

Fifth Edition

# Phlebotomy

A Competency-Based Approach



**Kathryn A. Booth** RN-BSN, RMA (AMT), RPT, CPhT, MS

**Lillian Mundt** EdD, MLS (ASCP) SH, LMT (NCBMT)



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PHLEBOTOMY: A COMPETENCY-BASED APPROACH, FIFTH EDITION

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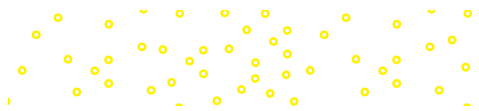
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# Dedication

To the users of this program, congratulations on your selection of an essential healthcare career. The skills and abilities learned in this program will provide you a lifetime of employment in a much-needed profession. To my children and grandchildren who help keep me young!

—*Kathryn A. Booth*

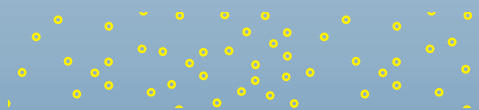
Thank you to my family and friends who were patient and encouraged me while I spent valuable time away from them working on this project.

—*Lillian Mundt*

## About the Authors

**Kathryn A. Booth, RN-BSN, RMA(AMT), RPT, CPhT, MS** is a registered nurse (RN) with a master's degree in education as well as certifications in phlebotomy, pharmacy tech, and medical assisting. She is an author, educator, and consultant for Total Care Programming, Inc. She has over 35 years of teaching, nursing, and healthcare work experience that spans five states. As an educator, Kathy has been awarded the teacher of the year in three states where she taught various health sciences, including phlebotomy. Kathy serves on the American Medical Technologists registered Phlebotomy Technician Examinations, Qualifications, and Standards Committee. She is a member of advisory boards at two educational institutions. Her larger goal is to develop up-to-date, dynamic healthcare educational materials to assist other educators as well as to promote the healthcare professions. In addition, Kathy enjoys presenting innovative new learning solutions for the changing healthcare and educational landscape to her fellow professionals nationwide.

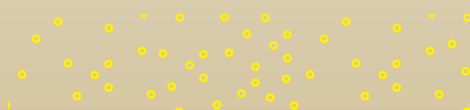
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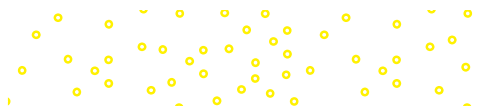


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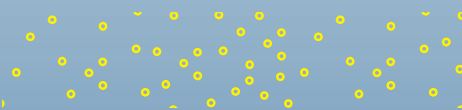
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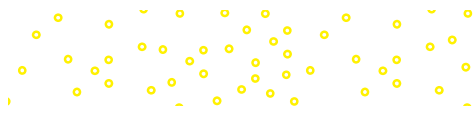


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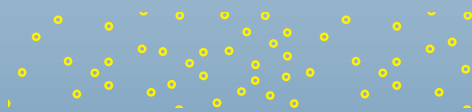
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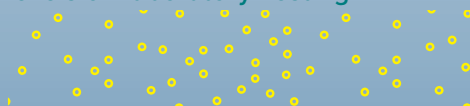


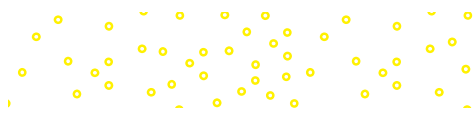
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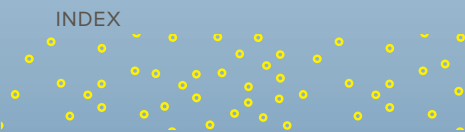


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# Preface

Competency is within your reach with the new, fifth edition of *Phlebotomy: A Competency-Based Approach*. With *Phlebotomy's* pedagogy-rich format and plentiful Check Your Competency features and Competency Checklists, you can easily grasp not only essential phlebotomy skills and competencies, but also the critical soft skills needed for a successful transition from classroom to lab. *Phlebotomy* is also now available with McGraw-Hill Education's revolutionary adaptive learning technologies, LearnSmart and SmartBook! You can study smarter, spending your valuable time on topics you don't know and less time on the topics you have already mastered. Hit your target with precision using LearnSmart. Join the learning revolution and achieve the success you deserve today!

