Role of the Electrocardiographer

Chapter Outline
- The Electrocardiogram (ECG) (p. 2)
- History of the ECG (p. 4)
- Role of an Electrocardiographer (p. 5)
- How ECGs Are Used (p. 6)
- What You Need to Know to Perform an ECG (p. 13)
- Troubleshooting (p. 20)

Learning Outcomes
1.1 Explain what an ECG is and its importance in medicine.
1.2 Discuss the history of obtaining and using the ECG.
1.3 Describe career opportunities for an electrocardiographer.
1.4 Compare the uses of the ECG in the hospital, in the doctor’s office or ambulatory clinic, or outside of a healthcare facility.
1.5 Identify the skills and knowledge needed to perform an ECG.
1.6 Define troubleshooting, and explain its importance to you as a healthcare professional.

Key Terms
- angioplasty
- arrhythmia
- automatic external defibrillator (AED)
- body mechanics
- cardiopulmonary resuscitation (CPR)
- cardiovascular
- Code Blue
- coronary artery disease (CAD)
- defibrillator
- electrocardiogram (ECG)
- electrocardiograph
- electrocardiology
- galvanometer
- healthcare provider
- Holter monitor
- isolation precautions
- myocardial infarction (MI) (heart attack)
- pacemaker (artificial)
- standard precautions
- stat
- technician
- technologist
- telemetry
The number one cause of death in the United States every year since 1918 is cardiovascular disease, or a disease of the heart and blood vessels. Approximately 2500 Americans die every day because of coronary artery disease (CAD), which is narrowing of the blood vessels surrounding the heart that causes a reduction of blood flow to the heart. Unbelievably, one out of every three American adults has some form of CAD. You may know someone who has hypertension (high blood pressure) or other heart conditions. Maybe someone you know has had an MI (myocardial infarction, or heart attack). Table 1-1 contains more information on ways to reduce or prevent heart disease, stroke, or heart attack.

An instrument known as an electrocardiograph 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 tracing is known as an electrocardiogram, or ECG. The standard ECG machine has lead wires that are attached to a patient’s chest to produce the electrical tracing (Figure 1-1).

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.

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

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

Knowing the history of obtaining electrical tracings from the heart will help you better understand the reasons ECGs are performed and their importance in medicine. As early as 1676, scientists made the discovery that animals generate electricity. In 1887, an English physician, Dr. Augustus D. Waller (1856–1922), was the first to show that electrical currents are produced during the beating of the human heart and can be recorded. Dr. Waller was credited with having performed the first electrocardiogram on a human.

Wilhelm Einthoven (1860–1927), a Dutch physiologist, continued the development of the ECG. He developed the first practical galvanometer, an instrument used to detect electrocardiograph waves. In 1903, Einthoven invented the first electrocardiograph. Einthoven’s instrument introduced the field of electrocardiology, or the study of the heart’s electrical activity, and he won the Nobel Prize in Physiology or Medicine in 1924 for the significance of his invention.

Other scientists extended the work of Einthoven. Sir Thomas Lewis of London (1881–1945) studied how the ECG related to cardiac arrhythmias (abnormal heartbeats). His work formed the basis for much of the current knowledge about the ECG. In 1918, an American physician, James B. Herrick, showed that an abnormal tracing and physical symptoms could indicate a myocardial infarction (MI), also known as a heart attack.

Advancements in technology have brought about today’s modern ECG machines. Computer interpretation of the ECG tracing is common. Currently, computer technology continues to improve the availability and speed of computer interpretation and quickly communicates this information to a healthcare professional. An ECG machine is now as small as a wristwatch. With the use of digital information, healthcare professionals are able to monitor patients from remote locations miles away. Patients in hospitals can be monitored through cameras, ECG readings, and other vital sign measurements.
1.3 Role of an Electrocardiographer

Electrocardiography is an expanding career field. Many healthcare professionals are trained to record or monitor the heart’s electrical activity. These include physicians, nurse practitioners, physician assistants, nurses, paramedics, medical assistants, trained nursing assistants, and emergency medical technicians, though this list is not inclusive. With the changing healthcare field, other healthcare employees, such as respiratory or radiology personnel, are also learning to perform ECGs to improve healthcare delivery in a variety of healthcare settings. Healthcare professionals who perform ECGs should also be trained in cardiopulmonary resuscitation (CPR), a technique used to provide ventilations (breaths) and chest compressions (blood circulation) for a person who shows no signs of breathing or having a heartbeat.

