clean wound. Absorbable suture material must be used if the suture will not be removed later.

1. Create an initial buried knot to anchor the suture (Fig. 32.12).
2. Begin making equal passes through the wound edges in the horizontal plane until you have traversed the length of the wound (entering and exiting the dermal

layer from side to side).

NOTE: It is important to keep the bites equal and approximate the tissue so that it aligns properly.

3. A final buried knot is tied at the opposite wound end to complete and anchor the opposite end of the suture. Leave the needle side of the suture tail uncut (cut the loop side).

NOTE: The suture is secure because of the final buried anchor knot.

4. Bury the final tail by reentering the closed wound with the needle and attached suture and exiting on the skin surface 1 cm away from the wound edge.
5. Cut it flush with the skin.
6. Apply skin tapes over the wound surface.

NOTE: No suture will be visible on the skin surface.

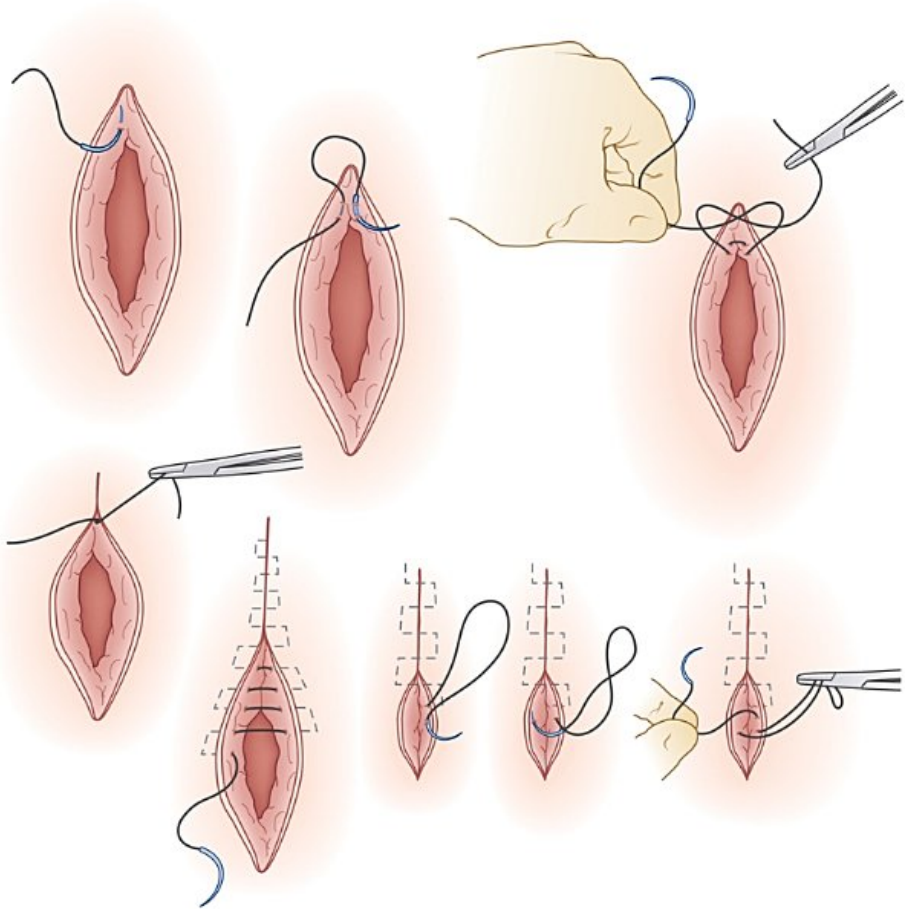

FIGURE 32.12 Subcuticular (Sub-Q) Stitch. (Modified from Trott AT. *Wounds and Lacerations: Emergency Care and Closure,* ed 2. St. Louis: Mosby–Year Book; 1997, p 160-162.)

Special Considerations

Several important general concepts exist and are discussed based on anatomic location.

- Hair can be shaved to allow for better wound exploration, irrigation, and closure, but this is not routinely recommended. Often, just trimming the surrounding hair is helpful without further traumatizing the skin by creating potential sites of infection from the minute lacerations and skin abrasions that often occur during the shaving process. Cutting the suture tails longer than usual and using an alternative suture color also facilitates removal in hairy anatomic locations and minimizes the need for shaving hair.
- Never shave an eyebrow, because the hair may not grow back at all or will grow back irregularly. It is also critical to line up the hair and skin borders exactly to avoid misalignment. If an eyebrow has been shaved and the wound is sutured closed, it is difficult to know where these borders exist. With even slight misalignment of the hair-to-the-skin border, the hair, if it grows back, will appear very disfiguring. Usually these areas can be visualized well enough to suture them adequately without the need for hair removal.

- Following this same principle is the concept of aligning the vermilion border of the lips. The best method for doing this begins by placing the first stitch at the border of the skin and mucosal edges (use 6-0 nylon). The remaining wound can be closed using nonabsorbable suture for the skin and absorbable suture for the lip itself. It is critical that this border be aligned exactly.
- If an incision has to be made, it is important to recognize and follow the natural skin tension lines. Scar visibility is minimized when it runs parallel to these lines and is more prominent when placed perpendicular or oblique to them (see Fig. 32.2).

Materials Used for Using Skin Staplers

- Stapler with staples—sterile disposable type
- Tissue forceps
- Skin tape

Procedure

Using Skin Staplers

Skin staplers are sterile, disposable, cost-effective, and useful for long, linear lacerations of the scalp, trunk, and extremities because they can be applied quickly with the same ultimate cosmetic result as suture.

1. Place staples over the approximated wound and firmly squeeze the trigger to deliver each staple, everting the tissue edges.

NOTE: Staplers should not be used to close lacerations of the face or hands or those over a small joint (e.g., a knuckle). They should also be avoided in areas that might later require computed tomography or magnetic resonance imaging (e.g., head injury).

2. To remove, use a special sterile, disposable device and squeeze this device at each staple. The staple legs are straightened. Then pull the staple from the tissue.

NOTE: Skin tapes are often placed after removal of the staples.

Materials Used for Applying Wound Adhesives

- Ampules or other delivery devices of wound adhesive
- Cotton-tipped applicator

Procedure

Applying Wound Adhesives

Wound adhesives are another variation of wound closure that may be used; they can be applied quickly and painlessly for easily approximating skin edges of surgical incisions or lacerations of the face, trunk, and limbs. They are not recommended over skin

creases, areas of movement, or long lacerations or for hand injuries. Other contraindications include wounds with active infection, those that involve mucosal surfaces or occur at mucocutaneous junctions, and areas exposed to body fluids. In addition, some clinicians avoid areas of dense hair, such as the scalp. After the usual cleaning, debriding, and care to achieve hemostasis, the area is carefully dried.

1. Crush an ampule and invert it, soaking the cotton-tipped applicator with solution.
2. With the applicator, lightly paint over the approximated wound edge three times in succession with 30 seconds of drying time between.

> It is important to avoid both applying the fluid into the wound and spillage to surrounding areas, such as the eye. Because the adhesive is of low viscosity (runny), position the anatomic area in the horizontal plane to avoid runoff or protect surrounding skin with a barrier.

3. After full strength is reached at 2.5 minutes, a protective dressing can be applied at 5 minutes, but it is not required.

NOTE: Follow manufacturer's instructions for other application delivery devices that deliver a high viscosity version skin adhesive.

Follow-Up Care and Instructions for Sutured or Stapled Wounds

The following should be taken into consideration in sutures or stapled wounds:

- Advise the patient to keep the wound site clean and dry. Some clinicians advocate no contact with water at all for 48 hours, whereas others allow gentle bathing with soap and water or a quick shower with careful drying of the site afterward, but all emphasize no prolonged soaking of the site in water.
- If applicable, elevate the area.
- Instruct the patient verbally and in writing regarding the desired frequency of wound checking and dressing changing. It is suggested that the patient remove the dressing twice each day to visualize the site for signs of infection. Some clinicians advocate for antibiotic ointment application during this wound check. A clean, dry dressing should then be applied. Some sites may be left open to the air (face, neck, scalp).
- Instruct the patient to apply a cold compress for the first 48 hours after surgery in sites with significant associated soft-tissue involvement, such as a contusion (20 minutes each time four to five times per day).
- Verbalize and write the signs of infection for the patient to watch for and instruct him or her to return if there is an increase in pain, redness beyond the wound margin, or red streaking; if the area becomes warm, swollen, and tender; if there is discharge or drainage from the wound; if there is tenderness under the arms or groin; or if he or she experiences fever or chills.

- Consider possible activity restriction or immobilization.
- Consider analgesics (acetaminophen, nonsteroidal antiinflammatory drugs [NSAIDs]).
- Advise the patient about when he or she should return for a wound check and suture or staple removal.
- Educate the patient that scars take 1 year to mature fully and that after initial healing it is best to avoid strong sunlight and to apply sunscreen to the site.
- Administration of antibiotics is sometimes advised, although small, uncomplicated wounds and lacerations often do not require them. If the particular wound is high risk, a wound check in 24 to 48 hours may be necessary. It is always best to have the original provider assess the wound, if possible, because he or she has a baseline for comparison.

Antibiotics should be considered in the following high-risk wounds:

- Wounds that are more than 12 hours old at initial presentation, especially those of the hands
- Human or animal bites, including those caused by the patient's teeth (intraoral laceration)
- Crush wounds
- Heavily contaminated wounds
- Wounds involving relatively avascular areas, such as the cartilage of the ear
- Wounds involving joint spaces, tendon, or bone
- Severe paronychia and felons
- Wounds in patients with a history of valvular heart disease
- Wounds in patients with immunosuppression (diabetes, chronic steroid use, infection with human immunodeficiency virus [HIV])

Suture Removal

Anatomic location dictates the length of time sutures should be left in place to ensure adequate healing. Table 32.4 may be useful as a general guide. It is important to remember that adults heal more slowly than children and that other medical conditions may increase healing time.

Table 32.4

Recommended Intervals for Removal of Percutaneous (Skin) Sutures

Location	Days to Removal
Scalp	6–8
Face	4–5
Ear	4–5
Chest/abdomen	8–10
Back	12–14
Arm/leg*	8–10
Hand*	8–10
Fingertip	8–12
Foot	12–14

* Add 2 to 3 days for joint extensor surfaces.

From Trott AT. *Wounds and Lacerations: Emergency Care and Closure,* ed 2. St. Louis: Mosby–Year Book; 1997, p 366.

- Before the sutures are removed, inspect the wound for signs of infection, including erythema beyond the wound margin, discharge, swelling, pain, or tenderness.
- Some practitioners advocate the use of povidone-iodine (Betadine) both before and after suture or staple removal.
- Using sterile instruments, cut the suture to minimize dragging contaminated suture through the patient's body.
- If sutures are tight and difficult to cut, consider the use of a no. 11 scalpel blade. Turn the sharp side away from the patient to sneak under the suture to avoid excessive pulling. Diagrams of correct and incorrect methods of various stitch removals are shown in Fig. 32.13.
- It is important to ensure that all of the nonabsorbable suture is removed and none is left inside the wound to act as a foreign body.
- Often, minimal erythema surrounding the wound, secondary to local reaction to these materials, is alleviated 24 to 48 hours after the sutures are removed.
- Some practitioners advocate the use of antibacterial ointment.
- Most wounds should be left open to the air at this point and do not require a dressing.

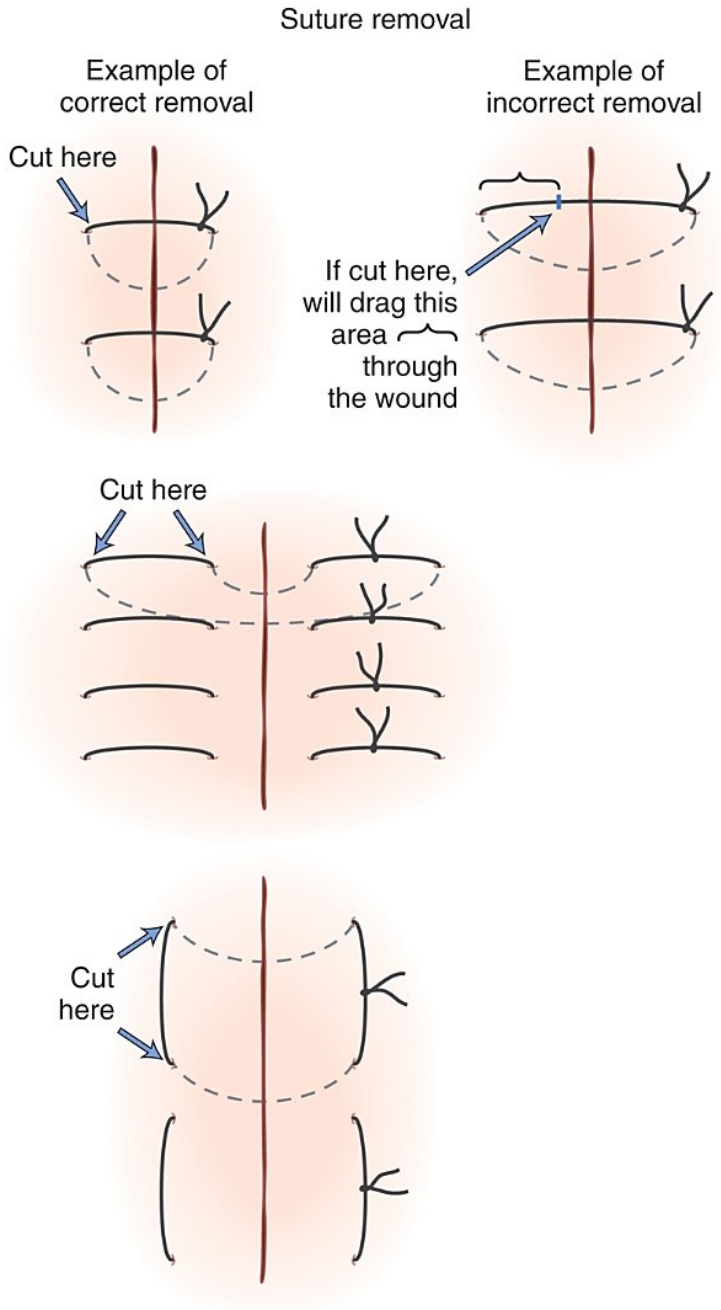

FIGURE 32.13 **Suture removal.**
[Top = Simple Interrupted, Middle = Vertical Mattress, Lowest = Horizontal Mattress]

Staple Removal

- Align the staple remover so that it is centered under the staple.
- It is important to recognize that the staple removal device is squeezed and then the staple is lifted in two distinct motions; combining them is painful to the patient and traumatizes tissue.

- Often, minimal erythema surrounding the wound, secondary to local reaction to the staples, is alleviated 24 to 48 hours after the staples are removed.
- Some practitioners advocate the use of antibacterial ointment.
- Most wounds should be left open to the air at this point and do not require a dressing.

Follow-Up Care and Instructions for Adhesive-Closed Wounds

- Notify the patient that the adhesive naturally starts to slough off 5 to 10 days after placement.
- Caution the patient to avoid scratching, rubbing, or picking at the site.
- Instruct the patient that the area should not be scrubbed, soaked, or exposed to prolonged wetness (the area should be kept dry; a quick shower can be taken, if necessary).
- Advise the patient not to apply medication in liquid or ointment form to the site.

The cost of skin adhesives is comparable when costs for suture kits, suture materials, clinician time, and follow-up visits for suture removal are considered.

Example of a Wound Closure Procedure Note

Date of Procedure _____
Consent _____
Time Wound Open _____
Mechanism of Injury _____
Anatomic Location/Associated Injuries _____
Length and Depth _____
Wound Classification (e.g., Clean, Dirty) _____
Cleansing Method/Irrigation Volume and Type _____
Anesthesia and Method _____
Suture Size and Type _____
Closure Method/Technique _____
Dressing Method _____
Patient responses or complications _____
Disposition/Follow-up _____
Patient Education Instructions _____
Signature_____

Disposal of Materials

Be sure to dispose all sharps, such as suture needles, into an approved needle/sharps container; and also be sure to avoid touching the needle with the fingers. Disposable instruments should also be disposed of according to institutional guidelines.

Further guidance Newell, K. Demonstration of Suturing and Stapling Techniques, Available at https://youtu.be/iA4X48fDmTo and the Subcuticular Stitch. Available at https://youtu.be/tCd_rhhNBRU Ethicon. Wound Closure Manual. New Brunswick, NJ: Ethicon.

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CHAPTER 33

Wound Dressing Techniques

Edward L. Williams

Abstract

Proper wound-dressing techniques consist of applying an appropriate wound dressing correctly to optimize healing and prevent infection. The indications, contraindications, and rationale for applying a wound dressing are discussed. Additionally, patient preparation, including informing the patient about the procedure of wound dressing, use of appropriate personal protective equipment, and cleansing of the wound, is discussed. Other topics include type of wounds, the wound healing process, properties of the ideal dressing, and standard precautions. Also discussed are the various types of dressings as well as characteristics of primary and secondary dressings. Proper application of wounds dressings is also discussed to include application on difficult areas such as fingers and areas of flexion. Finally, follow-up care and instructions are also reviewed.

Keywords

applying dressing
healing process
ideal dressing
primary dressing
secondary dressing

wound care
wound dressing
wound dressing selection
wound healing
wound infection
wound type

Procedure Goals and Objectives

GOAL: To apply wound dressings correctly, which will optimize conditions for healing.
OBJECTIVES: The student will be able to:

- Describe the indications and contraindications for applying a dressing over a wound.
- Identify the common complications associated with wound dressings.
- Describe the types of wounds.
- Describe the three biologic phases of wound healing.
- Identify the appropriate types of dressings and the rationale for their use.
- List the complications of dressing application and recognize the associated signs and symptoms.
- Demonstrate proper technique for dressing a wound.
- Describe wound follow-up care instructions to the patient.

Background and History

Several types of skin lesions benefit from the application of dressings: wounds from trauma or surgical intervention; ulcers from an arterial, venous, diabetic, or pressure cause; or burn injury. This chapter presents some of the basic principles of dressing techniques for wounds. The sources in the bibliography are provided for more in-depth information for the clinician who works in a setting where wound management is an ongoing responsibility.

Research and technology have significantly enhanced the medical community's ability to optimize healing and thus better treat wounds. Many new dressing materials are available, and much more is known and understood about the body's mechanisms of wound healing. When trauma occurs, either by accident or surgical intervention, the goal of managing the wound is to optimize the healing potential while preventing possible complications such as infection or deformity.

During the Middle Ages, Henri de Mondeville (1260–1320) made a major stand on the principle of cleanliness to avoid suppuration, a popular belief that remained in effect for centuries. In 1460, Heinrich von Pfolspeund wrote a book regarding trauma titled *Bundth-Ertznel,* which means "bandage treatment." Von Pfolspeund had considerable war experience, during which he developed a breadth of knowledge about war-related traumatic wounds. He subscribed to the belief that only certain types of wounds should be closed and that for most war wounds, oil of turpentine should be poured into the wound, with the resulting suppuration being a sign of healing. Von Pfolspeund wrote that wounds should be bound with clean white cloths, for if not clean, harm would result. He also advocated that physicians wash their hands before tending to individual patients.

In 1545, Ambroise Paré, a military surgeon, was accustomed to treating wounds with boiling oil. The custom was to pour boiling oil into the wound to stop suppuration. When Paré's supply of boiling oil ran out he simply dressed the wounds with clean cloths and minimal medication. He was dumbfounded to find on the following morning that the soldiers treated without the boiling oil were

relatively free of pain, afebrile, and resting comfortably. Paré spent the rest of his life advocating keeping medications out of wounds and letting nature work. His expression, "I dressed him, and God healed him," made medical history.

It was during the 19th century that a better understanding of wound healing emerged, and antiseptic surgery was introduced in 1867. With the development of general anesthesia in 1847, surgeons were better able to carry out more deliberate surgical procedures. However, at that time, pus was still believed to be necessary to the healing of wounds. The brilliant work of Louis Pasteur in France and the discovery of bacteria as the source of infection changed the management of surgical cases. A British surgeon, Joseph Lister, concluded that microorganisms were the cause of the high mortality rate and implemented the use of carbolic acid (a powerful antiseptic). With the advent of spraying carbolic acid into the wound and around the surgical operative site, Lister's patient mortality rate dropped precipitously. The theory of asepsis was developed and is the standard of care today.

Today, more than 2000 brands of wound dressings are available. The clinician should be aware of the major types and categories of dressings and the indications for each.

Indications

A **wound dressing** decreases the risk for infection, and the correct material covering the wound optimizes the healing process.

A **wound dressing** decreases the risk for infection, and the correct material covering the wound optimizes the healing process.

The ideal dressing accomplishes the following:

- Maintains a **high degree of humidity** between the wound and the dressing

It is important to maintain a moist, but not wet or dry, environment.

- Provides thermal insulation for the wound, which provides a better environment for cellular growth (Fig. 33.1)
- Removes excess exudate and toxic substances from the wound
- Allows gas exchange
- Is impermeable to bacteria to prevent infection
- Does not leave particulate material or contaminants within the wound

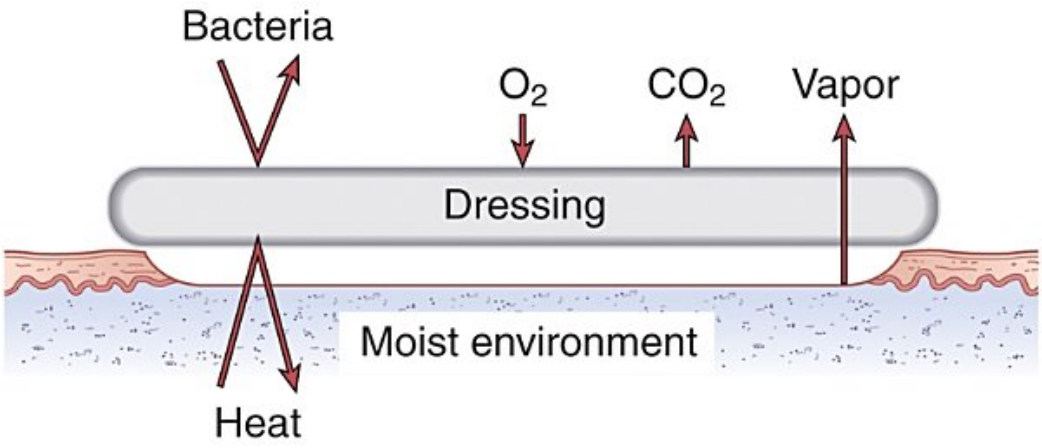

FIGURE 33.1 The ideal dressing.

Dressings are also indicated for the following:

- To apply the aesthetic principle of hiding the injury
- To protect the wound from accidental trauma, abrasions, self-inflicted "picking," or other irritations
- To provide support, immobilization, and compression

No single ideal product is available that provides all of these functions at once, but the clinician should consider carefully which **characteristics of the dressing** are the most important for the patient's wound. The wound treatment plan should consider factors such as the cause, severity, environment, size and depth, anatomic location, volume of exudate, and the risk or presence of infection.

Patient considerations, such as medical status, preferences, level of comfort, and cost-benefit analysis, must also be taken under advisement. The final factors to consider are the availability, durability, adaptability, cost, and uses of the wound care products.

The clinician should be aware of the major types and categories of dressings and the indications for each.

Contraindications

Ultimately, the dressing should not cause pain or traumatize the wound with removal. It is essential to avoid applying a dressing that may compromise the **blood supply** to the tissue within and surrounding the wound. No other significant contraindications apply to dressing a wound. Relative contraindications include the following:

It is essential to avoid applying a dressing that may compromise the blood supply to the tissue within and surrounding the wound.

- Skin sensitivity to the dressing and related products (i.e., allergies to tape, adhesives, latex, iodoform gauze, povidone, neomycin, or bacitracin) should be discussed with the patient before application of the dressing of choice.
- Persistent povidone application to a wound causes damage to the normal tissue and inhibits healing, and thus should be avoided.
- Decreased circulation in the affected area: Dressings can interfere with circulation in a digit or extremity if applied too tightly. Therefore, only material that stretches should be applied when the dressing will encircle an extremity.
- Application of gauze dressings, such as gauze squares (2 × 2-inch or 4 × 4-inch squares), directly on a wound: The gauze can adhere to the wound as the epithelial cells intertwine within the gauze. Removal of the dressing can cause removal of the eschar (scab) and new epithelial cells from the wound

and cause the patient significant discomfort. If a dressing has become adherent to a wound, it should be soaked in normal saline for approximately 10 minutes before removal is attempted. Some dressing materials have been designed to adhere to wounds less than traditional gauze does, and these should be considered when the potential for wound adherence is high.

- When dealing with elderly patients, carefully consider the texture and integrity of the skin before applying an adhesive tape directly to the skin. With the aging process, loss of collagen within the dermis and increased friability of the skin occur. Therefore, adhesives can readily tear the "normal" aged skin when removal of the adhesive tape is warranted to change the dressing. The way to keep a dressing in place is to use a gauze roll or elastic roll over the dressing and around the body part affected and apply tape only to the gauze or elastic roll ends or edges.
- When treating infants and children, be sure to reinforce the wound dressing with additional gauze covering the wound, thereby making it more difficult for the child to remove the dressing.

Essential Anatomy and Physiology

Wound Types

The **material used for a dressing** depends on the type, size, and location of the wound. The wound types include closed, open (full- or partial-thickness), necrotic, infected, granulating, and epithelializing.

The material used for a dressing depends on the type, size, and location of the wound.

Closed and Open Wounds

For a closed wound, in which the skin integrity is intact, no evidence indicates that a dressing decreases the risk for infection. Topical

antibiotics decrease infection rates in nonsterile wounds; nonadherent gauze dressings absorb exudate and prevent irritation. For an open wound, the objective is to encourage clean granulation by creating a moist environment without slough.

Necrotic Wounds

Necrotic wounds must be surgically debrided, if possible, to remove nonviable tissue, because necrotic tissue impedes the healing process. If the patient is not a surgical candidate, the use of hydrocolloids or hydrogels can facilitate debridement. Contact with the exudate causes the hydrophilic particles of the hydrocolloids to swell and form an impermeable gel. Rehydrating necrotic tissue separates from the normal tissues and sloughs off. Separation may take a few weeks depending on the size of the lesion. Hydrocolloids (e.g., DuoDerm) absorb exudate and produce a moist environment without maceration of the surrounding tissues.

Infected Wounds

Infected wounds should be treated with normal saline irrigation. Minor infections are adequately treated with saline bathing. Pack infected lacerations or lacerations at high risk for infection with nonadherent, absorbent dressing to prevent apposition of wound edges. Alginate dressings over the packing are used for more extensive infected wounds. These products contain calcium and sodium alginic acid prepared in a fiber form. Moisture causes the calcium alginate to convert to a soluble sodium salt and produces a hydrophilic gel. The gel is easily removed with saline irrigation or by bathing. Dressing removal is easy and comfortable for the patient.

Granulating Wounds

Granulating wounds require a moist environment, and removal of the dressing should not damage the tissue. Impregnated gauze (Xeroform) works well as long as the dressing is not allowed to dry out, in which case it then debrides the wound of new granulation tissue when the dressing is pulled off. Hydrocolloids or hydrogels with a transparent film covering are good alternatives to impregnated gauze.

Epithelializing Wounds

Epithelializing wounds (abrasions) should be treated in the same manner as granulating wounds, being careful not to remove the new epithelial layer when changing the dressing. Therefore, they should be covered with a nonadherent dressing, a biosynthetic sheet, or a transparent film.

Complex Wounds

Complex wound is the term used more recently to group those well-known difficult wounds, either chronic or acute, that challenge medical and nursing teams. Chronic wounds such as leg ulcers, diabetic foot ulcers, and pressure ulcers are common in both acute and community health care settings. They defy cure using conventional and simple "dressings" therapy and currently have a major socioeconomic impact. Complex wounds also include chronic venous ulcers, postinfection soft-tissue gangrenes, wounds after extensive necrotic processes caused by infections (Fournier and others), and chronic wounds related to vasculitis and immunosuppressive therapy that have not healed using simple care. Negative-pressure wound therapy appears to heal complex wounds more quickly than saline-soaked gauze.

