Electrocardiography

1

Learning Outcomes

1.1 Describe the history and the importance of the ECG.

1.2 Identify the uses of an ECG and career opportunities for an electrocardiographer.

1.3 Troubleshoot legal, ethical, patient education, and communication issues related to the ECG.

1.4 Perform infection control measures required for the ECG.

1.5 Compare basic vital sign measurements related to the ECG.

Key Terms

auscultated blood pressure
automatic external defibrillator (AED)
cardiac output
cardiopulmonary resuscitation (CPR)
cardiovascular disease (CVD)
cardiovascular technologist
Code Blue
coronary artery disease (CAD)
defibrillator
diastolic blood pressure
dysrhythmia
ECG monitor technician
electrocardiogram (ECG)
electrocardiograph
electrocardiograph (ECG) technician
ethics
event monitor
filtering facepiece respirator
healthcare providers
hypertension
hypotension
isolation precautions
law
libel
medical professional liability
myocardial infarction (MI) (heart attack)
personal protective equipment (PPE)
slander
standard precautions
stat
sphygmomanometer
systolic blood pressure
telemedicine
tilt table test
vital signs

cardiovascular disease (CVD) Disease related to the heart and blood vessels (veins and arteries).

coronary artery disease (CAD) Narrowing of the arteries of the heart, causing a reduction of blood flow.

myocardial infarction (MI) (heart attack) Occlusion (blockage) of one or more of the coronary arteries causing lack of oxygen to the heart and death of the muscle tissue.

electrocardiograph An instrument used to record the electrical activity of the heart.

electrocardiogram (ECG) A tracing of the heart's electrical activity recorded by an electrocardiograph.

1.1 The ECG and Its History

According to the Centers for Disease Control and Prevention (CDC), the leading cause of death in the United States every year since 1921 is **cardiovascular disease (CVD),** or a disease of the heart and blood vessels. Approximately 659,000 Americans die every year because of **coronary artery disease (CAD),** which is narrowing of the arteries of the heart, causing a reduction of blood flow. Unbelievably, one out of every three American adults has some form of CAD. You may know someone who has a heart condition. Maybe someone you know has had a **myocardial infarction (MI)** or **heart attack.**

An **electrocardiograph** is an instrument that allows the heart's electrical activity to be recorded and studied. It is used to produce an electrical (electro) tracing (graph) of the heart (cardio). This representative tracing of the electricity as it moves through the heart is known as an **electrocardiogram (ECG).**

Willem Einthoven (1860–1927) invented the first electrocardiograph, sometimes referred to as EKG (electro), Kardio (Greek for heart) gram (recording). There is no difference between an ECG and an EKG. ECG stands for electrocardiogram, and EKG is the German spelling for elektrokardiographie, which is the word electrocardiogram translated into the German language. An ECG (EKG) is a test that measures the electrical activity of the heart. An ECG may also be called a 12-lead ECG or a 12-lead EKG.

Advancements in this technology have brought about today's modern ECG machines (see Figure 1-1). Technology continues to improve the availability and speed of computer interpretation and quickly communicates

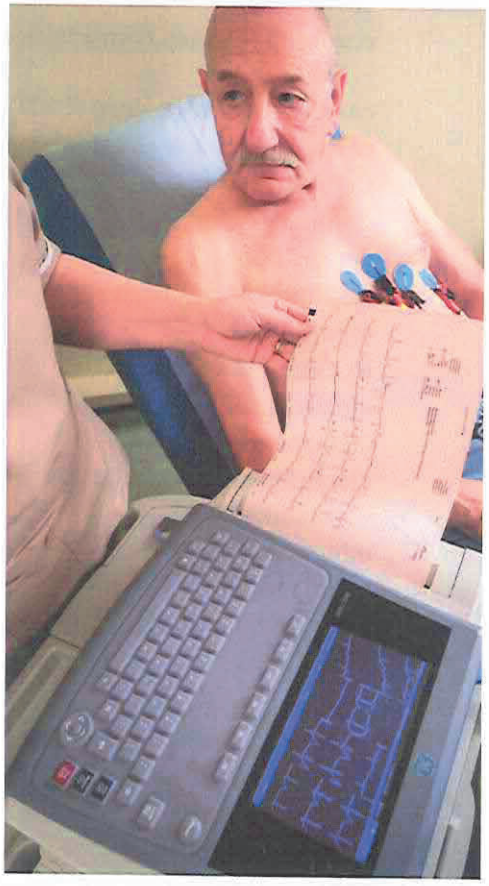


Figure 1-1 Today's 12-lead ECG machine is attached to the patient's chest, arms, and legs using electrodes and lead wires. It records a tracing of the electrical activity of the heart.

Jim Varney/Science Source

this information to a healthcare professional. Digital communication allows healthcare professionals to monitor patients from locations hundreds or even thousands of miles away.

Performing the actual ECG procedure is not difficult; however, it must be performed competently. The tracing of the electrical current of the heart must be accurate because it is used to make decisions about a patient's care. An inaccurate tracing could result in a wrong decision about the patient's medication or treatment. These decisions could result in a negative outcome for the patient.

Checkpoint Questions (LO 1.1)

1. What is the leading cause of death in the United States?

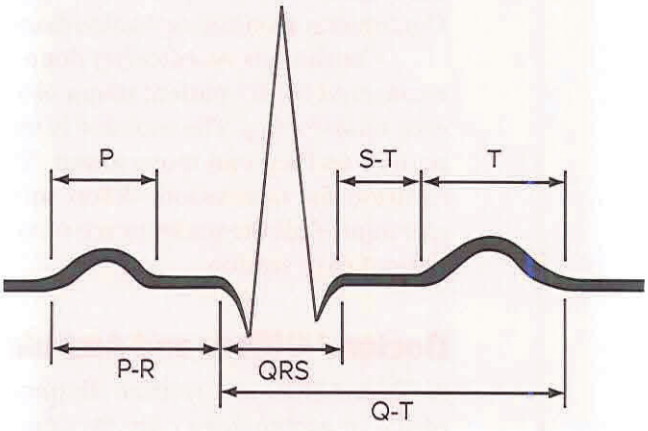
2. Who invented the first electrocardiograph?

1.2 Uses of an ECG

Healthcare providers study the ECG tracing to determine many things about the patient's heart. They look for abnormalities in the recording and changes from earlier recordings when available. The American Heart Association (AHA) recommends that individuals over the age of 40 have an ECG done annually as part of a complete physical. This baseline tracing assists the physician in diagnosing abnormalities of the heart. A sample of a normal tracing is shown in Figure 1-2.

healthcare provider The scope of practice of each healthcare provider will determine the extent of the interpretation and treatment of each of the cardiac dysrhythmias or conditions. Each specific scope is determined by the licensure of each state. For example: Prescribing a medication is the responsibility of the physician. But some state practices allow nurse practitioners and physician assistants to prescribe medication under the guidance of the physician.

Figure 1-2 A normal ECG tracing is a horizontal line with upward and downward waves or deflections that indicate electrical activity within the heart.



Electrocardiography can be performed in a number of healthcare settings. The type of ECG tracing produced depends on the setting and the type of ECG machine used.

In the Hospital (Acute Care)

Code Blue A code blue indicates a medical emergency such as cardiac or respiratory arrest and notifies healthcare providers that assistance is needed immediately.

stat Immediately.

The 12-lead ECG is one of the most commonly used tools to assess the heart in the hospital setting. A 12-lead ECG provides a tracing of the electrical activity in the patient's heart. In the hospital, routine ECGs are frequently done before surgery. A 12-lead ECG is usually performed during a **Code Blue** medical emergency such as a cardiac or respiratory arrest. An emergency ECG may also be required **stat,** or immediately. These are done for many reasons including when a patient experiences chest pain, shortness of breath, dizziness, syncope, altered mental status, or has a change in cardiac rhythm.

Think It Through

Remain Calm

It is essential that you remain calm when recording a stat ECG. Remaining calm is necessary to avoid stress to the patient and to reduce confusion during the emergency.

What would be an appropriate way to tell a patient you are doing a stat ECG?

_____

_____

Another use of the ECG tracing in the hospital is during continuous cardiac monitoring. The purpose of continuous monitoring is to observe the pattern of the electrical activity of the patient's heart over time. During continuous monitoring, sensors, also known as *electrodes*, are attached to the patient's chest. Wires are connected to the sensors and a small transmitter-like box or connected directly to a monitor displaying the patient's heart rhythm. Patients on continuous monitoring are usually in an intensive care unit (ICU), coronary care unit or cardiac care unit (CCU), surgical intensive care unit (SICU), inpatient telemetry unit, or emergency department (ED). Continuous monitoring is also done routinely during surgery (see Figure 1-3).