Healthcare personnel who are proficient at recording an ECG can expect to increase their employability and advance their careers. In addition, there are career opportunities for individuals who may want to specialize in the field of electrocardiography. These include, but are not limited to, the ECG technician, the ECG monitoring technician, and the cardiovascular technologist.

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, the ECG technician works in the home healthcare branch. He or she takes the ECG machine to the patient’s home, records the ECG, and gives, sends, or telecommunicates the report to the physician for interpretation. With the development of multiple tests to evaluate the heart, the ECG technician who obtains continuing education can expect a rewarding career.

ECG monitor technicians view and evaluate the electrical tracings of patients’ hearts on an oscilloscope (Figure 1-2). ECG monitor technicians are employed at hospitals or other inpatient facilities 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 are required to understand the various heart rhythms and recognize abnormal ones. ECG monitor technicians must be able to evaluate the ECG tracing. They may also be asked to perform other duties such as maintaining patient records and recording ECGs.

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 such as angioplasty, heart surgery, or implantation of electronic, artificial pacemakers. Another specialization for cardiovascular technologists is performing ultrasounds on the 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.

cardiopulmonary resuscitation (CPR) To provide ventilations (breaths) and chest compressions (blood circulation) for a person who shows no signs of breathing or having a heartbeat.
technician An individual who has the knowledge and skills to carry out technical procedures.
telemetry The transmission of data electronically to an unattached or distant location.
technologist An individual who specializes in a field of science.
angioplasty Surgical repair of blood vessels.
pacemakers (artificial) A device that delivers a small, measured amount of electrical energy to cause myocardial depolarization. Most artificial pacemakers are electronic.
1. An ECG technician’s role includes the following:

1.4 How ECGs Are Used

Healthcare providers, such as physicians, study the ECG tracing to determine many things about the patient’s heart. They look for changes from the normal ECG tracing or from the first ECG tracing, which provides a baseline for comparison of subsequent ECGs performed. The American Heart Association 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 1-3. We discuss normal and abnormal ECG tracings in Chapter 2 and Chapter 5.

The ECG tracing is recorded using a variety of ECG machines and can be performed in a number of healthcare settings. These include acute care settings such as hospitals, ambulatory care settings such as clinics or doctors’ offices, and even outside of a healthcare facility. Emergency personnel routinely perform ECGs during emergencies. An ECG tracing can also be transmitted over the telephone, mobile, or Internet from a person’s home or other remote location. The type of ECG tracing produced depends upon the setting and the type of ECG machine used to record.
In the Hospital (Acute Care)

A 12-lead ECG is one of the most commonly used ECGs in the hospital setting. A 12-lead ECG provides a tracing of the electrical activity in the patient's heart at the exact time the ECG tracing is done. In the hospital, a 12-lead ECG is done as a routine procedure or during an emergency such as a **Code Blue**. An emergency ECG may be referred to as **“stat.”** meaning immediately. These are done when a patient experiences chest pain or has a change in his or her cardiac rhythm. Routine ECGs are usually obtained in the early morning so they are available for the physician to review when he or she does patient rounds. Routine ECGs are also frequently done before surgery. Both routine or stat ECGs must be performed safely and with accuracy because these tracings will provide critical information about the patient. An inaccurate tracing could result in misdiagnosis, incorrect medications being administered, or other serious outcomes.

Another use of the ECG tracing in the hospital is in continuous monitoring. The purpose of continuous monitoring is to check the pattern of the electrical activity of the patient’s heart over time. During continuous monitoring, electrodes are attached to the patient’s chest and the tracing is viewed on an oscilloscope. 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), or even an emergency room (ER). Some continuous monitors can also monitor the vital signs and the oxygen level in the blood. Continuous monitoring is also done routinely during surgery.