Wound Healing

There are three stages in the healing process of a wound, regardless of whether the wound is surgical or traumatic in nature.

Inflammatory (0 to 6 Days)

Edema, erythema, heat, and pain characterize the inflammatory phase, which begins at the time of injury and lasts 4 to 6 days. Hemostasis controls bleeding, and polymorphonuclear leukocytes control bacterial growth. After about 4 days, macrophages migrate into the wound area and produce chemoattractants and growth factors, which facilitate wound healing.

Proliferative (4 to 24 Days)

In an open wound, granulation tissue is generated, which produces red, beefy, shiny tissue with a granular appearance. This tissue consists of macrophages, fibroblasts, immature collagen, blood vessels, and ground substance. As the granulation tissue proliferates, fibroblasts stimulate the production of collagen, which gives tissue its tensile strength and structure.

As the wound fills with granulation tissue, its margins contract, decreasing the wound's surface area. During epithelialization, cells migrate from the wound margins, ultimately sealing it. Epithelialization can occur only in the presence of viable, vascular tissue. When this phase is complete, a scar forms.

Maturation (21 Days to 24 Months)

During the maturation phase, the collagen fibers reorganize, remodel, and mature, gaining tensile strength. The maximal tensile strength that is regained is approximately 80%.

Poor Wound Healing

Advanced age, diabetes mellitus, immunosuppression, radiation therapy, vitamin deficiency, malnutrition, cancer, vascular insufficiencies, and wound infection are some of the more common causes of poor wound healing. If a wound is not healing readily, the clinician should undertake **a comprehensive evaluation of the patient**, looking for systemic inhibitors of wound healing.

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Environmental factors can impede wound healing, such as recurrent trauma or pressure on the wound site (which may occur with bending the affected area), edema that impedes oxygen flow to and from the wound, necrotic tissue within the wound, and patient incontinence, which can expose the wound to urine or feces. **Poorly**

healing wounds are at increased risk for infection, hemorrhage, dehiscence, evisceration, and fistula formation.

Environmental factors, such as recurrent trauma or pressure on the site of the wound (which may occur with bending the affected area), edema that impedes oxygen flow to and from the wound, necrotic tissue within the wound, and patient incontinence can impede wound healing.

Poorly healing wounds are at increased risk for infection, hemorrhage, dehiscence, evisceration, and fistula formation.

Prevention of Infection in Wounds

Clinicians must wash their hands before and after dressing a wound. A study conducted in April 2000 demonstrated a 16% compliance with handwashing before patient interaction and a 25% handwashing rate after patient contact.[1] However a study conducted in May 2018 demonstrated a more than 85% handwashing compliance rate, indicating better recognition of the necessity of handwashing by health care providers over time.[2]

The skin is the barrier against infection. When the skin is compromised, through trauma or surgical intervention, the patient is at risk for bacterial growth within the wound. The longer the wound is exposed to air particles, dirt, water, and so forth, the risk for infection increases exponentially. The appropriate surgical management, such as debridement, irrigation, or suturing, should be undertaken before wound dressings are applied. Debridement refers to the removal of tissue that is likely to impede the healing process, such as necrotic and unnecessary fibrinous tissue or damaged tissue that is unlikely to survive. This is typically performed as a surgical procedure, and its description is beyond the scope of this chapter. Irrigation involves cleaning the wound to minimize contamination by infectious and foreign materials. Typically, large quantities of normal saline solutions are used; large-capacity syringes can be used to spray the solution with sufficient pressure to irrigate structures

that may be difficult to reach. Wound closure and wound contamination classification are covered in depth in Chapter 32.

Prevention of wound infection in the trauma patient involves four steps. First and foremost is adequate and timely resuscitation of the patient. Hypoxia, hypovolemia, or both increase the risk for infection. Second is early wound care, which includes debridement, hemostasis, irrigation, and primary wound closure. Third is the application of antibiotics. Although most wounds do not require antibiotic therapy, if antibiotics are indicated, they should be administered early, using an agent that provides appropriate coverage of the most likely infecting microbes. In addition, achieving adequate concentrations of the antibiotic for bactericidal effects is essential. The fourth step is tetanus immune prophylaxis when indicated (see Chapter 35). These basic infection prevention principles are also applicable for nontraumatic wounds.

Standard Precautions

Every practitioner should use standard precautions at all times when interacting with patients, especially when performing procedures. Determining the level of precaution necessary requires the practitioner to exercise clinical judgment based on the patient's history and the potential for exposure to body fluids or aerosol-borne pathogens (for further discussion, see Chapter 35).

Patient Preparation

The following should be taken into consideration for preparing the patient for applying wound dressings:

- Inform the patient about the procedure of wound dressing.
- Explain to the patient exactly what is being done and why, and answer any questions that he or she might have.

Materials

Dressings should have the following characteristics: softness, permeability, sterility, and elasticity.

Primary Dressings

- Alginates

NOTE: These products are derived from brown seaweed. Alginates are absorbent and conform to the shape of a wound because they are provided in the shape of a rope (twisted fibers) or pads. An alginate interacts with wound exudate to form a soft gel that maintains a moist healing environment. Alginates can absorb up to 20 times their weight. These products absorb heavy exudate from a deep, draining wound, regardless of whether the wound is infected (Fig. 33.2).

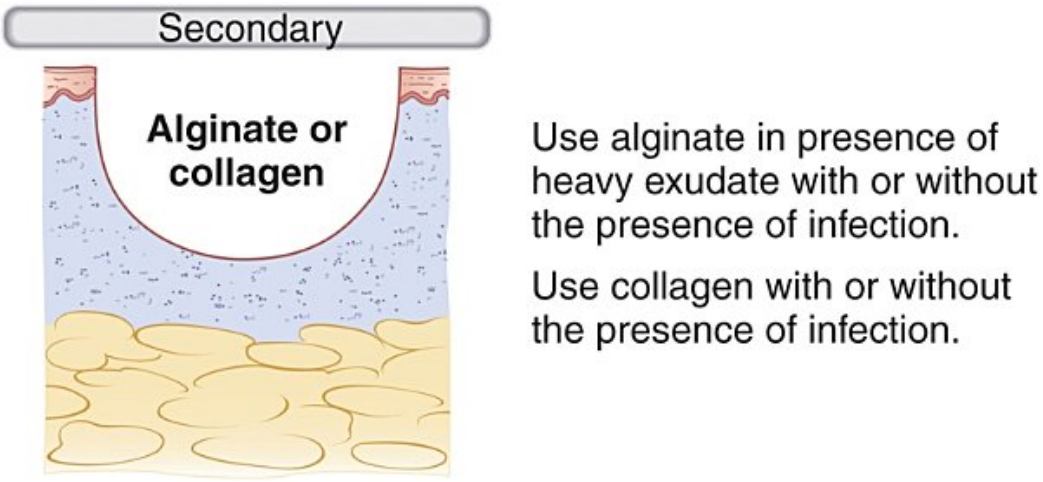

FIGURE 33.2 Alginate and collagen, which are used in the presence or absence of infection.

- Biosynthetic dressings

NOTE: Biosynthetic dressings were developed as temporary coverings for burns. A biosynthetic dressing may be a gel or a semiocclusive sheet that can be left in place for 1 to 10 days, depending on the clinical situation. Biosynthetic dressings facilitate wound healing by reepithelialization. These dressings may be used

to treat partial-thickness wounds, such as tears, burns, abrasions, and some pressure ulcers (Fig. 33.3).

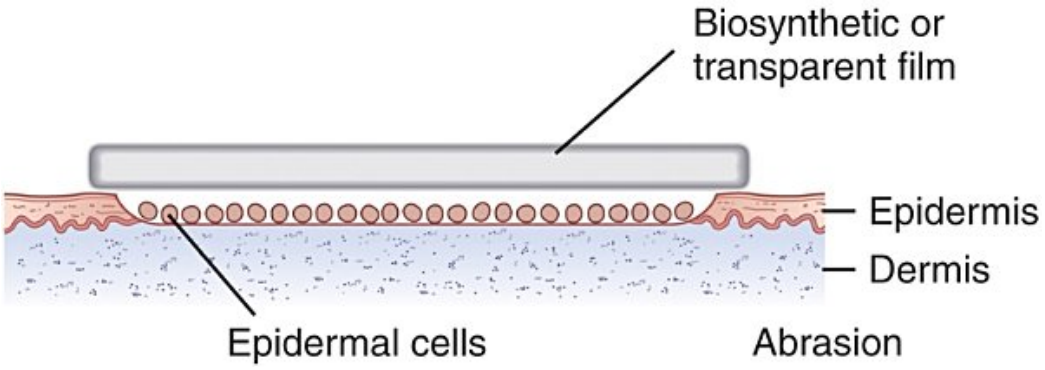

FIGURE 33.3 **The biosynthetic dressing.**

■ Collagens

NOTE: Collagen dressings may be used as a primary dressing for partial- and full-thickness wounds, regardless of whether they are infected (see Fig. 33.2). During wound healing, collagen encourages the deposition and organization of newly formed collagen fibers and granulation tissue in the wound bed. It stimulates new tissue development and wound debridement. With the use of collagen, a secondary dressing needs to be applied to absorb exudate. Collagen dressing products are available as sheets, pads, particles, and gels.

■ Foams

NOTE: Foam dressings are absorbent, nonadhering, and lint free. Foams may be either hydrophilic or hydrophobic and are nonocclusive unless they have a film coating. They are used as either a primary dressing, directly on the wound to provide absorption and insulation, or as a secondary dressing overlying a wound packing. Foams may require a secondary dressing to hold them in place if they do not have an adhesive border or film coating as an additional bacterial barrier (Fig. 33.4).

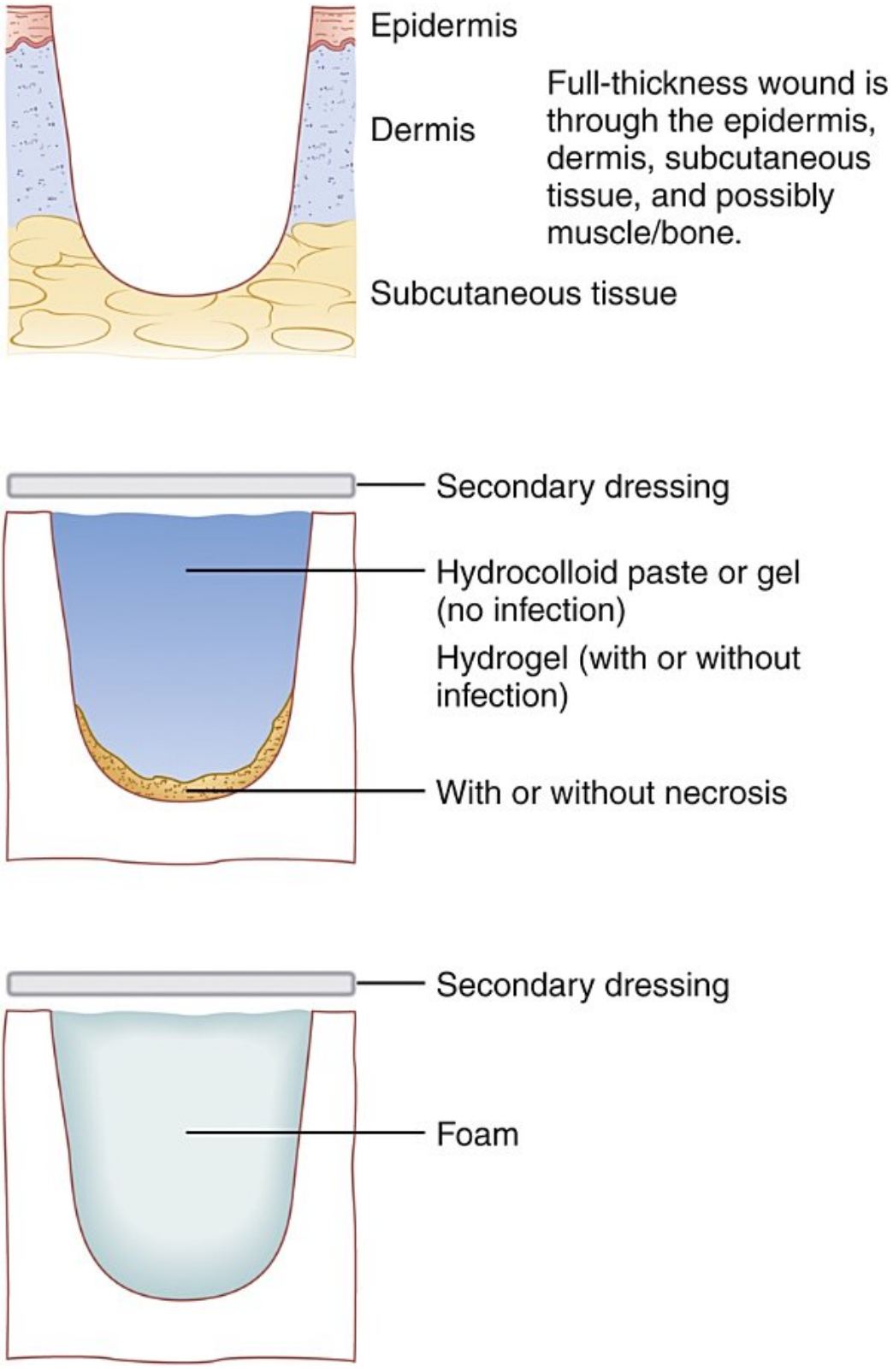

FIGURE 33.4 **The foam dressing.**

■ Hydrocolloids

NOTE: Hydrocolloids are occlusive or semiocclusive dressings that can be composed of gelatin, pectin, or carboxymethylcellulose (see Fig. 33.4). These types of dressings provide a moist healing environment that allows clean wounds to granulate or necrotic lesions to debride autolytically. These types of products are manufactured in various shapes, sizes, and forms, such as wafers, pastes, and powders. Hydrocolloid dressings are self-adhesive, provide light-to-moderate absorption capacity, minimize skin trauma, and may be used underneath a compression product such as Unna boots. However, they are not recommended for infected wounds or wounds with heavy exudate or exposed tendons or bones. Another benefit of this type of dressing is that it protects the lesion from contamination and can be left in place 1 to 10 days, depending on the type of lesion and placement.

■ Hydrogels

NOTE: Hydrogels are water- or glycerin-based amorphous gels. The gels can be applied to wounds directly; also, gauze or sheets impregnated with the hydrogel are available. They do not absorb exudate because of their high water content. These dressings maintain a moist wound environment, thereby promoting granulation and epithelialization or autolytic debridement of necrotic lesions. They are indicated for the management of partial- and full-thickness wounds, deep wounds, wounds with necrosis, slough, minor burns, and tissue damaged by radiation (Fig. 33.5). These dressings are applied and removed easily and can be used when infection is present.

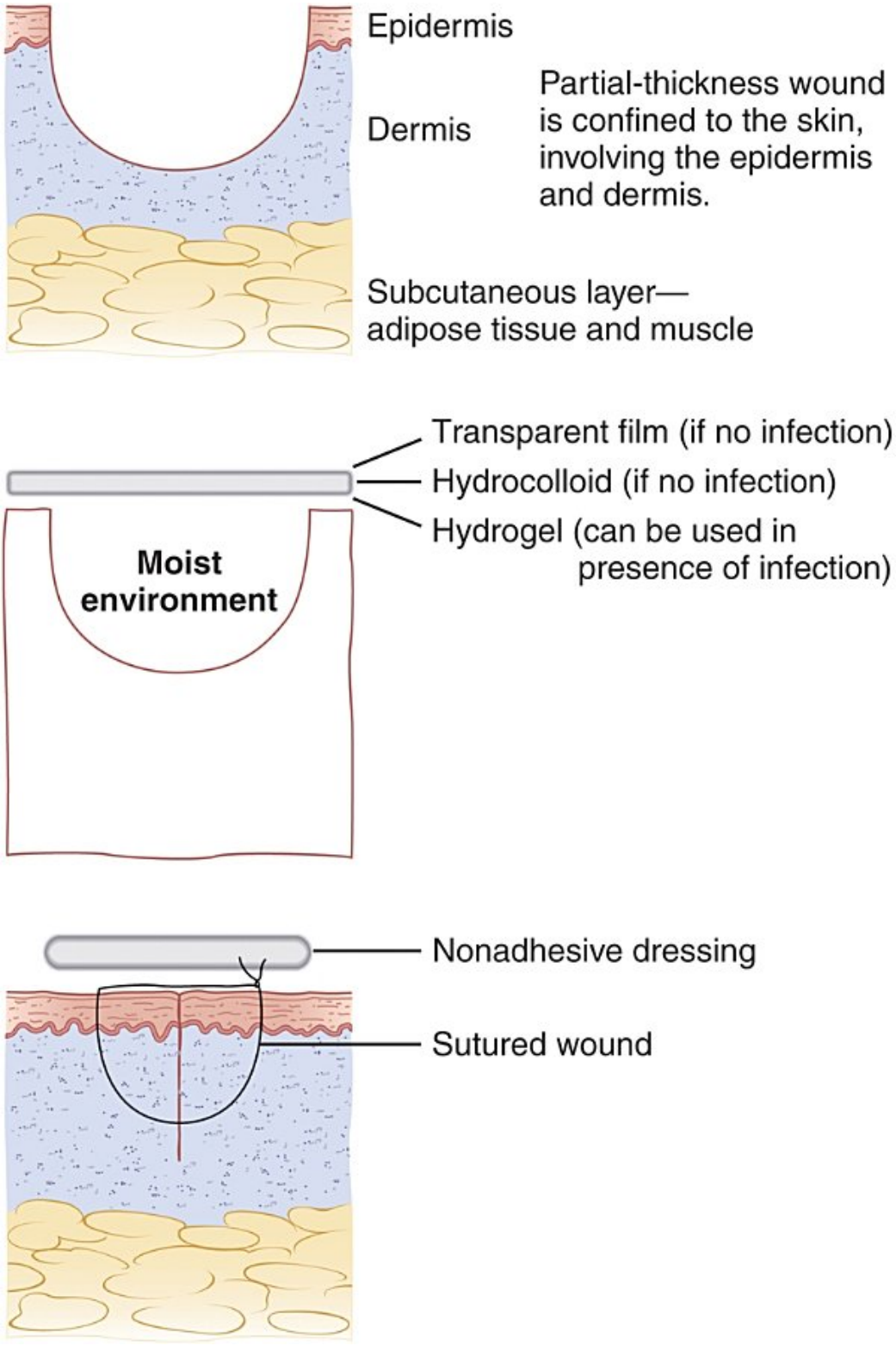

FIGURE 33.5 **The hydrogel dressing.**

Secondary Dressings

- Transparent films

NOTE: Transparent films are adhesive, semipermeable, polyurethane membrane dressings that vary in thickness and size. These films are waterproof and impermeable to bacteria, yet they permit water vapor to cross the barrier. Transparent films allow direct observation of the wound and do not require a secondary dressing. The limitations are that they should not be used on fragile skin or with infected wounds.

- Dressing gauze

NOTE: Gauze dressings are manufactured in many forms. They can be used as primary, secondary, or securing dressings. Gauze for cleaning, debriding, packing, and covering usually is available in the form of packets containing sterile 2 × 2-inch or 4 × 4-inch squares. Nonadherent gauze is an important improvement in gauze dressings because it does not stick to wounds and it facilitates exudate transmittal away from the wound. Gauze also comes impregnated with many different substances, such as oil emulsions, petrolatum, saline, silver, sodium chloride, water, or Xeroform. Some impregnated gauze dressings serve as occlusive dressings and prevent drainage from the wound.

- Flexible collodion

NOTE: Flexible collodion is a preparation of nitrocellulose dissolved in alcohol and ether. It is a plastic-like substance that is applied aseptically to a wound and forms a thin, clear sealant layer of plastic over the wound. This product is a good choice for scalp lacerations, where gauze dressing is difficult to apply.

- Dressing stabilizer (wrapping or rolling gauze)

NOTE: Rolls of dressing material are used to hold other materials against a wound. The ideal roll gauze has some elastic properties; it is used to add bulk and cushion to the dressing. Another type of wrapping gauze that is categorized as a dressing stabilizer is tubular gauze used to stabilize a dressing circumferentially (Tube-gauze). These types of dressings are applied using a stainless-steel metal-cage applicator and are useful for dressing digits.

- Tape
- Elastic bandage
- Tube gauze
- Cleansing materials
- Irrigation set
- Normal saline
- Hydrogen peroxide
- Povidone-iodine

NOTE: Antiseptic agents, such as povidone-iodine, can injure skin, delaying healing; therefore they should be used only when necessary and used sparingly on damaged skin.

Negative-Pressure Wound Therapy

Negative-pressure wound therapy (NPWT), also called vacuum-assisted wound closure, refers to wound dressing systems that continuously or intermittently apply subatmospheric pressure to the surface of a wound. NPWT has become a popular treatment modality for the management of many acute and chronic wounds. NPWT has been applied to a wide range of clinical situations, including the open abdomen, after surgical debridement of acute or chronic wounds (e.g., orthopedic, necrotizing infection, pressure ulcer), and reconstructive surgery (e.g., burns, skin graft, muscle flap) (Fig. 33.6). NPWT systems consist of an open-pore polyurethane ether foam sponge, semiocclusive adhesive cover, fluid collection system, and suction pump.

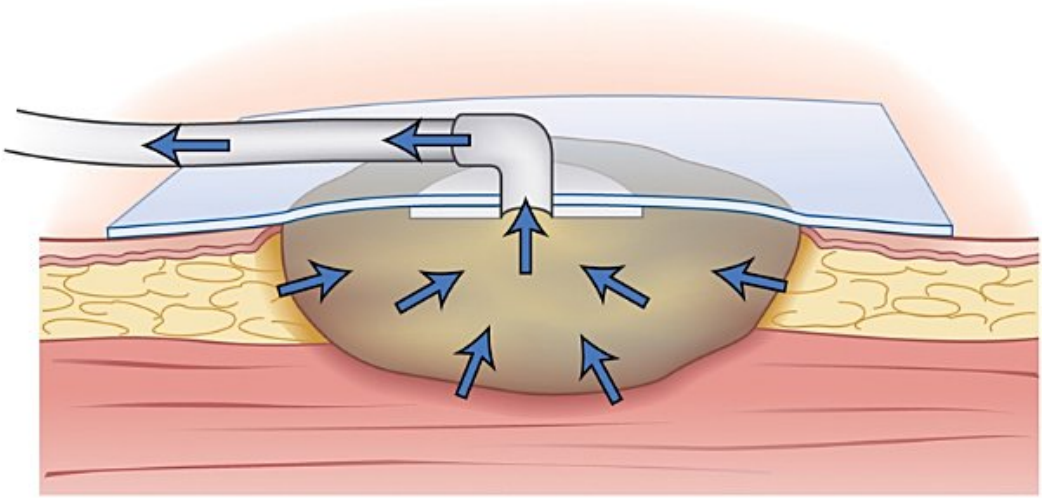

FIGURE 33.6 **Negative pressure wound therapy**

- The foam sponge is trimmed to fit the size of the open wound and placed into the wound, taking care that the foam does not extend beyond the margin of the wound.
- The foam is then secured beneath an adhesive sheet.
- A hole is cut in the adhesive and a suction port (more than one may be used) with tubing placed; the tubing extends to a disposable collection canister.

A portable pump is connected to the suction tubing. It is recommended that NPWT is used within a therapeutic range of −50 mm Hg to −150 mm Hg.[3] The porous nature of the polyurethane foam evenly distributes subatmospheric pressure to the surface of the wound and provides a conduit for fluid removal from the wound surface to the collection system. NPWT accelerates wound healing reportedly by the following mechanisms:

- Increased blood flow
- Diminished inflammatory response
- Altered bacterial burden
- Changes in wound biochemistry

Contraindications to NPWT are as follows:

- **Exposed vital structures**

It is important that all exposed vitals structures, such as blood vessels or major nerves, are avoided with NPWT.

- Ongoing infection, such as cellulitis, erysipelas, or necrotizing infections
- Devitalized tissue
- Malignant tissue
- Fragile skin
- Adhesive allergy
- Ischemic wounds

Procedure

Wound Dressing

1. Wash hands and don clean sterile gloves.
2. Clean the wound.

NOTE: Wounds contaminated with dirt or grease should be cleaned with mild soap and irrigated with water to remove the detergent. Irrigate deep wounds to remove excessive exudate, slough, or loose necrotic tissue (see Chapter 32). Closed wounds should be cleansed gently with normal saline or hydrogen peroxide to remove clotted blood from the wound edge, which can contribute to scarring, infection, or both. Excessive exposure to hydrogen peroxide can injure damaged skin, so make an effort to limit exposure to intact, dry skin surfaces only.

3. Determine the appropriate primary dressing based on the factors described previously. Maintain aseptic technique when applying dressings (see Chapter 33).
4. Apply the secondary dressing to absorb excessive exudate as well as provide a cushion (Figs 33.7 and 33.8).
5. Secure the dressing in a fashion that will provide flexibility and not restrict the movement of the patient, unless such

restriction is warranted by the nature of the wound (Fig. 33.9).

6. Make sure that the tape is wide enough and long enough to adhere the gauze to the skin.
7. Wounds overlying flexor surfaces on the extremities or digits will be unduly stressed with flexion of the joint; therefore, range of motion should be somewhat restricted to prevent dehiscence (Fig. 33.10). Splints or bulky dressings should be considered to reduce the range of motion of the affected joint.
8. Apply dressings to cover sutured wounds.