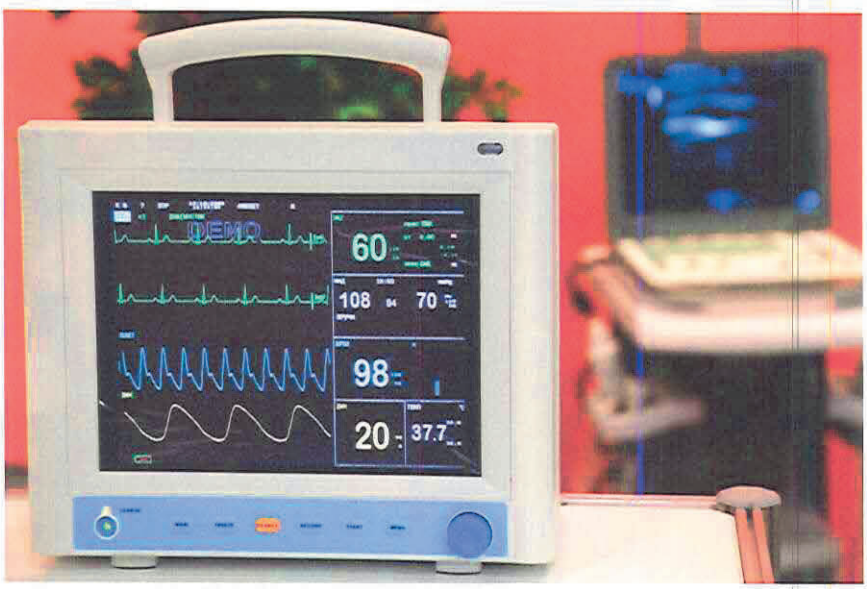
Continuous monitoring done in a hospital with a small transmitter box connected to the patient using electrodes and lead wires is known as *telemetry monitoring*. The monitor is usually housed in a case and attached to the patient so they can move about. The ECG tracing is transmitted to a central location for evaluation. When several patients are on a telemetry unit, the tracings of all the patients are recorded on multiple monitors at the nursing or patient care station.

Doctors' Offices and Ambulatory Care Clinics

A 12-lead ECG is a routine diagnostic test performed in almost any doctor's office or ambulatory care facility. It may be performed as part of a general, routine, or pre-operative examination. This routine ECG provides a baseline

Figure 1-3 Continuous monitoring in an acute care facility will include the ECG tracing as well as the patient vital signs.

Losevsky Pavel/Alamy Stock Photo



tracing to be used for comparison if problems arise with a patient. The physician or trained expert looks for changes in a tracing that may indicate different types of health problems. Table 1-1 provides a list of conditions that may be diagnosed by an ECG.

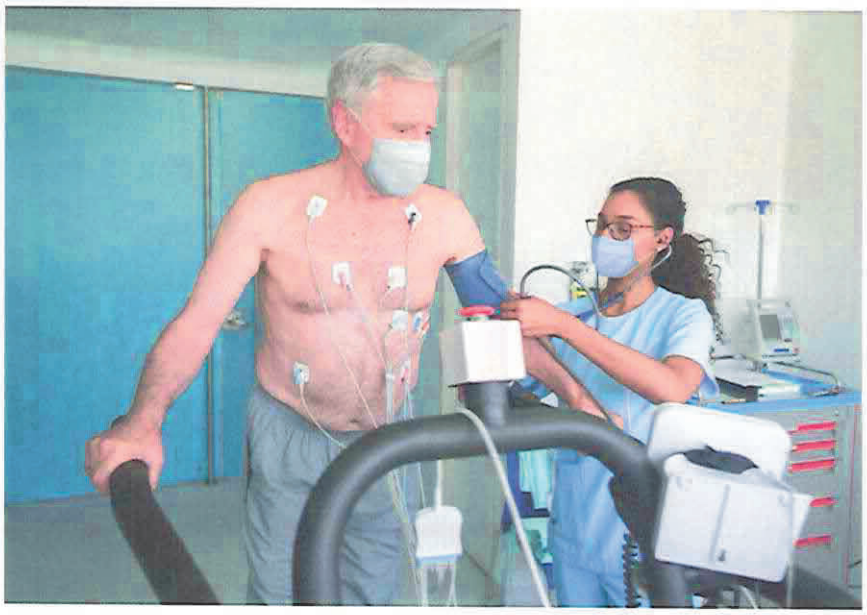
Another type of ECG that may be performed in an outpatient setting is treadmill stress testing (Figure 1-4). The treadmill stress test, also known as *exercise electrocardiography*, is done to determine whether the heart receives adequate blood flow during stress or exercise. The stress test is discussed in more detail in the chapter *Cardiac Stress Testing*.

TABLE 1-1 Conditions Evaluated by the ECG

- Disorders in heart rate or rhythm and the conduction system.
- Presence of electrolyte imbalance.
- Condition of the heart prior to defibrillation.
- Damage assessment during and after a myocardial infarction (heart attack).
- Symptoms related to cardiovascular disorders, including weakness, chest pain, or shortness of breath.
- Diagnosis of certain drug toxicities.
- Diagnosis of metabolic disorders such as hyper- or hypokalemia, hyper- or hypocalcemia, hyper- or hypothyroidism, acidosis, and alkalosis.
- Heart condition prior to surgery for individuals at risk for undiagnosed or asymptomatic heart disease.
- Damage assessment following blunt or penetrating chest trauma or changes after trauma or injury to the brain or spinal cord.
- Assessment of the effects of cardiotoxic or antiarrhythmic therapy.
- Suspicion of congenital heart disease.
- Evaluation of pacemaker function.

Figure 1-4 This patient is performing a treadmill stress test, also known as exercise electrocardiography. During the exercise, the patient's heart and blood pressure are monitored carefully.

andresr/E+/Getty Images

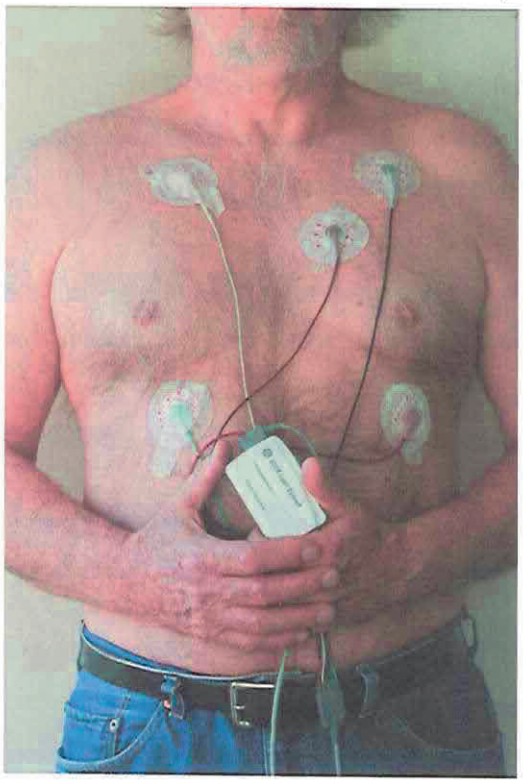


event monitor An event monitor is a battery-powered portable device that the patient controls to record the heart's electrical (ECG) when symptoms occur.

A Holter monitor is one type of ambulatory monitor. It is a small box that is strapped to a patient's waist, neck, or shoulder to continuously monitor the heart for 24 to 48 hours while the patient is at home (Figure 1-5). Other types of ambulatory monitors, such as **event monitors,** may be worn up to 30 days

Figure 1-5 The Holter, a type of ambulatory monitor, allows the patient to participate in routine daily activities while the electrical activity of the heart is being recorded.

Rob Walls/Alamy Stock Photo



as the patient performs normal daily activities. An event monitor is a battery-powered portable device that the patient controls to record the heart's electrical activity (ECG) when symptoms occur. After the monitoring period, the ECG tracing is analyzed and interpreted by the physician. Various types of ambulatory monitors are discussed in detail in the chapter *Ambulatory Monitoring.*

Outside of a Healthcare Facility

Outside of a healthcare facility, the ECG is used during cardiac emergencies such as a myocardial infarction. Emergency medical technicians and paramedics are equipped with portable ECG machines that can produce an ECG tracing at the site of the emergency. Whether the patient is at home, in a car, or in a crowded football stadium, emergency personnel can trace and monitor the electrical activity of the heart. Figure 1-6 shows one example of a portable ECG machine. In an emergency setting, the tracing can be evaluated for an abnormal ECG pattern. It is either transmitted back to the physician for evaluation or assessed by the emergency medical personnel at the scene. An abnormal pattern may require immediate treatment.

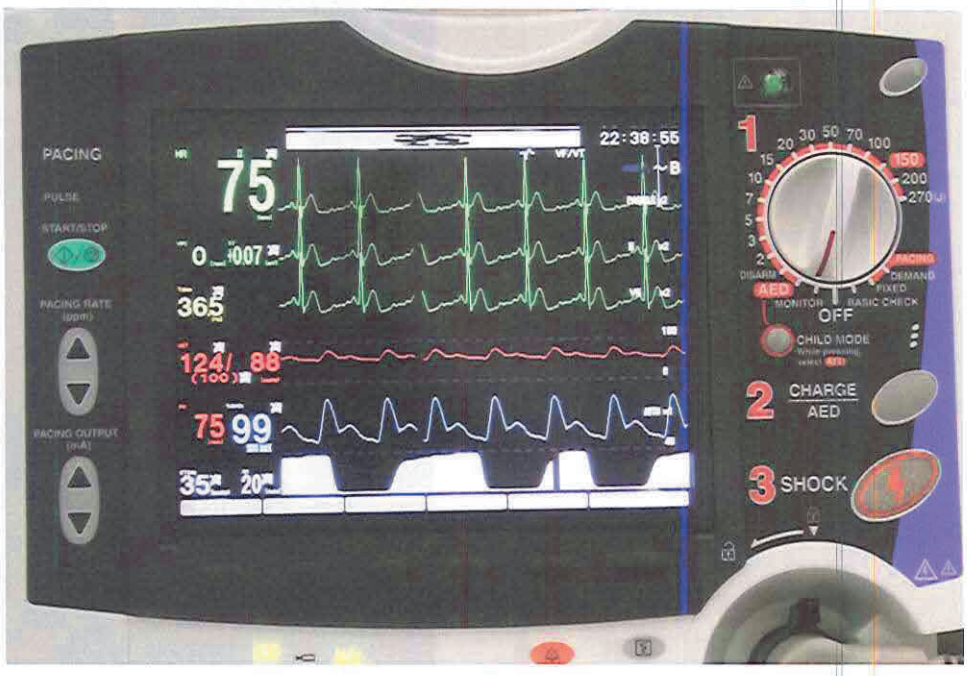
Defibrillators

defibrillator A machine that produces and sends an electrical shock to the heart in an attempt to correct the electrical pattern of the heart.