Another type of continuous monitoring done in a hospital is known as **telemetry monitoring.** Telemetry monitors are small boxes with electrodes and lead wires attached to the chest. The monitor is usually housed in a case and is attached to the patient so he or she 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 oscilloscopes at the nursing or patient care station.

New technology has allowed for evaluation and monitoring of patients and their rhythms from a remote location. This is being referred to as an **e-ICU.**
Patients are miles away being monitored by nurses for their heart rhythm and vital signs. This is in addition to the close monitoring done at the hospital.

**Performing ECGs in 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 or routine examination. This routine ECG provides a baseline 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 1-2 provides a complete list of conditions that may be diagnosed by an ECG. The procedure for performing a 12-lead ECG is discussed in Chapter 4.

Two other ECG-type tests that may be performed in an office include treadmill stress testing and the ambulatory monitor, or Holter monitor, testing (Figure 1-4 and Figure 1-5).

**TABLE 1-2 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 such as weakness, chest pain, or shortness of breath
- Diagnosis of certain drug toxicity
- 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
- Pacemaker function
The treadmill stress test, also known as exercise electrocardiography, is done to determine if the heart gets adequate blood flow during stress or exercise. While the stress test is being performed, the patient is attached to an ECG monitor as he or she is walking on the treadmill. The speed of the treadmill can be varied to measure how this might “stress” the heart. The ECG tracing is recorded and analyzed for changes during the exercise. A physician should always be present during this procedure. The stress test is frequently ordered because it is a safe, noninvasive, inexpensive, and reliable method of measuring the heart’s condition if a problem is suspected by the physician. We discuss the stress test in more detail in Chapter 6.
A Holter monitor is a small box that is strapped to a patient’s waist or shoulder to monitor the heart for 24 to 48 hours or up to 30 days during a patient’s normal daily activity. After the monitoring period, the patient returns to the office for the monitor to be removed. The ambulatory monitor is usually a small tape recorder or digital disc. When the recording is finished, it is examined with a special instrument called a scanner. The ECG tracing is then analyzed and interpreted by the physician. Some patients can connect these monitors to a computer where the information can be e-mailed to the physician. We discuss the ambulatory monitor in detail in Chapter 7.

Outside of a Healthcare Facility

Outside of a healthcare facility, the ECG is a valuable tool used during a cardiac emergency 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 monitor and trace 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, such as for sudden cardiac arrest, requires immediate treatment; the patient becomes unresponsive,

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.
which leads to death if not treated within minutes. Treatment for these abnormal rhythms includes use of a defibrillator and/or administration of cardiac medications. When the heart is in this chaotic rhythm of ventricular fibrillation or pulseless ventricular tachycardia, the heart must be “defibrillated” quickly. The survival rate of the victim decreases 7% to 10% for every minute a normal heartbeat is not restored. 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 appropriate personnel.

**Automatic external defibrillators (AEDs)** have enabled lay rescuers to help a patient with sudden cardiac arrest (Figure 1-7). AEDs are available in public and/or private places where large numbers of people gather or live or are kept 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.” The equipment is only placed on patients who are unresponsive (not able to be aroused) to stimulation and have no evidence of breathing or a pulse. AEDs will only shock the rhythms of ventricular fibrillation or ventricular tachycardia that do not produce a heartbeat. These rhythms are discussed in Chapter 5. When the machine recognizes other rhythms that cause the patient to be unresponsive, the AED recommends beginning 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 nitroglycerin patches, pacemakers, and metal objects that could cause burns. In addition, do not use an AED when the patient is in water.

Once the equipment is placed on the patient’s bare chest, the machine will either automatically analyze or require the operator to push the “ANALYZE” button. The machine will analyze the rhythm to determine if it is a rhythm that is likely to respond to an electric shock through the chest to the heart. Once it has positively identified the abnormal rhythm, the machine will indicate that a “SHOCK IS ADVISED.” All persons next to the patient...
must move back and not touch the patient. One person will then announce “I’m clear, you’re clear, we are all 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. These new machines now make it possible for laypersons to perform defibrillation safely. The AED is being viewed as a necessary piece of equipment—similar to a fire extinguisher.