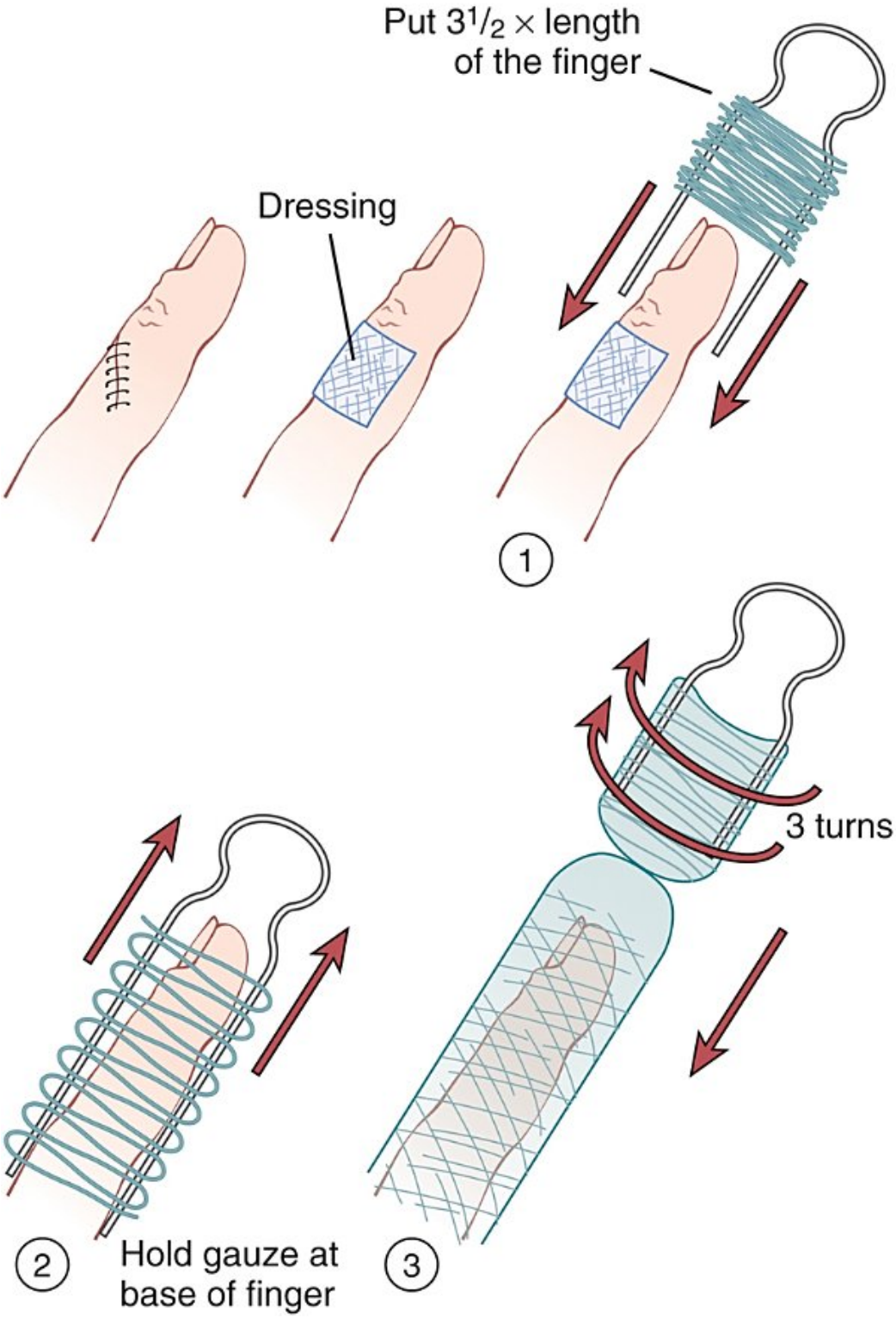

FIGURE 33.7 **Application of tubular gauze.**

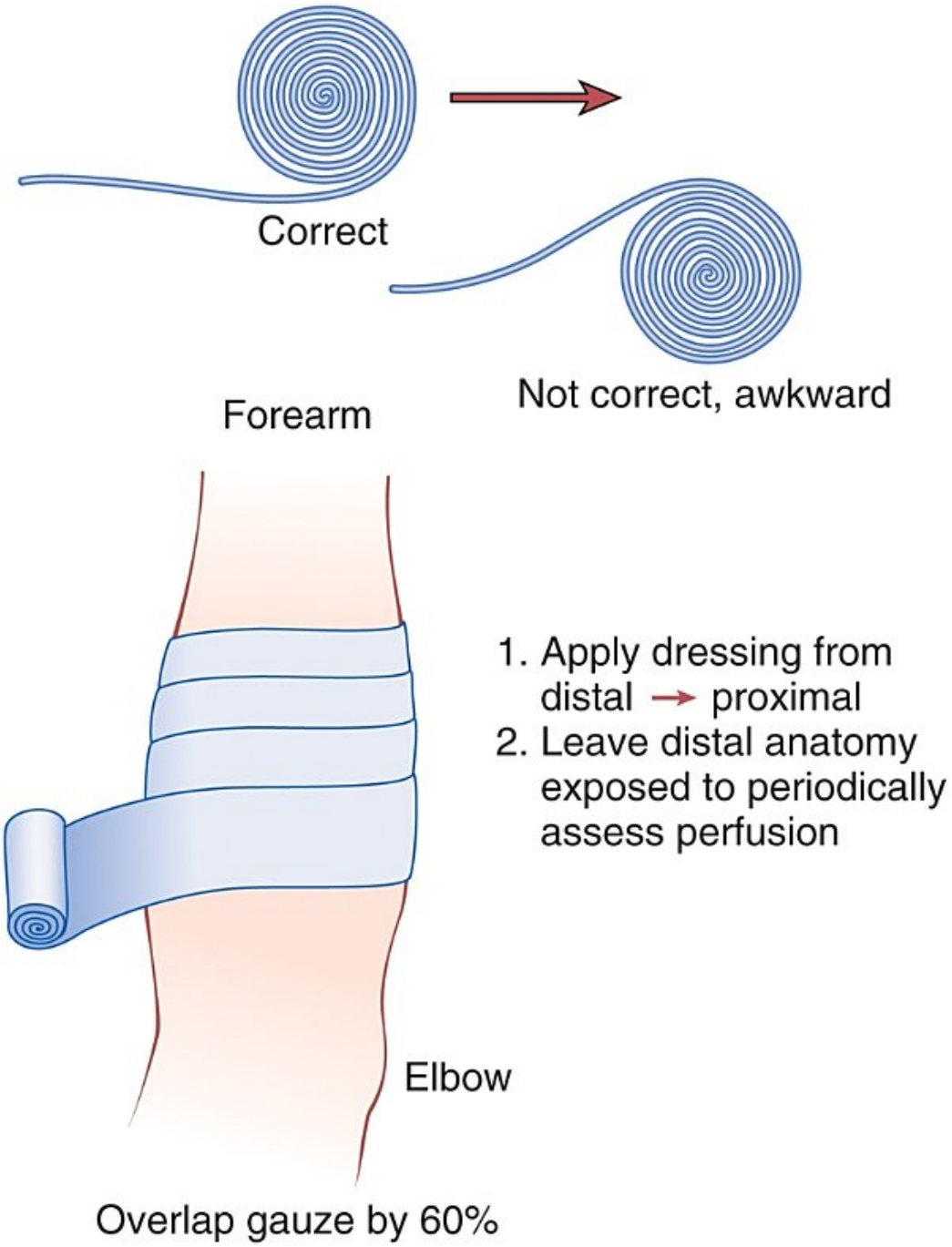

FIGURE 33.8 **Proper application using roll gauze.**

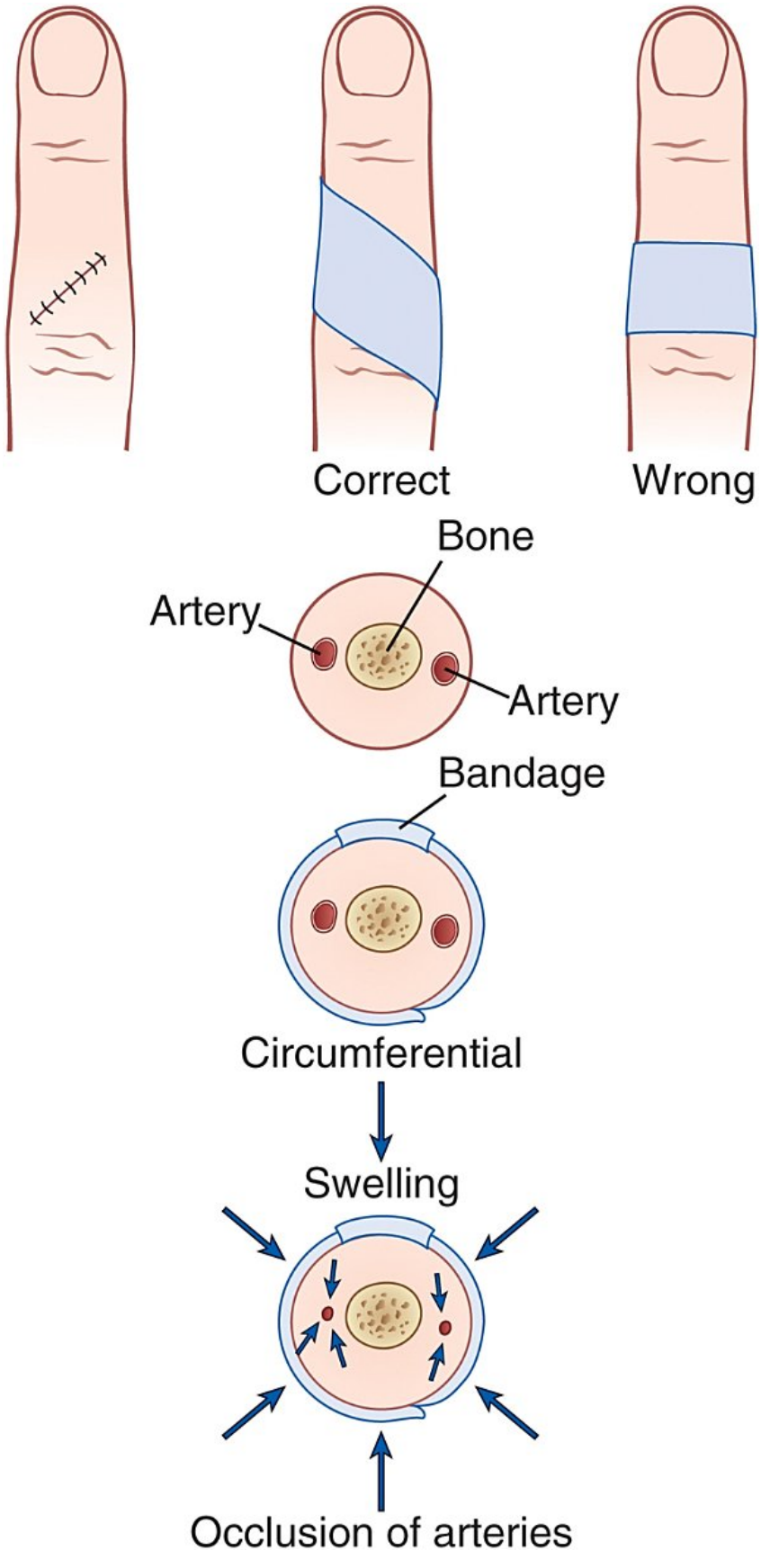
Correct
Wrong
Bone
Artery
Artery
Bandage
Circumferential
Swelling
Occlusion of arteries

FIGURE 33.9 **Prevent tamponade.**

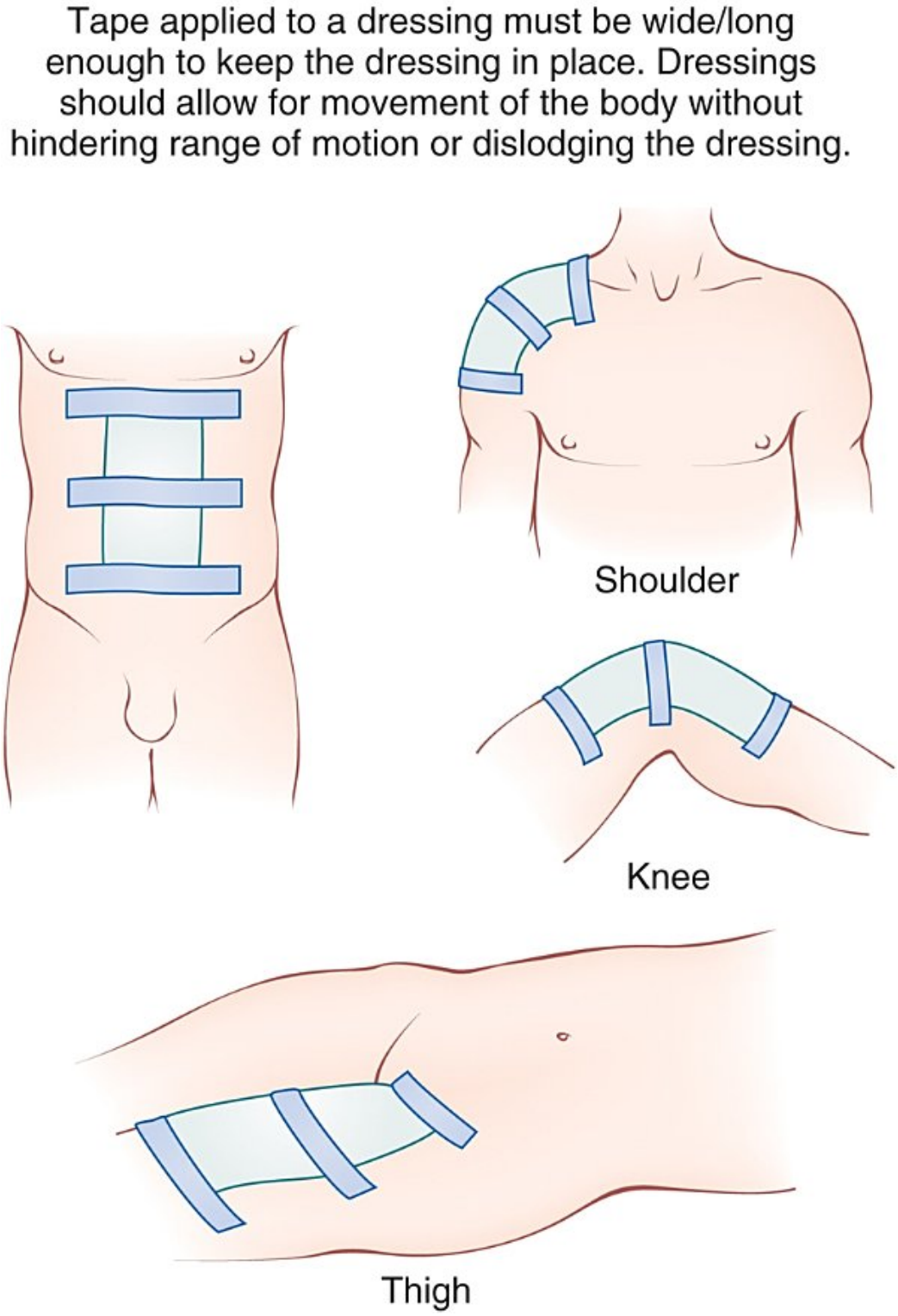

FIGURE 33.10 **Proper tape placement for bandages in areas of flexion.**

Follow-Up Care and Instructions

The following should be considered in providing follow-up care and instructions for wound dressings:

- When indicated, the patient or caregiver should undertake dressing changes. Carefully explaining the procedure to the patient helps facilitate timely, appropriate, and effective wound management. Noncompliance or the inadequate communication of information can result in poor healing, infection, pain, and disfiguring scars.
- Instruct the patient to apply a new dressing after cleansing the wound, if the dressing becomes wet or dirty, or after a certain amount of time has passed, typically 2 to 3 days.
- Instruct the patient to clean the wound gently approximately three times per day using a minimal amount of hydrogen peroxide on cotton swabs or gauze and then gently blot the wound dry. Dried blood or superficial coagulum should be removed from the wound edges to prevent widening of the final scar.
- Reassure the patient that body hygiene can be maintained by showering, but that the shower spray should not spray directly on the wound. Advise against bathing in a tub because of the possibility of an infection developing in the wound.
- Instruct the patient to observe the wound edges for increased redness or increased tenderness and to contact the office for assessment.
- Make the patient aware of what to expect concerning the progress of the wound over time. Normal wound healing often exhibits characteristics that can be confused with wound infections; therefore, describe in detail what the wound should look like and feel like in the course of the normal healing process. The normal healing process often involves a limited inflammatory response that produces erythema and tenderness for a few days.

- Additionally, make the patient aware of the signs and symptoms of a wound infection, which include erythema, pain, warmth, edema, discharge, throbbing, fever, regional adenopathy, and spreading erythema.
- Patients not able to perform dressing changes or evaluate the progress of their wounds may be candidates for visiting nursing services.
- Wound infections may require interventions that vary by factors such as severity and the proximity to other organ systems. Infections in closed wounds may require that sutures be removed or that incision and drainage be performed. Some infections may require aggressive systemic antibiotic therapy, especially those that are spreading by vascular or lymphatic systems or are following tissue lines such as fascia or muscle.
- Infected wounds should be cleaned with normal saline solution at least four times a day and the dressing changed.
- Instruct the patient to wash his or her hands with soap and water before and after tending to the wound.
- Instruct the patient to use the same primary and secondary dressing materials as used by the health care provider.
- When a wound is free of infection, sutures have been removed, all skin surfaces are dry, and the wound is no longer draining, the use of dressings can be discontinued. At this point, dressings may be still be used, when indicated, as padding to protect the fragile, newly healed tissues from damage resulting from physical trauma. However, in most cases, dressings can be discontinued when the indications for them, primarily protection of the wound, are no longer present.

Conclusion and Resources

Management of a chronic wound is a complex topic with extensive ongoing research to identify etiologic factors and to develop better materials and methods of dealing with the chronic wound. Surgical Materials Testing Laboratory (SMTL) sponsors a website

(http://www.smtl.co.uk) that lists wound care products. SMTL provides dressings datacards, technical papers, and test reports. The datacards contain information on many wound care products and detail the indications, contraindications, methods of use, frequency of change, warnings, presentation of the product, and sizes of the dressing products. The datacards also include a bibliography for each product.

SMTL is sponsored by the government of Wales to provide information to the National Healthcare Service. SMTL is a not-for-profit organization that sponsors the World Wide Wounds website, another resource that can be found online (http://worldwidewounds.com).

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CHAPTER 34

Informed Consent

Ellen D. Mandel

Abstract

Informed consent has a long and evolving history grounded in law, ethics, and societal perspective, and affects nearly every aspect of the clinician-to-patient bond. Historical abuse of informed consent birthed the Institutional Review Board (IRB), and case law has impacted informed consent with carefully defined terms such as capacity and competency. No non-emergent patient encounter or hospital admission is complete without the filing of carefully tailored informed consent paperwork. Yet, a core tenet of informed consent is its comprehension by the consenter, which requires embracing simple language designed to explain often complex activities - no simple task. Codes of Ethics stress appropriate informed consent constructs and clinicians are expected to assure the public trust with the long view in mind. History has shown that Informed Consent is a living, breathing process; clinicians should be mindful this.

Keywords

Clinician-to-Patient bonding
capacity
competency
comprehension
clarity

minors
disclosure
Codes of Ethics
blood transfusion
general consent
emergent consent
special consent
The Nuremberg Code
Institutional Review Board (IRB)
Salgo v. Leland Stanford Jr University Board of Trustees Case
Tuskegee Study
US Public Health Service
and Nazi physician experimentation

Procedure Goals and Objectives

GOAL: To provide clinicians with general considerations for medical informed consent.
OBJECTIVES: The student will be able to:

- Explain the historical basis and development of informed consent.
- Describe the philosophical doctrine of informed consent: The clinician-to-patient bond.
- List the four essential components of informed consent: **C**apacity, **c**ompetency, **c**larity, and authentic **c**onsent.
- Define circumstances supporting exceptions to the requirement for informed consent.

- Describe methods to improve comprehension of informed consent.

Narrative: A woman lies in pre-op on a gurney awaiting an elective laparoscopy for infertility, caused by adhesions from peritonitis many years ago. She trusts her surgeon and feels "prepared" for this "common" procedure. She hopes it will result in pregnancy. The anesthesiologist approaches with a checklist and begins his questions. He mentions insufflating air into her abdomen and the possible risk of perforation and so forth. The woman's eyes widen and her heart rate quickens as she asks him what he means. The anesthesiologist's eyes widen as he realizes that the woman was unaware of the details of her upcoming surgery and quickly covers the "basic points." The woman signs the document while the sedative begins to work. She awakens in post-op with protracted vomiting after a four-hour surgery. Too much insufflation, too little consent.

Brief History of Informed Consent

The term "informed consent" emerged in the 1950s, although its foundation is rooted with the Hippocratic Oath.[1] More recently, Physicians, Physician Assistants, and Advanced Practice Nurses (Clinicians) equate informed consent failures with historical events learned in school that markedly breached patient autonomy, an informed consent theme. Examples include the U.S. Public Health Service "Tuskegee Study of Untreated Syphilis in the Negro Male," or with the Nazi physicians experimentation leading to the Nuremberg trials, establishment of The Nuremberg Code and the subsequent Declaration of Helsinki.[1] These events fostered the creation of the contemporary Institutional Review Board (IRB), having more of a research focus, than on routine patient care. However, they established guidelines for voluntary consent of the human subject, describing key terms such as capacity and the exercising of free power of choice without elements of force, fraud, deceit, duress, and coercion.[1]

Similar to IRB research guidelines, the process of obtaining informed consent is the moral, ethical, and legal responsibility of all health care providers, and the human subject or patient must demonstrate sufficient subject matter knowledge and comprehension to make an enlightened decision.

In 1957, a landmark U.S. legal decision, Salgo v. Leland Stanford, Jr. University Board of Trustees, shined a bright light on procedural informed consent, emphasizing that consent for a treatments' nature and consequences was not enough, posing the question of whether the consent itself was adequately informed (Salgo).[2,3] In this malpractice action the jury awarded the defendant (the deceased patient's family) the sum of $250,000 against the defendants (physicians and facility), as the indicated procedure and its associated risks were not thoroughly explained. This award's 2018 monetary value would exceed $2 million. Clearly, fear of malpractice litigation provides a financial impetus to the moral and ethical features of informed consent.

In the 1970s, informed consent gained momentum as a result of malpractice concerns, leading to solidification that both physicians and researchers have not just a legal duty but a moral obligation to obtain consent for certain procedures.[3]

Current biomedical ethics maintains that informed consent must support autonomous choice by patients, knowing full well that, on some level, absolute informed consent is not possible.[3]

The Clinician-to-Patient Relationship: An Enduring Bond

The Principle of Respect for Persons/Autonomy is one of four ethical principles put forth by Philosophers Tom Beauchamp and Jim Childress and is essential to the clinician–patient compact and forming the essence of a morally complete informed consent process. Autonomy acknowledges a person's right to make choices, hold views, and make decisions on personal values and beliefs. The

maxim of "First, do no harm," or nonmaleficence, obligates the clinician to avoid an intentional infliction of harm. The remaining two pillars, justice and beneficence, promote the public trust, balancing patient autonomy with the greater depth and breadth of a clinician's medical knowledge and altruism, respectively.[3]

Informed consent is a two-way street between the clinician and the person being treated (the patient). The clinician is consulted for his or her knowledge and skills, and, under usual circumstances, there is alignment between recommendations and patient acceptance. However, this is not always the case, and the competent patient may exercise the right to personal autonomy and refuse the proposed treatment or procedure with impunity.

American law recognizes the fundamental right to control one's own body and to be protected from undesired intrusions. Clinicians have an "affirmative duty" to disclose relevant information, meaning that the clinician must volunteer the information, including risks and benefits, leaving the patient or surrogate to weigh the course of action. These specifics vary by state, with exemptions for emergency situations, and clinicians should be fully aware of those guiding their clinical care. Failure to do so may result in charges of battery, an intentional, nonconsensual touching of the patient.

Medical battery occurs when a patient is treated without patient's consent, when a clinician performs a treatment significantly different than the consented-to procedure, exceeds the scope of the consent, or when someone other than the consented provider performs the procedure.[4]

A claim of clinician negligence, which is related to battery, is a violation of a statute or regulation causing the type of harm that a statute was meant to prevent. Generally four elements need to be established for liability of the clinician and the patient defendant: (1) duty to meet a particular standard of care, (2) failure to perform that duty, (3) causal connection between the clinician's failure and the patient's injury, and (4) an injury for which monetary compensation provides adequate relief.[4] Empathy for the patient's position,

anticipating the patient's possible fears and anxieties,need for essential medical information, and seeking to foster a truthful clinician-to-patient relationship reduces risk of liability.[4]

The Four Cs: Capacity, Competency, Clarity, and Consent

The first two for adult patientsare **capacity and competency,** similar yet slightly different terms. **Capacity** describes a person's ability to understand about a condition/treatment, expressing a choice, appreciation, and reasoning about proposed treatment options with a decision congruent with one's values and preferences. **Competence** refers to a legal judgment, informed by an assessment of capacity and relating to an individual's legal right to make his or her own decisions.[4] In adults, competency defaults to the affirmative unless there is a formal and legal declaration of incompetence. On the other hand minors (less than age 18 or 19; age varies by state) are generally presumed to be legally incompetent based on emotional maturity and cognitive development. Clinicians should also be familiar with consent and confidentiality policies of their practice facility.[4–6]

Four essential conditions must be met for a patient's informed consent.

A third essential condition, **clarity,** is that patients must be provided candid and clear information, at a comprehensible language and level, which includes the expected course if no treatment is provided, risks/benefits, probabilities/uncertainties associated with the treatment, options/alternatives to the treatment, and a clinician recommendation supported by best clinical judgment.[4] The latter is not intended to support a paternalistic position, but to allow clinicians to offer the benefit of their cumulative wisdom, something patients often expect and desire. The shift from beneficence-focused medical care to supporting patient's decision-making autonomy is a paradox of choice, which only

heightens the importance of the informed consent. Physicians are primarily responsible for informing their patients; however, other clinicians and team members may supplement and enhance the provided information.[4,5]

The fourth condition is voluntary patient **consent** without coercion, manipulation, or duress. The known power mismatch between clinician and patient may result in the most well-meaning clinician slipping from supporting patient autonomy to paternalism in the guise of beneficence.[4,5] A useful acronym PARQ improves thoroughness: **P** is the explanation of the medical **p**rocedure, **A** is viable **a**lternatives, **R** material **r**isks, and **Q** is the last but all-important step of soliciting patient **q**uestions. This simple acronym improves proper medical record documentation of informed consent.

Minors

Minors may attain emancipation through marriage, military service, or living separately from parents and managing one's own financial affairs. This differs from medical emancipation, which is not a specific legal status. There is significant variability between state statutes regarding consent for medical care, including contraceptive services, termination of pregnancy, treatment for sexually transmitted infections, and prenatal care. The Guttmacher Institute serves as an excellent resource (https://www.guttmacher.org/united-states/teens/state-policies-teens).[6] The American Academy of Pediatrics Committee on Bioethics endorses the protection and health-related interests of the child and adolescent, citing the fiduciary relationship of acting in the best interest of the patient. Further, this duty may conflict with the parent's wishes, creating tension between the patients, parents/family, and clinician.[6]

Applying the adult definition of autonomy in the pediatric population is neither realistic nor legally imperative; discussions should be developmentally appropriate with the goal of securing "informed permission," assent, or dissent while promoting essential ongoing patient trust.[6]

Standards of Disclosure

Standards of disclosure have evolved. An early one, known as the professional standard or prudent physician, requires that the clinician disclose information that another clinician with the same skill-set and practicing in a similar community would disclose, or what a reasonable and prudent physician would disclose.[7] This approach supports the standard of practice as defined by the clinician, endorsing an age-old paternalism, whereas a more patient-centric model, the reasonable person standard, provides the information that a reasonable person would consider significant to make an informed decision.

> This reasonable patient standard is currently applied in approximately one- half of US states, yet many clinicians fail to meet the basic tenets of disclosing all relevant information and risks, benefits, and alternatives that an objective patient would find material in making an intelligent decision.[7]

This may change with mounting government scrutiny of shared decision-making documentation relative to reimbursement.[7]

A third approach is the subjective standard that is tailored to the specific needs of the patient. The clinician must assure meeting the legal requirements while including the moral/ethical features for an informed disclosure. And, of course, any significant posttreatment adverse outcome is likely to convert to "material" or important once it has happened.[5]

Regardless of the applied standard, assuring patient comprehension goes beyond the amount and kind of information conveyed, just as informed consent goes beyond a signature on a page. Explanations should be simple, clear, and educational.[8] Decision aids can provide balanced, evidence-based information about treatment options that usually are easier to read (fifth grade level) and may contain pictures and figures. Focus on the difference between patient knowledge over simple recall and patients'

deliberation abilities. Levels of anxiety, language and/or cultural differences, health beliefs, and physical impairments may form invisible process barriers. An interpreter may be necessary. One useful method applies the "teach-back" approach, whereby patients "explain" their interpretation of what they have been told. Documenting these step helps assure an authentic informed consent.[8] Further essentials are timing of the consent discussion and allowing adequate time for the process while keeping the patient's autonomy front and center.[8]

Types of Consent

Consent definitions vary by circumstance and fall into three categories: special, implied, and general.