Treatment for abnormal rhythms may include the use of a defibrillator and/or administration of cardiac medications. A **defibrillator** produces an electrical shock to the heart that is intended to correct the heart's electrical pattern. A defibrillator is commonly used in emergencies such as a Code Blue in the hospital or other care facilities or at the site of the emergency by specially trained personnel. In situations when defibrillation is the appropriate treatment (pulseless ventricular tachycardia and ventricular fibrillation),

Figure 1-6 A portable ECG monitor is transported to the scene during a cardiac emergency and is attached to the patient. The ECG tracing is recorded and viewed by the emergency personnel. In addition, the tracing can be transmitted to the hospital, where a physician can evaluate and determine the necessary drugs and treatment for the patient based upon the heart rhythm viewed and the report from the emergency personnel.

Vladislav Gajic/Alamy Stock Photo



the heart must be defibrillated quickly in an effort to restore a regular heart rhythm. The survival rate of the victim decreases by 7% to 10% for every minute a normal heartbeat is not restored.

Automatic External Defibrillators

automatic external defibrillator (AED) A lightweight, portable device that recognizes abnormal rhythm and determines if the rhythm is considered a "shockable rhythm."

dysrhythmia Abnormal heartbeat.

cardiopulmonary resuscitation (CPR) The provision of ventilations (breaths) and chest compressions (blood circulation) for a person who shows no signs of breathing or having a heartbeat.

Automatic external defibrillators (AEDs) have enabled lay rescuers to help patients with sudden cardiac arrest and serious **dysrhythmias** (Figure 1-7). AEDs are available in public and private places where large numbers of people gather or live. They may also be kept in homes by people who are at high risk for heart attacks. An AED is a lightweight, portable device that recognizes an abnormal rhythm and determines if the rhythm is considered a "shockable rhythm." *Note:* The equipment is placed only on patients who are unresponsive to stimulation (who cannot be aroused) and have no evidence of breathing or a pulse. AEDs shock abnormal heart rhythms such as pulseless ventricular tachycardia and ventricular fibrillation. Learning about normal and abnormal rhythms is part of rhythm strip interpretation, which is discussed in later chapters. When the machine recognizes other rhythms that cause the patient to be unresponsive, the AED recommends beginning **cardiopulmonary resuscitation (CPR).** Individuals using an AED should consider safety for themselves and the patient. A healthcare-provider-level CPR course is best for learning this technique. The patient should be checked for medication patches, pacemakers, and metal objects that could cause burns. In addition, do not use an AED when the patient is in water.

Figure 1-7 Automatic external defibrillators (AEDs) can deliver an electrical impulse that may correct an abnormal heart rhythm and increase the survival rate of myocardial infarction victims. AEDs can be found in public places and require minimal training to operate.

Chris Pancewicz/Alamy Stock Photo

Once the equipment is placed on the patient's bare chest, it analyzes the rhythm to determine if it is likely to respond to an electric shock. Once the machine has positively identified the abnormal rhythm, it may indicate that a "SHOCK IS ADVISED." Everyone near the patient must move back and not touch the patient. One person will then announce, "clear," "everyone clear," and press the shock button. After the shock has been provided, the rescuers continue administering CPR until the patient wakes up, the machine indicates to defibrillate again, or specially trained healthcare professionals take over. AEDs make it possible for laypeople to perform defibrillation safely. The AED is now viewed as a necessary piece of equipment—similar to a fire extinguisher.

Telemedicine

telemedicine A monitoring system in which ECG tracings are communicated from a patient outside a medical facility to the physician via a telephone or digital system.

Another use of the ECG tracing outside of a healthcare facility is **telemedicine.** Remote monitoring of patients is frequently used and ECG tracings are just one type of data that is communicated via the Internet or in some cases cellular service. For example, *transtelephonic monitoring* means transmitted (trans) over the telephone (telephonic). *Digital monitoring* allows ECG data to be recorded with an electronic device and then transmitted over the Internet to the healthcare facility.

Remote monitoring helps physicians evaluate, diagnose, and then monitor ECG tracings of a patient over time. The ECG tracing can be sent through various devices from external devices with leads and wires to implantable monitors. They are all useful for patients with symptoms of heart disease that did not occur while they were in the healthcare facility. The information from these devices may be transmitted to a healthcare facility continuously or on specific days throughout the monitoring period (Figure 1-8). Individuals with external or implanted devices must understand the purpose of the device, what to report, and when and how to record and send a transmission.

Figure 1-8 This small device known as a LINQ II Insertable Cardiac Monitor (ICM) is implanted in a patient with infrequent cardiac symptoms that requires long-term monitoring and management.

Bob Collier/AP Images

Career Opportunities in ECG

Many healthcare professionals work with electrocardiography as a part of their profession. Some examples include medical assistants, nurses, emergency medical technicians, and paramedics. There are a few careers in which people work exclusively with the ECG. These include the ECG technician, the ECG monitoring (telemetry) technician, and the cardiovascular technologist. Other careers include stress and Holter monitor technicians, cardiovascular technologists, electrophysiology technologists, and echocardiography technologists.

electrocardiograph (ECG) technician An individual who has the technical skills and knowledge to record an ECG and prepare it for the physician.

ECG monitor (telemetry) technician An individual who has the technical knowledge and skills to view and evaluate the electrical tracings of patients' hearts on an oscilloscope and, when necessary, alert the appropriate healthcare professional to treat abnormalities.

An **electrocardiograph (ECG) technician** is an individual who records the ECG and prepares the report for the physician. ECG technicians should be able to determine if a tracing is accurate and recognize abnormalities caused by interference during the recording procedure. Most ECG technicians are employed in hospitals, but they may also work in medical offices, cardiac centers, cardiac rehabilitation centers, and other healthcare facilities. In some large hospitals, ECG technicians work in the home healthcare branch. They take the ECG machine to the patient's home; record the ECG; and give or transmit the report to the physician for interpretation. With the development of multiple tests and devices to evaluate the heart, the ECG technician who obtains continuing education can expect a rewarding and expanding career. For example, you may chose to be a cardiac device specialist and service the devices used for electrocardiography.

ECG monitor (telemetry) technicians view, analyze, and report the electrical activity of multiple patients' hearts on a monitor (Figure 1-9). ECG monitor technicians are employed at hospitals or other inpatient facilities

Figure 1-9 Multiple patients can be monitored on a single monitor screen. The patients being monitored may be in a hospital or at home depending upon the type of monitoring device they are using.

Paul Burns/Corbis

where patients are attached to continuous or telemetry monitors. The main responsibility of an ECG monitor technician is to view the ECG tracings and, if an abnormal heart rhythm occurs, alert the healthcare professional who can treat the abnormality. ECG monitor technicians must be able to evaluate the ECG tracing. They must understand the various heart rhythms and recognize abnormal ones. They may also be asked to perform other duties, such as maintaining patient records and recording ECGs.

cardiovascular technologist An individual who has advanced skills and can assist physicians with invasive cardiovascular diagnostic tests and procedures, such as angioplasty or cardiac device implants.

If you enjoy the field of electrocardiology and want to advance your skills or education, you may choose to be a **cardiovascular technologist.** Technologists require more extensive training than technicians. They may assist physicians with invasive cardiovascular diagnostic tests and procedures such as cardiac catheterization. Cardiac electrophysiology technologists assist physicians with diagnosing and treating slow and fast heart rhythms by implanting internal cardiac devices and performing radio frequency ablation. Another specialization for cardiovascular technologists is performing ultrasounds on the heart and/or blood vessels. Ultrasound equipment transmits sound waves and then collects the echoes to form an image on a screen. As part of their duties, cardiovascular technologists may also perform ECGs.

Checkpoint Questions (LO 1.2)

1. An automatic external defibrillator (AED) is used to treat what conditions?

_____

_____

2. Briefly describe the role of an ECG technician.

_____

_____

1.3 Preparing for an ECG

Preparing for an ECG involves more than just making sure the equipment is in order. You must be aware of legal and ethical issues, and you must also communicate appropriately with the patient to make sure the patient understands the procedure.

Legal and Ethical Issues

law Rules of conduct enforced by a controlling authority such as the government.

ethics Standards of behavior and concepts of right and wrong.