Another use of the ECG tracing outside of a healthcare facility is through telemedicine. In telemedicine, ECG tracings are communicated to the physician via the telephone or digital system. Transtelephonic monitoring means transmitted (trans) over the telephone (telephonic). The improvements in solid-state digital technology have expanded transtelephonic transmission of ECG data and enhanced the accuracy of software-based analysis systems. Digital monitoring allows ECG data to be recorded with a personal computer and then transmitted over the Internet to the healthcare facility. Transtelephonic monitoring requires a licensed practitioner to read and evaluate the tracing, whereas the digital monitoring provides a report that is validated by the licensed practitioner.

Both of these types of monitoring evaluate the ECG tracing of a patient over time. The two types of ambulatory monitoring methods are useful for patients with symptoms of heart disease that did not occur while they were in the healthcare facility. The recorded monitoring can be accomplished with magnetic tape (transtelephonic) or digital (computerized) recordings that are used for up to 30 days. A transtelephonic monitor is placed on a telephone mouthpiece, and the ECG is transmitted to a healthcare facility on specific days throughout the monitoring period (Figure 1-8). Individuals using a transtelephonic monitor must understand when and how to record and send a transmission. A digital monitor requires the individual to be able to use a computer and understand how to send a transmission.

**Figure 1-8** Transtelephonic monitoring uses a cellular phone device (circled) to transmit the patient’s ECG tracing to a central location for monitoring.
Depending upon which equipment your facility uses, you may be required to teach the patient how to use the monitor. Become familiar with the type of monitor used at your facility.

There are two specific types of telemedicine monitors. One monitors the heart continuously, and the other records the ECG tracing when the patient is having symptoms. Continuous telemedicine monitoring is programmed to record the ECG tracing constantly. It is useful to record the ECG tracing before, during, and after a patient has symptoms. These symptoms may include chest pain, shortness of breath, dizziness, or palpitations. This type of monitor is a small device that attaches to the patient’s chest with two electrodes. The smallest monitor available is about the size and shape of a jump drive or a thin credit card.

Symptom-based telemedicine monitoring is in the form of either a handheld or a wristwatch device. The handheld type has electrode feet that are pressed against the patient’s chest after symptoms occur. Currently, one type is as small as a credit card and can be carried in a pocket or wallet. The wristwatch type monitor is worn on the left arm at all times. The patient must turn on this type of monitor when symptoms begin.

Telemedicine monitoring is generally used to evaluate artificial pacemaker functioning. In addition, monitors are sometimes given to patients after an emergency room visit. If the patient has symptoms of cardiac problems but is not admitted to the hospital, a physician will often give the patient a monitor to record an ECG when the symptoms recur. It is less expensive to give patients a monitor to take home than to admit them to the hospital.

1. A 12-lead ECG can be obtained by an electrocardiographer in which healthcare venues?

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

1.5 What You Need to Know to Perform an ECG

In order to perform an ECG, you should become familiar with the procedure and the ECG machine. You must have the ability to lift and move the patient, if necessary. This requires using proper body mechanics and getting assistance when needed. Body mechanics is using movements that maintain proper posture and avoid muscle and bone injuries (Table 1-3). You need to be able to transport and operate the ECG machine. In addition, you must understand basic principles of safety and infection control, patient education and professional communication, and law and ethics.
Chapter 1 Role of the Electrocardiographer

Equipment

Knowing how to use the equipment is part of performing an ECG. You must be able to transport, operate, maintain, and store the ECG equipment used at your facility. There are many different machines available to perform an ECG, and directions provided by the manufacturer are an important source of information. Many ECG machines have reference cards or instructions posted in a convenient place on or with the equipment. Refer to these printed materials when performing an ECG. Although all ECG machines are similar, you should become familiar with the particular machine you are using. You should always practice performing ECGs before using any machine on a patient. Since an ECG is noninvasive, you can practice on a volunteer, friend, co-worker, or fellow student. A procedure checklist like the one found at the end of Chapter 4 can be used for practice as well as to document your proficiency at the skill.