Special consent is required for specific high-risk procedures or treatments. For example, in an intensive care unit, consent may be secured at the time of the procedure or as an anticipatory bundled consent for procedures that may occur.[4,5]

Implied consent is often used under emergent circumstances. In an emergency department, the courts have recognized the doctrine of implied consent, whereby formal consent is waived during situations when the person requiring immediate life-saving treatment is unconscious or otherwise temporarily incapacitated, assuming that no reasonable person would refuse the intervention. These include administering CPR to someone who collapses on the street with cardiac arrest or establishing central vascular access in the setting of a massive upper gastrointestinal hemorrhage.[4,5]

General consent is often obtained on hospital admission, providing blanket consent for routine services and routine touching by the health care staff, and may also cover consent for certain invasive procedures that are part of routine ICU care.[4,5]

"Therapeutic privilege," a specific type of information withholding or nondisclosure, may be applied if the disclosure would interfere with treatment or would adversely affect the

patient's condition or recovery. Careful circumstance documentation is essential.[4,5]

Consent for everyday treatments and office visits is verbally consented when the patient has solicited a clinician's opinion and advice and receives easy-to-understand treatment. However, disagreements may arise from verbal consent. Written consent is the preferred form of consent because it provides concrete evidence of an exchange of information with its associated assent. It is legal and binding on the patient, providing it is fully informed. Consent by design is meant to assure patient understanding; however, it also protects the clinician and if properly executed, entry-documented in the patient's medical record, and is often central to a successful malpractice defense if a treatment issue develops.[5]

An important area of potential consent disagreement involves blood/blood products infusions. Some cultures equate blood donation with depletion of another's life force or patients may fear transmission of blood-borne diseases. Jehovah's Witnesses introduced a blood ban in 1945 based on the strict literal interpretation of several scriptural passages of the Bible. Under the aforementioned circumstances, clinician's cultural humility and sensibility are tested, as medical necessity is balanced with a competent patient's preference.[9] In the case of patient incapacity, relatives or friends who suggest that a patient would not accept a blood transfusion must be asked to provide documentary evidence. It is the duty of the clinician to respect the competently expressed views of the patient even if this amounts to death for lack of blood. Potential medical need for blood transfusion of a child generates strong feelings with legal and societal ramifications. Clinicians should consider consultation with their ethics committee, and/or a risk management group for legal protection advice. The courts have upheld the validity of competent patient refusals as well as refusals contained in advanced directives.[5,9]

Consent document language content requirements may vary by state. The general consent form (not special) identifies the patient, describes the proposed procedure, the procedure goals; steps,

risks, and benefits that were discussed; the indications; and the alternatives.

Pertinent patient questions (the Q in PARQ), should be documented. The note should specify that the patient authorizes the clinician obtaining the consent form to perform the procedure. As appropriate, the consent form should also contain clauses dealing with photography, disposition, and use of removed tissues, organs, and body parts.[4] Further, patients should be made aware that they may strike out any part of the form for which they do not consent, with the clinician documenting how patient refusal of portions of the consent may limit the clinician's ability to proceed in a standard fashion. The clinician may also advise the patient to seek alternative care if the restrictions might result in a suboptimal clinical outcome or interfere with good medical practice. A mutual understanding should be reached whenever possible.[4,7] Most states require a consent form be witnessed. Risk of conflict of interest suggests avoiding sole witnessing by office personnel.

Clinicians may misconstrue that a signed document constitutes an informed consent; it does not.[3]

The clinician must be confident that information-transferring occurred and patient comprehension is present to the degree possible. The right to agree to treatment is as important as the right to refuse it. When this occurs, careful documentation of the refusal is essential, especially the patient's understanding of the potential consequences of the refusal. A proper witness is recommended.[4,5]

Capacity Concerns

A need for surrogacy may arise if capacity is compromised. The clinician must distinguish between cognition, which describes various brain functions; functional status, which relates to activities such as proper taking of medications; and actual capacity.

No simple test exists for capacity; it may be a dynamic process.

High-risk conditions include delirium, moderate to severe Alzheimer's dementia, Parkinson disease, schizophrenia, substance abuse, traumatic brain injury, and those at the end of life. Capacity assessment, an essential to informed consent, takes on special importance when associated with high stakes decisions, extremes in range of risks/benefits, and the history of inconsistencies in prior decision making. A structured capacity assessment should be completed face-to-face and evaluate areas of understanding, choice expression, and appreciation for the situation and reasoning ability. Clinicians should determine which validated instrument is used by their facility/institution.[5] One such publicly available option is The Short Portable Assessment of Capacity for Everyday Decisions (ACED), which is quantifiable, patient centered, and decision specific (https://www.ono.ac.il/wp-content/uploads/The_Short_Portable_ACED.pdf).

Patients may decline the capacity assessment related to mistrust or to feelings of lack of respect. Reinforcing the clinician's honest interest in the patient's perspective and assistance from trusted family members or friends may be necessary. Of course, family members may not agree with the patient's preferences.[5]

Handling Patient Lack of Capacity

Urgency and degree of need to act inform surrogate appointment. Efforts should be instituted to treat reversible causes of capacity failure (i.e., delirium). Not all patients with Alzheimer's dementia or mental illness lack capacity. However, should a surrogate be deemed necessary, the clinician must secure any previously executed patient-selected surrogate. In the absence of such an appointed surrogate, the state law dictates the hierarchy of surrogacy appointment, which is generally the spouse, adult children, parents, siblings, or other relatives. If this fails, or if the parties cannot agree, formal guardianship, a less-common event, is assigned by a court of law based on the legal determination that the patient is decisionally

incompetent. Repeated assessments may be indicated owing to the competency waxing and waning.[5]

A Long View of Informed Consent: When Consent Lives On and On

Informed consent poses future ramifications as clinicians grapple with complex technology, such as next-generation genetic sequencing, as well as banking and future use of biologic specimens.[3,10] An additional area of inquiry is societal stewardship, which addresses how clinicians may consider moral- and justice-related aspects of distributing our limited financial resources and the significant percentage of medical care dollars utilized for end-of-life care and serious chronic illnesses and functional debility.[3,10] These issues will challenge clinicians, both professionally and personally. Best to begin thinking about them sooner than the later.

Codes of Ethics

The American Medical Associate (https://www.ama-assn.org/delivering-care/code-medical-ethics-consent-communication-decision-making), the American Nurses' Association (https://nursejournal.org/community/codes-of-practice-and-informed-consent/), and the American Academy of Physician Assistants (https://www.aapa.org/wp-content/uploads/2017/02/16-EthicalConduct.pdf) all have carefully constructed Codes of Ethics, which address informed consent. It behooves the clinician to be intimately familiar with their respective code, state laws governing this topic, as well as their facilities and institutions' guidelines/procedures. Further, careful consideration of one's personal approach to a sustainable clinician–patient relationship informs application of formal laws, professional codes, and local guidelines. Time, experience, and, at times, learning from mistakes promote an authentic informed consent. Your patient will thank you.

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CHAPTER 35

Standard Precautions

Gerald Kayingo

Abstract

Standard precautions refer to a set of infection control practices employed to reduce risk of transmission of diseases that can be acquired by contact with blood, body fluids, secretions, mucous membranes, and non-intact skin from both recognized and unrecognized sources of infection. It is critical that health care workers routinely use appropriate barrier precautions to prevent skin and mucous membrane exposure during contact with any patient's blood or body fluids that require universal precautions. Examples of protective barriers include gloves, gowns, and masks. N95 respirators should be worn to avoid potential exposure to infectious agents transmitted by the airborne route (e.g., tuberculosis). Standard precautions should also be followed when performing any procedure in which exposure to, or transmission of, infectious agents is possible. This chapter discuss the current guidelines and policies for standard precaution.

Keywords

HAI
standard precautions
universal precautions
infection control
patient safety

isolation

Procedure Goals and Objectives

GOAL: To provide clinicians with the essential knowledge and skills necessary to apply standard precautions when interacting with a patient. This chapter covers the principles and rationales for standard precautions and reinforces the importance of provider and patient safety during a clinical encounter.
OBJECTIVES: The student will be able to:

- Describe the indications, contraindications, and rationale for adhering to standard precautions.
- Identify and describe common problems associated with adhering to standard precautions.
- Describe the essential infectious disease principles associated with standard precautions.
- Identify the materials necessary for adhering to standard precautions and their proper use.
- Demonstrate proper technique for standard precautions when interacting with patients.

Background and History

Health care–associated infections are the most frequent adverse event in health care delivery, and a major threat to patient and employee safety worldwide. The 21st century has seen life-threatening outbreaks of HIV/AIDS, Ebola virus, Avian flu, West Nile virus, SARS, and Zika virus, which all require strict adherence to infection prevention practices at all levels of health care. The

Centers for Disease Control and Prevention (CDC) recommends ***standard precautions*** for the care of all patients, regardless of their diagnosis or presumed infection status. Standard precautions are a set of infection control practices used to reduce the risk of transmission of diseases that can be acquired by contact with blood, body fluids, secretions, mucous membranes, and nonintact skin from both recognized and unrecognized sources of infection. These practices include appropriate and consistent hand hygiene, use of personal protective equipment (PPE), and appropriate isolation procedures, if needed."Implementation of standard precautions constitutes the primary strategy for the prevention of healthcare-associated transmission of infectious agents and health care personnel."[1] Therefore, everybody in the health care field must understand the importance of standard precautions and apply them for all patients.

The concept of isolating patients with infectious diseases in separate facilities, which became known as infectious disease hospitals, was introduced in a published hospital handbook as early as 1877. Although infected and noninfected patients were separated, nosocomial transmission continued, largely because of the lack of minimal aseptic procedures, coupled with the fact that infected patients were not separated from each other by disease. By 1890 to 1900, nursing textbooks discussed recommendations for practicing aseptic procedures and designating separate floors or wards for patients with similar diseases, thereby beginning to solve the problems of nosocomial transmission.[2]

Shortly thereafter, the cubicle system of isolation changed US hospital procedures because patients were placed in multiple-bed wards. "Barrier nursing" practices, consisting of the use of aseptic solutions, handwashing between patient contacts, disinfecting patient-contaminated objects, and separate gown use, were developed to decrease pathogenic organism transmission to other patients and personnel. By the 1960s, the designation of specifically designed single- or multiple-patient isolation rooms in general hospitals and outpatient treatment for tuberculosis caused these specialized hospitals to close.[3]

The lack of consistent infectious patient isolation policies and procedures noted by the CDC investigators in the 1960s led to the CDC publication in 1970 of a detailed isolation precautions manual entitled *Isolation Techniques for Use in Hospitals,* designed to assist large metropolitan medical centers as well as small hospitals with limited budgets. After revision in 1983, the manual was renamed the *CDC Guidelines for Isolation Precautions in Hospitals.* These new guidelines encouraged hospital infection control decision-making with respect to developing isolation systems specific to the hospital environment and circumstances or choosing to select between category-specific or disease-specific isolation precautions. Decisions regarding individual patient precautions were to be based on factors such as patient age, mental status, or possible need to prevent sharing of contaminated articles and were to be determined by the provider who placed the patient on isolation status. Decisions regarding the need for decreasing exposure to infected material by wearing masks, gloves, or gown were to be left to the patient caregiver.[4,5]

Issues of over-isolation of patients surfaced while utilizing the 1983 categories, which included strict isolation, contact isolation, respiratory isolation, tuberculosis (acid-fast bacilli) isolation, enteric precautions, drainage-secretion precautions, and blood and body fluid precautions. In using the disease-specific isolation precautions, the issue of mistakes in applying the precautions arose if the patient carried a disease not often seen or treated in the hospital,[4,5] if the diagnosis was delayed, or if a misdiagnosis occurred. These factors, coupled with increased knowledge of epidemiologic patterns of disease, led to subsequent updates of portions of the CDC reports:

- Recommendations for the management of patients with suspected hemorrhagic fever published in 1988.[6]
- Recommendations for respiratory isolation for human parvovirus B19 infection specific to patients who were immunodeficient and had chronic human parvovirus B19 infection or were in transient aplastic crisis.[7]
- Recommendations for the management of tuberculosis, which stemmed from increasing concern for multidrug-

resistant tuberculosis, especially in care facilities in patients infected with human immunodeficiency virus (HIV).[8]

- Recommendations for hantavirus infection risk reduction.[9]
- Expansion of recommendations for the prevention and control of hepatitis C virus (HCV) infection and HCV-related chronic disease.[10]
- Occupational exposure recommendations and postexposure management for hepatitis B virus (HBV), HCV, and HIV.[11]
- Recommendations for infection control of avian influenza and management of exposure to severe acute respiratory syndrome–associated coronavirus (SARS-CoV) in the health care setting.[12,13]
- Recommendations for isolation precautions to prevent transmission of infectious agents in the health care setting.[14]
- Recommendation guidelines for disinfection and sterilization in the health care facility.[15]

Body Substance Isolation

An entirely different approach to isolation, referred to as *body substance isolation (BSI)*, was developed in 1984 by Lynch et al.[16,17] It required personnel, regardless of patient infection status, to apply clean gloves immediately before all patient contact with mucous membranes or nonintact skin and to wear gloves if contact with any moist body substances was likely. An apron or other barrier was also to be worn to keep the provider's own clothing and skin clean. Recommendation was also made that personnel be immunized if proof of immunity could not be documented when barriers, such as masks, could not prevent transmission by airborne routes (e.g., rubella, chickenpox). In addition, when immunity was not possible, as with pulmonary tuberculosis, masks were to be worn during all patient contact. Goggles or glasses, hair covers, and shoe covers were also used as barriers. Careful handling of all used sharps, recapping of needles without using the hands, and the disposal of used items in rigid puncture-resistant containers were stressed. Trash and soiled linen from all patients were bagged and handled in the same manner. This approach sought to protect the patient from

contracting nosocomial infections and the provider from bacterial or viral pathogens that might originate with the patient.

Universal Precautions

In response to increasing concerns by health care workers and others about occupational exposure and the risk for transmission of HIV, HBV, and other blood-borne pathogens during provision of health care and first aid, in 1987 the CDC defined a set of precautions that considered blood and certain body fluids from all patients to be potential sources of infection for blood-borne pathogens. These recommendations became known as universal precautions and have subsequently been integrated into the Recommendations for Isolation Precautions in Hospitals, 1996, which includes the current **standard precautions** (Box 35.1).

Standard precautions are a set of guidelines designed to minimize the spread of infectious diseases transmitted by exposure to infectious body fluids.

Box 35.1 Recommendations for Preventing Transmission of Infectious Agents in Health Care Settings (Healthcare Infection Control Practices Advisory Committee, 2007)

Standard Precautions

Assume that every person is potentially infected or colonized with an organism that could be transmitted in the health care setting and apply the following infection control practices during the delivery of health care.

1. Hand Hygiene
    I. During the delivery of health care, avoid unnecessary touching of surfaces in close proximity to the patient to prevent both contamination of clean hands from

environmental surfaces and transmission of pathogens from contaminated hands to surfaces.

II. When hands are visibly dirty, contaminated with proteinaceous material, or visibly soiled with blood or body fluids, wash hands with either nonantimicrobial soap and water or antimicrobial soap and water

III. If hands are not visibly soiled, or after removing visible material with nonantimicrobial soap and water, decontaminate hands in the clinical situations described below (–f). The preferred method of hand decontamination is with an alcohol-based hand rub. Alternatively, hands may be washed with an antimicrobial soap and water. Frequent use of alcohol-based hand rub immediately following handwashing with nonantimicrobial soap may increase the frequency of dermatitis.

Perform hand hygiene in the following clinical situations:

a. Before having direct contact with patients
b. After contact with blood, body fluids or excretions, mucous membranes, nonintact skin, or wound dressings
c. After contact with a patient's intact skin (e.g., when taking a pulse or blood pressure or lifting a patient)
d. If hands will be moving from a contaminated-body site to a clean body site during patient care
e. After contact with inanimate objects (including medical equipment) in the immediate vicinity of the patient
f. After removing gloves

IV. Wash hands with nonantimicrobial soap and water or with antimicrobial soap and water if contact with spores (e.g., *Clostridium difficile* or *Bacillus anthracis*) is likely to have occurred. The physical action of washing and rinsing hands under such circumstances is recommended because alcohols, chlorhexidine,

iodophors, and other antiseptic agents have poor activity against spores.

V. Do not wear artificial fingernails or extenders if duties include direct contact with patients at high risk for infection and associated adverse outcomes (e.g., those in ICUs or operating rooms) 30, 31, 559, 722–724. Category IA IV.A.5.a. Develop an organizational policy on the wearing of nonnatural nails by health care personnel who have direct contact with patients outside of the groups specified above.

2. Personal Protective Equipment (PPE)

I. Observe the following principles of use:

a. Wear PPE, as described below, when the nature of the anticipated patient interaction indicates that contact with blood or body fluids may occur.

b. Prevent contamination of clothing and skin during the process of removing PPE.

c. Before leaving the patient's room or cubicle, remove and discard PPE.

II. Gloves

a. Wear gloves when it can be reasonably anticipated that contact with blood or other potentially infectious materials, mucous membranes, nonintact skin, or potentially contaminated intact skin (e.g., of a patient incontinent of stool or urine) could occur

b. Wear gloves with fit and durability appropriate to the task

i. Wear disposable medical examination gloves for providing direct patient care.

ii. Wear disposable medical examination gloves or reusable utility gloves for cleaning the environment or medical equipment.

c. Remove gloves after contact with a patient and/or the surrounding environment (including medical equipment) using proper technique to prevent hand contamination. Do not wear the same pair of gloves for the care of more than one patient. Do not wash

gloves for the purpose of reuse because this practice has been associated with transmission of pathogens.

d. Change gloves during patient care if the hands will move from a contaminated body-site (e.g., perineal area) to a clean body-site.

III. Gowns

a. Wear a gown, that is appropriate to the task, to protect skin and prevent soiling or contamination of clothing during procedures and patient-care activities when contact with blood, body fluids, secretions, or excretions is anticipated.

i. Wear a gown for direct patient contact if the patient has uncontained secretions or excretions.

ii. Remove gown and perform hand hygiene before leaving the patient's environment.

b. Do not reuse gowns, even for repeated contacts with the same patient.

c. Routine donning of gowns upon entrance into a high-risk unit (e.g., ICU, NICU, HSCT unit) is not indicated.

IV. Mouth, Nose, and Eye Protection

a. Use PPE to protect the mucous membranes of the eyes, nose, and mouth during procedures and patient-care activities that are likely to generate splashes or sprays of blood, body fluids, secretions, and excretions. Select masks, goggles, face shields, and combinations of each according to the need anticipated by the task performed

V. During aerosol-generating procedures (e.g., bronchoscopy, suctioning of the respiratory tract [if not using in-line suction catheters], endotracheal intubation) in patients who are not suspected of being infected with an agent for which respiratory protection is otherwise recommended (e.g., *Mycobacterium tuberculosis*, SARS or hemorrhagic fever viruses), wear one of the following: a face shield that fully covers the

front and sides of the face, a mask with attached shield, or a mask and goggles (in addition to gloves and gown).

3. Respiratory Hygiene/Cough Etiquette
    I. Educate health care personnel on the importance of source control measures to contain respiratory secretions to prevent droplet and fomite transmission of respiratory pathogens, especially during seasonal outbreaks of viral respiratory tract infections (e.g., influenza, RSV, adenovirus, parainfluenza virus) in communities.
    II. Implement the following measures to contain respiratory secretions in patients and accompanying individuals who have signs and symptoms of a respiratory infection, beginning at the point of initial encounter in a health care setting (e.g., triage, reception and waiting areas in emergency departments, outpatient clinics, and physician offices).
        a. Post signs at entrances and in strategic places (e.g., elevators, cafeterias) within ambulatory and inpatient settings with instructions to patients and other persons with symptoms of a respiratory infection to cover their mouths/noses when coughing or sneezing, use and dispose of tissues, and perform hand hygiene after hands have been in contact with respiratory secretions.
        b. Provide tissues and no-touch receptacles (e.g.,foot-pedal–operated lid or open, plastic-lined waste basket) for disposal of tissues.
        c. Provide resources and instructions for performing hand hygiene in or near waiting areas in ambulatory and inpatient settings; provide conveniently located dispensers of alcohol-based hand rubs and, where sinks are available, supplies for handwashing.
        d. During periods of increased prevalence of respiratory infections in the community (e.g., as

indicated by increased school absenteeism, increased number of patients seeking care for a respiratory infection), offer masks to coughing patients and other symptomatic persons (e.g., persons who accompany ill patients) upon entry into the facility or medical office. and encourage them to maintain special separation, ideally a distance of at least 3 feet, from others in common waiting areas.

i. Some facilities may find it logistically easier to institute this recommendation year-round as a standard of practice.

4. Patient Placement
    I. Include the potential for transmission of infectious agents in patient placement decisions. Place patients who pose a risk for transmission to others (e.g., uncontained secretions, excretions, or wound drainage; infants with suspected viral respiratory or gastrointestinal infections) in a single patient room when available.
    II. Determine patient placement based on the following principles:
        - Route(s) of transmission of the known or suspected infectious agent
        - Risk factors for transmission in the infected patient
        - Risk factors for adverse outcomes resulting from an HAI in other patients in the area or room being considered for patient placement
        - Availability of single-patient rooms
        - Patient options for room-sharing (e.g., cohorting patients with the same infection)
5. Patient-care Equipment and Instruments/Devices
    I. Establish policies and procedures for containing, transporting, and handling patient-care equipment and instruments/devices that may be contaminated with blood or body fluids.

II. Remove organic material from critical and semicritical instrument/devices, using recommended cleaning agents before high-level disinfection and sterilization to enable effective disinfection and sterilization processes.

III. Wear PPE (e.g., gloves, gown), according to the level of anticipated contamination, when handling patient-care equipment and instruments/devices that are visibly soiled or may have been in contact with blood or body fluids.

6. Care of the Environment

I. Establish policies and procedures for routine and targeted cleaning of environmental surfaces as indicated by the level of patient contact and degree of soiling.

II. Clean and disinfect surfaces that are likely to be contaminated with pathogens, including those that are in close proximity to the patient (e.g., bed rails, over-bed tables) and frequently touched surfaces in the patient care environment (e.g., door knobs, surfaces in and surrounding toilets in patients' rooms) on a more frequent schedule compared with that for other surfaces (e.g., horizontal surfaces in waiting rooms).

III. Use EPA-registered disinfectants that have microbiocidal (i.e., killing) activity against the pathogens most likely to contaminate the patient-care environment. Use in accordance with manufacturer's instructions.

a. Review the efficacy of in-use disinfectants when evidence of continuing transmission of an infectious agent (e.g., rotavirus, *C. difficile*, norovirus) may indicate resistance to the in-use product and change to a more effective disinfectant as indicated.

IV. In facilities that provide health care to pediatric patients or have waiting areas with child play toys (e.g., obstetric/gynecology offices and clinics), establish policies and procedures for cleaning and disinfecting toys at regular intervals.

a. Use the following principles in developing this policy and procedures:
    - Select play toys that can be easily cleaned and disinfected.
    - Do not permit use of stuffed furry toys if they will be shared.
    - Clean and disinfect large stationary toys (e.g., climbing equipment) at least weekly and whenever visibly soiled.
    - If toys are likely to be mouthed, rinse with water after disinfection; alternatively, wash in a dishwasher.
    - When a toy requires cleaning and disinfection, do so immediately or store in a designated labeled container separate from toys that are clean and ready for use.

V. Include multiuse electronic equipment in policies and procedures for preventing contamination and for cleaning and disinfection, especially those items that are used by patients, those used during delivery of patient care, and mobile devices that are moved in and out of patient rooms frequently (e.g., daily).
    a. No recommendation for use of removable protective covers or washable keyboards.

7. Textiles and Laundry
    I. Handle used textiles and fabrics with minimal agitation to avoid contamination of air, surfaces, and persons.
    II. If laundry chutes are used, ensure that they are properly designed, maintained, and used in a manner to minimize dispersion of aerosols from contaminated laundry.
8. Safe Injection Practices

The following recommendations apply to the use of needles, cannulas that replace needles, and, where applicable, intravenous delivery systems:

I. Use aseptic technique to avoid contamination of sterile injection equipment.

II. Do not administer medications from a syringe to multiple patients, even if the needle or cannula on the syringe is changed. Needles, cannulae, and syringes are sterile, single-use items; they should not be reused for another patient or to access a medication or solution that might be used for a subsequent patient.

III. Use fluid infusion and administration sets (e.g., intravenous bags, tubing and connectors) for one patient only and dispose appropriately after use. Consider a syringe or needle/cannula contaminated once it has been used to enter or connect to a patient's intravenous infusion bag or administration set.

IV. Use single-dose vials for parenteral medications whenever possible.

V. Do not administer medications from single-dose vials or ampules to multiple patients or combine leftover contents for later use.

VI. If multidose vials must be used, both the needle or cannula and syringe used to access the multidose vial must be sterile.

VII. Do not keep multidose vials in the immediate patient treatment area: store in accordance with the manufacturer's recommendations; discard if sterility is compromised or questionable.

VIII. Do not use bags or bottles of intravenous solution as a common source of supply for multiple patients.

9. Infection Control Practices for Special Lumbar Puncture Procedures

Wear a surgical mask when placing a catheter or injecting material into the spinal canal or subdural space (i.e., during myelograms, lumbar puncture, and spinal or epidural anesthesia).

10. Worker Safety

Adhere to federal and state requirements to protect health care personnel from exposure to blood-borne pathogens.

Adapted from Siegel JD, Rhinehart E, Jackson M, Chiarello L, and the Healthcare Infection Control Practices Advisory Committee, 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings https://www.cdc.gov/infectioncontrol/guidelines/isolation/index.html

Standard Precautions

Although universal precautions were designed to address the transmission of blood-borne infections through blood and certain body fluids, they do not address other routes of disease transmission, which were addressed at the time by body substance isolation guidelines. Additionally, confusion arose as to which guidelines should be used, because both dealt with similar circumstances but offered conflicting recommendations. The guideline for isolation precautions in hospitals was revised in 1996 by the CDC and the Hospital Infection Control Practices Advisory Committee (HICPAC), which was established in 1991. The CDC guideline revision was designed to include the following objectives[3]:

- To be epidemiologically sound
- To recognize the importance of all body fluids, secretions, and excretions in the transmission of nosocomial pathogens
- To contain adequate precautions for infections transmitted by the airborne, droplet, and contact routes of transmission
- To be as simple and user friendly as possible
- To use new terms to avoid confusion with existing infection control and isolation systems

The 1996 guideline for isolation precautions in hospitals was further revised and expanded in 2007 to account for the new developments in health care delivery.[1] Such developments included:

- The shift of health care delivery from primarily acute care hospitals to other health care settings, such as ambulatory

care and long-term care
- The emergence of new pathogens, such as SARS and Avian influenza, in humans
- Continued increase in the incidence of health-associated infections (HAIs) caused by multidrug-resistant organisms (MDROs) in all health care settings

Because it is not always possible to determine in advance whether a specific patient is **infectious,** standard precautions should be followed routinely for all patients.

Standard precautions should be followed when performing any procedure in which exposure to, or transmission of, infectious agents is possible.

The new guidelines were designed to supersede universal precautions and body substance isolation guidelines and, in essence, combine parts of both these previous guidelines. This synthesis of guidelines allows patients who were previously covered under disease-specific guidelines to now fall under standard precautions, a single set of recommendations. For patients who require **additional precautions** (defined as transmission-based precautions, for use when additional transmission risk exists,such as from airborne or droplet contamination), additional guidelines have been developed to go beyond those of standard precautions (see Box 35.1).[1,3]

Protective barriers, such as gloves, gowns, and masks, are major components of the practice of standard precautions.

Gloves, Gowns, Masks, and Other Protective Barriers as Part of Universal Precautions

All health care workers should routinely use appropriate barrier precautions to prevent skin and mucous membrane exposure during contact with any patient's blood or body fluids that require universal precautions.

Gloves should be worn in the following situations:

- For touching blood and body fluids requiring universal precautions, mucous membranes, or nonintact skin of all patients
- For handling items or surfaces soiled with blood or body fluids to which universal precautions apply

Gloves should be changed after contact with each patient. Hands and other skin surfaces should be washed immediately or as soon as patient safety permits if contaminated with blood or body fluids requiring universal precautions. Hands should be washed immediately after gloves are removed. Gloves should reduce the incidence of blood contamination of hands during phlebotomy, but they cannot prevent penetrating injuries caused by needles or other sharp instruments. Institutions that judge routine gloving for all phlebotomies as unnecessary should periodically reevaluate their policy. Gloves should always be available to health care workers who wish to use them for phlebotomy. In addition, the following general guidelines apply:

- Use gloves for performing phlebotomy when the health care worker has cuts, scratches, or other breaks in the skin.
- Use gloves in situations in which the health care worker judges that hand contamination with blood may occur, for example, when performing phlebotomy in an uncooperative patient.
- Use gloves for performing finger or heel sticks, or both, in infants and children.