## New to the Fifth Edition

### Overview

A number of enhancements have been made in the fifth edition to enrich the user's experience with the product.

- Based on market feedback, former chapter "Infection Control and Safety" is now two chapters; Chapter 2, "Safety and Preparedness," and Chapter 3, "Infection Control." These two new chapters expand and clarify the information about these two critical topics.
- Six new Competency Checklists have been added and others have been updated to provide extra practice and student remediation for key procedures. Covering procedures for using an eyewash station, using safety equipment, order of draw, maintaining a chain of custody, and quality assurance, these new checklists make practicing skills and preparing for certification and accreditation easy.
- Per customer feedback, the former chapter "Waived Testing and Collection of non-Blood Specimens" is now two chapters; Chapter 14, "Collection of Non-Blood Specimens," and Chapter 15, "Waived Testing."
- The Troubleshooting features have been renamed "Think It Through" and now contain questions to encourage critical thinking.
- More than 50 new photographs—taken by the authors—have been added that accurately reflect the realities of today's phlebotomy workplace.
- *Connect Phlebotomy* has been updated to reflect updates in the chapters and feedback from customers.
- *Phlebotomy* is now available with the LearnSmart Advantage, a series of adaptive learning products fueled by LearnSmart and SmartBook.
- Updated content to align with 2017 Essential Elements of a Phlebotomy Training Program and the 2017 Collection of Diagnostic Venous Blood Specimens CLSI standards.

## Chapter Highlights

While content updates have been made to all of the chapters, here are the highlights:

- **Chapter 1:** Now covers patient advocacy, and includes a new Check Your Competency, "Communication and Customer Service."
- **Chapter 2:** Includes the safety portion of former chapter 2 and two new Competency Checklists: "Using an Eyewash Station" and "Safety Equipment in the Clinical Setting."
- **Chapter 3:** Includes the infection control portion of former chapter 2 and has been revised and reorganized for clarity.
- **Chapter 4:** Contains a new section on electrolytes and expanded coverage of the parts of a cell. The list of tests were also updated and expanded. Added key terms *pathophysiology* and *homeostasis*.
- **Chapter 5:** Expanded to include discussions about various body systems—including voluntary and involuntary muscles, immune response, and types of neurons—and relevant conditions, such as acidosis and alkalosis. Also includes a new section covering test profiles and test panels.
- **Chapter 6:** Now includes information on patterns of vein configuration, as well as a new table comparing plasma and serum.
- **Chapter 7:** Formerly chapter 8 includes the content regarding healthcare law and ethics and patient identifications was clarified and updated.
- **Chapter 8:** Reorganized for clarity, this chapter now contains information about lancet widths, as well as two new Competency Checklists: "Order of Draw for Venipuncture" and "Order of Draw for Dermal (Capillary) Puncture." Additional information about equipment for drawing trace elements.

- **Chapter 9:** Included technique for handling difficult collection with a collapsed vein. Added information turning off IV if blood must be drawn from arm with IV. Includes warning to not force a patient’s arm straight for venipuncture.
- **Chapter 10:** Now includes types of lancets and depth of puncture.
- **Chapter 11:** Includes updates to the existing Competency Checklists, as well as a new Competency Checklist, “Maintaining a Chain of Custody.”
- **Chapter 12:** Includes a new Competency Checklist, “Quality Assurance in the Laboratory.”
- **Chapter 13:** Reorganized to include separate sections for each type of procedure. In addition, information has been added about the modified Allen test. Updated VAD discussion including length of time inserted and PICC catheter.
- **Chapter 14:** Formerly the first part of Chapter 13, the material in this chapter has been divided into separate sections for each type of specimen, and a new table was added to describe other non-blood specimens.
- **Chapter 15:** Formerly the last two sections in the chapter Waived Testing and Collection of Non-Blood Specimens, the material in this chapter has been updated and divided into separate sections for each type of test.

- **Chapter 16:** Now includes a Law & Ethics feature on cell phone use on the job, as well as updated information about job outlooks and licensure requirements.