Safety

When performing healthcare procedures, you must always maintain the safety of yourself and the patient. General safety guidelines should be followed at all times. Certain safety precautions specific to performing the ECG procedure should also be followed. These specific precautions are discussed in more detail in Chapter 4.

### TABLE 1-3 Proper Body Mechanics

<table>
<thead>
<tr>
<th>Movement</th>
<th>Your Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintain a wide base of support</td>
<td>Keep your feet apart and at shoulder-width at all times.</td>
</tr>
<tr>
<td>Avoid twisting</td>
<td>Face the direction in which you intend to move.</td>
</tr>
<tr>
<td>Protect your back</td>
<td>Bend at your hips and knees, and keep your back straight at all times.</td>
</tr>
<tr>
<td>Use stronger and/or most muscles for lifting</td>
<td>Lift with your legs, not your back. Use both arms</td>
</tr>
<tr>
<td>Maintain body alignment</td>
<td>Keep your chin up and shoulders back, and avoid unnecessary reaching.</td>
</tr>
</tbody>
</table>

Infection Control

Preventing the spread of infection is an essential part of providing healthcare and performing an ECG. This is for your safety as well as the safety of your patients. The Centers for Disease Control and Prevention (CDC) have implemented two levels of precautions to prevent infections—**standard precautions** and isolation precautions.

**standard precautions**

Procedures, such as wearing gloves, used with all patients that are designed to prevent the spread of infection.

**Guidelines**

Follow safety and infection control guidelines at all times when working in a healthcare facility and performing an ECG.
Standard precautions include a combination of hand hygiene and wearing gloves when there is a possibility of exposure to blood and body fluids, nonintact skin, or mucous membranes (Figure 1-9). Standard precautions applies to blood, all body fluids, secretions, and excretions (except sweat), regardless of whether or not they contain visible blood, nonintact skin, and mucous membranes. Universal precautions, a subset of Standard Precautions, apply to blood and any other body fluids only if they contain visible blood. Standard precautions reduce the risk of transmission of microorganisms from both recognized and unrecognized sources of infection. In addition to hand hygiene and wearing gloves, practices may include the use of personal protective equipment (PPE) such as a gown, mask, and eye protection (Figure 1-10). In addition, the CDC advises that healthcare workers should not wear artificial nails, as those workers are more likely to harbor gram-negative pathogens on their fingertips than are those with natural nails, both before and after handwashing. Natural nails should be no more than one-fourth inch long.

The second level includes isolation precautions, which are based on how the infectious agent is transmitted. Isolation precautions are

1. airborne precautions that require special air handling, ventilation, and additional respiratory protection (HEPA or N95 respirators);
2. droplet precautions requiring mucous membrane protection (goggles and masks); and
3. contact precautions requiring gloves and gowns for direct skin-to-skin contact or for contact with contaminated linen, equipment, and so on.

Isolation precautions are practiced in all employment situations in which exposure to blood or body fluids is likely. Isolation precautions are used less often 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. Table 1-4 provides a list of standard precautions that should be practiced when recording an ECG. See Appendix B for additional information about standard and isolation precautions.

**Patient Education and Communication**

Communicating with your patients is key to successfully recording an ECG. You must develop a positive relationship and atmosphere to reduce apprehension and anxiety during an ECG. You can reduce the patient’s fears and make the ECG a positive experience by developing a helpful relationship with your patient and practicing effective communication techniques. Clearly explaining the procedure and answering questions are essential for good patient communication. Maintain a friendly, confident manner while interacting with your patient. Your patient will be more cooperative if he or she trusts that you are competent to perform your job.

Helping the patient understand the procedure and follow instructions is essential to performing any ECG procedure. 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.
In addition, in your role as a healthcare professional, you will need to be able to work in a variety of situations as a team member and be able to resolve conflicts. As with any job, you should continue to improve in your performance through further education and practice.
Legal and Ethical Issues

As a healthcare professional, you must understand some legal and ethical considerations of patient care. 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 concerned with standards of behavior and concepts of right and wrong. They are based upon moral values that are formed through the influence of the family, culture, and society. Unethical acts result in poor job evaluations or job loss. When comparing law and ethics, you should understand that illegal acts are always unethical but unethical acts are not always illegal.