- Use gloves when persons are receiving training in phlebotomy.

Masks and protective eyewear or face shields should be worn by health care workers to prevent exposure of mucous membranes of the mouth, nose, and eyes during procedures likely to generate droplets of blood or body fluids requiring universal precautions. **N95** or higher respirators, if available, should be worn to avoid potential exposure to infectious agents transmitted by the airborne route (e.g., tuberculosis). N95 or higher respirators are to be fit-tested at least annually and according to Occupational Safety and Health Administration (OSHA) requirements. Gowns or aprons should be worn during procedures likely to generate splashes of blood or body fluids requiring universal precautions.

N95 or higher respirators, if available, should be worn to avoid potential exposure to infectious agents transmitted by the airborne route (e.g., tuberculosis).

All health care workers should take precautions to prevent injuries caused by needles, scalpels, and other sharp instruments or devices during procedures, when cleaning used instruments, during disposal of used needles, and when handling sharp instruments after procedures. To prevent needlestick injuries, needles should not be recapped by hand, purposely bent or broken by hand, removed from disposable syringes, or otherwise manipulated by hand. After they are used, disposable syringes and needles, scalpel blades, and other sharp items should be placed in puncture-resistant containers for disposal. The puncture-resistant containers should be located as close as is practical to the area of use. All reusable needles should be placed in puncture-resistant containers for transport.

General infection control practices should further minimize the already small risk for salivary transmission of HIV. These infection control practices include the use of gloves for digital examination of mucous membranes and endotracheal suctioning, handwashing after exposure to saliva, and minimizing the need for emergency

mouth-to-mouth resuscitation by making mouthpieces and other ventilation devices available for use in areas where the need for resuscitation is predictable.

The Application of Standard Precautions in Clinical Procedures

Standard precautions should be followed when performing any procedure in which exposure to, or transmission of, infectious agents is possible. These guidelines attempt to minimize exposure to infectious body fluids. Because it is not always possible to determine in advance whether a specific patient is infectious, these precautions should be followed routinely for all patients. The nature of performing clinical procedures often results in exposure to body fluids. Consequently, as practitioners involved in performing clinical procedures, it is imperative that we attempt to anticipate potential exposures and implement preventive guidelines to reduce exposure risks.

Additionally, it is important that the practitioner assess the health status of each patient to determine if additional precautions are warranted and, if so, apply the necessary transmission-based precautions, as described in Box 35.1. Standard precautions are the current recommended behaviors designed to prevent the transmission of pathogens from patient to practitioner or practitioner to patient. It is imperative that all providers be knowledgeable about standard precautions and transmission-based precautions and how to practice them competently and consistently.

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CHAPTER 36

Sterile Technique

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Abstract

Health care–associated infections increase morbidity, mortality, and antimicrobial drug resistance and place financial burdens on health systems at all levels. Sterile technique during various procedures has been heavily researched for decades and is known to help reduce the spread of infections when used properly. Although hospitals and health systems implement their own protocols, this chapter provides a standard approach using the most up-to-date information. On completion of this chapter, you will have a better understanding of the historical context for developing a standard technique, the common cleansing agents, and best practices for gowning, scrubbing, and maintaining a sterile field.

Procedure goals and objectives

GOAL: To provide clinicians with the knowledge to perform clinical procedures using sterile techniques.
OBJECTIVES: The student will be able to:

- Describe the development of the concept of sterile technique.
- Identify the indications, contraindications, and principles behind sterile techniques.
- Describe the principles and materials used for surgical attire.
- Demonstrate the essential steps of a surgical hand scrub.
- Demonstrate the essential steps of preparing and draping the surgical patient.
- Describe the principles of universal and standard precautions.
- Discuss the safe handling and disposal of materials.

Statements

1. Complete sterilization of skin is unachievable; therefore utilization of appropriate barriers worn by providers and the use of cleansing agents on patients are essential for preventing infection.
2. When in doubt, consider it contaminated.
3. Two methods of surgical scrubbing include the timed, or anatomic, scrub and the counted, or numbered, scrub.
4. Standard precautions should be the minimal amount of precautions used when handling patients.
5. Handling and disposal of contaminated supplies and sharps requires extreme precaution and adherence to Occupational Safety and Health Administration (OSHA) protocols.

Background and History

Sterile technique, also known as aseptic technique, is a modern surgical standard that has evolved over several hundred years of

practice. The primary function of asepsis is to prevent infection and reduce morbidity. Although this seems obvious today, centuries and millennia ago, the idea of an invisible microorganism being the source of putrid wounds and fatal disease was not so apparent.

Ridiculed during his lifetime and recognized after his death, Ignaz Semmelweis is known as a pioneer of sterile technique. In Austria in 1847, he introduced handwashing with chlorinated lime solutions in the birthing wards, reducing the incidence of puerperal fever by 10-fold when compared with wards without handwashing practice.[1] Many colleagues were offended by his research and propositions. Not until 20 years later, following Louis Pasteur's germ theory and the discovery of microorganisms involved in the fermentation and spoiling of food, did people begin to think critically about Semmelweis's "rants" Pasteur developed a technique of heating fluids that resulted in the death of bacteria and molds previously grown out of those fluids. This process is known today as pasteurization.[2] His successes, in turn, influenced Joseph Lister's advancements on the sterilization of his operative field by washing his hands and instruments. In 1867, Lister published a piece in *The Lancet,* stating, "The material which I have employed is carbolic or phenic acid, a volatile organic compound, which appears to exercise a peculiarly destructive influence upon low forms of life, and hence is the most powerful antiseptic with which we are at present acquainted."[3] Since his landmark paper, a plethora of research and literature has been conducted and published exploring and ranking by efficacy the agents and processes used to acquire asepsis. This chapter presents the current literature-based guidelines for the best sterile technique achievable.

Indications and Principles of Sterile Technique

The goal of asepsis is to provide an environment in which to perform an invasive procedure on a patient that prevents exposure to infectious agents, thereby minimizing recovery time and maximizing healthy healing. The most obvious indication for the use of sterile technique is surgery. Aseptic practice, however, should also be maintained outside the operating room for a variety of bedside

procedures, including biopsies, central line placements, various dressing changes, lumbar punctures, thoracentesis, and paracentesis. According to the World Health Organization's *Global Guidelines for the Prevention of Surgical Site Infection* (SSI), there is overwhelming evidence that SSIs are a leader in health care–acquired infections, representing a significant burden in terms of patient morbidity and mortality, increases in drug-resistant microorganisms, and additional costs to health systems and service payers worldwide.[4] When in doubt, be as clean as possible—no one will ever be faulted for using extra precaution and implementing an aseptic technique for infection prevention.

When in doubt, consider it contaminated.

Sterile technique refers to more than just "handwashing." It is the creation of a field to work in that is free from all living microorganisms. Within an uncontaminated sterile field, all instruments, fluids, sutures, devices, and individuals have either performed protocolled cleansing techniques or have been packaged under controlled sterile precautions. This includes using only gas-cleansed, steam-autoclaved, or sterile disposable packaged materials to minimize the risk of microbial spread. Complete sterilization of skin is not achievable; therefore utilization of appropriate barriers worn by providers and the use of cleansing agents on patients are essential for preventing infection.[4] The following are basic principles to remember when achieving and performing sterile procedures:

Complete sterilization of skin is not achievable; therefore utilization of appropriate barriers worn by providers and the use of cleansing agents on patients are essential for preventing infection.

- All items used within a sterile field must be sterile.
- A sterile barrier that has been permeated must be considered contaminated.

- The edges of a sterile container are considered contaminated once the package is opened.
- Gowns are considered sterile in front from shoulder to waist level, and the sleeves are considered sterile to 2 inches above the elbow.
- Sterile property, including hands, instruments, and the table, are considered sterile above table or waist-height only.
- Sterile persons and items touch only sterile areas; persons and items not sterile touch only nonsterile areas.
- Nonsterile personnel must remain at least 12 inches away from the sterile field.
- Remain facing the sterile field when moving within or around the sterile field to avoid accidental contamination.
- When in doubt, consider it contaminated.

Contraindications and Potential Complications

A documented allergy or allergic dermatitis to a specific aseptic agent or a material used in the drapes, gloves (e.g., latex), or other protective wear are the only relative contraindication to sterile technique. In most instances, another agent or product may be substituted.

The major culprits of aseptic agents leading to skin breakdown are associated with CHG (chlorhexidine gluconate) cleansers and iodine sealants, whereas allergic reactions to more simple alcohol-based products are uncommon.[5] Skin reaction severity directly correlates with contact time and concentration of the antiseptic. If skin irritation does occur, it is not always evident immediately. Skin breakdown is a known risk of infection; therefore, as soon as it becomes apparent, it should be addressed with appropriate treatment.[4]

Patient Preparation

Prior to an invasive procedure, the following are several Centers for Disease Control and Prevention (CDC) recommendations for patient

preparation that can help reduce the presence of microorganisms and make asepsis more achievable.[4]

- Whenever possible, especially in the setting of elective procedures, the patient should take a shower with either plain soap or an antibacterial soap prior to the procedure. There is not enough literature to support the use of CHG-impregnated sponges.
- Decolonization of the nares with mupirocin ointment and CHG washes prior to surgery in patients who are *Staphylococcus aureus* positive can reduce the risk of cutaneous infections caused by this microbe.
- The current literature indicates beneficial use of preoperative intravenous antibiotics (with coverage of typical skin flora) if given within 120 minutes of skin incision.
- Specifically, for gastrointestinal surgeries, mechanical bowel preparation *with* adjunctive oral antibiotics has shown to decrease the risk of surgical site infections in elective colorectal surgeries.
- Hair removal has had its share of controversial literature in reducing infection rates. The most up-to-date CDC literature states that the hair should be prepared with a sterilizing agent similarly as skin is. If, and only if, the hair needs to be removed, it should be removed with clippers and not shaved with a razor.
- Skin antiseptic cleansers should be alcohol-based solutions (including CHG and iodine-based agents).

Materials

For preparing the patient[4]

- Hair clippers to remove hair from the procedure site if necessary (no razors)
- Antiseptic soap, preferably alcohol-based combination agents such as CHG or povidone-iodine. These are rapid-acting, broad-spectrum antimicrobials effective against

gram-positive and gram-negative microorganisms. Each is prepared in combination with a detergent to give a cleansing action and antimicrobial effect.
- Sterile towels, gauze sponges, large clamp or ring forceps to hold the preparation sponge or gauze

For the provider[4]

- Sterile surgical gowns. These can be purchased as sterile disposable gowns, or reusable gowns can be obtained through a laundering service that utilizes gas sterilization.
- Sterile gloves
- Mask that fits snugly over the nose and mouth
- Hat, whether skullcap or bouffant, that covers all hair except for minimal exposure at the nape of the neck or modest sideburns. The benefits of cloth versus disposable scrub hats and skullcaps versus bouffant have not yet been studied.[6]
- Handwashing materials
  - Chlorhexidine gluconate or povidone-iodine solutions
  - Sterile disposable scrub brushes or sponges impregnated with chlorhexidine gluconate, povidone-iodine, or other CDC-approved products

Procedure

Surgical Scrub

Two methods of surgical scrubbing typically used are the timed, or anatomic, scrub, which lasts for a total of 3 to 5 minutes (Fig. 36.1); and the counted, or numbered, scrub in which there is an allotted number of strokes for each body part. In the latter method, 30 strokes are needed for the fingernails and 20 strokes are needed for each surface of the fingers, hands, wrists, arms, and elbows, respectively. Both methods begin with scrubbing of the fingernails, followed by each of the four surfaces of the fingers, then to the palmar and dorsal surfaces of the hand and wrist, then to the forearm, and finally extending to 2 inches above the elbow.

One hand and forearm should be completed first before moving on to the next and never return to a previously scrubbed area. Studies demonstrate that scrubbing for 5 minutes reduces microbial counts as effectively as the previously used 10-minute scrub, which resulted in skin damage.[7] Alternatively, a 2- to 3-minute scrub also reduces the bacterial load, therefore being as effective as the 5-minute scrub.[5] It is recommended to follow one's institution's protocol, but that no scrub should be less than 2 minutes.

Below is a general guideline to be used for either the timed or counted scrub:

1. Be sure that the proper surgical attire is being worn, including bonnet/skullcap, mask, protective eyewear, and shoe covers. Now assure that the necessary supplies for the scrub are prepared and ready for use. The water should be set at a comfortable temperature because scalding hot water can be harsh on the skin and cold water prevents the soap from lathering properly.[8]
2. Wet hands and forearms with water and prewash with a nonmedicated soap.
3. Clean subungual areas with a disposable nail cleaner under running water.
4. For the timed scrub, start the timer. For the counted scrub be sure to count with each stroke.
5. Beginning at the tip of the finger, scrub each side of the finger, between the fingers, then the palmar and dorsal aspects of the hand using a sponge, brush, or approved antimicrobial soap. Scrubbing with a combination sponge brush has been shown to reduce bacterial counts on the hands as effectively as scrubbing with a brush.[5]
6. Next, divide the wrist and arm into four sides and scrub each side of the wrist and arm up to 2 inches above the elbow. Keep the hand higher than the arm and away from the scrub attire by keeping the elbows in a flexed 90 degree angle to avoid contamination.

7. Transfer the sponge/brush to the other hand and repeat steps 5 and 6. If during any time of the scrub-brush the body touches anything other than the sponge/brush, that area is considered contaminated and must be re-scrubbed.
8. Discard the sponge/brush accordingly and rinse hands and arms starting with the fingers and moving toward the elbow. Do not move the hands and arms back and forth through the water.
9. Continue to keep elbows elevated in a 90 degree angle and allow excess water to drip away from the surgical attire.
10. Once in the operating room, hands and arms should be thoroughly dried using aseptic technique prior to donning the sterile gown and gloves.

FIGURE 36.1 **Surgical Scrub Technique.**

Special Considerations

- Keep nails short because many microbes are found beneath the nail.
- No artificial nails or nail polish should be worn. If nail polish is worn and approved by the facility, be sure that it is free of chips because chipped polish or polish worn for more than four days harbors a greater number of bacteria as compared with unpolished nails.[7]
- All jewelry, including rings, bracelets, watches, and earrings, must be removed prior to performing the surgical scrub.

Two methods of surgical scrubbing include the timed, or anatomic, scrub and the counted, or numbered, scrub.

Procedure

Surgical Attire

Wearing appropriate operating room attire is essential to help minimize the number of microbes present in the operating room and therefore prevent infection. As outlined earlier, all sterile personnel should wear a sterile surgical gown, sterile gloves, mask, and hat. When donning the sterile surgical gown (Fig. 36.2), be sure to face the nonsterile assistant and place arms through the sleeves. The nonsterile assistant will pull the gown over the shoulders and tie the back of the gown. Then proceed with gloving, either with or without assistance, making sure to touch only the inside of the glove. Ensure that the cuffs of the gloves cover the ends of the gown sleeves (Figs. 36.3 and 36.4)

FIGURE 36.2 **Donning the sterile surgical gown.**

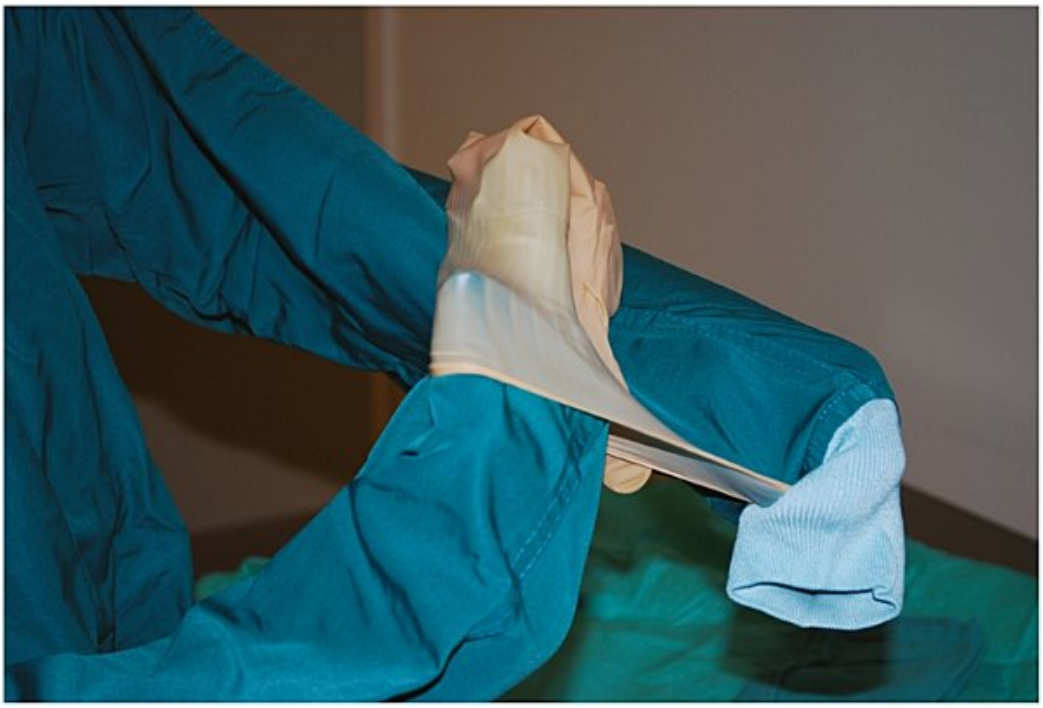

FIGURE 36.3 **Donning sterile gloves and ensuring that the cuff of the gloves covers the gown sleeve.**

FIGURE 36.4 **Complete sterile attire. Note that the model's hands remain above waist level to avoid contamination.**

Procedure

Preparing the Operative Site

Using a clamp or ring forceps to hold the antiseptic-impregnated sponge or gauze, vigorously scrub the skin by beginning at the operative site and working outward in a circular fashion toward the periphery of the field (Fig. 36.5). The prepared area should be wider than the operative site. Never return to a previously scrubbed area with a contaminated sponge. Discard the first sponge and repeat until all prepared sponges are used.

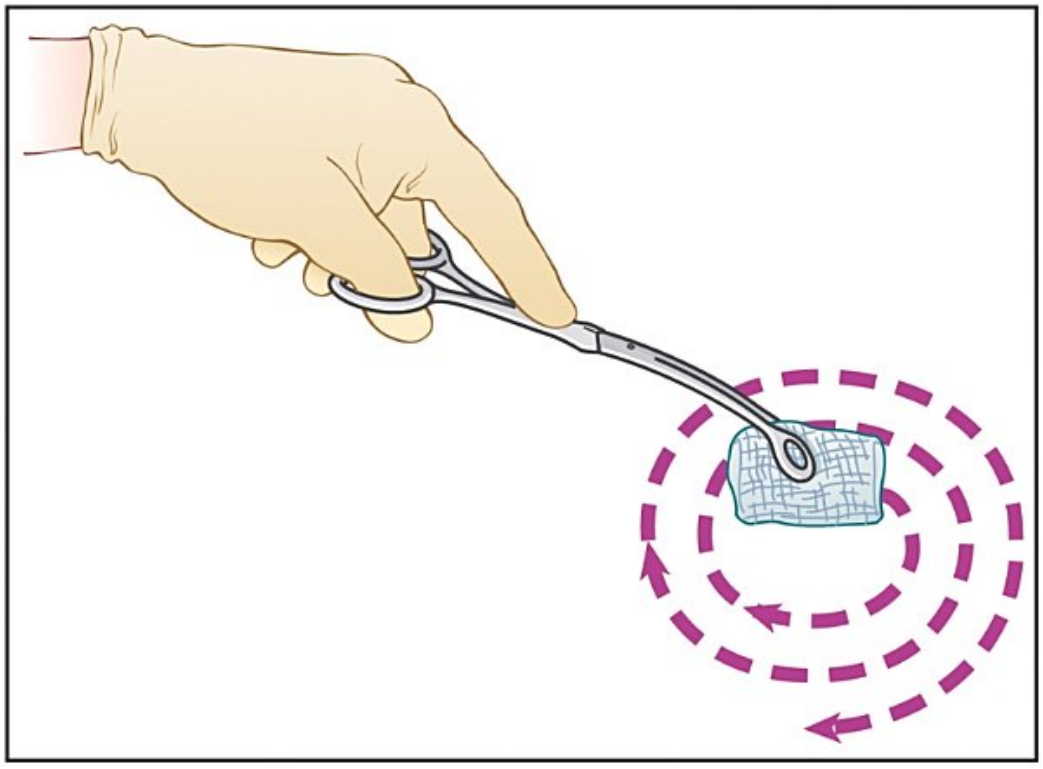

FIGURE 36.5 Scrubbing the skin beginning at the operative site and working outward in a circular motion.

Procedure

Draping

Draping is important to maintain sterility around the operative site by creating a barrier from surrounding or contaminated areas. Drapes consist of towels, sheets, split sheets, fenestrated sheets, stockinettes, and plastic incision drapes. All have a specific use and are made to fit specific areas of the body. They are intended to be fluid-resistant and their colors and materials are made in a manner that reduces glare and prevents eye fatigue.
When draping, it is important to abide by these rules:

- Never reach over the patient. When draping the opposite side, always walk around the table.
- Hold the drapes high enough to avoid touching nonsterile areas. Any part of the drape below waist or table level is considered nonsterile.
- Never shake out wrinkles.
- Make a cuff with the drape over the gloved hand to protect against touching a nonsterile area. Place folded and taped edges toward the incision site to prevent surgical instruments from falling between the drapes.
- Drapes should never be adjusted or moved once placed. If placed improperly, cover with another drape.
- If a hole is present in the drape, cover with a second drape.

Maintaining a Sterile Field

The sterile field consists of the draped patient, scrubbed personnel, and the sterile surgical instruments. If the sterility of any person or item is in question, it must immediately be considered contaminated and be removed from the sterile field promptly. See "Indications and Principles of Sterile Technique" earlier in the chapter to review the basic principles regarding achieving and performing sterile procedures.

Universal/Standard Precautions

Beginning in 1983, the CDC recommended that precautions be used around blood and body fluids when a patient was known or suspected to be infected with a blood-borne pathogen.[9] This evolved to a recommendation that blood and body fluid precautions be consistently used for all patients regardless of suspicion for being infected with a blood-borne pathogen. The latter recommendation is known as "Universal Precautions"; in 1996 this term was replaced with "Standard Precautions."[10] Universal or standard precautions are designed to prevent parental, mucous membrane, and nonintact skin exposures of health care workers to blood-borne pathogens.[9] These recommendations should be the minimal number of precautions used when handling patients. The precautions apply to a number of fluids, including blood, semen and vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, peritoneal fluid, pericardial fluid, and amniotic fluid. Feces, nasal secretions, sputum, sweat, tears, urine, and vomit do not apply unless they contain visible blood. (See Chapter 35 titled "Standard Precautions" for specific recommendations and further information.)

Standard precautions should be the minimal number of precautions used when handling patients.

Follow-up Care and Instructions

If a glove is punctured during a procedure, promptly remove it, wash hands with soap and water or an alcohol-based hand rub, rescrub using the timed or counted method, and replace with a new glove. Immediate washing is important in case of skin exposure. If an injury from a sharp instrument or device does occur, hospital protocols for stick injuries should be implemented immediately.

Disposal of Materials

Handling and disposal of contaminated supplies and sharps requires extreme precaution. The goal is to dispose of materials to avoid

accidental transmission of pathogens. Receptacles with bags labeled and identified as "biohazard" should be used for body fluids, human tissue, disposable personal protective equipment, and drapes. Sharps should never be disposed of in the garbage or in a biohazard bag. Puncture-resistant marked containers should be used to dispose of all disposable sharp instruments and devices. Biohazard bags, receptacles, and sharps containers should be disposed of using OSHA protocols.

Handling and disposal of contaminated supplies and sharps requires extreme precaution and adherence to OSHA protocols.

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CHAPTER 37

Patient Education Concepts*

Richard D. Muma

Abstract

The goal of effective patient education is to provide a healthy outcome. The chief means to accomplish this goal is taking a patient through an interactive educational process. Whether it involves asking an individual simply to take medication or to make substantial lifestyle changes to promote better health, providers must be able to communicate, educate, and motivate the patient effectively.

Keywords

communication in health care
counseling
patient education

Goals and Objectives

GOAL: To perform effective patient education.
OBJECTIVES: The student will be able to:

- Recognize the importance of patient education as the first step in managing a patient's health concerns.
- Outline the techniques involved in the communication interview process to be able to effectively educate and motivate patients to be active participants in their own health care.
- Discuss issues surrounding patient education in terms of demographics and chronicity of disease.
- Evaluate how patients react to illness and its management according to their cultural norms and according to their own perception of the severity of the illness.
- Provide patient education to various patient populations.

Background and History

As we continue in the 21st century, it is an understatement to observe that the health care field is increasingly complex and diversified. In recent years, dramatic changes have occurred in the number of providers, advances in medical technology, and understanding of disease—and striking developments have been made in various methods to treat these conditions. The bottom line is to be able to provide better patient treatment toward the goal of effecting a healthy outcome. The chief means to accomplish this goal is through an interactive educational process.[1] Whether it involves asking an individual simply to take medication or to make substantial lifestyle changes to promote better health, providers must be able to communicate, educate, and motivate the patient effectively.

Various approaches to patient education have been outlined over the years and still apply today.[2–8] All emphasize the importance of providing accurate information and encouraging patients to assume more responsibility for their own treatment. Many of the techniques

employed to accomplish such education share common characteristics. For example, explanations need to be given in simple terms, avoiding jargon that might be confusing. Also, the health care provider must assess the patient's understanding of the information in case further explanation is necessary to clarify questions or reduce confusion. Careful attention also must be given to patients' emotional responses to a particular diagnosis or treatment method, because these reactions can have significant impact on outcome.

Effective patient education should be duly recognized as an integral building block in the entire health delivery process, of equal importance to clinical and technologic advancements in the field.

For example, in 1989, Greenberg[9] noted how important the patient and provider communication process was and how its impact can be felt far beyond the immediate medical problem being treated. Still appropriate today, he suggested that good patient education will accomplish the following:

- Enable patients to assume greater responsibility for their own health care
- Improve their ability to manage acute and chronic illnesses
- Provide opportunities to choose healthier lifestyles and practice preventive medicine
- Improve adherence with medication and treatment regimens
- Increase satisfaction with care and thus reduce the risk for liability
- Attract patients to your practice
- Lead to a more efficient, cost-effective health care system

A Model for Patient Education

Recognizing the importance of patient education is the first step. Then follows the actual learning of techniques involved in the communication interview process to be able to effectively educate and motivate patients to be **active participants** in their own health care, rather than passive responders.

Providers must be able to encourage patients to be participants in their health care toward the goal of affecting a healthy outcome.

One can easily adapt this model to accommodate whatever disease problem needs to be reviewed with the patient. Following is a brief discussion of the elements listed, which can serve as a refresher for conducting the interview.

Opening the Interview

The following points should be taken into consideration in opening the interview:

- Putting the patient at ease
- Use of social amenities
- Eye contact
- Professional demeanor
- Layout of interview the plan

Opening the patient education interview, like opening any communicative interchange, can be enhanced by using several short phrases that serve as social amenities. These can include such remarks as, "Any issues` getting into the office today?" or "How have you been since I saw you last?," or "Are you enjoying the nice weather today?" All of these serve to "break the ice" and set the stage for the social interaction about to follow. Furthermore, they can be of clinical importance in that they allow the interviewer to assess the patient's general attitude quickly. A smile and pleasant response communicates a mood far different from one in which the patient simply grunts or stares back. This latter communication may suggest pain or discomfort, a "let's get down to business" attitude, or perhaps underlying fear at what may be about to happen. Other essential ingredients of the interview involve using good eye contact and maintaining a professional demeanor (e.g., neat appearance, concerned and attentive attitude, appropriate note-taking).