Laws are rules of conduct that are enforced by a controlling authority such as the government. An unlawful act can result in loss of your job, a fine, or other penalty such as time in jail. **Ethics** are standards of behavior and concepts of right and wrong. They are based on moral values that are formed through the influence of the family, culture, and society. Unethical acts may result in poor job evaluations or even job loss. When comparing law and ethics, you should understand that illegal acts are always unethical, but unethical acts are not always illegal.

Protecting Patient Information: HIPAA

The Health Insurance Portability and Accountability Act (HIPAA) established a national standard for electronic healthcare transactions and also for providers, health plans, and employers. HIPAA is meant to ensure that widespread use of electronic data is limited and secure. The patient can specify who can see information and what information is protected. A patient's information cannot be shared among healthcare professionals unless it is necessary for the patient's treatment.

Law & Ethics

Keep Information Private

The patient's healthcare data should not be left open in an area where other patients or visitors may be able to view it. This is a breach of confidentiality and HIPAA.

Practicing Ethics

Many professions have a *code of ethics*. These are standards of behavior or conduct as defined by the professional group. As a healthcare professional, you must follow the standards of behavior or code of ethics set forth by your profession and place of employment. ECG professions also have a *scope of practice*. The scope of practice is the procedures and processes permitted for a specific practice. Practice outside your scope of practice is both unethical and can be illegal. The following are some basic ethics you should practice.

Confidentiality is an essential part of patient care. You may collect information about a patient for use during their care and treatment; however, this information should not be made public. Confidentiality is a basic right of every patient. You should not speak about your patient or allow information about your patient to be heard or seen by anyone other than those caring for them. A breach in confidentiality is both unethical and illegal.

Treat all patients with respect and dignity. You should respect the privacy of patients at all times. Avoid exposing your patient's body when performing any procedure by closing the door, pulling the curtain, and/or draping the patient. In some cases, it may be necessary for a male healthcare professional to have a third person present when performing an ECG on a female. Check the policies at the facility where you are employed. Practicing ethics also includes acting professionally and cooperating with co-workers, supervisors, and other healthcare professionals. Maintain your professionalism by continuing your education and training to provide the highest level of care for your patients.

Professional Liability

medical professional liability Legal responsibility of healthcare professionals for their performance.

Medical professional liability means that a healthcare professional is legally responsible for their performance. Healthcare professionals can be held accountable for performing unlawful acts (*malfeasance*), performing legal acts improperly (*misfeasance*), or simply failing to perform an act (*nonfeasance*) when they should. For example, if you find a patient's wallet after they leave and you decide to keep it, this is an illegal act. While you are assisting with a treadmill stress test, if you report the blood pressure

results incorrectly, resulting in the patient having a severe heart attack, this is performing a legal act improperly. If you decide to take a break when you are supposed to be monitoring a patient's heart rhythm and during the time you are gone the patient experiences an abnormal heart rhythm resulting in death from lack of prompt treatment, you have failed to perform your duties as required. Always work within your scope of practice and the standards set by your profession.

Slander and Libel

You will be speaking and writing about patients as part of your job as an electrocardiographer; you should never speak defamatory words about patients even when they upset you. Making derogatory remarks about a patient—or anyone else—that jeopardizes their reputation or means of livelihood is called **slander.** Slander is an illegal and unethical act that could cause you to lose your job. If you write defamatory words, this is known as **libel,** which is also illegal and unethical.

slander Making derogatory remarks about someone that jeopardizes his or her reputation or means of livelihood; slander is both illegal and unethical.

libel Writing defamatory words about someone; this is both illegal and unethical.

Documentation

Medical care and treatment must be documented as part of the medical record. The medical record is for communication about a patient but can be used in court as evidence in a medical professional liability case. To protect yourself legally and to provide continuity of patient care, be sure to include complete information in the medical record. Each entry must be clear, accurate, legible, dated, and signed. Table 1-2 contains a list of the information that needs to be documented in the medical record.

Medical records may be paper or electronic. Electronic records are digitally signed. Electronic records improve communication and the quality and efficiency of healthcare. For example, an ECG recorded electronically can be transferred through a wireless connection immediately to a healthcare provider on the other side of the country.

Consent

Before you can perform an ECG on any patient, the patient must agree, or consent, to having the procedure done. Consent is often implied between the patient and healthcare professional. For example, when a patient comes

TABLE 1-2 Required Entries for Medical Records

- Patient identification, including full name, medical record number or Social Security number, birth date, full address and telephone number, marital status, and place of employment, if applicable.
- Patient's medical history.
- Dates and times of all appointments, admissions, discharges, and diagnostic tests (such as an ECG).
- Diagnostic test results.
- Information regarding symptoms and reasons for appointment, diagnostic tests, and admissions.
- Physician examinations and records of results, including patient instructions.
- Medications and prescriptions given, including refills.
- Documentation of informed consent when required.
- Name of legal guardian or representative, if patient is unable to give informed consent.

to the physician's office, they are agreeing to be treated by the physician. This is implied consent. When a patient agrees to the ECG procedure, this is also implied consent.

Think It Through

Obtaining Consent

When a patient who cannot read is required to sign a consent form, you will need to explain the procedure to both the patient and a family member or the patient's legal guardian or representative. The patient then signs the consent form. If the patient cannot write, explain the procedure to the patient with a witness present. Ask the patient to place an *X* on the form in the witness's presence, and then have the witness sign.

Who should sign the consent form if a patient cannot read or write?

_____

_____

Medical procedures such as surgery and certain diagnostic tests, including a treadmill stress test, require *informed consent.* The patient must understand the procedure, benefits, alternative procedures, associated risks, and potential risk if there is a refusal of treatment. Informed consent requires the patient to sign a consent form.

Education, Communication, and Critical Thinking

Professional communication is necessary for successful recording of an ECG. You must develop a positive relationship and atmosphere to reduce apprehension and anxiety during the procedure. Maintain a friendly, confident manner while interacting with your patient.

Helping the patient understand the procedure and follow instructions is essential. When explaining the procedure, use simple terms and speak slowly and distinctly. Encourage the patient to ask questions and repeat the instructions. This process will help ensure patient understanding. Your patient will be more cooperative if they trust that you are competent to perform your job.

Communicate & Connect

Improving Communication

When speaking to a patient who is hard of hearing, look directly at the patient and speak slowly and distinctly. The patient may be able to read your lips. If the patient speaks another language, a certified medical interpreter is required to interpret or assist you with communication, thus reducing apprehension and anxiety.

Think It Through

Critical Thinking and Problem Solving

Being able to troubleshoot situations that arise during the ECG procedure is essential. Troubleshooting requires critical thinking. Critical thinking is the process of thinking through the situation or problem and making a decision to solve it. The problem-solving process includes the following steps:

1. Identify and define the problem.
2. Identify possible solutions.
3. Select the best solution.
4. Implement the selected solution.
5. Evaluate the results.
6. If, in step 5, you determine that the problem has not been solved, repeat steps 2 through 5 until an acceptable solution is reached.

While performing an ECG, you may need to troubleshoot actual or potential complications using the steps of the problem-solving process. These problems may arise from the patient's condition, lack of patient communication, equipment failure, or other complications. For example, suppose that you are about to perform an ECG, and the patient refuses to let you attach the lead wires. As part of troubleshooting, you ask the patient why they are refusing. The patient states, "I do not want that electricity going through me!" In a calm manner, you explain that the machine does not produce or generate electricity, and it is not harmful. After your explanation, the patient agrees to have the ECG. You have performed successful troubleshooting.

The previous example describes a problem with communication. However, you may also need to troubleshoot problems that occur with the equipment or tracing produced. Throughout this text, the Think It Through boxes will provide a variety of problems or situations you may encounter and then ask for your solution. Use your critical thinking and problem-solving skills to answer each question. In each chapter, review the "What Should You Do?" questions to check your ability to think critically and troubleshoot.

Checkpoint Question (LO 1.3)

1. Explain how you would employ the steps of the problem-solving process if a patient refuses to have an ECG.

1.4 Infection Control

Healthcare-associated infections (HAIs) are infections that occur while patients are receiving any type of healthcare. HAIs are a threat to patient safety. Preventing the spread of infection is an essential part of providing healthcare and performing an ECG. The CDC has implemented two levels of precautions to prevent infections—standard precautions and isolation precautions.

standard precautions Procedures, used with all patients, which are designed to prevent the spread of infection, such as performing hand hygiene and wearing gloves.

personal protective equipment (PPE) Devices such as gloves, gowns, face masks or shields, and eye protection designed to protect a healthcare worker from sources of infection.

filtering facepiece respiratory (FFR) Specialized PPE mask to be worn when caring for patients with or with the potential for respiratory illnesses or contagious diseases.

Standard Precautions

Standard precautions include a combination of performing hand hygiene and wearing gloves when there is a possibility of exposure to blood and body fluids, nonintact skin, or mucous membranes (Figure 1-10). Standard precautions apply to blood and all body fluids, secretions, and excretions (except sweat), regardless of whether they contain visible blood, and are practiced in all employment situations in which exposure to blood or body fluids is likely. Standard precautions reduce the risk of transmission of microorganisms from both recognized and unrecognized sources of infection. In addition to performing hand hygiene and wearing gloves, practices may include using **personal protective equipment (PPE)** such as a gown, mask, and eye protection (Figure 1-11). A faceshield is worn over the mask and glasses or goggles when splashes and splatters are likely. Specialized PPE masks such as a **filtering facepiece respirators (FFR)** may be required when caring for patients with respiratory illnesses or contagious diseases. (Figure 1-12)

In addition, the CDC advises healthcare workers not to wear artificial nails because they are more likely to harbor Gram-negative pathogens than natural nails, both before and after handwashing. Natural nails should be no more than 1/4-inch long.