For a detailed transition guide between the fourth and fifth editions of *Phlebotomy*, visit the Instructor Resources in *Connect*!

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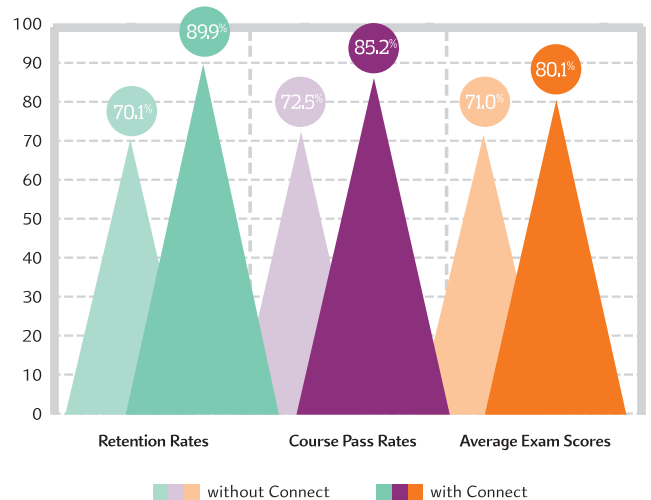
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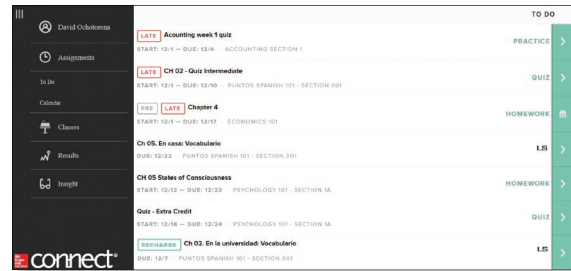
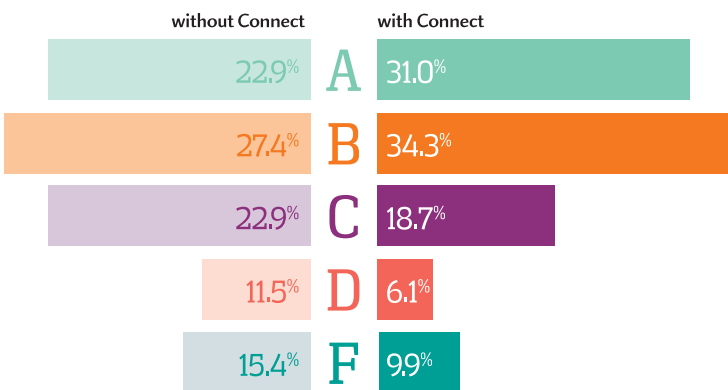
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# 1

## Phlebotomy and Healthcare

### essential terms

American Medical Technologists (AMT)  
aseptic  
Centers for Disease Control and Prevention (CDC)  
Centers for Medicare & Medicaid Services (CMS)  
Clinical and Laboratory Standards Institute (CLSI)  
clinical chemistry  
Clinical Laboratory Improvement Amendments (CLIA '88)  
College of American Pathologists (CAP)  
Commission on Office Laboratory Accreditation (COLA)  
cytology  
dermal (capillary) puncture  
Department of Health and Human Services (HHS)  
Environmental Protection Agency (EPA)  
Food and Drug Administration (FDA)  
hematology  
histology  
immunohematology (blood bank)  
immunology  
medical microbiology  
microsurgery  
molecular diagnostics  
National Accrediting Agency for Clinical Laboratory Sciences (NAACLS)  
Occupational Safety and Health Administration (OSHA)  
patient advocate  
phlebotomist  
phlebotomy  
physician office laboratory (POL)  
point-of-care testing (POCT)  
pre-examination  
professionalism  
reference laboratory  
serology  
The Joint Commission (TJC)  
toxicology  
urinalysis  
venipuncture



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### Learning Outcomes

- 1.1** Summarize the definition and history of phlebotomy.
- 1.2** Explain the role of the phlebotomist in the various healthcare facilities where he or she may be employed.
- 1.3** Describe inpatient and outpatient healthcare facilities and their relationship to the practice of phlebotomy.