Finally, in setting the stage for the interview, giving the patient some sense of what is going to occur (e.g., a layout) is essential for

the soon-to-follow educational process. Just as in a classroom situation in which an outline of a lecture can help a student follow the material, so can a layout for the health education interview assist the patient. For example, one might say, "What I would like to do today is explain our findings to you and what we have come up with as a diagnosis. Then I would like to describe the treatment plan we have developed for you and respond to any questions you may have about it. Does that sound okay?"

Discussion of the Disease

The following points should be taken into consideration in discussion of the disease:

- Report laboratory findings
- Give diagnosis
- Assess what the patient knows
- Assess the patient's initial feelings and attitudes
- Explain the pathophysiology
- Use vocabulary appropriate to the patient
- Correctness of information
- Assess the patient's final understanding

One can make the transition from the opening interchange to this section with a remark such as, "Now let's talk about our findings." This is the opportunity to report on laboratory work, radiographs, or other medical procedures completed so that a patient clearly understands what he or she was being tested for and what the results suggest. As noted earlier, using clear explanations with no jargon is essential.

After summarizing the laboratory and physical findings gathered during the patient's first appointment, it is time to give a diagnosis, which might begin, "After reviewing the laboratory findings and your physical examination, we have concluded that you have a condition called…." It is best then to ask the patient, "What do you know about this condition?" This will allow the interviewer to quickly identify any myths or misinformation the patient currently

holds, as well as any particular fears the individual may have about the diagnosis (e.g., perhaps a relative had a similar diagnosis and experienced continuing problems). Clearly such issues will need to be addressed during the course of the education interview.

The importance of assessing the patient's attitudes and feelings regarding a diagnosis cannot be overemphasized. This should be done early on in the interview and again toward the end. One might, for instance, say, "How do you feel now about learning you have this sort of condition?" Being able to provide support and reassurance to a patient apprehensive about his or her condition is an integral part of the treatment process and can help ensure compliance with later treatment directives.

At this point in the interview, it is valuable for the health care provider to explain the pathophysiology of the disease process. Such information should be provided in simple, straightforward terminology; it often can be facilitated by the use of diagrams or analogies that are more comprehensible. Providing such information, both verbally and visually, may contribute to a more complete understanding. Once the explanation has been provided, it is critical to check the patient's comprehension and understanding of his or her condition. To do so, one might ask, "I would like you to explain back to me, very briefly, your understanding of this condition." Any misinformation can then be corrected to ensure full and accurate awareness of the situation.

Discussion of Treatment

The following points should be taken into consideration in presenting the treatment plan:

- Present treatment goals
- Present complete treatment plan
- Treatment individualized to the patient
- Explain side effects or complications of the medication
- Correctness of information
- Assess patient's compliance
- Assess patient's final understanding

Following the pathophysiology discussion, one needs to review the specific treatment plan designed for this particular patient. To move into this section one might say, "Now let's talk about how we're going to treat this condition." It's best to start off by highlighting the overriding goals of the treatment plan. For example, common goals can be to alleviate pain, reduce and eliminate the disease process, ensure satisfactory functioning, and maintain a satisfying quality of lifestyle. Then one might go on to say, "To accomplish these goals, we've developed a three-step treatment plan for you." This would be the opportunity to identify and explain fully the specific steps in the treatment plan (e.g., medication, exercise, weight reduction, smoking cessation, or whatever is appropriate for the defined condition). It should be noted that it is particularly helpful if the interviewer identifies the number of steps in the treatment plan—whether three or four or more. Doing so can provide a framework, which tends to be less confusing for the patient and aids in acquiring a full picture of what is being asked, rather than what so often happens when a health care provider tries to explain a treatment plan by saying, "And next …, and next …, and next…." Facilitating the treatment explanation by providing handouts or diagrams and encouraging a question-and-answer dialogue can maximize the effectiveness of this interactive process.

When medication is being discussed as a treatment step, it is of special importance that one be very clear about the uses and side effects of such medication, including any potential interactions with other drugs or food as well as proper methods of storing the medication. Reviewing such important considerations and providing package inserts or other data sheets regarding a medication that a patient can take home are vital to increasing adherence and avoiding unnecessary problems.

As might be expected, certain aspects of a treatment plan will likely be easier for a patient to follow than others. For example, it may be easier for an individual to take medication than to try to make substantial changes in lifestyle. One can always expect some resistance and difficulty when trying to effect the latter changes. To make some assessment of how a patient is going to handle the prescribed treatment plan, it can be prudent to ask probing

questions such as, “Which of these treatment steps will be the easiest for you to follow?” and “Which will be the most difficult?” In some instances, it may be more practical to try to encourage the patient to accomplish those treatment steps that are easiest to comply with and save the more difficult ones to address for a later interview. Otherwise, one may run the risk of turning off the patient completely and he or she may not return for follow-up.

Whether it involves asking an individual simply to take medication or to make substantial lifestyle changes to promote better health, providers must effectively communicate, educate, and motivate the patient.

At the conclusion of this section it is once again important to assess the patient’s final understanding of what needs to be done. This might be accomplished by a request such as, “I would like you to repeat for me now the treatment steps involved in your plan.” Doing this ensures the patient comprehends the treatment program and is prepared to go forward with the prescribed plan.

Summarizing the Interview

The following points should be taken into consideration in summarizing the interview:

- Assess the patient’s overall understanding of disease and treatment
- Allow for questions
- Assess the patient’s attitudes and feelings toward disease and treatment
- Provide handouts
- Schedule a follow-up visit

Careful attention must be given to patients’ emotional responses to a particular diagnosis or treatment method, because these reactions can have a significant impact on outcome.

On completion of discussing both pathophysiology and treatment, it is helpful to assess the patient's overall understanding. This can be done by asking, "Are there any questions now about your condition or about the treatment plan we have developed?" This provides the patient the final opportunity to raise issues that may be unclear and allows the interviewer to evaluate final comprehension and gauge compliance. In addition, this would be the time for the interviewer to ask, "Now that you are aware of your condition and the treatment steps you need to follow, how do you feel about this whole process?" Again, assessing how the patient feels about the situation is critical to ensuring an eventual positive outcome. Underlying fears or doubts about being able to follow the treatment plan need to be addressed. Typically, a patient may be overwhelmed by what has been presented and may feel unable to handle the necessary steps in treatment. This is often a point at which the health care professional can demonstrate empathy, offering support and encouragement. For example, one might say, "I know this is a lot to deal with right now, but I want to assure you that I will be here to support you throughout this process." This sort of reassurance can be timely and helpful to the patient about to leave and begin making changes. In addition, providing various materials that the patient can take home for further study and for sharing with family can be quite helpful. Finally, scheduling a follow-up appointment and making sure the patient will be able to attend at the appointed time brings the interview to conclusion.

Effective patient education should be duly recognized as an integral building block in the entire health delivery process, of equal importance to clinical and technologic advancements in the field.

Appropriate use of Interviewing Techniques

The following points should be taken into consideration in using these interview techniques:

- Clarification of the patient's statements

- Reassurance and empathy
- Appropriate use of silence
- Appropriate vocabulary
- Use of open-ended questions
- Facilitative behavior
- Use of notes
- Use of educational aids
- Flexible in presentation
- Good transitions
- Appropriate pacing
- Good use of summaries
- Professional appearance and demeanor
- Appropriate use of nonverbal language
- Appropriate use of the patient's background
- Make clear the next step for the patient
- Ask for questions
- Closure and follow-up

These techniques are basic to any good interview process. It is critical to use appropriate vocabulary to make sure a patient fully understands the nature of the disease as well as the treatment being prescribed. In addition, patients should be encouraged to express their thoughts and feelings, which can be accomplished with such techniques as facilitation, eye contact, use of silence, and open-ended and direct questions. The key to a successful interchange involves flexibility on the part of the interviewer. It may be important to vary from the didactic, informational aspects of the interview to pay attention to a patient's need for reassurance and empathy. Moving through the interview in a well-paced fashion and using smooth transitions from section to section makes the entire interview more understandable to the patient as he or she tries to absorb all of the information being offered. Finally, the use of audiovisual aids or handouts can be critical to ensuring that a patient fully comprehends his or her medical condition and what needs to be done to address it.

Specific Suggestions for Enhancing the Patient Education Process

Pay Attention to using Good Interviewing Techniques

Helping patients successfully deal with medical conditions involves being able both to educate and to motivate for change. This requires skillful use of interpersonal techniques. It is important to be attuned to both verbal and nonverbal aspects of the interaction. Time and practice will develop a sense of when it is best to be silent and listen to a patient and when to provide specific educational information or support. Being prepared and organized ahead of time (e.g., having laboratory work on the chart, pulling together handouts, having a written-out treatment plan specifically for the patient) will facilitate the entire process and likely improve understanding and compliance.

Present Information through Several Channels

Do not simply rely on direct verbal communication to ensure a patient's understanding. For some people, verbal learning is not as successful as visual learning. That is, some individuals may understand and retain information better if they are able to look at a handout or chart or follow an examination of a radiography. Also, some patients may benefit from the opportunity to meet and talk with others who have dealt with a certain problem or are currently undergoing treatment for a particular medical condition. Such peer support can be a very effective tool in motivating an individual to comply with treatment.

Always Supplement the Educational Process with Resources

The patient education process can be overwhelming because so much information may need to be covered. It is therefore recommended to provide patients with brochures, handouts, medication inserts, an outline of the treatment plan, or other

electronic materials (e.g., Internet links) that will permit later perusal to reinforce what was covered during the actual interview.

Involve Families or Significant Others where Possible

Remember that the patients are part of a larger family system. Most often these family members are very concerned about the health of their loved one, and involving them in the treatment process can be very useful. Indeed, such involvement may in some cases ensure compliance with a treatment plan. Ask how the patient is going to explain a particular health condition to his or her family. Invite family members to attend a follow-up appointment so that they, too, can hear about the situation and learn how they can help.

Be Sure to Raise the Sensitive Issues

Certain subjects tend to be highly sensitive, and some patients may have underlying concerns or fears they may not openly voice. Topics such as sexuality and death and dying fall into this category. Because these topics may produce embarrassment or feelings of despondency, a patient may be reluctant to inquire about them. Therefore it is critical for the health care professional to initiate such discussion when it is clearly pertinent to the treatment plan (e.g., medications that might interfere with sexual functioning, the need for a patient to recognize that the treatment options for a particular condition may be only palliative). Raising these issues signals that it is all right to talk about more sensitive matters and allows the patient to express underlying fears and concerns openly.

Be Attuned to Emotional Reactions

As noted earlier, patients experience emotional reactions to learning of a particular illness and the need to follow a course of treatment. Providing comprehensive health care requires exploring these emotional topics. Whether the patient is expressing fear, anger, anxiety, or depression, unless the health care professional inquires about such reactions and takes steps to address them, treatment

outcome may be in jeopardy. Allowing for ventilation of feelings and offering support are viewed as an integral part of the patient education process.

Do Not Think That Once the Topic is Covered It is Completely Resolved for the Patient

For some individuals, providing education about a disease or treatment plan will be enough to motivate them to go forward and carry out what has been prescribed. For others, however, lingering confusion or questions after this interview will need to be addressed at a later time. In addition, certain aspects of the treatment plan that are more difficult for a patient to deal with (e.g., making lifestyle changes, such as smoking cessation or weight reduction) will need to be reviewed with further encouragement at a later appointment. It is always prudent to review a patient's treatment plan at each subsequent follow-up visit, offering praise for the accomplishments and noting areas for additional attention.

It is Okay to Say, "I Don't Know"

It is not uncommon for a health care professional to be asked a question that he or she is unprepared for and for which a ready answer is not immediately available. Rather than trying to stumble through a lame explanation or using technical jargon in an effort to cover up, it is always recommended that the interviewer simply respond with, "I don't know." Realistically, one may not have the answer to certain questions, and it is best to acknowledge this fact. The interviewer might go on to say something such as, "I really don't know the answer to that question, but let me look into it and I'll get back to you with an answer."

Other Factors Influencing Patient Education

The concept of health has many parts, including how one thinks about disease and its cures. Health care in the United States is based primarily on treating acute, well- advanced disease processes, using an infectious disease paradigm. However, the causes of poor health

and serious disease processes are no longer associated with a single infectious microbe but instead linked to a multiplicity of factors, particularly behavioral and cognitive habits along with specific social and physical environments. Patients often react to illness and its management in ways learned from others, according to their cultural norms, and according to their own perception of the severity of the illness.

Age

Although an obvious consideration, age is not always reflected in patient education materials and is often overlooked in the patient education counseling session. One must remember that the range of care starts with infants and ends with the elderly. Let us start with children. They are not small adults, and their wants, needs, thinking processes, and emotional and physical status differ from those of an adult. For example, small children often view hospitalization as a punishment, not as means of getting well.[10] This belief is further reinforced when parental figures make such statements as, "If you go outside without shoes on you may get sick and have to go see the doctor." This type of belief often leads to false perceptions about clinicians and to a child's difficulty in accepting medical advice or treatment. Infants, although not directly involved in patient counseling sessions, have special needs and respond to touch and nonverbal communication.[10] As children grow older, however, one must keep in mind the current fads, language, and norms that exist. For example, teenagers often believe themselves to be experts in every area and, in some cases, do not heed advice. Furthermore, certain instructions given to teenagers regarding prevention of illness may not be "cool" or in line with the thinking of their peer group.

Adults are more mature and have concerns that differ from those of adolescents. For instance, young adults (ages 20 to 40) are at a point in life in which multiple activities (e.g., college, relationships, children) keep them busy.[10] These patients need practical approaches to education; approaches that are not time-consuming and unrealistic in relation to their lives. As adults grow older (ages

40 to 60), they become more conscious of the possibility of health problems and, in most cases, are willing to follow a patient education prescription. However, some may lack self-confidence, which can cause avoidance of the risk for failure in learning anything new.[10] Adults over the age of 65 are similar to middle-aged adults in their willingness to learn new ideas, but the provider must be aware of the individuals' past experiences, involve them in the learning process, and motivate them to learn.[10] Elderly patients may think it is hardly worth the effort to learn new information and skills because they think their life is nearing the end.[10]

Ethnicity

Ethnicity pertains to a social group that claims or is accorded special status on the basis of complex, often variable traits, including religious, linguistic, ancestral, or physical characteristics. *Ethnicity* is simply defined as the condition of belonging to a particular ethnic group. Examples of ethnic groups in the United States include African American, Asian, Caucasian, Hispanic, and Native American. At least 106 ethnic groups and more than 170 Native American groups live in the United States.[11] Ethnic groups should not be confused with minority groups, because the latter are seen as different from the majority group of which they are a part. However, some ethnic groups are also classified as minorities (e.g., African Americans in the United States). Ethnicity is complex, ambivalent, paradoxical, and elusive.[12] As clinicians, it is important to be aware of the ethnic backgrounds of patients. The differences in language and culture each group exhibits will certainly influence the way patient education is communicated.[13,14] For example, some feel human immunodeficiency virus (HIV) infection prevention literature is not communicated effectively to African-American populations. HIV programs are hampered because of the presence of culturally specific attitudes and beliefs, including those pertaining to the roles of males and females.[14]

Family

Although consideration of the individual is important in patient education (and briefly discussed previously), the patient's family is also of central importance if teaching is to be effective.[15] How a family functions influences the health of its members and how an individual reacts to illness. Including the family members and significant others in patient education sessions will facilitate adherence, understanding of the disease process, and the confidence needed to perform specific skills. Hence, the health professional should capitalize on what family members can do for the patient and work with them in encouraging the patient in tasks that may be difficult. For example, when educating a patient with diabetes mellitus who requires insulin injections, involvement of the family in teaching sessions demonstrating insulin injections will most likely improve compliance. Family members also can serve as troubleshooters when the patient has difficulty performing complex tasks. However, not all patients have family or significant others available for support. This is frequently seen in cases of HIV infection. Patients are often isolated from others after their diagnosis is made known. These patients are often on complex medical regimens involving the use of intravenous catheters. Unavailable support sometimes leads to poor care, missed doses, and increased morbidity and mortality.

The health professional can do much to facilitate the effectiveness of patient teaching by fostering discussion among significant others. A professional who has continued contact with the patient and his or her significant others may check on the progress of the patient when necessary and identify any new problems that may interfere with optimal care.

Socioeconomic Status

The socioeconomic status of patients should be carefully considered when initiating education sessions. Individuals in lower socioeconomic groups are less likely to seek treatment; if they seek treatment, they tend to access health care later in the course of their illness; and they die sooner than individuals in higher socioeconomic classes. Hence, the clinician should be aware of the patient's

personal income, living arrangements, and employment status and also have an increased awareness of the patient's health. Lower socioeconomic status has been linked to the development of disease states, the most noted being coronary artery disease.[8,16] For example, the provider clearly cannot erase poverty and improve access to health care for all; however, he or she can exert a positive impact on lower socioeconomic groups by working with their members to promote healthier lifestyles.[17] Some individuals do not know what resources are available. The provider should point individuals to local resources that provide services and, if not possible, attempt to arrange for those services for the patient.

Chronicity of Disease

Finally, illnesses that are acute present differently from those that are chronic and will cause a variety of reactions among patients. Health care providers must be aware of illnesses that require extra emotional support and possible psychiatric intervention when preparing for patient education sessions. Furthermore, it is not enough simply to inform a patient of his or her medical condition without time for an initial reaction. Patients require time to react to a new diagnosis. The perceived seriousness and natural course of a disease will help determine how a patient will respond. For instance, the patient diagnosed with acute pharyngitis may feel really terrible during the illness, but knows that it is a curable disease and usually self-limiting. Hence, this patient may have fewer emotional problems and require less counseling. In contrast, the patient diagnosed with end-stage congestive heart failure, in which the long-term prognosis is likely fatal, will have a response that may need further intervention involving a psychiatrist, social worker, or nursing care.[18]

Conclusion

It is hoped that the model and suggestions offered in this chapter on how to approach the patient education interview will serve as a "refresher" for the reader. Although this is certainly not the only

approach to use, it is one that is comprehensive and addresses both process and content aspects of the interview. It is expected that each health care provider will develop his or her own style of interacting with patients, perhaps altering this model to fit his or her specific needs.

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CHAPTER 38

Outpatient Coding for Medical Services

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Abstract

The accuracy of medical documentation for coding clinical encounters is paramount in offering a contiguous record of patient care and ensuring the professional and financial survival of medical practices in the United States. As continuous changes occur in the industry, establishing good descriptive habits in recording patient encounters will be rewarded with quick and optimal reimbursement and quality of care throughout the health care system. When clinicians effectively communicate what occurred in a patient visit, others will have few questions regarding the activities and thought processes associated with providing medical care and what was intended to be carried out.

Keywords

documentation
ICD-10-CM
ICD-10-11-CM
medical billing and coding
medical decision-making
medical reimbursement criteria
patient care
patient history
physician assistant
physical examination documentation requirements
quality-of-care coding

Goals and Objectives

GOAL: To increase the clinician's understanding of the process and documentation required to code for medical services in the outpatient setting properly.
OBJECTIVES: The clinician will be able to:

- Describe the purpose, importance, and process of the various coding systems used by medical practices in the United States.
- Explain the importance of accurate and precise documentation required to assist coding specialists to code outpatient medical services properly.

- Identify specific elements required by evaluation and management (E/M) services in obtaining historical data.
- Identify specific elements required by E/M services in documenting a physical examination.
- Identify the specific requirements and components of the E/M documentation required for determining the effort of decision-making during the patient encounter.
- Determine the correct and most accurate level of coding for E/M services following a patient encounter.

Background and History

"If it isn't documented, it hasn't been done" is an adage that is frequently heard in the health care and legal settings. As the health care industry in America has grown into a multitrillion-dollar entity, increased requirements in documentation have become paramount for practices to survive. In the United States, health care insurers process over 5 billion claims for payment per year.[1] Improper coding and billing as a result without supportive documentation can cost health care organizations billions of dollars with the increase in **federal investigations and audits**.[2]

Improper coding and billing as a result without supportive documentation can cost health care organizations billions of dollars with the increase in **federal investigations and audits**.

The American Health Information Management Association defines coding as the conversion of verbal descriptions of diseases, injuries, and procedures into numeric or alphanumeric terms that enable access to medical records by diagnoses and procedures and are required for reimbursement, clinical care, research, and instruction.[1]

Clinicians practicing outpatient medicine require a working knowledge of the International Classification of Diseases (ICD) and Current Procedural Terminology (CPT®) codes.The World Health Organization (WHO) has a constitutional mandate to develop international standard classifications and terminologies for health. The ICD has been maintained by WHO and serves as the international health information standard for collection, classification, processing, and presentation of disease-related data in national and international health statistics.[3]

Driven by the US Department of Health and Human Services, the Centers for Medicare & Medicaid Services (CMS), all third-party insurers must adopt the new coding mandates. Practitioners need to understand the specific information to support accurate communication among colleagues, enhance population-based research, and subsequently improve patient care. Despite the government demanding a more specific coding process in the name of better quality of care, the bottom line is this: accurate documentation justifies qualified and correct reimbursement.

In 1994, the international community began using the Tenth Revision, Clinical Modification (ICD-10-CM). The United States eventually adopted ICD-10-CM in 2015. The WHO decided that the ICD-10-CM needed to be updated to allow operations using an electronic environment; therefore, ICD-11-CM has been in the revision stage since 2012 and adoption is looming in the near future.

The ICD-X-CM is a morbidity classification system. Initially it was meant to keep track of reasons for the death of individuals, but with the Clinical Modifications, it is now used for classifying diagnoses and reasons for patient visits in all health care settings. ICD-10-CM uses seven digits to classify diseases, an increase of two descriptor digits from the earlier version.[4,5] The CMS portends ICD-10 provides benefits such as increased specificity in clinical information that can lead to more accurate and timely reimbursements, better quality of patient care, and improved disease and care management.[6,7]

Outpatient providers are increasingly responsible for determining the exact ICD-10-CM code; therefore, they must document the pertinent facts to support the diagnosis and procedure accurately prior to submission for payment.

The ICD-11-CM will incorporate a more interactive Web platform with daily updates and a search site to assist practitioners to identify specific codes more easily using the electronic environment.[3] The update will also be multipurposed, with a focus on mortality, morbidity, the degree of primary care, research, and public health. It also accommodates many specialties and is translated into many languages.[8]

Current Procedural Terminology (CPT), a numeric coding system annually reviewed and maintained by the American Medical Association, is used to report outpatient medical procedures and services under public and private health insurance programs, specifically Medicare and Medicaid. CPT codes were updated in January 2018 to reflect the adoption of the ICD-10-CM transition and include many new, revised, resequenced, and elimination of codes.[9]

A significant part of the CPT system is the Evaluation and Management (E/M) Service codes.[10] These codes specifically represent the level of service provided in the evaluation and management of the patient. It is based on setting, extent of history and physical examination, and the level of medical decision-making. The practitioner is responsible for the codes selected to bill for medical services. In this chapter, outpatient services will not include the newly defined "outpatient hospital," surgery, or radiology E/M criteria.

Understanding the criteria and terminology used in the CPT E/M outpatient services is crucial(Table 38.1). The following will be helpful to keep track of what is required:

- **Components:** History, physical examination, medical decision-making, and time
- **Elements:** Specific subsections of each component
- **Levels:** Based on the obtained elements of each component, the level of service can be determined.

Table 38.1

Criteria for Current Procedural Terminology Evaluation and Management Coding

History			Examination	
HPI	**ROS**	**PFSH**	**Examination Areas/Systems**	**Diagnostic and Management**
Location Quality Severity Duration Timing Context Moderating factors Associated symptoms	Constitutional Eye ENT Cardiovascular Respiratory Gastrointestinal Genitourinary Musculoskeletal Skin Neurologic Psychiatric Endocrine Lymphatic Allergy	**Past:** Prior illness Surgery Hospital Medications Allergies Dietary status **Family:** Current health Causes of death Hereditary **Social:** Marital status Employment Occupation Drugs, alcohol, tobacco Education	General appearance Eyes ENT Neck Respiratory Cardiovascular Chest Abdomen Genitourinary Lymph Musculoskeletal Skin Neurologic Psychiatric	Status of problems Diagnosis under investigatio Begin or change of treatment Additional workups Referrals

ENT, Ears, nose, mouth, and throat; *HPI,* history of present illness; *PFSH,* past family and/or social history; *ROS,* review of systems.

Purpose of Accurate Medical Record Documentation

The **accuracy of coding** is only as good as the proper medical documentation. This is particularly true in using the ICD-10-CM diagnostic and E/M service codes because they require higher quality data and increased specificity.

The **accuracy of coding** is only as good as the proper medical documentation.

Proper documentation facilitates:

- Communication with patients, providers, caregivers, payers, employers
- Legal verification of the patient care provided at the time of the encounter
- Accurate and timely submission of claims for review and payment
- Collection of accurate data regarding diseases, wellness, and prevention programs and injuries for use in education and research
- Appropriate use of review and quality-of-care evaluations

General guidelines regarding documentation include the need for complete and legible descriptions of the reason for the visit, relevant history, physical examination findings, diagnostic test results, assessment of the patient's current status, clinical impression or diagnosis, proposed treatment plan, and the time spent in the encounter. Clearly recorded descriptions of the care process offers

communication and rationale for ordering diagnostic testing or services, identifying potential risk factors, documenting evolving patient response to treatments and revisions of diagnosis and medical decision-making processes to consulting health care providers. Documentation should occur during or immediately following the encounter to ensure accuracy.

Considerations when using Electronic Documentation

As the transition from written to electronic health records (EHR) evolves, a number of issues have emerged:

- Implementation and training providers on the electronic medical record system is often expensive, time-consuming, and cumbersome with features driven toward reimbursement rather than traditional medical charting.
- Requires new computer skills for less tech-savvy providers. Preparing or educating providers and patients how effectively to communicate and establish rapport while using computers during the visit
- Diluting the patient–provider interaction based on increased emphasis by management to document while examining, once described as the medical equivalent of texting while driving
- Potentially disjointed, inaccurate, and/or unreliable documentation may occur automatically while using default templates.
- Emphasis on producing "bullets" of information to satisfy billing, coding, or other requirements that rarely improve patient care or contribute to a meaningful note
- Failed interoperability of EHR systems
- Privacy and security concerns with increased frequency of data breaches

The Outpatient Coding Process

The claims management process begins when the patient first arrives at the front desk of the office with his or her personal and insurance information and is complete once the practice or organization receives compensation for the provided services. Delays in compensation will be minimal if an efficient process is set up and proper documentation is available.

The practitioner sees the patient and documents the components of the visit. This demands proper use of medical terminology, including anatomic structures for specificity in the ICD-10-CM coding. Multiple elements of the history of the present illness, physical examination, diagnosis, medical decision-making, and time for the visit are recorded for the E/M coding for services. At the completion of the patient encounter, the clinician indicates the diagnostic, procedural, and service elements that were performed. With the advent of EHR, the provider now has guidance in selecting the correct procedure codes.

Many practices employ coding and billing specialists who review documentation prior to submitting electronic claims for reimbursement. These specialists frequently perform random chart audits for missing or inappropriate charges, documentation that does not support medical necessity, and compliance because billing fraud and errors (even unintentional) have come under increased scrutiny in the past several decades.[2] They pay close attention to required elements to justify a level of service or procedure and may add specific modifiers to clarify certain services(Fig. 38.1). If information is not available, the practitioner is required to review the record and fill in the missing data prior to submission for reimbursement. This will delay the process and may cause significant backlogging and financial constraints to the organization.