Figure 1-10 Hand Hygiene *A.* Handwashing especially when your hands are visibly soiled is essential to prevent the spread of infection. *B.* The use of an alcohol-based rub on hands is accepted when the hands do not have visible soilage.

Jill Braaten/McGraw Hill

Lillian Mundt

A.

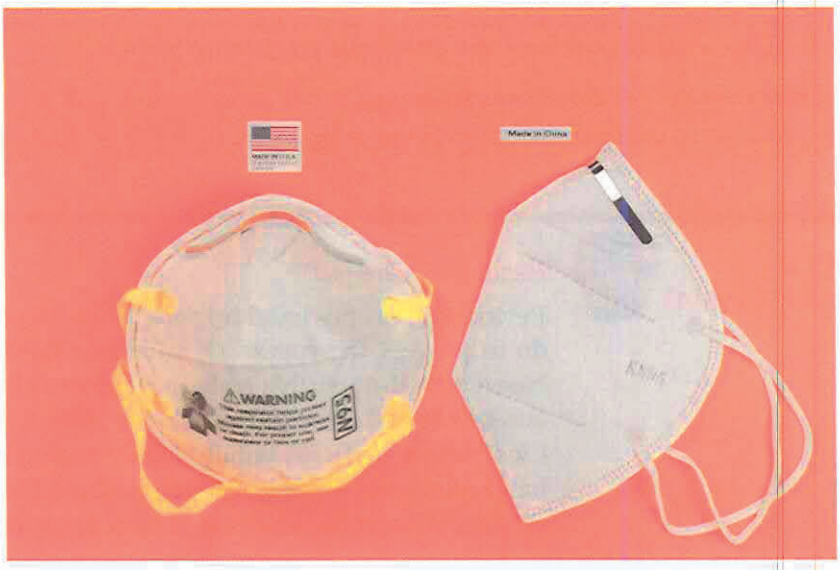
B.

Figure 1-11 Wearing appropriate personal protective equipment (PPE) reduces the risk of transmission of infection. PPE includes items such as gloves, mask, gown, and eye protection.

Total Care Programming, Inc.

Figure 1-12 Filtering facepiece respirators (FFR): *A.* N95, *B.* KN95.

new york rat/Alamy Stock Photo



A. *B.*

Table 1-3 provides a list of standard precautions that you should practice when recording an ECG. See the appendix *Standard and Isolation Precautions* for additional information about these precautions.

TABLE 1-3 Standard Precautions Related to Electrocardiography

Hand Hygiene

- Wash your hands after touching blood, body fluids, secretions, excretions, and contaminated items.
- Wash your hands before putting on gloves and after removing gloves.
- Wash your hands between patient contacts.
- Wash your hands between tasks and procedures on the same person.
- Use alcohol-based hand rub if you have no visible soilage.

Gloves

- Wear gloves when touching blood, body fluids, secretions, excretions, and contaminated items.
- Wear gloves when touching mucous membranes and nonintact skin.
- Change gloves between procedures and patients.
- Change gloves after contacting materials that are highly contaminated.
- Remove gloves promptly after use.
- Remove gloves before touching uncontaminated surfaces or items.
- Wash your hands immediately after glove removal.

Masks, Eye Protection, and Face Shields

- Wear mask, eye protection, and face shield during procedures and tasks that are likely to cause splashes or sprays of blood, body fluids, secretions, and excretions.
- Wear specialized masks as required when care for respiratory illness or contagious disease.

Gowns

- Wear a gown during procedures and activities that are likely to cause splashes or sprays of blood, body fluids, secretions, or excretions.
- Remove a soiled gown promptly.
- Wash your hands immediately after gown removal.

Equipment

- Handle used equipment carefully. It may be soiled with blood, body fluids, secretions, and excretions.
- Prevent skin and mucous membrane exposure and clothing contamination.
- Clean, disinfect, or sterilize reusable equipment before it is used on another person.
- Discard single-use equipment promptly.

Environmental Control

- Follow facility procedures for the routine care, cleaning, and disinfection of surfaces. This includes environmental surfaces, nonmovable equipment, and other frequently touched surfaces.

Occupational Health and Bloodborne Pathogens

- Use resuscitation devices for mouth-to-barrier resuscitation.

Safety & Infection Control

Hand Hygiene

Performing proper hand hygiene is the single most important thing you can do to prevent the spread of infection. Wash your hands or use an alcohol-based rub (if no visible soilage is present) between patients and procedures and before and after you use gloves. *Note:* Certain types of infections, such as *Clostridium difficile*, require handwashing because the use of alcohol-based hand rubs is not sufficient to kill all the infectious organisms. Always use the method of hand hygiene that is most appropriate for the patient's condition.

Isolation Precautions

isolation precautions The second level of steps taken to prevent the spread of infection; some examples include separating the infected patient from others and using personal protective equipment.

Isolation precautions make up the second level of protection. These precautions are based on how the infectious agent is transmitted. Isolation precautions include the following:

- Airborne precautions—require special air handling, ventilation, and additional respiratory protection (N-95 or other filtering facepiece respirators).
- Droplet precautions—require mucous membrane protection (goggles and masks).
- Contact precautions—require gloves and gowns for direct skin-to-skin contact or for contact with contaminated linen, equipment, and so on.

Isolation precautions are used less often than standard precautions and only with patients who have specific infections. When isolation precautions are in place for a patient during an ECG, you will be required to follow the specific guidelines for the type of precautions implemented. Follow the facility's policy and the guidelines provided in Table 1-4.

TABLE 1-4 Isolation Precautions for Isolation of Hospitalized Patients

In addition to standard precautions, follow these guidelines and the policy of your place of employment to prevent the spread of infections.

Airborne Precautions

For patients known or suspected to be infected with microorganisms transmitted by minute airborne droplets:

- Use a private room that has monitored negative air.
- Keep the room door closed and the patient in the room.
- Wear special FFR, EFR, or PAPR masks for respiratory protection when entering the room of a patient with known or suspected infectious respiratory disease.
- Do not enter the room of a patient known or suspected to have rubeola or varicella if you are susceptible; if you must enter the room, wear respiratory protection.
- Limit the movement and transport of patients from the room to essential purposes only.
- Place a mask on the patient if transport or movement is necessary.

Droplet Precautions

For patients known or suspected to be infected with microorganisms transmitted by droplets that can be generated by the patient during coughing, sneezing, talking, or the performance of procedures.

- Place patient in a private room (special air handling and ventilation are not necessary and the door may remain open).
- Wear a mask when working within 3 feet of the patient.
- Limit the movement and transport of the patient from the room to essential purposes only.
- Use a mask on the patient if transport or movement is necessary.

Contact Precautions

Contact precautions are used for patients known or suspected to be infected or colonized with microorganisms that can be transmitted by direct or indirect contact. *Direct contact* includes hand or skin-to-skin contact that occurs when performing patient care that requires touching the patient's dry skin; *indirect contact* includes touching environmental surfaces or patient-care items in the patient's environment. For these patients:

- Place patients in a private room.
- Wear gloves according to standard precautions.
- Wear gloves when entering the room and while providing patient care.
- Change gloves after having contact with infective material that may contain high concentrations of microorganisms, such as feces and wound drainage.
- Remove gloves before leaving the patient's room.
- Wash hands immediately.
- Do not touch potentially contaminated environmental surfaces or items in the patient's room after glove removal.
- All equipment must be disinfected after leaving the patient's room. The 12-lead ECG machine must be wiped down immediately.

Disinfecting Equipment and Surfaces

Equipment and surfaces can act as a sources of infection if not kept clean. The CDC recommends "cleaning high-touch surfaces at least once a day or as often as determined is necessary." In the medical setting, a list of such surfaces includes, but is not limited to, counter tops, writing instruments, ECG machines and carts, computer keyboards, phones, and other ECG equipment. Disinfectants may include 10% bleach, 3% hydrogen peroxide, 70% isopropyl alcohol, or specialized chemical disinfectant wipes. The surface is either wiped or sprayed with the disinfectant and left to remain on the surface for a period of time (contact time as indicated on the label). Some equipment requires special cleaning procedures. Follow the cleaning procedure established at your facility.

Checkpoint Questions (LO 1.4)

1. What measures would you use to prevent the spread of infection to you and your patients?

   _____

   _____

2. Name three types of isolation precautions and describe the PPE required for each.

   _____

   _____

1.5 Vital Signs

vital signs Temperature, pulse, respirations, blood pressure, and pain assessment.

A patient's **vital signs**—pulse, respiration, blood pressure, temperature, pulse oximetry, weight, and pain assessment—are among the most important assessments for determining a patient's current health status. Changes in the vital signs can indicate an abnormality, or they can be a normal response to exertion, heat, stress, or other environmental factors. This section focuses on adult pulse, respirations, and blood pressure since these vital signs may be checked or monitored by ECG professionals. The normal ranges for these are found in Table 1-5.