- 1.4** Identify the healthcare providers and other members of the healthcare team with whom the phlebotomist will interact in inpatient and outpatient facilities.
- 1.5** Summarize the organization of the medical laboratory.
- 1.6** Recognize the agencies that regulate hospitals and medical laboratories.
- 1.7** List the qualities and characteristics of a phlebotomist.

## Related NAACLS Competencies

**1.00** Demonstrate knowledge of the healthcare delivery system and medical terminology.

**1.1** Identify the healthcare providers in hospitals and clinics and the phlebotomist's role as a member of this healthcare team.

**1.2** Describe the various hospital departments and their major functions in which the phlebotomist may interact in his/her role.

**1.3** Describe the organizational structure of the clinical laboratory department.

**1.4** Discuss the roles of the clinical laboratory personnel and their qualifications for these professional positions.

**1.5** List the types of laboratory procedures performed in the various sections of the clinical laboratory department.

**9.00** Communicate (verbally and nonverbally) effectively and appropriately in the workplace.

**9.3** Interact appropriately and professionally with other individuals.

**9.6** Model professional appearance and appropriate behavior.

## Introduction

This chapter introduces the role of the phlebotomist in the delivery of healthcare. It includes information about the phlebotomist's duties in several healthcare settings. In addition, it briefly describes various disciplines within the field of healthcare, including the medical laboratory. The chapter also describes the governmental agencies that regulate how specimens are collected, handled, and tested.

### 1.1 Phlebotomy

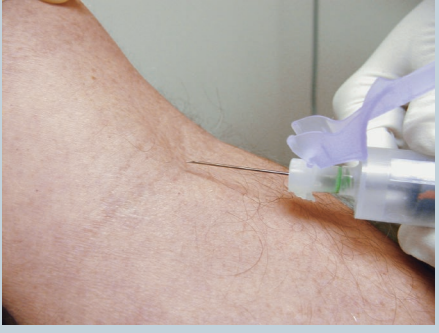

**Phlebotomy** simply means to cut into a vein. The term comes from *phlebos*, which is Greek for "vein," and *tome*, which means "to cut." Professionals called *phlebotomists* perform this invasive procedure that involves making an incision into the skin and blood vessels.

Results of laboratory testing are crucial in providing appropriate, quality healthcare. Over 70% of medical decisions are based on laboratory results. The primary role of a **phlebotomist** is to obtain blood specimens for this diagnostic testing. These specimens are used to test everything from levels of glucose, proteins, and drugs to blood cell counts, antibodies, and infectious diseases. Blood is obtained either by **venipuncture** (puncturing a vein) or **dermal (capillary) puncture** (puncturing the skin). The terms *phlebotomy* and *venipuncture* are often used interchangeably, as are *dermal puncture* and *capillary puncture* (see Table 1-1).

### History of Phlebotomy

The process of removing blood from the veins may date back as far as 1400 BC; an Egyptian tomb painting shows a leech being applied to the skin of a sick person. Bloodletting was thought to rid the body of impurities and evil spirits or, as in the time of Hippocrates, simply to return the body to a balanced state, also known as homeostasis. Hippocrates is known as the father of medicine and is the originator of the Hippocratic Oath. Figure 1-1 shows a painting of bloodletting from this era. As recently as the 1800s, anyone claiming medical training could perform bloodletting. Barbers—not unlike those working in salons today—frequently performed bloodletting procedures. The look of the barber pole is linked to bloodletting, with red representing blood and white representing the bandages used to stem the bleeding. The pole itself is said to symbolize the stick that a patient squeezed to make the veins in his arm stand out more prominently for the procedure. In Europe, barber poles traditionally are red and white, while in America, the poles are red, white, and blue.

**TABLE 1-1** Two Common Collection Methods

|                             |  |   |
|-----------------------------|--|---|
| Venipuncture                | Insertion of a needle into a vein to allow blood flow into a vacuum tube or syringe                |  <p>©Total Care Programming, Inc.</p> |
| Dermal (Capillary) puncture | Use of a lancet or puncture device to prick the skin to remove a small specimen of capillary blood |  <p>©Lillian Mundt</p>                |

One theory holds that blue is symbolic of the veins cut during bloodletting, while another interpretation suggests blue was added to the pole as a show of patriotism and a nod to the nation's flag.