Hand Hygiene

Proper hand hygiene is the single most important thing you can do to prevent the spread of infection. Handwashing or the use of an alcohol-based rub on hands without visible soilage should be practiced between patients and procedures and before and after the use of 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 condition of the patient.

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. When your patient speaks another language, you may want to ask an interpreter or family member to assist you with communication, thus reducing apprehension and anxiety.

Protecting Patient Information: HIPAA

Patient information has always been considered to be confidential or private. In 1996, the Health Insurance Portability and Accountability Act (HIPAA) was established in response to information that was being transferred electronically for medical transactions. This act establishes a national standard for electronic healthcare transactions and also for providers, health plans, and employers. It was to ensure that the widespread use of electronic data was limited and secured. The patient can specify who is able to see information and what information is protected. A patient’s information can only be sent and viewed when specific to insurance payments and further medical treatment with a consulting healthcare professional. A patient’s information cannot be shared among healthcare professionals unless it is for the patient’s treatment.
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. 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 his or her 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 unethical, illegal, and a violation of HIPAA.

Patients should be treated 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 professionalism, respect, and cooperation. You should maintain professionalism by continuing your education training in order to provide the highest level of care for your patients. You should respect your patients’ beliefs, values, and morals; and you should work cooperatively with your co-workers and supervisors at all times.

Legal Issues You Should Know

Medical professional liability means that a healthcare professional is legally responsible for his or her performance. Healthcare professionals can be held accountable for performing unlawful acts, performing legal acts improperly, or simply failing to perform an act when they should. For example, if you find a patient's wallet after he or she leaves 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.

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

Law & Ethics

Keep Information Private

The patient’s chart or computer screen with patient data should not be left out or open in an area where other patients or visitors may be able to view it. This is a breach of confidentiality and HIPAA.
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.

Medical care and treatment must be documented as part of the medical record. The medical record can be used in court as evidence in a medical professional liability case. To protect yourself legally and provide continuity of patient care, you should include complete information in the medical record. Table 1-5 contains a complete list of the necessary information to document on the medical record.

Whatever ECG procedure you are performing, the patient must agree or consent to having the procedure done. Implied consent is between the patient and healthcare professional, such as a physician in an office. For example, when a patient requests care and comes to the physician’s office, he or she is agreeing to be treated by the physician. This is implied consent. When a patient agrees to the ECG procedure, this is also implied consent.

Certain diagnostic procedures, including a treadmill stress test, require informed consent. The patient must understand the procedure and its associated risks, alternative procedures and their risks, and the potential risks to the patient if he or she refuses treatment. Informed consent requires the patient to sign a consent form.

### Checkpoint Question (LO 1.5)

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

### 1.6 Troubleshooting

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.

When caring for patients and recording an ECG, you may experience a variety of problems. These problems may stem from the patient's condition, patient communication, equipment failure, or other complications. While performing an ECG, you may need to troubleshoot actual or potential complications during the procedure using the steps of the problem-solving process.

Let us say 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 he or she is 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. This example, as you can see, is a problem with communication, however, other problems can occur with the equipment or tracing produced and troubleshooting will be necessary. Throughout this text the Troubleshooting 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.

Consent

When a patient who cannot read or write is required to sign a consent form, you will need to explain the procedure to a family member and have that person sign and the patient sign unless he or she has been determined to be incompetent. If this is not possible, explain the procedure to the patient with a witness present and have the witness sign, along with having the patient place an X on the form.