TABLE 1-5 Vital Sign Ranges by Age

Age	Blood Pressure	Pulse (beats/min)	Respirations (breaths/min)
> 12 years	Systolic: 110–135 Diastolic: 65–85	60–100	12–20
6–12 years	Systolic: 100–120 Diastolic: 60–75	60–110	16–22
3–6 years	Systolic: 95–110 Diastolic: 60–75	70–120	20–24
1–3 years	Systolic: 90–105 Diastolic: 55–70	80–150	22–30

Source: Adapted from PALS Algorithms 2021.

Pulse and Respiration

Pulse and respiration are related because the circulatory and respiratory systems work together. Pulse is measured as the number of times the heart beats in 1 minute. Respiration is the number of times a patient breathes in 1 minute. One breath, or respiration, equals one inhalation and one exhalation. Usually, if either the pulse or respiration rate is high or low, the other is also.

Pulse

cardiac output The volume of blood the heart pumps each minute.

A pulse rate gives information about the patient's cardiovascular system. It is an indirect measurement of the patient's **cardiac output,** or the amount of blood the heart is able to pump in 1 minute. If the pulse is weak, irregular, or abnormally fast or slow, the patient may show signs of low cardiac output.

Measure the pulse of adults at the radial artery, where it can be felt in the groove on the thumb side of the inner wrist (Figure 1-13). Press lightly on this pulse point with the pads of your fingers. Do not use your thumb because your thumb has a pulse, which you may feel instead of the patient's pulse. Count the number of beats you feel in 1 minute and note the rhythm and volume. The rhythm can be regular or irregular. The volume can be weak or thready, strong, or bounding. A bounding pulse feels like it is leaping out and then quickly disappearing with each pulse beat.

In some instances, you will not be able to feel a pulse at the wrist, especially if the patient is very weak or has unstable vital signs. In these cases, you can check for a pulse at the carotid artery. This artery is located on the side of the neck next to the airway (Figure 1-14). This is the same pulse location that is used for adults during basic life support.

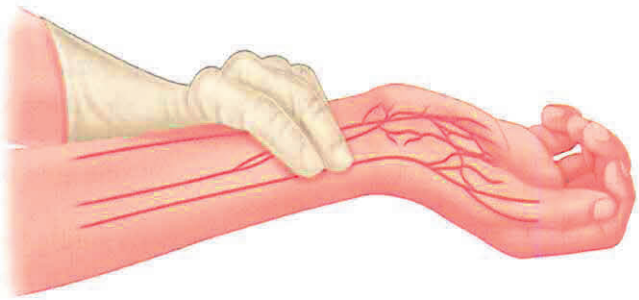


Figure 1-13 Place your fingers in the groove on the thumb side of the inner wrist to check a patient's pulse.

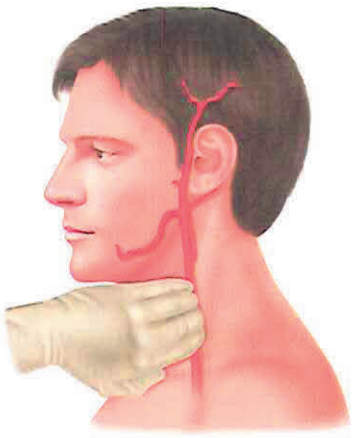


Figure 1-14 To check the carotid pulse, place your fingers on the side of the neck next to the airway.

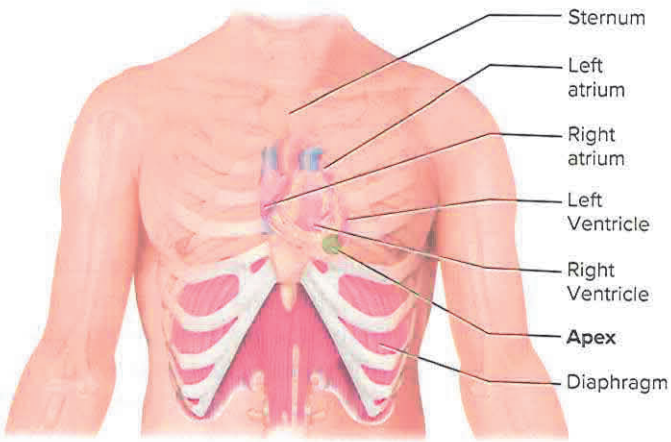


Figure 1-15 A stethoscope is used over the apex of the heart to listen for the heart sounds and measure the heart rate in patients in whom pulse is not otherwise detectable.

If you are still unable to palpate a pulse when checking the carotid artery, you may need to obtain an apical pulse (Figure 1-15). This is done with a stethoscope placed over the left side of the chest at the fifth intercostal space about 3 inches to the left of the sternum (breast bone) at approximately the midclavicular line. The pulse is counted for 60 seconds. This technique is commonly used on infant/small children and patients who are gravely ill.

Respiration

A patient's respiration rate indicates how well the patient's body is providing oxygen to tissues. The best way to check respiration is by watching, listening, or feeling the movement at the patient's chest, stomach, back, or shoulders. If you cannot see the chest movement, then place your hand over the patient's chest, shoulder, or abdomen and listen and feel for the movement of air. Respirations also may be counted with a stethoscope. Place the stethoscope on one side of the spine in the middle of the back to count respirations.

Count the respirations subtly because once the patient is aware that respiration is being measured, they may unintentionally alter their breathing. If you are using a stethoscope, tell the patient that you want to listen to their lungs. If you are not using a stethoscope, count the respirations while you have your hand on the pulse site.

Respirations are counted for one full minute to determine the rate, rhythm, and effort (quality). Counting for less than a minute may cause you to miss certain breathing abnormalities. The rhythm should be regular. The quality or effort may be normal, shallow, or deep. Irregularities such as *hyperventilation* (excessive rate and depth of breathing), *dyspnea* (difficult or painful breathing), *tachypnea* (rapid breathing), or *hyperpnea* (abnormally rapid, deep, or labored breathing) are indications of possible disease and should be noted.

When using a stethoscope, rales, rhonchi, and gurgling are types of noisy breathing that can indicate an abnormality. Rales—crackling sounds—may indicate fluid in the lungs and can be heard in patients with

pneumonia, congestive heart failure, and other conditions. Rhonchi are wheezing or snore-like sounds that occur when the airways are narrowed or obstructed.

Blood Pressure

systolic blood pressure The blood pressure measured when the left ventricle of the heart contracts; the number corresponding with the first Korotkoff sound heard when performing an auscultated blood pressure.

diastolic blood pressure The blood pressure measured when the heart relaxes, representing the minimum amount of pressure exerted against the vessel walls at all times; the number corresponding to the last Korotkoff sound heard when performing an auscultated blood pressure.

hypertension High blood pressure.

Blood pressure (also known as *arterial blood pressure*) is the force at which blood is pumped against the walls of the arteries. The standard unit for measuring blood pressure is millimeters of mercury (mm Hg). The pressure measured when the left ventricle of the heart contracts is known as the **systolic blood pressure.** The pressure measured when the heart relaxes is known as the **diastolic blood pressure.** The diastolic pressure indicates the minimum amount of pressure exerted against the vessel walls at all times.

Expected adult systolic readings are less than 120 mm Hg and adult diastolic readings are less than 80 mm Hg. These values may increase with advancing age. When monitoring blood pressure it is necessary to be aware of normal and abnormal measurements. Table 1-6 outlines blood pressure categories as established by the American Heart Association.

Factors Affecting Blood Pressure

Many factors can affect blood pressure. Risk factors such as being overweight or obese, lack of physical activity, too much salt in the diet, too much alcohol consumption (more than one to two drinks a day), stress, age, and genetics can play a role in increasing the blood pressure. Internal factors such as cardiac output, blood volume (amount of blood in the body), vasoconstriction (constriction of the blood vessels), presence of atherosclerotic plaque in the blood vessels, and blood viscosity (thickness) can impact the blood pressure within the body.

If a patient's blood pressure reading is consistently elevated after two or more visits to the physician, the patient may be diagnosed with **hypertension** or high blood pressure. Hypertension may be categorized as essential or secondary. *Essential (primary) hypertension* has no identifiable cause and is sometimes referred to as *idiopathic.* According to the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure, part of the National Heart, Lung, and Blood Institute in the National Institutes of Health, 95% of all hypertension is essential. *Secondary hypertension* occurs as a result of some other condition, such as kidney or heart disease.

TABLE 1-6 Blood Pressure Classifications

Classification	Systolic (mmHg)	Diastolic (mmHg)
Normal	<120	**AND** <80
Elevated	120–129	**AND** <80
Stage 1 hypertension	130–139	**OR** 80–89
Stage 2 hypertension	Greater than 140	**OR** greater than 90
Hypertensive crisis (emergency care needed)	>180	**AND/OR** >120

hypotension A lower than normal blood pressure that can cause reduction of blood flow to vital organs.

tilt table test A test to determine whether a change in a patient's blood pressure or heart rate due to a change of position is causing symptoms of lightheadedness or fainting.

sphygmomanometer Blood pressure cuff.

Hypotension, or low blood pressure, is not generally a chronic health problem. Slightly low blood pressure may be normal for some patients and does not usually require treatment. Severe hypotension may be present with dehydration, shock, heart failure, severe burns, and excessive bleeding.