In the early 1800s, the popularity of bloodletting created an enormous demand for leeches. Leeches are segmented worms that have two suckers, one at each end. Most leeches live in freshwater environments. One type of leech feeds on blood making it useful in medical treatments. Leech farms were established to breed them under controlled conditions. Interestingly, the use of leeches has resurfaced in medicine today (see Figure 1-2). They are prescribed to remove blood that has collected at newly transplanted tissue sites and to decrease the swelling following **microsurgery** (which involves the



**Figure 1-1** Early Romans used bloodletting as a form of healing.  
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**Figure 1-2** Leeches are still used today for localized removal of impurities from the blood.

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reconstruction of small tissue structures). Leeches have both anti-coagulant and vasodilation properties. Medicinal leeches may be found in a hospital pharmacy.

Bloodletting also used a process called *venesection*, in which the vein was pierced with a sharp object, called a *lancet*, to drain blood. The lancet, a short, wide, pointed blade, was the most popular medical instrument during the 1800s. Venesection was thought to be an effective procedure for removing unwanted diseases from the body and reducing fever. In fact, the untimely death of the first U.S. president, George Washington, was believed to be the result of excessive bloodletting in an attempt to treat a throat infection. It is important to note that **aseptic**, or microorganism-free, practices were unknown during that time, so the same lancet was used on several patients without any cleansing.

Another method used for bloodletting was called “cupping.” This method produced a vacuum effect by pulling blood to the capillaries under a heated glass cup, which was placed on the patient’s back to allow for increased blood flow. Then, a spring-loaded box containing multiple blades pierced the skin to produce bleeding. The procedure typically caused scar tissue.

It was during the 1980s and 1990s that the phlebotomy profession emerged as a result of technology and an expansion of laboratory functions. Initially, only medical laboratory scientists (MLSs, formerly known as medical technologists) and medical laboratory technicians (MLTs) were responsible for collecting blood specimens. However, as technology and the healthcare industry underwent rapid changes, specimen collection was delegated to other groups of trained professionals, including medical assistants, nurses, paramedics, and phlebotomists. At all times during their professional practice, phlebotomists must demonstrate a mastery of the principles and techniques established by the **Clinical and Laboratory Standards Institute (CLSI)**.

## Checkpoint Questions 1.1

1. What does the word *phlebotomy* mean?
2. What is the difference between venipuncture and dermal (capillary) puncture?
3. Which organization established the principles and techniques that professional phlebotomists must master?
4. When did phlebotomy first emerge as a profession?

## 1.2 Phlebotomist’s Role

The phlebotomist is a valuable member of the healthcare team and is responsible for the collection, processing, and transportation of blood specimens to the laboratory. This is known as the **pre-examination** (pre-analytical) phase of laboratory testing. Other roles of the phlebotomist may include the removal of blood from donors for blood transfusions and from patients with a condition called *polycythemia* (overproduction of red blood cells), in which blood must be removed to decrease its viscosity (thickness). Phlebotomists may also give instructions to patients on how to properly collect a urine or fecal specimen, and they are responsible for properly packaging specimens (blood, urine, fecal, cultures, and body fluids). In some settings, the phlebotomist’s job also includes accepting incoming specimens, logging specimens into the computer system, and routing specimens to the proper departments for testing and analysis. As a member of the healthcare team, the phlebotomist may assume other

responsibilities, such as basic patient care services at inpatient facilities. For example, a phlebotomist also trained as a patient care technician (PCT) may perform additional duties such as delivering meal trays and assisting with the transportation of patients from one department to another as well as obtaining electrocardiograms (ECGs).

While performing these various duties, phlebotomists may also have the opportunity to assist patients who are confused or overwhelmed by their healthcare needs. This is known as *patient advocacy*. A **patient advocate** helps guide patients through the healthcare system. This may include tasks such as helping a patient schedule a needed appointment or simply providing directions within or to a healthcare facility where the patient has medical tests or other appointments scheduled. Patient advocates help patients become more comfortable with the healthcare system.