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

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

<table>
<thead>
<tr>
<th>Learning Outcomes</th>
<th>Summary</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.1</strong> Explain what an ECG is and its importance in medicine.</td>
<td>An ECG is the tracing of the heart’s electrical activity using an electrocardiograph. It is used to diagnosis cardiovascular disease, which is the number one cause of death in America.</td>
<td>2-3</td>
</tr>
<tr>
<td><strong>1.2</strong> Discuss the history of obtaining and using the ECG.</td>
<td>The heart’s electricity was discovered as early as 1676. In 1903, Wilhelm Einthoven is credited with developing the first electrocardiograph and introducing the field of electrocardiography.</td>
<td>4</td>
</tr>
<tr>
<td><strong>1.3</strong> Describe career opportunities for an electrocardiographer.</td>
<td>Careers in electrocardiography are expanding and include such careers as ECG technician, ECG monitor technician, and cardiovascular technologist.</td>
<td>5-6</td>
</tr>
<tr>
<td><strong>1.4</strong> Compare the uses of the ECG in the hospital, in the doctor’s office or ambulatory clinic, and outside of a healthcare facility.</td>
<td>The ECG is used routinely in the hospital before surgery, during emergencies, and as part of continuous monitoring. In a clinic, an ECG is part of an exam or is used during a treadmill stress test or Holter monitoring. Outside the healthcare facility, the ECG is used for evaluation during emergencies.</td>
<td>6-13</td>
</tr>
<tr>
<td><strong>1.5</strong> Identify the skills and knowledge needed to perform an ECG.</td>
<td>To perform an ECG you should know the procedure and equipment and have the ability to communicate and to lift and move patients.</td>
<td>13-20</td>
</tr>
<tr>
<td><strong>1.6</strong> Define troubleshooting, and explain its importance to you as a healthcare professional.</td>
<td>Troubleshooting is the process of critical thinking or thinking through the situation, then making a decision to try to solve it. Troubleshooting is a necessary part of performing ECGs.</td>
<td>20-21</td>
</tr>
</tbody>
</table>
Chapter Review

Matching

Match these terms with the correct definition. Place the appropriate letter on the line to the left of each term.

1. cardiovascular (LO 1.1)
2. electrocardiogram (LO 1.1)
3. arrhythmia (LO 1.2)
4. electrocardiology (LO 1.1)
5. electrocardiograph (LO 1.1)
6. defibrillator (LO 1.3)
7. AED (LO 1.3)

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 study of the heart's electrical activity
d. abnormal or absence of normal heartbeat, also known as dysrhythmia
e. used to analyze the heart rhythm and produce a shock if necessary
f. related to the heart and blood vessels (veins and arteries)
g. a machine that produces and sends an electrical shock to the heart that is intended to correct the abnormal electrical pattern of the heart

True/False

Read each statement and determine if it is true or false. Circle the T or F. For false (F) statements, correct them on the line provided to “make them true.”

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

9. Standard precautions are guidelines written for healthcare providers to help prevent the spread of infection. (LO 1.5)  
T  F

10. When performing an ECG, you should know the equipment, infection control principles, communication techniques, and safety guidelines. (LO 1.5)  
T  F

11. A transtelephonic monitor transmits an ECG over the Internet. (LO 1.4)  
T  F
Multiple Choice

Circle the correct answer.

12. Which of the following is a reason that an ECG is performed? (LO 1.4)
   a. To determine if the electrolyte balance is normal.
   b. To determine pacemaker function.
   c. To determine cardiac output.
   d. To predict the possibility of an MI.

13. Which physician invented an instrument to detect electrograph waves? (LO 1.2)
   a. Sir Thomas Lewis
   b. William Einthoven
   c. Augustus Walker
   d. Joseph Electrocardiograph

14. The first ECG machine was developed in ________________ by ________________. (LO 1.2)
    He won the Nobel Prize for this invention.
    a. 1903, Wilhelm Einthoven
    b. 1918, James B. Herrick
    c. 1876, Augustus D. Waller
    d. 1945, Sir Thomas Lewis

15. The main responsibility of an ECG monitor technician is to (LO 1.3)
    a. Determine whether an abnormal heart rhythm occurs.
    b. View the ECG tracing.
    c. Alert the healthcare professional.
    d. All of the above.