People who have severe hypotension, a very slow heart rate, or both may have frequent fainting episodes. For patients complaining of feeling faint or lightheaded, the practitioner may order a **tilt table test.** In this test, the patient lies quietly on a table, and straps are applied to hold the patient in place. After a short time, the table is tilted upright to simulate moving from a lying position to standing, and the table remains at that angle until the patient's heart rate and blood pressure stabilize. The patient's heart rate and blood pressure are monitored during the entire test to determine whether a drop in heart rate or blood pressure is causing the person's symptoms.

Measuring Blood Pressure

Blood pressure is measured using a **sphygmomanometer,** or blood pressure cuff. To measure blood pressure, wrap the blood pressure cuff around the patient's upper arm, 1 to 2 inches above the pulse point of the brachial artery (Figure 1-16). This pulse point is located in the bend of the elbow, called the *antecubital space.* Make sure the cuff is lined up over the brachial artery to ensure the inflation bladder is centered for an accurate blood pressure reading. Never apply the blood pressure cuff over clothing or place the stethoscope under the blood pressure cuff. Ensure that the patient's legs are not crossed and the feet are flat on the floor during the measurement.

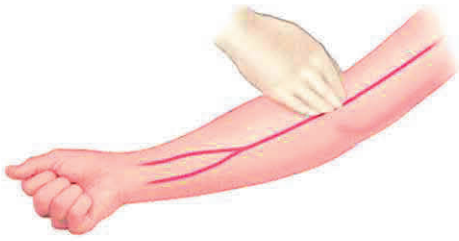
When measuring blood pressure, you may need to determine the palpatory pressure that represents the target peak inflation. Palpation provides an approximation of the systolic blood pressure to ensure an adequate level of inflation when the actual measurement is made. It also helps prevent overinflation, which is uncomfortable for the patient. In most situations, you may simply inflate the cuff to 180 to 200 mm Hg or at least 30 mm Hg over the highest recorded systolic blood pressure for your patient.

When palpatory pressure is required, inflate the cuff as you palpate the radial pulse. Inflate the cuff until you can no longer feel the radial pulse and

Figure 1-16 *A.* Place the blood pressure cuff about 2 inches above the bend in the patient's elbow. *B.* Palpate the blood pressure at the antecubital space.

Jeffrey Coolidge/Stockbyte/Getty Images

A.



B.

note the pressure at that point. Release the air from the cuff and allow the arm to rest for 30 to 60 seconds, or remove the cuff entirely and replace it after 30 to 60 seconds.

auscultated blood pressure Blood pressure determined while listening with a stethoscope.

To determine the **auscultated blood pressure,** inflate the cuff to 30 mm Hg above the palpatory result, generally in the range of 180 to 200 mm Hg. Then, while you slowly release the air in the cuff (2 to 4 mm Hg/second), listen with the stethoscope placed over the brachial pulse point. You will hear vascular sounds (thumping) that will change. These sounds are called *Korotkoff sounds*. Record the number on the sphygmomanometer when you hear the first sound. This is the systolic number. Record the number on the sphygmomanometer when you hear the final sound. This is the diastolic number.

Checkpoint Questions (LO 1.5)

1. Which three vital signs are of particular importance to ECG technicians?

   _____

   _____

2. What is the difference between a palpated blood pressure and an auscultated blood pressure?

   _____

   _____

Chapter Summary

Learning Outcomes	Summary	Pages
1.1 Describe the history and the importance of the ECG.	An ECG is a tracing of the heart's electrical activity made using an electrocardiograph. Willem Einthoven is credited with developing the first electrocardiograph. The ECG tracing created by the heart is used to diagnose cardiovascular disease, which is the number one cause of death in America.	2–3
1.2 Identify the uses of an ECG and career opportunities for an electrocardiographer.	The ECG tracing is used routinely in healthcare facilities before surgery, during emergencies, and as part of continuous monitoring. In an outpatient setting, an ECG tracing is part of an exam or is used during stress tests or Holter monitoring. Outside of the healthcare facility, the ECG tracing is used to evaluate patients cardiac status and during emergencies. Careers in ECG include ECG technician, ECG monitoring (telemetry) technician, stress and Holter monitor technicians, cardiovascular technologists, electrophysiology technologists, and echocardiography technologists.	3–11

(Continued)

Learning Outcomes	Summary	Pages
1.3 Troubleshoot legal, ethical, patient education, and communication issues related to the ECG.	Legal and ethical issues include protecting patient information in accordance with HIPAA, preventing situations that lead to professional liability, avoiding slander and libel, documenting all procedures thoroughly, and obtaining the patient's consent before performing any procedure. Communicating with and educating the patient are an important part of preparing for an ECG. Troubleshooting may involve solving problems with the patient, the equipment, or the tracing produced.	**11–15**
1.4 Perform infection control measures required for the ECG.	Follow all infection control guidelines at your facility, including standard precautions and isolation precautions as necessary. Performing proper hand hygiene is the single most important thing you can do to prevent the spread of infection.	**16–20**
1.5 Compare basic vital sign measurements related to the ECG.	The vital signs include pulse, respiration, blood pressure, temperature, pulse oximetry, weight, and pain assessment. ECG technicians are commonly asked to check or monitor the pulse, respiration, and blood pressure of adults. Normal vital signs for most adults are a pulse of 60–100 beats per minute, 12–20 respirations per minute, and a blood pressure of less than 120 mm Hg (systolic) over 80 mm Hg (diastolic).	**20–25**

Chapter Review

Matching

Match the term on the left with its definition on the right.

_____ **1.** cardiovascular disease (LO 1.1)

_____ **2.** electrocardiogram (LO 1.1)

_____ **3.** coronary artery disease (LO 1.1)

_____ **4.** standard precautions (LO 1.4)

_____ **5.** electrocardiograph (LO 1.1)

_____ **6.** defibrillator (LO 1.2)

_____ **7.** AED (LO 1.2)

_____ **8.** isolation precautions (LO 1.4)

a. an instrument used to record the electrical activity of the heart

b. a tracing of the signal produced by the heart's electrical activity and used for diagnostic evaluation of the heart

c. the second level of protection against the transmission of disease; based on how the infectious agent is transmitted

d. narrowing of the heart's blood vessels that causes a reduction of blood flow to the heart

e. used to analyze the heart rhythm and produce a shock if necessary

f. disease related to the heart and blood vessels (veins and arteries)

g. a machine that delivers an electrical shock to the heart that is intended to correct the abnormal electrical pattern of the heart

h. guidelines that apply to blood, body fluids, secretions, and excretions (except sweat); followed when there is a possibility of exposure to blood or body fluids

True/False

Read each statement and determine if it is true or false. Circle the T or F. Correct false (F) statements on the line provided.

T F 9. An ECG machine records the electrical activity of the heart. (LO 1.1)

T F 10. Standard precautions are guidelines written for healthcare providers to help prevent the spread of infection. (LO 1.4)

T F 11. Libel is the act of making derogatory remarks about someone. (LO 1.3)

T F 12. A transtelephonic monitor transmits an ECG over the Internet. (LO 1.2)

T F 13. Because an ECG is not an invasive procedure, it is not necessary to wear personal protective equipment (PPE) when performing this procedure under any circumstances. (LO 1.4)

Multiple Choice

Circle the correct answer.

14. The normal range for an adult's pulse is (LO 1.5)
    a. 40–80 beats per minute.
    b. 50–60 beats per minute.
    c. 60–100 beats per minute.
    d. 90–120 beats per minute.

15. Which physician received a Nobel Prize for inventing the electrocardiograph? (LO 1.1)
    a. Augustus D. Waller
    b. Sir Thomas Lewis
    c. Willem Einthoven
    d. Joseph Lister

16. The main responsibility of an ECG monitor technician is to (LO 1.2)
    a. view and evaluate ECG tracings on an electronic display and alert healthcare professionals when abnormalities appear.
    b. attach the ECG electrodes to patients who will be monitored remotely.
    c. assist physicians with angioplasty, heart surgery, and implantation of artificial pacemakers.
    d. perform ultrasounds on patients' blood vessels.

17. Which of the following is a reason for performing an ECG? (LO 1.2)
    a. To evaluate heart conditions
    b. To check for problems with the flow of blood through the heart
    c. To see how well the veins are contracting
    d. To evaluate the rate and rhythm of breathing

18. A defibrillator can be used (LO 1.2)
    a. to treat an abnormal heart rhythm.
    b. without training.
    c. to produce an electrical rhythm.
    d. to record the patient's breathing pattern.

19. Transtelephonic monitoring allows for information to be (LO 1.2)
    a. reviewed immediately by the patient.
    b. transmitted over a telephone.
    c. submitted for billing purposes only.
    d. recorded by a computerized device.

20. A continuous ECG monitor is used most commonly in a(n) (LO 1.2)
    a. physician's office.
    b. hospital.
    c. assisted-living center.
    d. clinic.

21. A person whose blood pressure has been above normal for two or more doctor visits may be diagnosed with (LO 1.5)
    a. low cardiac output.
    b. low blood volume.
    c. hypotension.
    d. hypertension.

22. To write derogatory words about a patient is (LO 1.3)
    a. slander.
    b. libel.
    c. a HIPAA violation.
    d. ethical.

23. Your most important duties include watching an ECG tracing and notifying the physician of abnormalities. You are most likely a(n) (LO 1.2)
    a. ECG monitoring technician.
    b. cardiovascular technologist.
    c. ECG technician.
    d. physician assistant.