Several other members of the healthcare team, such as physicians, nurses, medical assistants, paramedics, and patient care technicians, are also trained to perform phlebotomy. Just as the role of these healthcare team members may include phlebotomy, a phlebotomist may be responsible for performing a variety of other duties, including transporting other specimens—such as arterial blood, urine, sputum, and tissue—to the laboratory for testing.

The phlebotomist may also be responsible for performing **point-of-care testing (POCT)**, such as blood glucose monitoring. Point-of-care testing is performed at the patient's bedside or a work area using portable instruments. POCT can assist the physician in making diagnoses more quickly, which often reduces the length of stay for hospitalized patients. POCT procedures are explained in the chapter *Waived Testing*. In addition, phlebotomists perform quality control testing and various clinical and clerical duties. Table 1-2 summarizes the essential duties and responsibilities of the phlebotomist.

The phlebotomist must be familiar with the process, equipment, and variables involved in venipuncture and dermal (capillary) puncture procedures to obtain quality specimens while maintaining patient safety. Nothing is more important in healthcare delivery than patient safety. This means safety not only in the performance of procedures but also in the proper handling of specimens to promote accurate test results, which will influence a patient's diagnosis and treatment. The quality of the specimens sent to the laboratory determines the accuracy of the test results obtained. There is nothing laboratory scientists can do to obtain accurate results on compromised specimens. The phlebotomist is responsible for obtaining the highest-quality specimen possible and ensuring that it is handled properly during transport to the laboratory.

**TABLE 1-2** Duties and Responsibilities of the Phlebotomist

- Demonstrate professional attire, attitude, and communications
- Observe all safety regulations
- Know and follow the facility's policies and procedures
- Properly identify patients
- Collect both venous and capillary blood specimens
- Select the correct specimen container for the specified tests
- Properly label, handle, and transport specimens following departmental policies
- Sort specimens received and process specimens for delivery to laboratory departments
- Perform computer operations and/or update log sheets where required
- Perform point-of-care testing and quality control checks



## Phlebotomy Training

Entry into phlebotomy training programs usually requires a high school diploma or its equivalent. Training programs are typically offered at hospitals, technical and private schools, and community colleges as well as through continuing education courses. The course can vary from a few weeks to a few months in length, depending on the program.

Various agencies, such as the **National Accrediting Agency for Clinical Laboratory Sciences (NAACLS)** and **American Medical Technologists (AMT)** have established standards to which approved programs must adhere. Programmatic approval ensures that students completing the training program are qualified to take a certification examination. In some states, phlebotomists must be both certified and licensed. Certification and licensure are discussed further in the chapter *Practicing Professional Behavior*.

### Checkpoint Questions 1.2

1. Briefly describe the role of the phlebotomist in the delivery of healthcare.
2. What is point-of-care testing?
3. What is the most important duty and concern of the phlebotomist?

## 1.3 Healthcare Facilities

The two main categories of healthcare delivery systems in the United States are inpatient and outpatient services. Phlebotomists are employed in both of these settings as well as in special settings.

### Inpatient Facilities

Hospitals, nursing homes, and rehabilitation centers, where patients stay for one night or long term, are examples of inpatient facilities. Phlebotomists employed at inpatient facilities work directly with several members of the healthcare team. Phlebotomists may be part of the medical laboratory staff (see Figure 1-3) or patient care technicians (PCTs) with phlebotomy responsibilities. Physicians order specific tests to assist with the evaluation of the patient's condition, and the phlebotomist's role is to collect the blood, properly label the specimen, and transport it to the laboratory.



**Figure 1-3** An inpatient laboratory is known as a clinical laboratory; personnel perform a wide range of laboratory tests.

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### Outpatient Facilities

Outpatient settings include physician offices, ambulatory care centers, and blood collection centers, where patients visit for a short time and leave the same day. In addition, phlebotomists work for home healthcare agencies, which require them to collect blood in the patient's home. Other special settings include veterinary offices, health maintenance organizations (HMOs), the American Red Cross, and insurance companies, to name a few. The phlebotomist's duties within outpatient facilities vary; however, collecting and processing blood specimens are consistent duties throughout every type of healthcare facility the phlebotomist encounters.