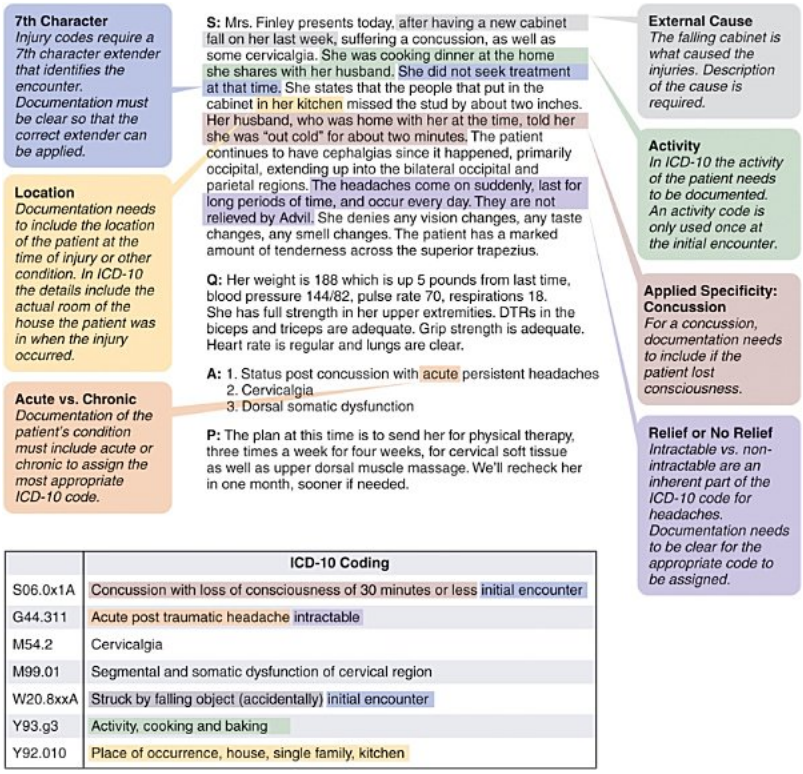

FIGURE 38.1 An example of an outpatient clinical note that highlights the specifics needed for proper ICD-10-CM coding. (Originally published in a white paper from the American Academy of Professional Coders Physician Services, August 2011, p. 8. Reprinted by permission.)

Criteria in Selecting the Proper Evaluation and Management Service Codes

Every encounter in the medical record should reflect whether the patient is a new or existing patient. Although the essential elements of the history, physical examination, and medical decision-making remain basically the same, the assumption is that the amount of time spent obtaining historical data and making decisions is longer with a new patient in contrast to an existing patient.[5,10]

A *new patient* is described as "an individual who has not received any professional services from the physician/nonphysician practitioner (NPP) or another physician of the same specialty who belongs to the same group practice within the previous three years." These outpatient medical services would be billed under "new office visit" codes (Table 38.2).

Table 38.2

Documentation Requirements for New Patient Office Visits and New Patient Codes

Code Levels, 1-5	History	Examination	Medical Decision-Making	Typical Face-to-Face Time (min)
99201	Problem focused	Problem focused	Straightforward	10
99202	Expanded problem focused	Expanded problem focused	Straightforward	20
99203	Detailed	Detailed	Low	30
99203	Comprehensive	Comprehensive	Moderate	45
99205	Comprehensive	Comprehensive	High	60

An *established patient* is "an individual who has received professional services from the physician/NPP or another physician of the same specialty who belongs to the same group practice within the previous three years." Therefore, this encounter would be coded under a level for "established office visit"(Table 38.3).

Table 38.3

Elements of Current Procedural Terminology Evaluation and Management Service Levels

99212 Level II CPT E/M Service Brief Problem Focused	99213 Level III CPT E/M Service Brief Problem Expanded	99214 Level IV CPT E/M Service Extended Problem Detailed	99215 Level V CPT E/M Service Extended Problem Comprehensive
1 HPI	1 HPI	4 HPI	4 HPI
0 ROS	1 ROS	2 ROS	10 ROS
0 PFSH	0 PFSH	1 PFSH	3 PFSH
1 exam	2–4 exams	5–7 exams	8+ exams
Straight DM	Low DM	Moderate DM	High DM
10 minutes	15 minutes	25 minutes	40 minutes

DM, decision making; *HPI*, history of present illness; *PFSH*, past family and/or social history; *ROS*, review of systems.

The *setting of service* should be easily identified in the medical record. The basic categories of settings are office or other outpatient setting, hospital inpatient, emergency department, and nursing facility.

If the encounter is predominantly for counseling or coordination of care, then *time* can be used a major component for coding.

With proper documentation by the practitioner, the following should be included in the record to ensure accurate coding and billing:

- Identify the level of service provided based on the *history* and *physical examination*.
- Determine the complexity of the *medical decision-making*.
- Identify the amount of *time* involved in the encounter.

How to Determine Evaluation and Management Service Levels

Levels of service in the E/M system are determined by the amount of effort exerted to obtain the history, perform a physical examination, and engage in a medical decision-making process and the time spent in the encounter. Each level of service is reimbursed at a different rate. The slight difference between coded levels can have a profound impact on the reimbursement to the practice and to productivity data for the practitioner. A note of caution with EHRs and computer-assisted coding modules that autogenerate medical codes based on chart input: although these codes are usually accurate, they are not always appropriate and require careful oversight by the provider or coding specialist.

As illustrated in Table 38.3, two levels are described as "Brief Problem" (99212 and 99213) and two levels described as "expanded problem" (99214 and 99215). Each of the levels of complexity increases as more details are obtained in the history, as more elements of the organ systems are examined, or as the level of medical decision-making or time increases.

The E/M code in Table 38.3, for example, "99212" or "Level II," is described with the required elements listed below it. This encounter is labeled "Brief Problem" and "focused." In this example, the historical requirements include one element of the History of Present Illness (HPI); no additional review of systems (ROS); no previous, family, or social historical data (PFSH); one element (see later discussion) of a physical examination, straightforward medical decision-making, and approximately 10 minutes of time (Example A).

Historical Data Collection

The four elements of the Type of History are identified as essential for specific E/M codes (Table 38.).

1. Chief complaint (CC): Required in all types of history
2. HPI: Record as many of the elements of the HPI that are pertinent to the problem in chronologic order from the time of onset of the illness or injury.
   - **Brief:** HPI includes one to three of the HPI elements.
   - **Extended:** HPI includes four or more HPI elements or associated comorbid conditions or at least three chronic or inactive conditions.
3. Review of Systems (ROS): The E/M codes recognize 14 body systems in this section. The organ system-based questions are asked to ascertain problems directly related to the CC and HPI. If suspected association of illness or injury may affect other organ systems, this would be considered "pertinent" and the clinician may expound on the survey. When the review is complete, the types of ROS documentation will be determined to fall in one of the following:
   - **Problem pertinent or focused:** One system is reviewed extensively.
   - **Extended:** Review of one system directly related to the problem identified in the HPI and an additional review of two to nine other body systems.
   - **Complete:** Review of one system directly related to the visit and a minimum of 10 other organ systems using a positive or negative response.
4. Past, family, and social history (PFSH): The elements of each of the specific areas of history include the following:
   - **Past history:** Previous medical illness, operations, injuries, and treatments
   - **Family history:** Hereditary conditions, major diseases or medical events
   - **Social history:** Age-appropriate review of past and current activities and situation

Once this line of questioning is complete, based on the relevant information and presentation, the types of PFSH documentation will be determined (see Table 38.4) and fall into one of the following descriptions:

- **Pertinent:** Review of history of areas in direct relation to the presenting problem; at least one item of the three historical areas must be documented.
- **Complete:** A review of two or all three of the historical elements, depending on the category of the E/M services. If a comprehensive assessment is performed, this must include all three areas.

Table 38.4

Components and Elements to Determine Type of History

Type of History	Chief Complaint	History of Present Illness	Review of Systems	Past, Family, and/or Social History
Problem focused	Required	Brief (1–3 elements)	N/A	N/A
Expanded problem focused	Required	Brief (1–3 elements)	Problem pertinent (1 system)	N/A
Detailed	Required	Extended (4 or more elements/3 or more active or inactive conditions)	Extended (1 system directly related to problem plus 2–9 other systems reviewed)	Pertinent (at least 1 of the 3 components of history are recorded)
Comprehensive	Required	Extended (4 or more elements/3 or more active or inactive conditions)	Complete (1 system directly related to problem plus at least 10 other systems reviewed)	Complete (at least 2–3 components of history are recorded)

The CMS directs that separate documentation of all of the elements is not required. Some may be included in the HPI to include other areas of the history, such as the PFSH or ROS. The clinician may have reviewed previous documentation and should indicate there are no changes in the condition. If any of the elements of the history are obtained by ancillary staff or a student, the practitioner must note a review of that section with any supplemental or confirming statements. Often a patient will be asked to complete a health form to be reviewed with the signature and/or notation by the practitioner.

Example A

History Type (see Table 38.4)

CC: "My knees have been hurting me" *(Required element)*

HPI: This is a 26 y/o single man stating he has had bilateral knee pain on and off for the past 2 weeks. He reports the injury started when he was under a car on an automotive creeper and moving around a lot. He said he got up and down off it several times and started noticing his knees began to hurt. It continues to bother him even though he has stopped working on the car. He takes 2 × 200 mg Advil 2 to 3 times per day with some relief. He purchased some knee braces and has been wearing them for a week. He works in a warehouse that requires him to go up and down ladders to get supplies for shipments. He is worried about making it worse or tearing something (*5 elements are present*: *intermittent, bilateral pain, lasting 2 weeks, mechanism of injury, alleviating factors*).

PMH: No previous surgeries or hospitalization. No known drug allergies. Current medications: Zocor 40 mg/day

Social history: Tobacco use: none *(2 elements of PFSH are presented, but are not required)*

ROS: No additional systems reviewed

Summary: This is considered a problem-focused type of history.

Physical Examination

The levels of E/M services are based on four types of examination.[10] The type of examination is determined by the intensity of the investigation of one system or the inclusion of a number of organ systems to evaluate additional systemic involvement. Table 38.5 illustrates the coding elements for the 14 identified body areas or systems.

Table 38.5

Coding Elements for the Physical Examination

System/Body Area	Elements of Examination
Constitutional	Measurement of any of the following three of seven vital signs: (1) sitting or standing BP; (2) supine BP; (3) pulse rate and regularity; (4) respirations (5) temperature; (6) weight; (7) height
Ear, nose, mouth, and throat (ENT)	Inspection of the external ears, nose (overall appearance, lesions, masses, or scars noted)
	Otoscopic examination of the external ear and tympanic membrane
	Hearing assessment (whisper test, finger rub, or tuning fork)
	Inspection of nasal mucosa, septum, and turbinates
	Inspection of lips, teeth, and gums
	Examination of the oropharynx: oral mucosa, salivary glands, hard and soft palate, tongue, tonsils, and posterior pharynx
Eyes	Inspections of the lids and conjunctivae
	Examination of the pupils and irises (PERRLA)
	Ophthalmoscopic examination of the optic disks (full funduscopic examination)
Neck	Examination of the neck for masses, symmetry, tracheal position, and crepitus
	Examination of the thyroid
Chest (breasts)	Inspection of the breasts
	Palpation of the breasts and axillae
Respiratory	Assessment of respiratory effort (e.g., intercostals, retractions, use of accessory muscles, diaphragmatic movement)
	Percussion of the chest
	Palpation of the chest (e.g., tactile fremitus)
	Auscultation of the lungs (e.g., breath sounds, adventitious sounds, rubs)
Cardiovascular	Palpation of the heart (location, size, thrills)
	Auscultation of the heart with notation of abnormal sounds and murmurs
	Examination of carotid arteries, abdominal aorta, femoral arteries, pedal pulses
	Extremities for edema and/or varicosities
Gastrointestinal (abdomen)	Examination of abdomen with notation of masses of tenderness; liver and spleen; presence or absence of hernia; when indicated, anus, perineum, and rectum, including sphincter tone, presence of hemorrhoids, and rectal masses
	Obtain stool sample for occult blood test when indicated
Genitourinary	**Male:** Examination of scrotal contents, with notation of hydrocele, spermatocele, tenderness of cord, testicular mass; penis; digital rectal, with notation of size, symmetry, modularity, tenderness of the prostate
	Female: Pelvic examination with or without collection for smears and cultures, including examination of external genitalia; vagina; urethra; bladder; uterus; adnexa, for masses, tenderness, organomegaly, modularity

System/Body Area	Elements of Examination
Lymphatic	Palpation of lymph nodes in two or more areas: neck, axillae, groin, other
Musculoskeletal	Gait and station
	Inspection and/or palpation of digits (e.g., clubbing, cyanosis, inflammation, petechiae, ischemia, infections, nodes)
	Examination of joints, bones, and muscles of one or more of the following six areas: head and neck; spine, ribs, and pelvis; right or left upper extremity; right or left lower extremity
	The examination is to include the following for each area: inspection and/or palpation noting misalignment, asymmetry, crepitation, defects, tenderness, masses, effusions; assessment of range of motion, noting pain, crepitation, or contracture; assessment of muscle strength and tone with notation of atrophy or abnormal movements
Neurologic	Cranial nerves with notation of deficits
	Deep tendon reflexes noting pathology
	Sensation (sharp, dull, vibrations, proprioception)
Psychiatric	Description of patient's judgment and insight
	Mental status: orientation to time, place, and person; recent and remote memory; mood and effect
Skin	Inspection of skin and subcutaneous tissues (rashes, lesions, or ulcers)
	Palpation of skin and subcutaneous tissues (for indurations, nodules and tightening)

PERRLA, Pupils equal, round, and reactive to light and accommodation.

The physical examination types are defined and determined by the following:

- **Problem focused:** A limited examination of the affected body area or organ system. Include one to five elements in one or more organ system(s).
- **Expanded problem focused:** A limited examination of the affected body area or organ system and any other symptomatic or related body area(s) or organ system(s); include at least six elements within one or more organ system(s).
- **Detailed:** An extended examination of the affected body area(s) or organ system(s) and any other symptomatic or related body area(s) or organ system(s); include at least six organ systems with at least two elements within each organ system. Alternatively, 12 elements in two or more organ systems would qualify.
- **Comprehensive:** A general multisystem examination (nine or more organ systems or body areas) or a complete examination of a single organ system. Documentation of at least two elements in each organ system is expected; however, each element in each organ system should be performed.

Example B

A 4-Year-Old Girl

Objective: VS: Temp 101.4° F, left ear; P 142, R 40

General: This patient is alert, good eye contact, moving freely and playful.

ENT: Mucous membranes are moist and pink. Tympanic membranes are intact without perforations. Left TM is normal in color with good light reflex. The Right TM is erythematous and bulging.

Lymph: There is no anterior, posterior, cervical, or subclavicular lymphadenopathy.

Heart sounds: S_1 and S_2 without S_3 or S_4, murmur, gallop, or rubs.

Lungs: Clear to auscultation bilaterally without wheezes, rales, or rhonchi.

(The physical examination has six elements. Each location had at least two areas examined.)
Summary: This is an expanded problem-focused physical examination.

Medical Decision-Making

The medical decision-making area of coding tends to be the most confusing for many clinicians. Some decision-making activities may take quite a bit of time and effort, whereas others can be made in seconds and have enormous consequences. Experience may allow for a quick decision to be made in an emergent situation, but it does not dilute the decision-making process. To a skilled surgeon the maneuver may be instinctive, based on reacting to the same situation many times, yet the choice to perform a specific cut in a specific area requires a great deal of knowledge to make the judgment and decision.

The following factors are involved in the decision-making process:

- The number of different diagnoses or management options that must be considered.
- The amount and complexity of the medical data. This includes documentation, diagnostic test interpretation, and other pertinent information that must be included to be thorough in the assessment.
- The risk for complications, morbidity, or mortality related to further testing or treatment options.

Types of Medical Decision Making

The level for the types of decision-making elements considered is based on the gain in complexity of the three factors listed (Table 38.6). Two of the three elements must be documented as met or exceeded for each type.

Table 38.6

Types of Medical Decision-Making

Critical Thinking	Differential Diagnoses	Amount and Complexity of Reviewed Data	Risk for Complications, Morbidity, and Mortality
Straightforward	Minimal	Minimal/none	Minimal
Low complexity	Limited	Limited	Low
Moderate complexity	Multiple	Moderate	Moderate
High complexity	Extensive	Extensive	High

- **Straightforward:** Minimal diagnosis or treatment options; minimum or no amount/complexity of data; minimal risk for complications
- **Low complexity:** Limited diagnosis or treatment options; limited amount/complexity of data; low risk for complications, morbidity, or mortality
- **Moderate complexity:** Multiple diagnoses or treatment options; moderate amount/complexity of data; moderate risk for complications, morbidity, or mortality if left untreated
- **High complexity:** Extensive diagnoses or treatment options; extensive amount/complexity of data; high risk for complications, morbidity, or mortality if left untreated

To illustrate the complexity and thought process for each patient encounter based on the number of diagnoses or management options, an assessment, clinical impression, or diagnosis should be described. The following should be considered:

- A diagnosed condition is easier to process than an unidentified diagnosis.
- An established diagnosis should reflect the status of the condition and whether it is improved, controlled, or resolved or, if not, a descriptor of the current status.
- If a presenting problem does not have a clear diagnosis, the documentation should include terms such as "possible," "rule out," or "probable." The practitioner then needs to determine that the significant symptoms are identified for ICD-10-CM.[7]
- The number and types of diagnostic tests may indicate a more complex differential diagnosis.
- The status of the problem. For example, a problem that is resolving is less complex than a problem that is getting worse.
- Seeking additional consultation or services may indicate a more complex encounter. The documentation should detail from whom and why these opinions were sought.
- Any initiation or change in the treatment plans should be specifically documented, including new patient education, instructions, changes in medications or therapy, and the basis for new or different treatments.

Documenting the risk for complications, morbidity, and mortality is based on the disease or injury process from the present encounter to the next. These risks are to be considered in selecting any diagnostic procedures or management options immediately before and after any procedure or treatment. Using Table 38.6, the practitioner can be guided toward a decision-making level regarding risk.

Example C

Medical Decision-Making

CC: "I have this burning feeling in my stomach."

Subjective: This is a 41 y/o single woman reporting RUQ discomfort. She thinks she may have blood in her stool but isn't sure. Her history is scant, and she has difficulty giving facts. She describes burning sensations, more frequent after she eats and late at night when she goes to bed. In reviewing previous records of her last office visit with Dr. Smith, dated November 30, 2010, she was prescribed ranitidine 150 mg PO bid. She reports she does not take this on a regular basis, only when she feels the symptoms. She also reports having a lot of bloating and gas. She was given simethicone for these symptoms at some point (doesn't remember who prescribed the simethicone previously.), and she reports she doesn't use it even though she seems to know why she was prescribed the medication. She reports her stools are orange, with no black- or red-colored stools. She reports she had 5 loose, watery bowel movements yesterday after having none for at least 2 days. She had a regular bowel movement today. She notes that she frequently has this type of cycle with no movements and then several loose ones. She reports, and the records show, she has not had any endoscopic studies in the past. She reports she was treated for a "rectal fissure" 3 months ago and denies a history of hemorrhoids. She denies fevers, sweats, nausea, vomiting, or other abdominal discomfort. She reports that her gallbladder was removed many years ago, although this is not in the medical record. Her diet consists of foods high in fat, and she recognizes this exacerbates her diarrhea, especially since her cholecystectomy.

Objective: General: she does not appear in any distress.

VS: Weight: 185 lb, T 98.8° F, P 92, R 18

Rectal examination revealed a small healed area in the 10 o'clock position where it appeared a hemorrhoid had been. No pain or tenderness on palpation of the rectal mucosa. There is a small, nonbleeding anal fissure at the 3 o'clock position. No prolapse and the sphincter tone is good. Guaiac negative.

Assessment:

1. Dyspepsia: Chronic, uncontrolled. Concerned it may be GERD.
2. Irregular bowel habits: Consider gluten intolerance or sensitivity, anxiety, or IBS.
3. Rectal fissure: Nonbleeding, healing
4. Hemorrhoid: Almost completely healed

Plan:

- Counseled patient on proper use of ranitidine on a daily basis, so we can determine if this is helping her symptoms or not. She agreed to this. May need to do *Helicobacter pylori* testing.
- She received a Fecal Immunochemical Test (FIT) to collect a sample at home and return it to the clinic. She received instructions on collecting the sample.
- She agreed to try the simethicone as prescribed when she is feeling bloated.
- Prescribed Metamucil 30 mL PO q AM with a meal to regulate her bowel movement.
- Education on decreasing fatty foods, avoiding gluten products, and drinking water regularly to avoid constipation and decrease chances of reinjury of fissure. She will start keeping a diary of her daily food intake.
- Follow-up appointment in 1 week to reassess symptoms. She agrees to this plan.
- Time with patient: 25 minutes.

Summary: Moderate complexity of medical decision-making because there are four diagnosis or assessments and six management plans (including some dietary counseling), and it took approximately 25 minutes.

Other Contributing Factors in Documentation and Coding of Patient Encounters

If a patient encounter is dominated (>50%) by counseling or coordinating care, then *time* is considered the controlling factor. The record should reflect the amount of time spent, what activities took place, and who was present.

If the encounter was shared with another provider, the amount of time each spent should be reflected in the documentation. For example, if a physician assistant saw the patient initially but requested an opinion of the supervising physician, this should be clearly documented. When the visit is complete, anyone reading the documentation of the providers should be able to ascertain the setting, components of the visit, time spent, and decision-making components to determine accurately and bill appropriately for each of the services.

Summary

The accuracy of medical documentation for coding clinical encounters is paramount in offering a contiguous record of patient care and ensuring the professional and financial survival of medical practices in the United States. As continuous changes occur in the industry, **establishing good descriptive habits** in recording patient encounters will be rewarded with quick and optimal reimbursement and quality of care throughout the health care system. When clinicians effectively communicate what occurred in a patient visit, others will have few questions regarding the activities and thought processes associated with providing medical care and what was intended to be carried out.

Establishing good descriptive habits in recording patient encounters will be rewarded with quick and optimal reimbursement and quality of care throughout the health care system

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CHAPTER 39

Procedural Notes and Documentation

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Abstract

This chapter provides clinicians with the knowledge and skills necessary to document clinical procedures accurately and successfully.

Keywords

documentation
procedures

Procedure Goals and Objectives

GOAL: To provide clinicians with the knowledge and skills necessary to document clinical procedures accurately and successfully.

OBJECTIVES: The student will be able to:

- Describe the purpose of documenting clinical procedures.
- Discuss the importance of documenting clinical procedures in the medical record.
- List the components of a standard clinical procedure note.

Background and History

The medical record is a repository of information compiled by many individuals regarding a single patient. The information includes history and physical examination findings, data, interpretation of data, and descriptions of medical acts that were performed. The record serves many different audiences, which may include the clinician, other health professionals involved in the patient's care, the patient, supervisors, clinical investigators, and administrators.

Many of the clinical procedures discussed in this text warrant or require the clinician involved in performing the procedure to prepare and record a clinical note for the medical record that documents and describes the performance of the procedure and the associated findings. Performing a procedure without documenting it in the clinical note can result in loss of critical information affecting patient care or the ability of the health care system to receive reimbursement for the care provided. Documentation of procedures that have been performed in the medical record can serve several purposes, including the following:

- **Memory aid:** The medical record originally served as a vehicle for recording information that may otherwise be forgotten about the patient's medical condition. However, the patient's complete medical database is a combination of the clinician's written information and thought processes. Documentation of the clinical procedure and its findings can

serve to assist the clinician in recalling important findings, techniques used, or complications encountered while performing a procedure.

- **Communication device:** The medical record also functions to communicate information about a procedure performed and its findings to other clinicians and health professionals. Because medicine is a team function, many others will access the information recorded in a patient's medical record as they provide care to the patient. It is vital to have the information in an easily accessible standardized format for the next practitioner accessing the record. For example, knowing the exact number of sutures or staples placed in an eyebrow laceration is critical information for the provider who is removing them.
- **Quality assurance instrument:** Individuals and organizations involved in providing patient care need to monitor the quality of the care provided. A key component of this process involves medical record review by peers. The medical record is assessed for thoroughness, accuracy, and documentation of essential elements of a procedure. Record review can serve as a source of feedback that helps to ensure that the clinician is following established standards of care.
- **Risk reduction aid:** One of the best defenses against malpractice litigation is a detailed, concise, and accurate medical record that demonstrates the rational and systematic approach the clinician used in performing a procedure. The medical record serves as a legal document and may be used in court as evidence.
- **Reimbursement aid:** Most third-party payers require chart review in assessing reimbursement or reimbursement levels. In performing clinical procedures, it is essential to document all aspects of the history, physical examination, indications, and findings to support the charges for which reimbursement is being requested. The medical record is used to verify that the procedure performed was indicated and performed appropriately. In view of this, it becomes critical to document all of the associated activities involved

with performing the procedure carefully. The perspective that the third-party payer may use is: If it is not recorded, it was not done. Chapter 38 provides a review of the importance of documentation related to the billing and coding process.

- **Evaluation tool: Documentation** of clinical procedures may be used in evaluation. Virtually all medical systems have a mechanism of quality control that includes evaluation of all clinicians' charts by peer review or quality control boards. Write-ups by students and others in training are evaluated, and performance is monitored by their supervising faculty and staff. Developing strong documentation skills is an important competence for clinicians in training to obtain.
- **Research tool:** The medical record also serves as a data source for clinical research in some cases. Retrospective chart reviews are commonly used in clinical epidemiology studies, so it is imperative that data must be accurately recorded to be useful in research studies.

Documentation in the medical record of procedures that have been performed can serve several purposes, including memory aid, communication device, quality assurance instrument, risk reduction aid, reimbursement aid, evaluation tool, and research tool.

Other Points for Consideration in Recording Clinical Procedures

The following points should be considered in record documentation:

- Record all of the pertinent data.
- Include both positive and negative findings that contribute directly to the assessment and differential diagnosis.
- Another clinician should be able to read your account and be able to determine the rationale for your conclusion.
- Be objective.

- Avoid judgmental or condescending statements.
- Remember the medical record is the property of the patient and will be read not only by your colleagues but perhaps by the patient as well.
- Consider using diagrams.
- Use diagrams to identify topographic locations of lesions or techniques used in performing a procedure or to illustrate clinical findings.
- In institutions using electronic medical records (EMRs); usually information can be scanned to the record, allowing the use of manual or computer-generated diagrams.
- Consider using digital photographs.
- Technology available through smart phones and other handheld devices make uploading digital pictures into the EMR practical and painless.
- Obtain patient consent before taking any pictures.
- Make every attempt to spare any identifying information from the picture.
- Digital pictures can be **very useful i**n documenting before and after pictures, especially of complication laceration repairs.
- Avoid the use of nonstandard abbreviations.
- When in doubt, spell it out.
- Make sure the record is legible if it is to be handwritten.
- Review completely if using an EMR template.
- Templates can make documentation more efficient.
- Be sure to revise templates to accurately portray the procedures performed.

The use of diagrams and digital photos can be a quick, easy, and precise way to document appearance, changes before and after a procedure, location of procedure on the body, and so forth.

Clinical Procedure Notes

Entries made into the medical record specifically regarding clinical procedures performed constitute a unique format. Although they

may be incorporated into a subjective, objective assessment and plan (SOAP) note format in some instances, the more significant procedures often warrant a separate entry specific to the procedure performed. Each time an entry is made into the medical record regarding a clinical procedure, a conventional format should be used to help ensure the essential and important aspects of the procedure are included and to aid others who access the record in finding the important information. One such format is listed in the following section. A sample note is presented in Fig. 39.1.

Demographic data:
Name: Mary Smith, ID# 123-45-6789, Age: 48 years, Date: 08/09/01, Time: 1:45 pm,
Location: procedure room, outpatient clinic.

Procedure performed:
Incision and drainage of abcess in perirectal area.

Primary indication(s) for performing the procedure:
Treatment of localized skin infection and relief from associated pain.

Contraindications:
None, patient reports no known allergies.

Consent:
Informed consent was obtained and form signed and filed in medical record prior to performing the procedure.

Personnel:
Procedure was performed by Jane Doe, PA, with assistance from Sara Shoe, RN.