16. Which of the following is not a reason for performing an ECG? (LO 1.4)
    a. To evaluate heart conditions
    b. To check for problems with the flow of electricity through the heart
    c. To see how well the heart is contracting and pumping
    d. To evaluate the rate and rhythm of breathing

17. A defibrillator can be used (LO 1.1)
    a. to treat an abnormal heart rhythm.
    b. without training.
    c. to produce an electrical rhythm.
    d. to record only ECG rhythms.

18. Transtelephonic monitoring allows for information to be (LO 1.4)
    a. reviewed immediately by a physician.
    b. transmitted over a telephone.
    c. submitted for billing purposes only.
    d. recorded by a computerized device.

19. A continuous ECG monitor is used most commonly in a(n) (LO 1.4)
    a. physician’s office.
    b. hospital.
    c. assisted-living center.
    d. clinic.
20. Which of the following is most commonly performed in a clinic or hospital? (LO 1.4)
   a. Transtelephonic monitoring
   b. Ambulatory monitoring
   c. 12-lead ECG
   d. Defibrillation

21. To write derogatory words about a patient is known as (LO 1.5)
   a. slander.
   b. libel.
   c. ethical.
   d. unethical.

22. Your most important duties include monitoring an ECG tracing and notifying the physician of abnormalities. You are most likely a(n) (LO 1.5)
   a. ECG monitoring technician.
   b. cardiovascular technologist.
   c. ECG technician or medical assistant.
   d. physician’s assistant.

23. Which of the following measures help ensure that your patients’ information is protected? (LO 1.5)
   a. Standard precautions
   b. Isolation procedures
   c. Patient precautions
   d. HIPAA

24. _________________ is the key to successful recording of an ECG. (LO 1.5)
   a. Hand hygiene
   b. Communication
   c. Patient education
   d. HIPAA

25. What is the single most important procedure you can perform to prevent the spread of infection? (LO 1.5)
   a. Use of standard precautions
   b. Hand hygiene
   c. Patient education
   d. Communication

26. When speaking to a person who is hard of hearing, it is important that you (LO 1.5)
   a. look directly at the patient.
   b. speak slowly and distinctly.
   c. speak into the hearing aid if the patient has one.
   d. all of the above.

27. When caring for patients and recording an ECG, you may encounter many situations that require you to (LO 1.5)
   a. critically think about the situation.
   b. always follow the same steps each time.
   c. not worry about what the patient tells you.
   d. not prepare for what may possibly be asked of you during the procedure.
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.

28. You have been performing ECGs at a local clinic for about six months. Your favorite uncle says to you, “Since I just turned 40, your Aunt Beth 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 1.6)

Should your uncle have an ECG? ____________________________

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

29. Mr. Smith has been having some mild chest pain. During his ECG, he says, “How does it look? Is there anything wrong?” What would be your best response? (LO 1.6)

__________________________

30. 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 1.6)

__________________________

31. 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 1.6)

__________________________

Get Connected Internet Activity

Visit the McGraw-Hill Higher Education Online Learning Center Electrocardiography for Healthcare Professionals Web site at www.mhhe.com/boothecg3e to complete the following activities.

1. History of the ECG If you would like to learn more about the history of the ECG, visit the ECG Library: A brief history of electrocardiography.

2. Career Exploration If you would like to obtain more information about a career as a cardiovascular technologist or technician, visit the Bureau of Labor Statistics Occupational Outlook Handbook.
3. **Automatic External Defibrillators**  To learn more about automatic external defibrillators, visit the American Heart Association’s Web site and search for the keyword *AED* or *automatic external defibrillator*.

4. **Risk Factors**  Go to the American Heart Association’s Web site. Identify at least five cardiovascular facts related to a specific cultural group and/or identify five risk factors for cardiovascular disease and what can be done to reduce the risk of disease for males or females.

**Using the Student CD**

Now that you have completed the material in the chapter text, return to the student CD and complete any chapter activities you have not yet done. Practice your terminology with the “Key Term Concentration” game. Review the chapter material with the “Challenge” and “Spin the Wheel” games. Take the final chapter test; complete the troubleshooting question, and email or print your results to document your proficiency for this chapter.