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The fastest-growing outpatient settings are ambulatory care centers. These sites are walk-in facilities that patients can go to not only during the day but also after business hours and on weekends, when most physician offices are closed. Lab tests involving chemistry, hematology, urinalysis, serology, coagulation studies, and microbiology are ordered to assist with the diagnosis and treatment of minor conditions, such as sore throat, urinary tract infection, and therapeutic drug monitoring. In addition to blood collection, phlebotomists working in this setting are responsible for providing instructions to the patient on how to properly collect a urine, fecal, or other specimen. Phlebotomists in these settings may also be responsible for performing other basic patient care duties that include obtaining vital signs and transporting patients for procedures (such as X-rays).



**Figure 1-4** A medical assistant or phlebotomist in a physician office laboratory performs “waived” tests, which carry fewer risks to the patient.  
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Physician offices are also considered outpatient facilities. Phlebotomists and medical assistants are usually responsible for collecting and labeling a variety of specimens in the physician office, which are then transported to a **reference laboratory** (off-site laboratory) for testing. A physician office laboratory (POL) may perform only basic lab tests according to the certification it has been granted by the Clinical Laboratory Improvement Amendments (CLIA). Waived tests are the most common and, as defined by CLIA, are “simple laboratory examinations and procedures that have an insignificant risk of erroneous result.” These tests are typically performed on small amounts of blood and other specimens such as urine. Waived tests are discussed in more detail in the chapter *Waived Testing*. (See Figure 1-4.)

Nasal smears to determine if infection is present and simple blood tests such as cholesterol are approved for in-office tests. Therefore, depending on the facility of employment, a phlebotomist may be required to perform some of these tests as well as quality control checks on any test he or she performs.

Other outpatient facilities, such as blood banks and the American Red Cross, employ phlebotomists to collect donor blood. The collected blood becomes a unit that might be used for a blood transfusion. Phlebotomists working for agencies are often hired to go into patient homes to collect blood specimens. As healthcare delivery systems change, more care is being provided to patients in nursing homes and in their own residences. Some medical centers provide mobile venipuncture, in which the phlebotomist goes to the patient’s home to obtain blood specimens. Additionally, insurance agencies hire phlebotomists to perform in-home phlebotomy as a way of determining a customer’s overall health before an insurance policy is written. Other facilities that hire phlebotomists include complementary and alternative medicine (CAM) settings, such as chiropractor offices. Regardless of the work setting, the proper collection, labeling, and handling of all specimens are critical measures for ensuring accurate test results. These steps must be followed correctly to prevent the need for repeating a test unnecessarily or, worse yet, the misdiagnosis or mistreatment of a disorder.

1. Name two types of inpatient facilities.
2. List at least four types of outpatient facilities in which phlebotomists may work.

## Checkpoint Questions 1.3

## 1.4 The Healthcare Team

Whether they are members of the laboratory staff or a nursing unit, phlebotomists must be aware of the healthcare specialties and the professionals found in medical settings. The following pages explain some of the most common healthcare specialties.