Anesthesia:
A regional field block was performed using 8 cc of 1% lidocaine without epinephrine.

Description of the procedure performed:
The patient was positioned in a dorsal recumbent position and the skin of the perianal area was cleansed using Betadine. A regional field block was performed with 1% lidocaine. The patient was then draped and an elliptical incision was performed parallel to the skin tension lines in the skin overlying the abscess. The abscess margins were approximately 1.5 cm deep by 2.0 cm wide. The abscess was explored with a sterile cotton tip applicator and cultures were obtained and sent. A sterile blunt hemostat was then used to disrupt loculations in the skin comprising the abscess with blunt dissection technique. The depths of the abscess were explored with no evidence of rectal fissure formation. The abscess appeared to be limited to the subcutaneous fat layer of the skin. No foreign bodies or matter were noted in the abscess. The area was massaged to facilitate the expression of purulent materials from the depths of the abscess. The wound was irrigated with 300 cc of normal saline solution. The wound was then packed with iodoform gauze. The wound was covered lightly with an absorbent bandage.

Complications, including blood loss, side effects, and adverse reactions:
No complications were encountered. Estimated blood loss was 5 cc.

Instructions and follow-up plans:
The patient was instructed on the proper technique to pack the abscess with iodoform gauze and bandage the wound. Patient was advised to repack the wound twice daily. Patient was instructed regarding signs of advancing infection and instructed to contact our office or return to the clinic if they occur. A prescription for Tylenol #3 1–2 tablets PO every 6 hours during the next 48 hours for pain relief was given (total of 16 tablets provided). The patient was advised not to drive or operate equipment while taking this medication. Patient was advised to schedule a return appointment in 10 days.

Time procedure completed and condition of patient:
The procedure was completed in 20 minutes and the patient was released to travel home with her spouse in good condition.

FIGURE 39.1 Sample procedure note.

Clinical Procedure Note Format

If the clinician performing the procedure determines that a separate note is warranted, the format proposed in this section may be used to record the essential information.

- Name or description of procedure performed
- Primary indication(s) for performing the procedure
- Consent (if obtained)—indicate that informed consent was obtained and that forms were signed and filed in the medical record before performing the procedure.
- Personnel—indicate the clinician who performed the procedure and any attendants who assisted with the procedure.
- Anesthesia (specific agent, quantity used, and route administered), if applicable
- Description of the procedure performed (include description of equipment used and any variations to the technique); diagrams may be useful in documenting the location of lesions, and so forth.
- Complications, including blood loss, side effects, and adverse reactions
- Time that the procedure was completed and the condition of patient at that time

Conclusion

Documentation of the clinical procedure in the medical record is an essential component of any complete procedure. Exercising care to be certain that the entry into the medical record follows a conventional format and is thorough helps to avoid potential problems associated with incomplete entries.

It is critical to follow a standard procedure note format to avoid inadvertently leaving out essential material and to assist other users of the record in locating important content.

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CHAPTER 40

Giving Sad and Bad News

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Laura A. Katers

An expert in breaking bad news is not someone who gets it right every time—she or he is merely someone who gets it wrong less often, and who is less flustered when things do not go smoothly.

Robert Buckman, 1992

Procedure Goals and Objectives

GOAL: To give sad or bad news consistently and with minimal anxiety or stress to the patient and provider.
OBJECTIVES: The student will be able to:

- Define sad and bad news.
- Describe the goals for giving sad and bad news.
- Explain the principles of SPIKES, and describe the six-step approach for giving sad and bad news.
- Discuss the six steps in the SPIKES protocol.

- Demonstrate the technique for giving sad or bad news to a patient.

When the words cleared, we sifted through the medical jargon, beeps
and clicks of machinery, the stone-faced
downcast expression of the provider, to where our father lay. Was he dying?
Hypercarbic respiratory failure
meant nothing to us. What we needed to know was that he was never leaving
the hospital, the bed that arrived at our home would be empty for days.

Background and History

For the past 3000 years, physicians have had an exquisite ability to describe disease processes. Their ability to observe, diagnose, prognosticate, and treat disease—in a manner appropriate for the time—is well documented.[1] But truth-telling to the patient was not the norm.

In 1951, Kline and Sobin[2] described methods to avoid giving information. A 1961 paper in the *Journal of the American Medical Association* reported that 90% of physicians would choose not to let their patients know of a diagnosis of cancer.[3] This was done in good faith and in the spirit of beneficence, based on the belief that the truth would shatter patients' hope and hasten their deaths.

By 1971, there was a sea change in attitudes, and 97% of physicians would tell their patients of a cancer diagnosis.[4] However, sharing bad news with a patient is difficult and causes significant stress.[5] A major cause of this stress is the lack of proper training and feedback on techniques for providers. Lack of training and subsequent inappropriate communications can result in long-term devastating effects to both patients and providers. For the most part, patients want to know the truth even if it is sad, bad, or difficult.[6] The

principle of autonomy requires this level of information for patients to make informed decisions about their care.[7] A decision not to know is also a choice and is discussed later in this chapter. A mutually responsive patient–clinician relationship is crucial for productive, secure, and successful therapeutic encounters, and giving sad news is often part of the interaction.

Indications

Many of the clinical procedures within this text provide practitioners with diagnostic data. For example, the patient–clinician relationship can create an expectation that observed results will be shared. In any procedure, preparations must be made and instruments must be obtained and set up. In many cases, a step-by-step method for a procedure has been planned with the knowledge that normal anatomic variation may change some of the steps. The procedures are done in a case-based manner, and both the provider and the patient should be aware of the contraindications and potential complications. This is also true of breaking difficult news to patients. The most powerful instrument for this procedure is your words. Medical expertise allows us to cure disease, to remove organs and put them back, and to retest and reimage for the most accurate diagnosis. However, we cannot take back our words. The art of medicine requires the use of carefully thought out words, but also the practice of listening and the artful use of silence.

What is "bad" news? In Buckman's paper, "Breaking bad news: Why is it still so difficult?" it means "any news that drastically and negatively alters the patient's view of his or her future."[8] Despite the passage of time, breaking bad news is still difficult. Sad, bad news is not necessarily news of fatal illness. The information can be any chronic disease that changes a patient's life, such as diabetes, hypertension, macular degeneration, progressive hearing loss of unknown origin, or multiple sclerosis. Sometimes we diagnose these so often that it becomes commonplace. However, for the patient the diagnosis is new and can be both life-changing and life-threatening. The choice of words and how we present them may well change the patient–clinician relationship forever in either a positive or negative

manner. The name given an illness can alter the patient's personal, family, and societal life.[9] In the majority of instances, when the clinician states and confirms a life-changing diagnosis, the patient does not hear anything else during the encounter.

Preparing to Share Bad News

In preparing to give sad or bad news, clinicians must ensure that the **information they are to deliver is accurate**. They should confirm the medical facts up front. This should not be delegated, but rather done personally.

In preparing to give sad or bad news, clinicians must ensure that the information they are to deliver is accurate.

The clinician should think about the content of the message. Confidence is built on a foundation of competence. Cultural sensitivity and awareness and language should be part of the initial considerations. Remember that sharing the information is a dialogue with the patient, not a monologue by the provider. Silence is not an enemy; it can provide needed time for the patient to comprehend the information. An empathetic, caring, comforting, and pleasant manner is crucial in giving this news.[10] To remain calm and reassuring requires preparation and experience.

Just as procedures are not exactly the same every time, bringing sad or bad news requires individualized consideration. Different approaches are required. Just as experience builds a provider's confidence and ability in history-taking or performing physical examinations, the provider's approach to sharing bad news may change with time, and frequency will help build confidence. Interviewing skills should incorporate the Buckman recommendations.[11] Following are some guidelines for this process:

- Nonverbal communication: Make eye contact, lean forward, give encouraging looks, and nod (when appropriate).

- Questions should be simple and brief, open-ended progressing to focused; closed questions should be used only if necessary to obtain specific information.
- Summarize information periodically and ask clarifying questions to obtain a fuller understanding of the history.
- Engage in active listening, including restatement and summarization, which indicates you have heard the patient.
- Listen with empathy, reflect back to the patient empathetically what the patient has said. Respond to the mood and feelings of the patient.

A Procedure for Sharing Bad News

Robert Buckman was one of the first to develop guidelines for sharing bad news. The guidelines are meant to "be practical and useful in daily clinical situations based on some consistent and coherent principles, intelligible, teachable, and, most important, learnable."[11]

The SPIKES approach[12] to sharing bad news, which can be an effective strategy, consists of the following elements:

- **S**etting up: **S**etting up the interview
- **P**erception: Assessing the patient's **P**erception
- **I**nvitation: **o**btaining the patient's **I**nvitation
- **K**nowledge: Giving **K**nowledge and information to the patient
- **E**motions: Addressing the patient's **E**motions with empathetic responses
- **S**trategy: **S**trategy and **S**ummary

Setting Up

Setting up the interview involves five areas in planning a strategy. Some may seem obvious, but should not be overlooked. Arrange for privacy in an office or private room; if this is not possible, create some privacy in the patient's room.The patient should not be alone for this information unless specifically requested. A friend or family

member can buffer the patient emotionally when he or she receives bad news. Sit down so it conveys to the patient you are not in a rush to leave. Sitting puts you at eye level with the patient and creates a more supportive impression. Eye contact can establish a connection with the patient; however, being culturally aware in this situation is fundamental. Showing common courtesy and respect and not appearing rushed go a long way toward a successful discussion. Address the patient by his or her surname unless you know the patient well and have used the first name in the past. Depending on the comfort level of the patient, touching the patient on the arm or shoulder may help make this connection. Set your pager or cell phone on silent mode and schedule sufficient time for sharing this information. If there are any issues with time let the patient know so it is not a surprise if you must leave. Arrange that there will be no interruptions.

Perception

Assess the patient's perception. How does the patient perceive the medical situation? How much does the patient know about the illness? The choice of words in the opening question is important. They should be your words so that you feel comfortable with them. The content in such questions can be as follows:

- Do you know why you have had this procedure?
- What have you been told about your condition?
- Have you been very worried about this…?
- When these symptoms first started, what did you think it was?
- How worried have you been about yourself?
- Have you been worried about this being serious?
- What do you think is going on with...?

Asking open-ended questions allows you to hear the patient's story. Thus, you gain the ability to evaluate the patient's capacity to recall previous relationships with other providers; it also may give you a sense of the patient's medical judgment, which may help you

later to determine the goals of care. Gauge how much the patient knows, which may reveal the patient's expectation of treatment, concerns, or denial of his or her illness. This information may provide a conversational starting point, and may also allow you to correct misconceptions or misinformation. Listen for the emotional content of the patient's responses to learn what he or she wants to talk about or does not want to talk about. Body language can provide a considerable amount of information; for example, if the patient moves away, wrings the hands, or is tearful. Seemingly happy, nonchalant, or blasé body language and attitude also can indicate the patient's emotional state.

Invitation

Providers must obtain permission from the patient before divulging sad or bad news. Most patients want to know the diagnosis, prognosis, and any available treatment. Some do not. Health care decisions may be made or shared with family or community leadership.[13] If the patient does not want to know specifics, offer support and an appointment to talk again in the future. With the patient's permission, talking to a family member or close friend can be arranged. Again, the style and exact words to use should be your own. The following are some examples of the content:

- Would you like me to tell you the specifics of your condition, or is there someone else you would like me to have a word with?
- How much do you want to know if your condition is serious?
- If this condition turns out to be serious, would you like to know specifically what the situation is?
- Some folks would like to hear the treatment plan first without knowing the full details of what is wrong. Is that what you would be more comfortable with?
- Would you like me to summarize your condition or do you want to know precisely what we are dealing with?

Knowledge

One of the best ways to ensure knowledge and information is successfully passed between provider and patient is to offer to record the interview. A plethora of options are available for recording with today's technology, including the use of cell phones, as well as sharing the session in real time with a loved one who cannot be present by way of video, such as Facetime or Skype. Sharing knowledge has two parts. First, provide understandable information to the patient. Second, offer a therapeutic conversation in which you listen, hear, and respond to the patient's reaction to the information.

Before starting this section of the paradigm, it is imperative to know the purpose or goals of the interview. The goals should incorporate four key components: diagnosis, plan of treatment, prognosis, and support. Although the content of each component is case-based and specific for each patient, you need to have a goal for the interview. Your goal and the patient's may differ, but they may be brought closer together by the end of the interview. The patient has the right to accept or reject the information, as well as the treatment or diagnosis. The patient has a right to respond in any (lawful) way he or she may choose. Medical providers must be prepared to accept these responses.

By this point in the dialogue, the patient has given consent about the amount of information he or she is willing to hear. The process of imparting knowledge to the patient is a true dialogue. This process must be assessed frequently by observing the patient's responses to the information. Sharing the information should be gentle, consistent, and at the patient's pace. Information should be given in small digestible portions. Whether the information is being comprehended can be determined by asking questions such as these:

- Can I clarify anything?
- Does this information make sense to you?
- This can be confusing, but do you follow me so far?
- If a gap exists between the patient's expectations and the data being presented, the following statement may be

included: This condition is much more serious than…

The patient requires the information to make an informed choice. When providing the information, start at the level of the patient's understanding and terminology. For example, instead of saying "demyelination," say "damage to the insulation covering of the nerve"; instead of saying "metastasize," use the word "spread." Clarify to make sure your meaning of the words and the patient's understanding of the words are the same. To do this, ask the patient to repeat the general meaning of what has been said. Repeat the essential portions. People hearing sad or bad news have limitations in processing information when facing serious illness. Remember, empathy is the ability to understand and *share the feelings of* another. An empathetic response may be as follows:

- I know it is hard to hear and remember all the specifics at once…

The use of simple handwritten illustrations or flow charts can be helpful; including your name and office number can bring a very personal feeling to the situation. This handwritten aid may help the patient remember more of the encounter. Pamphlets and educational materials should also be used, as well as offering to record the session, as mentioned above. Listen for the patient's concerns while proceeding through the sharing of information. Ask about worries and fears, because many times they stem from rumors or inaccurate information. The patient may have concerns about the effects of the treatment or quality-of-life issues. By listening and acknowledging the patient's concerns you can address them then or at a future appointment. Sometimes patients ask questions while the clinician is talking. These are often important questions and should be addressed carefully. Finish the sentence, then ask the patient to repeat the question. Many times these questions are the heart of the discussion and can be very productive. Not infrequently, as the interview is drawing to an end, the patient wants to restart a portion of it. This is not necessarily obstinate behavior, but rather is an indication that the patient is afraid and anxious. Sit down for a

moment to reassure the patient, acknowledge the concern, and set up another time to talk further about the issue. A short moment may save significant anguish for the patient and illustrates your concern. Demonstrating concern by listening allows the clinician to accommodate the patient's perspective. These actions can help bring together the provider's and patient's goals and objectives to create a stronger patient–provider relationship.

Emotions

Addressing the patient's emotions with an appropriate empathetic response can determine the outcome of breaking sad or bad news. Emotional reactions by the patient are often the cause of considerable trepidation for the provider. Experience is the one thing that addresses the anxiety of the unknown. Each encounter decreases the number of unexpected reactions to sad and bad news. The reactions are as varied as the patients; however, some general categories and behaviors can be expected.

Patient reactions can include disbelief, shock, denial, displacement, fear and anxiety, anger and blame, anger against specific entities, guilt, depression, overdependency, crying and tears, "why me," threats, humor, bargaining, awkward questions, and the search for meaning. Not all of these reactions can be addressed here, but those seen most frequently are identified. Additionally, specific issues relate to breaking sad or bad news to children, whether the bad news is about themselves or others. Although these issues are not discussed in depth in this chapter, it is important to be aware of the different needs that younger patients have.

Disbelief

Disbelief is a frequent response, especially if the news is not expected. This reaction is not meant to create tension with the provider; it highlights the difficulty of taking in the news. The issue is not about factual disagreements, and the provider needs to focus on acknowledging the patient's difficulty in acceptance. Consider the following responses:

- News about this serious illness must come as a shock, especially when you are feeling so good.
- How does this make you feel?

Shock

The common meaning of shock is alarm, distress, or terror. This reaction is not difficult to identify. The provider's response is much more difficult. How can you console and support this reaction? Shock shows a failure to function and an inability to make decisions. It is most commonly expressed in silence, with an inability to speak or respond to your questions. Occasionally more dramatic expressions of wailing and deep anguish may be expressed by pacing around the room or falling to the floor inconsolably. Allowing the patient to express very deep feelings is appropriate. Questions that may help are as follows:

- Are you okay?
- What are you thinking now?

For both disbelief and shock, try the following:

- This news must be overwhelming for you.

Denial

When experiencing denial, the patient has a sincere conviction that the news is incorrect or a mistake. The patient may ask you to recheck results because he or she is sure there was a mix-up in the laboratory. In a more subtle form, the patient may start talking about long-term plans (e.g., planning to build a house, a year-long sailing excursion) when the news is such that the probability for these plans to be fulfilled is unrealistic. Denial is a protective response to shield the self from harm and to view the future self intact. Denial is a normal response to overwhelming information that threatens the future existence of the person. Questions to ask the patient should include the following:

- What is it that makes you believe the information is inaccurate?
- Accepting this news must be difficult…

Denial in the initial period of hearing sad and bad news is normal. Denial that continues for an extended time will increase the patient's distress; it needs to be addressed cautiously and requires comprehensive negotiation.

Fear and Anxiety

Fear and anxiety often are used interchangeably; however, they are different entities. A specific object or event or the thought of a specific object or event often prompts fear. Fear is acute, with a quick response to the prompt and a quick fade when the prompt is removed. Anxiety is chronic, and has largely to do with the unknown. It may come on rapidly and often takes longer to resolve after the prompt has been removed. Identify the cause or source of the fear or anxiety by listening adequately to the patient's feelings. Trying to reassure the patient without discovering the source will be ineffective and will not decrease the intensity of anxiety or fear. Identifying and acknowledging the patient's feelings may reduce the fear or anxiety in some cases. Provide as much detailed information as seems appropriate to the case. If the information does not appear to help, stop giving it, because the patient will not accept the information. If the patient's fears and anxiety are severe or prolonged, get help and consider referral to a mental health professional. The following are some empathetic questions for patients with anxiety or fear:

- With all this news, what worries you the most?
- Have you been thinking about what might happen to you? Could you tell me your biggest worries?

Finally, with anxious or fearful patients, the greater their anguish, the greater will be your urge to over-reassure them. **Over-reassurance** creates a greater distance from the reality of the

situation, which is counterproductive for both the provider and the patient.

Over-reassurance creates a greater distance from the reality of the situation, which is counterproductive for both the provider and the patient.

Anger and Blame

Anger and blame are the emotions most often directed at the health care provider, or the medical system as a whole. Understanding the anger a patient may feel is useful and can prepare you for using specific techniques to address it rather than being overwhelmed by it. Knowledge and recognition of the types of anger will make it easier for you to keep hold of the situation and sustain a sense of composure to support the patient during the interview.

Understanding the anger a patient may feel is useful and can prepare you for using specific techniques to address it rather than being overwhelmed by it.

Being judgmental in this situation is not helpful. Buckman[11] has identified "rough and ready" classifications of a patient's anger, as follows:

- Abstract anger (appropriate or inappropriate)
- Anger against the disease—symptoms, disability, freedom, "death sentence"
- Anger against loss of control and powerlessness—determination of lifestyle, movements, dependency on others
- Anger against loss and potential loss—loss of hopes and aspirations: career, relationships, family, life fulfillment
- Anger against laws of nature or randomness—random biologic events, unfairness (why me?)
- Anger against specific entities (appropriate or inappropriate)

- Anger against self—causal anger (if patients feel they are causing their own disease), body for failing, opportunities missed, own attitude
- Anger against friends and family—own health, "residual anger from old family rifts or feuds," receiving advice, charity, sympathy; may be appropriate (e.g., believes friends caused disease through passive smoke) or inappropriate (abandonment or distancing)
- Anger against medical and other health professionals —"blaming the messenger" for the news, loss of control (which is now with the medical team), medical team members who are healthy, communication gaps (not listening, uncaring), management decisions (should have diagnosed earlier and treated differently)
- Against "outside forces"—workplace, occupation, environment, home, socioeconomic or political forces
- Against God—abandonment (he or she has forsaken me), perceived vindictiveness (divine retribution), poor return on faith and religious observances over manyyears[11]

Appropriate statements may be as follows:

- You are angry. What other feeling do you have?
- You sound very angry that this was not picked up earlier.

Anger is a natural outcome of bad or sad news—sitting and riding out the tide with the patient will assist in developing rapport and ensure the patient hears the information you need to share. Open-ended questions and acknowledging anger seem simple, but can cause an explosive outburst. An empathetic question removes the provider as the target and does not escalate the patient's anger. Often the conversation can move on to the present situation.

Occasionally sad or bad news is delivered with a patient on the examination table or in a bed. Human beings seem to be programmed to decrease their anger when it meets a submissive response. Body language that moves away helps to diffuse a patient's anger. When a patient is angry it is worth trying to keep

your head lower than the patient's. A useful technique is to have the patient seated upright on the examination table or bed while you sit on a chair or stool. It is interesting to note how difficult it is to maintain anger when the target of it is sitting below you.[11]

Guilt

Guilt appears to have three components and is either self-focused or directed emotion. Self-blame is felt, along with sorrow or regret. Rarely are any of these components helpful to the patient. In most cases guilt about an illness is maladaptive. An empathetic comment might be the following:

- Thinking this (condition) is your fault must be very painful.

Depression

Situational depression is not an uncommon reaction to difficult news. The diagnostic criteria are well known: depressed mood, irritability, weight change, difficulty sleeping or sleeping too much, fatigue, feelings of worthlessness, recurrent thoughts of death or suicide, or decreased ability to think, concentrate, or make decisions. If the symptoms are present and a diagnosis is made, be prepared to treat the condition. The patient will usually feel significant relief after the provider has identified the depression for the patient, reviewed the symptoms, and explained that it is treatable and resolvable.

Crying and Tears

Crying and tears are not an emotion; they are symptoms of anger, fright, rage, sadness, frustration, despair, and other feelings. Tears come easily to some and rarely for others, just as some providers easily comfort one who is crying whereas others do not. Some fairly straightforward actions can help the provider cope and comfort. Move closer to the patient. Often people who are crying feel alone. Make sure tissues are available when you are giving sad or bad news. Offering a tissue gives the patient evident permission to cry,

gives the patient something to dry the tears and clean a runny nose (it is very difficult to continue a conversation without this accommodation), gives the provider something to do, and brings the provider and patient closer together. Try touching the patient on the shoulder, elbow, or arm to try to identify the emotion causing the tears and to offer an empathetic response. If the cause is not obvious, simply ask:

- Can you tell me what is causing you to cry?

Awkward Question

Two questions that many providers find thorny are "How long do I have?" and "Am I terminal?" These are probably the most common questions asked when hearing bad news. It is also difficult to provide a single answer to cover all the possibilities. However, three principles should be kept in mind[12]: (1) Assess what the patient thinks the situation is at the moment;[7] (2) Ask the patient what he or she has been thinking about this question;[6] (3) Clarify what the patient is truly asking. Assume nothing. You can ask the following question:

- Are you asking me how long you have to live?

Remember the power of words and that the answer will be remembered for a long time, even if it is inaccurate. Give hard data, if possible, because the outcome is patient-specific. Statements could include the following:

- It could be several months or a small number of years, but probably not many.
- This condition is very serious, maybe several weeks or a few months.

Uncertainty is difficult and unpleasant. People are unique organisms who know they are going to die at some point in time, yet

the exact time and date are always uncertain. It can be difficult to make a genuine heartfelt empathetic statement. Simply offer a comforting acknowledgment, such as the following:

- It must be very difficult not knowing what will happen next or when it will happen.

When the patient asks, "Am I terminal?" be sure to clarify what *terminal* means to the patient. Providing an answer to the question you assume is being asked can be very embarrassing and may be less than endearing. The content of your response could include the following:

- Your question is very important and I will attempt to answer it. But could you tell me what you are thinking when you ask about being terminal?

Sad and Bad News Presented to Children

Breaking sad or bad news to children about themselves or others requires a unique skill set and a high-quality delivery. Considerable literature exists on this subject, including books and new guidelines developed by the American Academy of Pediatrics. It is generally thought that early knowledge of a life-threatening diagnosis and not suppressing or concealing it is associated with healthy psychological adjustment for the child.[14] Providing this information is normally done with the help of a skilled specialist counselor, but at times it may need to be done without a counselor. Buckman[11] has identified the following five principles for delivering sad and bad news to children:

1. The closest adult family member should always be present, and an agreed-upon approach to the interview should be followed. The family member may request participation. Family members often have insights that can help avoid unexpected surprises. Only in the most ominous, urgent

situation should you attempt to discuss these issues without a close relative present.

2. Review frequently with the child his or her understanding of the information you are providing. A child's perception of what you are saying can be very different from what the child is hearing. Provide the information in a language that reflects the questions that the child is asking.
3. It is common for the same question to be asked repeatedly. It is the normal manner in which children process information they have been told so they can be sure they have understood correctly what has been said.
4. Many children believe that if they think something, then it will happen. If they are angry with someone who later becomes seriously ill, children may believe their anger toward that person caused the illness. This is called "magical thinking." If a child is asked repeatedly by a parent to perform a task, such as putting toys away, and the child does not remember to perform the task, the child may feel guilty and responsible if the parent then becomes ill. (If only I had picked up my toys, papa would not be so sick.) This type of thinking is not obvious; however, one way to assuage the child's potential guilt is to say the following directly:
    - Sometimes people get ill for no apparent reason.
    - It's not your papa's fault he is ill, it's not our fault, and it definitely is not your fault.
    - Sometimes these things just happen.

If you are inexperienced or uncertain, find assistance as soon as possible. Find an expert or a more experienced team member. You may be asked to be in further interviews with the child if a bond has been created or you know the family well. As your patient responds emotionally to sad or bad news, recognize that you may feel uncomfortable yourself. Recognize that this is normal, and relax as much as possible.

Strategy

Contemplate a strategy for the case. By this point in the interview, depending on the sad or bad news, the patient may feel isolated and uncertain. The patient will be looking to you to help make sense out of the uncertainty. Knowing the patient's perspective on the illness and how much he or she knows about the situation and combining the patient's goals and your modified goals, expresses an alliance with the patient in creating a plan for the near future. The medical treatment plan forms the initial element of the patient's support strategy.

Help the patient identify his or her best coping skills and what type of support system can be created. Engaging the patient in some responsible action can be empowering. The concept of support does not mean doing everything possible for the patient. That is impractical and impossible. Active, effective listening is the initial step in support. Listen in a nonjudgmental manner to what the patient says. Help the patient identify the observed emotions and behavior and support the patient, especially if you may not agree personally with the other point of view.

Summarize the discussion to include the patient's condition and the plan for the future. In the plan it is helpful to provide the patient with the sequence of coming events, including tests, treatment or palliative care, and the next appointment time frame. Writing these down for the patient provides a reminder of the events to come and the personal interaction that is needed in giving sad and bad news. Finally, ask the patient in your style and words:

- Is there anything we missed or other questions you would like to ask?

Conclusion and Further Thoughts

For many of us, the best way to learn how to give bad news, unfortunately, is to receive it, or watch it delivered poorly. Much like when we are speeding across town late for an appointment or to pick up a child, we notice every red light. Rarely do we notice if all the lights are green. In this way, people do not readily forget bad or sad news because they only see red. Most often it is because one can

never prepare for it. By incorporating the strategies presented in this chapter, a provider finds a place to prepare both themselves, and the patient. Although experience improves and bolsters confidence, it does not necessarily make things easier.

Clinical empathy as an element of emotional labor can provide the clinician more professional satisfaction.[10] When giving sad and bad news, remember that we have two things in common with all human beings on earth: We are born and we die. As far as we know, we are the only species that is aware of life's limitation. Between birth and death is commentary. As medical providers we have the honor of witnessing the commentary and listening to our patients' stories. Providing sad and bad news is part of our commentary.

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