24. Which of the following measures help(s) ensure that your patients' information is protected? (LO 1.3)
    a. Standard precautions
    b. OSHA
    c. Patient precautions
    d. HIPAA

25. What amount of time is the respiration rate count based upon? (LO 1.5)
    a. 10 seconds
    b. 15 seconds
    c. 30 seconds
    d. 60 seconds

26. What is the single most important procedure you can perform to prevent the spread of infection? (LO 1.4)
    a. Standard precautions
    b. Hand hygiene
    c. Patient education
    d. Communication

27. When speaking to a person who is hard of hearing, it is important to speak (LO 1.3)
    a. in high-pitched tones.
    b. rapidly.
    c. slowly and distinctly.
    d. loudly.

28. Which of the following is *not* considered a vital sign? (LO 1.5)
    a. Blood pressure
    b. Pain assessment
    c. Urinary output
    d. Respirations

29. Which of the following is the most common pulse point for measuring an adult's pulse? (LO 1.5)
    a. Radial artery
    b. Popliteal artery
    c. Brachial artery
    d. Temporal artery

30. The systolic blood pressure represents the blood pressure when (LO 1.5)
    a. the right atrium relaxes.
    b. the left ventricle contracts.
    c. the right ventricle relaxes.
    d. the left atrium contracts.

31. A patient's pulse is an indirect measurement of (LO 1.5)
    a. blood volume.
    b. blood viscosity.
    c. vasoconstriction.
    d. cardiac output.

32. Which of the following is not a specific type of isolation precaution? (LO 1.4)
    a. AIDS precautions
    b. Droplet precautions
    c. Airborne precautions
    d. Contact precautions

Critical Thinking Application *What Should You Do?*

Read the following situations and use critical thinking skills to determine how you would handle each. Write your answer in detail in the space provided.

33. You have been performing ECGs at a local clinic for about 6 months. Your favorite uncle says to you, "Since I just turned 40, your aunt thinks I should have an ECG. Will you do one on me if I come by where you work?" What would you say or do for your uncle? Consider the following: (LO 1.3)

    Should your uncle have an ECG?

    _____

    _____

    Should you do the ECG if he stops by your office? Why or why not?

    _____

    _____

34. The patient has been having some mild chest pain. During the ECG, the patient says, "How does it look? Is there anything wrong?" What would be your best response? (LO 1.3)

35. You walk by a room where a co-worker is performing an ECG on a female patient. The door is open and the patient is not covered. What would you do? (LO 1.3)

36. You are responsible for monitoring the heart rhythms on six patients at a local hospital when you begin to feel ill. You are in desperate need to go to the restroom, and you really want to go home. What should you do? (LO 1.3)

Now that you have completed the material in the textbook, go to Connect and complete any chapter activities you have not yet done.

Competency Checklists

Use the following Competency Checklists 1-1 and 1-2 to practice and perform the skills presented in this chapter. (LO 1.5)

COMPETENCY CHECKLIST 1-1

Measuring Pulse and Respirations

Procedure Steps (*Rationale*)	Practice		Practice		Test		Mastered	
Preprocedure	Yes	No	Yes	No	Yes	No	Date	Initials
1. Gather the equipment.								
2. Wash your hands.								
3. Introduce yourself and identify the patient using two forms of identification.								
4. Explain to the patient that you are going to check vital signs. Do not say that you will be counting respirations. (This prevents the patient from unconsciously changing their breathing rate while you are counting.)								
Procedure								
1. Ask the patient to sit comfortably and rest the arm on the table, palm down.								
2. Place yourself so that you can see (or feel) the patient's chest wall movements.								
3. Locate the patient's pulse by first locating the radial bone on the thumb side of the wrist, then slide your fingers into the groove on the inside of the wrist. Place two or three fingers on the pulse site. *Note:* If you are having trouble seeing the patient's respirations, you may place the patient's arm across the chest to feel the respirations while you are checking the pulse.								
4. If the pulse is regular, count it for 30 seconds, noting both the rhythm and the volume. If the pulse is irregular, count for a full 60 seconds. (Counting for a full minute allows a more accurate measurement of an irregular pulse.)								
5. Without releasing the wrist, observe or feel the respirations for a full 60 seconds, observing the rhythm, volume, and effort of the respirations.								
Postprocedure								
1. After you have counted both the pulse and the respirations, release the patient's wrist.								

Procedure Steps (*Rationale*)	Practice		Practice		Test		Mastered	
Preprocedure	Yes	No	Yes	No	Yes	No	Date	Initials
2. Record both numbers in the patient's chart. If you counted the pulse for less than a full minute, remember to calculate and record the beats per minute. If you counted for 15 seconds, multiply by 4. If you counted for 30 seconds, multiply by 2.								
3. Document the results with the date and time, and report any abnormal findings, or findings that are significantly different from previous readings on this patient.								
4. Wash your hands.								

Comments:

_____

_____

_____

_____

_____

Signed

Evaluator: _____

Student: _____

COMPETENCY CHECKLIST 1-2

Measuring Adult Blood Pressure

Procedure Steps (*Rationale*)	Practice		Practice		Test		Mastered	
Preprocedure	Yes	No	Yes	No	Yes	No	Date	Initials
1. Gather the equipment. Check the sphygmomanometer to be sure it is calibrated and in working order. (Accurate results can be obtained only when the sphygmomanometer is correctly calibrated.)								
2. Introduce yourself and identify the patient using two forms of identification.								
3. Wash your hands and explain the procedure to the patient.								
4. Select the appropriate size cuff for the patient. The bladder in the cuff should encircle at least 80% of the arm. If you are not sure which size cuff to use, use a larger cuff. (Using the proper cuff size increases the accuracy of the reading.)								
Procedure								
1. Wrap the cuff snugly around the patient's bare upper arm so that the midline of the bladder is over the brachial artery. The cuff should be 1 inch above the antecubital space. If the patient is wearing long sleeves, ask them to roll up the sleeve loosely. If the sleeve is too tight to be rolled up, ask them to change into a gown. (Checking the blood pressure through the clothing decreases the accuracy of the reading.)								
2. Position the manometer so that the gauge is at eye level and easy to see. Make sure the tubing from the blood pressure cuff is not obstructed.								
3. Close the valve on the bulb so that it is finger-tight, but do not overtighten it.								
4. Determine the palpatory pressure if required. To do so, squeeze the bulb to inflate the cuff rapidly to 70 mm Hg. Then increase the pressure in 10 mm Hg increments while using your other hand to palpate the radial pulse in the patient's wrist. Note the pressure at which the radial pulse disappears. This is the palpatory pressure. Open the valve and deflate the cuff completely. Then wait 30 seconds or remove and replace the cuff before proceeding with the auscultated blood pressure measurement. (Failure to deflate the cuff completely may cause blood to pool in the artery, which can result in an inaccurate reading.)								
5. Place the stethoscope's earpieces in your ears so that they point up or toward your nose. Rotate the head of the stethoscope in the diaphragm position and test it by tapping gently.								
6. Place the diaphragm of the stethoscope over the patient's brachial artery and hold it firmly using your index and middle fingers. Make sure the entire surface of the diaphragm is in contact with the patient's skin and that it does not touch the blood pressure cuff. (Do not use your thumb to hold the stethoscope in place because your thumb has a pulse that can interfere with the reading.)								

Procedure Steps (*Rationale*)	Practice		Practice		Test		Mastered	
Preprocedure	Yes	No	Yes	No	Yes	No	Date	Initials
7. Inflate the bladder rapidly to a pressure that is 20 to 30 mm Hg higher than the palpatory pressure (if obtained) or at least 30 mm Hg higher than the highest recorded systolic blood pressure for the patient. If neither are known, inflate cuff to 180 to 200 mg Hg.								
8. Partially open the screw on the valve to deflate the bladder at about 2 mm per second. Listen for the Korotkoff sounds. Note the pressure at which you first hear the repetitive sounds. This is the systolic pressure.								
9. Continue to deflate the cuff at the same rate, noting the pressure at which the sound becomes muffled, and then the pressure at which the sound disappears. The pressure at which the sound disappears is the diastolic pressure.								
10. Continue to deflate the cuff and listen for another 10 mm Hg. Listen to be sure the repetitive sounds do not resume. (This ensures that you are measuring the diastolic pressure, not an auscultatory gap.)								
11. Rapidly deflate the cuff the rest of the way and remove it from the patient's arm.								
Postprocedure								
1. Record the systolic and diastolic numbers in the patient's chart, separated by a slash. Record the date and time, the arm in which you measured the pressure, and the patient's position (sitting or lying). If you used a nonstandard cuff size, record the cuff size as well.								
2. Use an alcohol moistened gauze to disinfect the diaphragm and earpieces of the stethoscope.								
3. Dispose of the used gauze appropriately and wash your hands.								

Comments:

_____

_____

_____

_____

_____

Signed

Evaluator: _____

Student: _____

Design Elements: Think It Through icon (gears in head) ©Fine Art/Shutterstock.com RF; Communicate & Connect icon (computer and stethoscope) ©lenetstan/Shutterstock.com RF; Safety & Infection Control icon (apple with Band-Aid) ©Ezume Images/Shutterstock.com RF; Law & Ethics icon (gavel and stethoscope) ©Lisa S./Shutterstock.com RF.