- *Anesthesiology* is the management of pain before, during, and after surgery. Anesthesiologists and nurse anesthetists provide this service.
- *Cardiology* is the study, diagnosis, and treatment of conditions pertaining to the heart and cardiovascular system. The cardiologist is a medical doctor who specializes in disorders of the heart and cardiovascular system.
- *Diagnostic imaging (radiology)* involves the use of ionizing radiation, X-rays, and specialized procedures such as computed tomography (CT) scans, positron emission tomography (PET), magnetic resonance imaging (MRI), and ultrasound to produce diagnostic images. Radiologic technicians and technologists produce these images, which are then interpreted by radiologists. Radiologists are medical doctors who specialize in diagnosing and treating disease using radiation and imaging processes.
- *Electrocardiography* is the study of the heart's electrical patterns. Nurses, medical assistants, or ECG technicians place electrodes on the skin and record electrical patterns, which are interpreted by cardiologists.
- *Electroencephalography* is the study of electrical activity of the brain. Nurses and EEG technicians place electrodes on the scalp. Neurologists, who are physicians specializing in nervous system disorders, interpret brain activity recordings.
- *Emergency department* physicians and nursing staff specialize in the delivery of acute care for initial treatment of life-threatening or otherwise unplanned medical events. Phlebotomists may need to interact with various healthcare professionals in the emergency department as they respond to trauma assessment and treatment needs.
- *Endocrinology* is the study, diagnosis, and treatment of hormone disorders. Endocrinologists are medical doctors specializing in disorders of the hormone-producing organs and tissues.
- *General medicine (family practice)* is the general care of patients of all ages. Family practice physicians, physician assistants, and nurse practitioners provide this kind of care.
- *Geriatrics* is the diagnosis and treatment of disorders associated with elderly patients. Gerontologists are medical doctors specializing in disorders of elderly individuals.
- *Internal medicine* is the diagnosis and treatment of disorders related to the internal organs. Physicians who are internists provide this type of care. It is also a common practice area for osteopathic physicians, physician assistants, and nurse practitioners.
- *Neonatology* is the study, diagnosis, and treatment of disorders associated with newborns. Nurses and other healthcare professionals care for these infants, treated by neonatologists, who are medical doctors specializing in disorders of newborns and prematurely born infants.
- *Nephrology* is the study, diagnosis, and treatment of disorders of the kidneys. Physicians specializing in kidney disorders may be nephrologists or urologists.

- *Neurology* is the study, diagnosis, and treatment of disorders of the brain and nervous system. Neurologists are medical doctors specializing in disorders of the brain and nervous system.
- *Nuclear medicine* is the use of injectable radionuclides to diagnose and treat diseases, such as tumors. Medical radiation physicists and physicians specializing in radiotherapy customize treatments for patients based on their disease state and the needs of their particular anatomy.
- *Nutrition and dietetics* is responsible for ensuring that patients receive proper nutritional intervention during and after their hospital stay. Registered dietitians supervise food preparation, develop modified diet plans, and provide special nutrient preparations to patients unable to consume food normally.
- *Obstetrics/gynecology* is the study, diagnosis, and treatment of the female reproductive system. Physicians who are obstetricians and/or gynecologists, as well as nurse practitioners, provide this kind of care.
- *Occupational therapy* enables people to perform meaningful and purposeful activities within the limits of a disability. Occupational therapists and occupational therapy assistants provide this service to people of all ages by using everyday activities as a part of therapy.
- *Oncology* is the study, diagnosis, and treatment of malignant tumors. Oncologists are medical doctors specializing in the study of cancerous tumors.
- *Orthopedics* is the diagnosis and treatment of bone and joint disorders. An orthopedic surgeon provides surgical intervention for these disorders. Physical therapists provide rehabilitation services under the direction of an orthopedic specialist.
- *Pathology* is the study and diagnosis of disease. Pathologists are medical doctors who specialize in this field of medicine. Medical laboratory personnel often work closely with pathologists.
- *Pediatrics* is the diagnosis and treatment of disorders associated with children. Pediatricians are medical doctors specializing in disorders of children.
- *Pharmacy* ensures the safe and effective use of therapeutic drugs. Pharmacists and pharmacy technicians dispense physician-prescribed medications and use laboratory results in monitoring appropriate dosages.
- *Physical therapy* is a rehabilitative science that focuses on the development, maintenance, and restoration of maximum movement and functional ability. Physical therapists and physical therapy assistants provide this service to people of all ages, particularly to those whose movement and functionality are threatened by aging, injury, disease, or environmental factors.
- *Psychiatry* is the study and treatment of mental disorders. Psychiatrists are medical doctors specializing in affective, behavioral, cognitive, and perceptual disorders.
- *Respiratory therapy* is the assessment and treatment of breathing disorders. Respiratory therapists, also known as respiratory care practitioners, provide this service through airway management and mechanical ventilation. They work with the laboratory or may perform their own laboratory tests for acid-base balance and blood gas levels.